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Planning Weed Management for Ecosystem Recovery

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Session 1: Laws & Regulations

An Overview of Environmental Compliance and Permitting

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Environmental compliance is a key component of many projects, including those focusing on weed abatement and habitat restoration. Understanding environmental laws and regulations and when they apply is a key factor in the successful and timely implementation of projects. Environmental laws and regulations relating to resource protection can generally be grouped into three broad categories: federal laws including the National Environmental Policy Act (NEPA), Federal Endangered Species Act, Federal Clean Water Act, and National Historic Preservation Act; State laws including the California Environmental Quality Act (CEQA), California Endangered Species Act, California Department of Fish and Game Code and Porter-Cologne Water Quality Control Act; and local city and county laws and ordinances. This presentation will provide an overview of when and where these laws and regulations apply, the permits and regulatory documents typically required for weed abatement and habitat restoration projects, and the steps to acquiring the permits and obtaining regulatory approvals.

Efficient Watershed and Regional Permitting and Compliance Strategies

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Watershed groups, agencies, land trusts and other entities that implement numerous weed abatement, habitat restoration, and resource enhancement projects often find themselves facing the same permitting and environmental compliance hurdles with each new project. This presentation will cover the uses, limitations, and steps to achieving renewable, streamlined watershed-scale or regional permits and regulatory approvals that enable new projects to be accomplished without seeking new permits and regulatory approvals. This approach to permitting and compliance helps groups and individual landowners quickly accomplish their beneficial projects otherwise stalled for lack of know-how, money, or time to acquire permits and regulatory approvals. The approach also can increase the likelihood of winning grants because grantors recognize the value of having regulatory approvals already in place and because more of the grant money will be spent achieving results on the ground.

The Role of the Agricultural Commissioner

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The State of California has a system of agricultural regulation that is unique. Instead of state agencies enforcing their various areas of responsibility, such as plant quarantine regulation, pesticide regulation, or fruit and vegetable quality control, each county has an Agricultural Commissioner who is responsible for these activities. The County Agricultural Commissioner has primary jurisdiction over all pesticide use enforcement within his or her county. The primary goal of the Agricultural Commissioner concerning pesticides is to

insure that they are used safely and legally. The Commissioner and his or her staff are responsible for issuing pesticide use permits, registering pest control businesses, collecting pesticide use data, monitoring pesticide use in the field, investigating possible pesticide related illnesses, and many other related tasks. When monitoring pesticide use in the field, the Commissioner and his or her staff will check for compliance with the pesticide label, adherence to employee safety regulations, proper restricted materials permits or operator identification numbers, and a pest control advisor's recommendation when necessary. Proper stewardship of pesticides, including compliance with all applicable laws and regulations, will help to insure that these tools are available for use in the future.

Herbicide Use, Water Quality, and Regulatory Considerations

Jason Churchill, California Regional Water Quality Control Board, Lahontan Region

Regulatory agencies recognize that replacement of native plants by invasive weeds is detrimental to the natural environment. Water quality regulators realize that invasive weeds can affect water quality (e.g., by promoting increased erosion), and impair beneficial uses of water (e.g., by spoiling aquatic life habitat and recreation). Weed management experts find that herbicides are often an effective and efficient tool for invasive weed management. Consequently, water quality regulatory agencies must balance the sometimes-conflicting goals of controlling invasive weeds, and protecting waters from degradation due to herbicides.

The Regional Water Quality Control Board, Lahontan Region (Regional Board), is one of nine Regional Water Quality Control Boards, California state agencies responsible for protecting water quality in their respective watershed basins. The Lahontan watershed basin encompasses all of California east of the Sierra Nevada crest, and the northern Mojave Desert. The Regional Board's regulatory authorities are established in the Porter-Cologne Water Quality Act (California Water Code Section 13000 et seq.). The Regional Boards also implement certain parts of the federal Clean Water Act.

The basis of the Regional Board's program, to regulate the discharge of wastes that could affect the quality of state waters in the Lahontan Region, is the *Water Quality Control Plan for the Lahontan Region* (Basin Plan), which designates beneficial uses of water bodies, establishes water quality objectives (narrative and numeric standards) to protect those uses, and includes the Regional Board's implementation plan and policies. The Basin Plan contains water quality objectives for pesticides (defined to include herbicides) which state that "Pesticide concentrations . . . shall not exceed the lowest detectable levels, using the most recent detection procedures available, " and which prohibit any increase in bottom sediment pesticide concentrations or bioaccumulation of pesticides in aquatic life. (Other Regional Water Quality Control Plans may have different objectives for pesticides—applicators should check with the appropriate Regional Board to determine applicable water quality objectives for their area.)

Though restrictive, these objectives do not prohibit the application of herbicides to land for invasive weed control within the Lahontan Region, provided that the treatment does not result in a discharge of pesticide residues to state waters (defined broadly in the California Water Code to include "any surface water or groundwater within the boundaries of the state"). The risk of violating the objectives gives applicators an incentive to carefully evaluate their treatment plans and promotes

management measures designed to minimize the potential discharge of pesticides to waters. Such measures may include using alternatives to herbicides when feasible; minimizing the amount of herbicide applied; avoiding persistent or easily mobilized herbicides; using buffer zones near surface waters; avoiding applications during windy conditions or prior to forecasted storms; and avoiding herbicide use in areas with shallow groundwater.

Because they prohibit pesticides in waters at detectable concentrations, the Basin Plan pesticide objectives in effect prohibit the use of aquatic herbicides in waters (including wetlands) of the Lahontan Region, since the objectives preclude the application of pesticides/herbicides at concentrations that would be necessary to kill target organisms. However, eligible dischargers may use aquatic herbicides under conditions established in the statewide Aquatic Pesticides National Pollutant Discharge Elimination System (NPDES) General Permit (the APGP, Water Quality Order No. 2001-12-DWQ) issued by the State Water Resources Control Board (SWRCB) pursuant to Clean Water Act Section 402. The NPDES program is a federal permitting program, administered in California by the SWRCB and Regional Water Quality Control Boards, applicable to "point source" discharges of pollutants to surface waters of the U.S.

The APGP was adopted in response to a 9th U.S. Circuit Court decision (Headwaters vs. Talent Irrigation District) which found that a U.S. Environmental Protection Agency (USEPA) pesticide label establishing usage requirements does not obviate NPDES permitting requirements for discharges of pesticides to U.S. waters. The decision created liability for aquatic pesticide users, exposing them to potential third-party lawsuits unless covered by an NPDES permit. The APGP was adopted on an "emergency basis," as a limited-term permit expiring in January 2004, to provide NPDES coverage to eligible entities (public agencies using aquatic pesticides for protecting waterways or public health, e.g., for vector control, invasive weed control, or maintenance of water conveyances) until a full-term permit could be developed. SWRCB staff is currently preparing a draft full-term permit, to take effect after the current permit expires, for consideration by the SWRCB.

The APGP requires covered dischargers to evaluate alternatives to pesticides, to identify/implement BMPs to reduce water quality impacts from pesticides, and to implement an approved pesticide monitoring plan.

The USEPA has promulgated numeric standards for "priority" pollutants (including copper and acrolein, present in certain pesticide formulations) in California in accordance with CWA Section 303(c)(2)(B). The APGP grants covered pesticide users an exemption from meeting numeric water quality criteria for priority pollutants, subject to the specified permit conditions. Covered dischargers are not considered to be in violation of Basin Plan objectives for non-priority pollutants provided they notify the Regional Board within 60 days if applicable water quality standards are exceeded, and provided they have implemented required control measures, and propose/implement additional control measures to prevent or reduce such pollutants. In effect, the APGP allows conditional use of aquatic herbicides by eligible dischargers where it would otherwise be prohibited in the Lahontan Region by the Basin Plan.

Several examples illustrate how the Regional Board has recently engaged with agencies and entities using, or proposing to use, terrestrial or aquatic pesticides:

1. The Lake Tahoe Basin Weed Coordinating Group (LTBWCG) proposed an agreement defining criteria for terrestrial herbicide applications under which the LTBWCG will provide information and consult with the Regional Board, depending on factors such as proximity to surface waters, and extent of the treatment area.

2. The Regional Board amended the Basin Plan in 1990 to allow conditional use of the fish poison rotenone by the California Department of Fish and Game (CDFG) for fishery management purposes. The Basin Plan rotenone policy, which includes specific water quality objectives for rotenone formulation ingredients, is implemented through a Memorandum of Understanding between the Regional Board and the CDFG.

3. The Regional Board recently adopted (Resolution No. 6T-2003-0001) a policy waiving Waste Discharge Requirements (a type of Regional Board permit) for timber harvest activities meeting certain eligibility criteria and conditions. For timber harvest activities involving terrestrial herbicide use, to qualify for coverage under the waiver policy, project proponents must agree to comply with any herbicide monitoring requirements imposed at the discretion of the Regional Board Executive Officer.

4. The Regional Board recently considered a request to allow APGP coverage for a proposed 2003 pilot-scale treatment study of aquatic herbicide use for Eurasian watermilfoil control in the Tahoe Keys, at Lake Tahoe. The Tahoe Keys is a residential development with a system of canals and lagoons connected to the Lake. The Regional Board denied APGP coverage after considering factors including: the high resource value of Lake Tahoe; the lack of scientific information or scientific consensus about the scope and urgency of the Eurasian watermilfoil problem at Lake Tahoe; certain concerns about the specific treatment protocol that were not addressed in the proposal at Lake Tahoe; need for thorough environmental review and public review/comment on the proposal.

Herbicide applicators are advised to work closely with the Regional Board in their area for assistance, and to stay fully informed of applicable regulations and regulatory developments.

Cultural Resources in Your Restoration Site

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Cultural resources are abundant in California and must be addressed whenever ground disturbance occurs. Cultural resources include buildings, structures, objects, sites, districts, Traditional Cultural Properties, and Cultural Landscapes. Archaeology sites, both prehistoric and historic, are the most abundant cultural resource. Federal, state, and local statutes that guide the management of cultural resources include the following:

- Section 106 of the National Historic Preservation Act of 1966 as amended
- National Environmental Policy Act (NEPA)
- Native American Graves Protection and Repatriation Act (NAGPRA)
- California Environmental Quality Act (CEQA)
- California NAGPRA (Cal NAGPRA)
- Local laws and regulations

New laws, such as the Traditional Tribal Cultural Sites bill, address more than sites with artifacts. Various laws and regulations guide the management of these resources during removal of exotic species and habitat restorations. This paper will define what statutes apply and how to assure that you are

in compliance. In addition, this paper will provide brief information on potential guidelines to protect and preserve both cultural and natural resources.

Session 2: Assessing, Planning, and Setting Priorities

Invasive Plant Infestation Assessment on Catalina Island: Determination of Mapping Sample Size and Accuracy

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In order to accurately discern the extent of invasive plant infestations on wildlands, it is vital to map the location, density and size of each population. Land managers are often faced with choosing between controlling and mapping invasive plants, but with limited resources, it is difficult to justify spending time mapping when the goal is control. However, it is problematic to effectively control invasive plants without knowing their population size and distribution. The Catalina Island Conservancy, which owns and manages 42,000 acres on Catalina Island, California, commissioned a one-year study to map and rank 62 known invasive plant species throughout the island for prioritization and control. Mapping data collected from this study was used to determine how small of a mapping sample could be gathered to predict the same results of population size and overall distribution with less effort. The original sample size consisted of surveying 50 miles of coastline, 200 miles of roads, 233 ridges and 233 major drainages and the towns of Avalon and Two Harbors, both on foot and from a vehicle and helicopter. The accuracy of the surveying techniques was evaluated by extensively covering a random sample of plots on foot. Results from this study could be utilized by land managers who control invasive plants in an ecosystem with a mosaic of habitats to determine the extent of their invasive plant infestations. This could result in saving limited resources and time.

How Did We Get the Project Going and How are we Doing it? Assessing, Planning, and Prioritizing

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The Tri-County Program is an invasive weed program covering over 23 million acres across three Nevada counties. Land is primarily under various federal jurisdictions, but with significant areas of state and private ownerships. The program was put together without levying a local property tax as is commonly done in weed districts across the west.

Flexibility, efficiency, patience, and persistence are necessary ingredients to make an Invasive Weed Program effective. To make our program work required collaboration, organization, compliance within the social and legal structure, the use of CWMA's, and efficient use of technology. The vast amount of area required the use of modern communications, GIS and GPS to collect data during inventory and treatments, direct injection of herbicides, electronic time management of personnel, and comprehensive knowledge of problems so solutions "outside-the-box" can be developed. Electronic information is then shared with others so more knowledgeable decisions can be made. All of the various steps of inventory, using the various weed management tools, and any necessary restoration efforts are all directed at keeping plant communities from crossing

ecological thresholds and to restore working ecological systems.

A Watershed Approach to *Arundo donax* Removal and Riparian Restoration

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Giant reed (*Arundo donax*), an invasive grass native to Asia, is widespread in the Russian River watershed and is beginning to invade other north coast stream ecosystems. Giant reed has a profoundly negative impact on native riparian plant communities and may affect the species that rely upon these communities, including three federally listed salmonids. We represent a community-based organization that is working in collaboration with agencies, landowners and community members to identify invaded sites, remove giant reed and restore native habitat. Basin wide mapping and GIS programs enable site prioritization, tracking of giant reed populations and monitoring of project success. Experimental trials indicate that giant reed reduces native plant species richness and abundance, as well as suppressing native seedling recruitment. These experiments also demonstrate that herbicide and tarping are highly effective control methods, and that removing giant reed allows for rapid natural regeneration of invaded sites. Results from our mapping and research program are incorporated into an ongoing watershed education and outreach program focused on reed removal and floodplain habitat recovery.

Planning for Invasive Plant Control in the Context of Threatened and Endangered Species Risks

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A planning tool becoming prevalent in the United States to ensure success managing threatened and endangered species is the U.S. Fish and Wildlife Service's Habitat Conservation Plan (HCP). Habitat Conservation Plans are agreements between the Service and private landowners that enable development and 'take' of species and habitats of concern while providing mitigation. Clark County, Nevada is home to the largest HCP in the country which includes the entire county of more than 5 million acres. The area is comprised of diverse landscapes and dynamic social and political issues. The County effort to allow for development while at the same time providing mitigation for species of concern and their habitats currently includes focus on 78 species; making this plan a Multiple Species Habitat Conservation Plan (MSHCP). Las Vegas is the largest city within Clark County and entered into the HCP along with several other smaller cities and towns. Given the explosive human population growth and consequent development of the area, natural areas are becoming heavily impacted, resulting in loss of habitat for the desert tortoise (*Gopherus* agassizii) and many other terrestrial and aquatic species of concern.

The growth in southern Nevada has brought land disturbance, invasive species, and a public that is uneducated as to the problems that invasive plants bring to our natural ecosystems. In 2001, the Clark County MSHCP designated a technical working group charged with focusing on invasive plants in the context of their impacts to the 78 species of concern. The group has focused on planning

efforts while continuing an existing robust control effort on public lands. A strategic plan is being finalized that was largely based on the New Zealand Department of Conservation Strategic Plan for Invasive Plants.

The strategic plan for Clark County was created to map and characterize infestations and prioritize management actions based on specific invasive plant impacts and threats to species of concern. The plan includes 13 goals that concern weed survey; inventory and monitoring; prioritization; prevention; restoration and rehabilitation; research needs; funding; and education and information exchange. Information feeds into an extensive database that temporally and spatially characterizes risks of invasive plants to species and habitats of concern. Adaptive management will be used to monitor and redirect resources as situations and risks change. The result is a county-wide, comprehensive approach to invasive species control while enhancing opportunities for species of concern.

Session 3: Working With Ecosystem Processes in Recovery

Atmospheric CO_2 Influences on Recovery Potential

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The human-caused invasion and spread of alien plant species in the Great Basin has altered, and continues to alter, vegetation cover and plant community structure of arid-shrubland ecosystems. One important consequence of the dramatic changes in vegetation cover has been an increase in the occurrence, intensity and extent of wildfires, which have resulted in the wholesale elimination of native plant communities. Two ecologically important questions remain unanswered, though: How does alien plant invasion following fire affect key ecosystem processes and services? And, how will global environmental change affect alien plant invasion? I will present some results from two ongoing field experiments, one in a sagebrush steppe ecosystem in the northern Great Basin and one in a creosote bush-dominated ecosystem of the northern Mojave Desert. In the first study, we are measuring the effects of post-fire plant succession (mainly non-native annuals, including *Bromus tectorum*, cheatgrass) on ecosystem carbon fluxes and hydrology. In the second study, we are quantifying, among many other things, the effects of future atmospheric CO_2 levels—those that we expect by the year 2050—and year-to-year climate variability (El Niño climatic events) on the population dynamics of the invasive annual grass *Bromus madritensis*, red brome. Our results indicate that post-fire non-native species invasion can affect ecosystem carbon and water fluxes when moisture is available (i.e. years with average or above-average precipitation), and that alien plant invasion may be stimulated as atmospheric CO_2 levels continue to rise and the frequency of moist El Niño years increases.

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Too Much of a Good Thing: Restoration of Native Biodiversity Following Soil Nitrogen Enrichment

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As any gardener of farmer knows, nitrogen (N) is an essential nutrient for plant growth. Though it is the most abundant component of the Earth's atmosphere, it is unavailable to vegetation unless it is "fixed" into an inorganic form that can be taken up. As a result, it is frequently the nutrient most limiting primary productivity in the temperate region. Human alteration of the N cycle, however, has increased the rate of N fixation to such an extent that human-derived N now exceeds natural processes. Sources of fixed N come from a variety of sources, including automobile and industrial emissions, agricultural fertilization, livestock, and from plants with associated N-fixing bacteria. These processes are taking place at different spatial scales, from the regional- or continental-scale in the cases of automobile and power-plant emissions, to the more local agricultural or vegetation-derived processes.

Ecosystem N enrichment is a common barrier to invasive species control and native plant restoration. While general characteristics of non-native invading plant species have proven elusive, enhancement of N availability has been shown to favor fast-growing invasive species in a variety of habitats, including California serpentine and coastal prairie grasslands and Colorado shortgrass steppe. Restoration of N-enriched habitats must, therefore, deal with the question of how to promote slower-growing native species in competition with faster-growing exotic species.

Effects of elevated N on vegetation and soil communities

In California, invasion of northern coastal prairie grasslands by a variety of N-fixing shrubs commonly known as "brooms",e.g., *Genista monspessulana* (French broom) and *Cytisus scoparius* (Scotch broom), and *Ulex europeus* (gorse), has been shown to have significant impacts on soil N availability and plant community composition. N inputs from atmospheric N deposition is more well-known in eastern North American and northern European forest ecosystems, however dry deposition

of N in southern California can reach as high as 40-80 kg N ha^{-1} yr^{-1}. Such input rates approach the highest rates of input recorded for any region.

Elevated N availability has been shown to shift species composition in grasslands in California and elsewhere. John Maron and Robert Jefferies demonstrated that the invasion of *Lupinus arboreus* (yellow bush lupine) in northern coastal prairie grasslands resulted in a shift from native perennial-dominated communities to ones dominated by exotic annual grasses and forbs. In northern Europe, species composition has shifted and species diversity has declined in grasslands and shrublands experiencing elevated N deposition. Elevated N availability has also been shown to influence plant-mycorrhizal associations. The percentage of roots of southern California coastal sage scrub ecosystems infection by mycorrhizae has been shown to decline along a N deposition gradient. Similarly, the composition of ectomycorrhizal fungi shifted along a N deposition gradient in Alaska, as different species were found in low- versus high-deposition regions. Together, these results indicate that elevated N inputs have the potential to affect plant composition and plant-soil relations in a profound way.

Restoration of N-enriched habitats

In considering methods to restore habitats that have experienced elevated N inputs, the mechanism of N enrichment – e.g local via regional processes – is likely a factor in the likelihood of success. For local processes, there is frequently a reasonable opportunity to remove the source of input by ending agricultural or grazing activities or by removing N-fixing shrubs. The source of N inputs may leave behind a "legacy" in the form of higher N levels, but such strategies as the addition of labile carbon (C) (as sucrose, sawdust, or mulch), or repeated mowing of above-ground biomass, have shown some promise in reducing N levels and favoring native species. When such tools as C addition are combined with addition of native seeds, in order to overcome propagules limitation by native species, there can be reasonable opportunities for successful restoration of native biodiversity.

The prospects are less rosy in the case of N inputs from regional processes such as atmospheric N deposition. Since the N inputs are chronic, there is little hope that the N levels in the soil can be reduced. Furthermore, in regions of high N deposition rates, even ecosystems that are protected from development and agricultural activities are likely to experience impacts to vegetation and soil communities. The impacts on soil microbial and mycorrhizal communities is of particular concern, as disruption of soil microbial and mycorrhizal communities can have important consequences for biodiversity, vegetation dynamics, and nutrient cycling and storage. Yet, strategies to restore altered soil communities is even less developed than those for vegetation.

In conclusion, human alteration of the N cycle and dramatic increases in N inputs into natural ecosystems offer new challenges to restoration scientists. While promising strategies exist for locally-derived processes such as the invasion of N-fixing shrubs when the source of the inputs can be removed, the prospects for restoring habitats affected by regional-scale N deposition are less sanguine. Within California, the coastal sage scrub habitats of southern California are particularly vulnerable to change as a result of altered vegetation and soil dynamics following elevated atmospheric N inputs.

Fire Regimes and Potential for Ecosystem Recovery After Plant Invasions

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Landscapes altered by plant invasions may be difficult to restore to pre-invasion conditions when ecosystem properties such as fire regimes have been altered. Plant invasions can alter fuel structure, which can affect fire behavior and ultimately the fire regime. If there is a positive feedback between the invader and the fire regime, then an invasive plant/fire regime cycle can become established. At progressive stages of this process, there is an exponential increase in the cost of successful restoration, and decrease in the probability that restoration efforts will be successful. Early detection and eradication systems for managing invasive plants should take into account the possible ways that invasions may alter fire regimes.

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Managing Stream Flow Regimes for Riparian Ecosystem Restoration

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Hydrologic regimes have been modified on most of the rivers in the semi-arid southwestern United States. Water diversions and impoundments have allowed for extensive urbanization and agricultural development but also have reduced stream flow rates and altered flood regimes. Depending on the nature and extent of the hydrologic changes, riparian vegetation along the region's rivers has variously declined in abundance, increased in abundance, or undergone change in species composition, diversity, and physiognomy (Briggs and Cornelius 1998; Shafroth et al. 2002). Along the floodplains of many rivers, there has been a compositional shift from Fremont cottonwood (*Populus fremontii*)-Goodding willow (*Salix gooddingii*) forests to shrublands of tamarisk (*Tamarix ramosissima*), a naturalized species that was intentionally introduced to the USA in the early 1800s (Horton 1964).

Many factors may contribute to shifts in plant species composition. A particular plant species may increase in abundance and expand its range simply due to increased abundance of local seed sources. The chances that the species will become abundant, however, increase if there have been changes in environmental resource levels or disturbance regimes that favor the species (Lonsdale 1999; Davis et al. 2000). If the 'new' species has adaptive traits that allow for high fitness in the new environment, and if corresponding fitness levels of the existing suite of species declines, the composition of the plant community will change.

The purpose of this talk is to discuss some of our research findings relating to the causes of compositional shifts from Fremont cottonwood-Goodding willow woodlands to tamarisk shrublands within the US Southwest, and to discuss some implications for ecosystem restoration. We focus on two hydrologic processes and conditions, flood flows and groundwater availability, that influence seedling establishment and long-term survivorship of these pioneer tree and shrub species. We demonstrate our points by examining two case study rivers, both located in the Sonoran Desert in Arizona.

Flood flows and seedling establishment. The general conditions that enable seedlings of Fremont cottonwood and Goodding willow seedlings to establish in abundance along alluvial rivers of the Sonoran desert are well understood (Stromberg 1997; Shafroth et all. 1998). Large-scale establishment typically occurs during 'El-nino' years, such as 1993 and 1995, when large winter floods are followed by declining water levels or by smaller flood peaks during spring. The large floods scour vegetation and mobilize sediment and thus deposit or expose the bare mineral soils needed for seedling establishment of these small-seeded species. Slow recession of the water levels during the spring season exposes the moist soil during the vernal period of seed dispersal. When these climatic flood patterns are altered by river damming and flow management, conditions for plant establishment change.

The flows on the Verde River in central Arizona are impounded behind two dams which are managed to provide drinking water and irrigation water to the Phoenix metropolitan area. However, both reservoirs have relatively small storage capacity. Although most of the small floods are captured, very large winter floods can exceed the reservoir storage capacity. In years with very wet winters, water has been released downstream with a relatively unmodified temporal pattern. This has allowed cottonwoods and willows to establish in the below-dam reach. During 1995, for example, the flow release pattern in the Verde was favorable for cottonwood and willow establishment above

and below the dam, with large scouring flows to create seed beds followed by slowing declining water levels during the trees' period of early spring seed dispersal and germination (March-April). However, conditions in the below-dam reach also allowed for abundant establishment of tamarisk. In a study comparing riparian tree stem densities within cottonwood-willow patches, we found that stem densities of young tamarisk were more abundant in the below-dam reach than in the above-dam reach (Beauchamp and Stromberg, in prep). The most likely explanation lies with the pattern of flow release and, specifically, with small-scale modifications made to the early summer hydrograph. In the below-dam reach, there was an additional managed release that created a small peak flow in May and June. This small flood peak and subsequent water draw-down period coincided with the period of tamarisk seed dispersal, and presumably allowed for high numbers of seedlings to establish. Tamarisk is more reproductively opportunistic than Fremont cottonwood and Goodding willow, with viable seeds present over most of the growing season. It can therefore take advantage of flood pulses that occur in summer as well as spring. This opportunism may explain, in part, why tamarisk has become abundant in some below-dam reaches, where the flood flow pattern now deviates from the climatic pattern to which the local species have become adapted. Similar below-dam increases in tamarisk abundance have been observed on other flow-regulated rivers in Arizona, including the Bill Williams River below Alamo Dam (Shafroth et al. 2002).

Our knowledge of species biology is such that flow releases can be designed to favor establishment of cottonwoods, willows, and other vernal-seeding plant species that are adapted to the winter-spring flood pulse characteristic of hot-desert rivers of western USA (Rood et al. 2003). By doing so, opportunities for establishment of later-seeding species, including tamarisk, are reduced. Such an approach will not completely exclude the establishment of tamarisk, nor do we favor that as a restoration goal. The goal of restoring viable populations of characteristic regional species can be accomplished by focusing on restoring the ecosystem processes that will allow them to have high success.

Groundwater levels and tree survivorship. Our second case study focuses on the hydrologic regimes associated with long-term survivorship of Fremont cottonwood and Goodding willow trees. Here, we examine the San Pedro River, a free-flowing river located in southern Arizona. Gradients of depth to groundwater and stream flow duration exist over the length of the river due to differences in local geology and extent of groundwater pumpage for mining, agricultural and urban use. Our research shows that tamarisk is the dominant species at the drier sites while cottonwood-willow are most abundant (in absolute and relative terms) at the wetter sites. Tamarisk are deeper-rooted and more drought tolerant than Fremont cottonwood and Goodding willow and thus more likely to survive and thrive at drier sites (Shafroth et al. 2000; Horton et al. 2001). At the wetter end of the moisture gradient, the low abundance of tamarisk may be due to competitive effects of cottonwoods on tamarisk (Sher et al. 2002).

Along the San Pedro River, depth to groundwater and stream flow duration thresholds at which community dominance shifted from tamarisk to cottonwood-willow are evident. Cottonwoods and willows gave way to tamarisk as groundwater levels averaged greater than about 3 m below the floodplain surface and as stream flow duration dropped below about 75% (Lite and Stromberg 2003; and Lite and Stromberg in prep). These threshold values for groundwater depths are consistent with those reported for other rivers in the deserts of the US Southwest. Dry riverbeds where water tables are only seasonally high or where mean depths exceed 5 m may support low-density Fremont cottonwood forests. However, dense, multi-aged cottonwood-willow forests develop only along perennial or intermittent rivers where depth to ground water remains less than 3 m or 4 m (depending on environmental context).

These findings have implications for the nature of changes in water management needed to restore cottonwood-willow to the many tamarisk-dominated rivers in southwestern USA. Politically, it can be very difficult to restore adequate stream and groundwater flows to rivers, given regional water scarcity and high demands on water for municipal, agricultural, and industrial uses. However, there are cases where re-watering is being implemented and tested as a potentially cost-effective technique to restore cottonwoods, willows, and many other hydrophytic plant species to river reaches that have become dominated by tamarisk and other drought-tolerant species (Haney 2002). And, certainly, factors other than hydrologic conditions influence the abundance of these species. Grazing by livestock or other ungulates, for example, can favor the less palatable tamarisk over the more palatable cottonwoods and willows, as can high soil salinity levels. Thus, restoration requires a holistic approach of addressing and managing all of the environmental factors that are influencing the desired end-points in terms of ecosystem structure and function.

Along some rivers, the environmental conditions favorable to cottonwood-willow forests may not realistically be restorable. For example, adequate stream flows and groundwater levels may not be available for river restoration, large flood pulses may not be desired or feasible to implement, or land managers may desire to continue to graze livestock. In such cases, we suggest being realistic about assessing the functions and values of the existing vegetation before embarking on restoration projects that involve clearing of species, such as tamarisk, that are considered to be "invasive". In some settings, such as dry or grazed river reaches, tamarisk can supply valuable habitat no longer provided by the cottonwoods and willows (Stromberg 1998a and 1998b). Without addressing the underlying physical factors driving the changes in the plant community, it is *possible* that vegetation-clearing efforts will cause more harm than good. In some cases, the underlying factors driving the change in species composition may have been transient and no longer operating. In other cases, however, the factors may still be continuing, necessitating continuous and repeated vegetation-clearing efforts, until the root-causes of the ecosystem change are ultimately addressed.

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Session 4: New Management Tools and Techniques

Native Grass Seeding, Nutrient and Mulch Effects on Weedy Species

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Abstract

Attempts to revegetate, restore or stabilize impacted sites, especially those that have been drastically disturbed, can be problematic. The Lake Tahoe Basin presents a microcosm that represents a much larger and systematic problem of watershed dysfunction throughout the arid west. Lake Tahoe has lost over 0.3 m of clarity over the past 35 years. Much of that loss is associated with sediment movement from disturbed sites. In addressing this issue, attempts are often made to re-create a 'pre-disturbance' site condition in embryo, using seedlings of the intended plant community, with the intention that those seedlings will mature and develop into the intended community. Another approach is to use a seed mix that will result in some seral stage along a perceived 'restoration trajectory'. One element in either approach that has often been overlooked but is receiving an increasing amount of attention is the soil component of the restoration process. While soil is the underpinning of any restoration process, either natural or human induced, relatively little is known about short-term soil succession on highly disturbed soils.

Soil components such as organic matter, water holding capacity, particle size, microbial (and macrobial) communities, nutrient cycling regime, mulch type and many other variables have yet to come under close enough scrutiny in wildland systems to allow us to adequately address the re-creation of those variables effectively and consistently. In an ongoing program, originally supported by Caltrans, the State Water Resources Control Board, the US Forest Service and UC Davis, we have attempted to better understand some of these parameters through an adaptive management process using a combination of literature review, laboratory and greenhouse research, field experiments and demonstration plots. Work by Claassen, Claassen, Zasoski and Southard, Carey, and Claassen and Hogan has helped identify critical variables in soil-plant community restoration in drastically disturbed sits in the Lake Tahoe Basin and other parts of the Sierra Nevada Mountains.

This work has produced successful reestablishment of native plant cover on extremely steep slopes of up to 0.75:1 (h: v). However, the increased presence of certain weed species on some sites, especially *Bromus tecorum* (cheatgrass) has become a focus of concern. As the need for nutrient replacement has been recognized and attempts made to replace those nutrients through compost and slow release organic fertilizer applications, an increased presence of weedy species has been noted. As soil nutrient cycles have been re-established, weed species respond. Questions have arisen regarding the source of these weeds and whether weed presence is a result of an existing seed bank or importation in compost, commercial seed or mulch, or some other mechanism. A portion of our work has been focused on this issue, through the use on nutrient response plots, seeding density (competition) trials and mulch plots. Initial results suggest that:

1) some weedy species respond to an increase in available nutrients, regardless of form. This has been shown to be especially true on very shallow soils of low water holding capacity and high density, such as on the Brockway Summit and Dollar Hill project areas. When soil is physically treated, weed density is usually reduced. Data indicated that where an increased level of nutrients was

present, a higher level of Cheatgrass cover was noted. This was true regardless of mulch type, whether the plot was seeded on not, or the nutrient source (fertilizer or compost) indicating that cheatgrass seed was either in the soil seed bank or was translocated by wind.

2) that mulch can inhibit some weed growth, depending upon the type. Results for mulches are highly variable, most likely due to other independent variables such as soil depth, soil nutrient regime, seed mix and pre-existing seed bank.

3) a high seeding rate of native grasses can reduce or nearly eliminate weedy species through competitive pressure. Results from at least three sites where all other variables were maximized for growth (full soil physical and biochemical treatment applied), cover by Cheatgrass was reduced to less than 5%.

A related question that is being asked is whether some amount of 'weedy' species might be part of a successional process that will ultimately result in a near-native plant and soil community. In other words, what does the 'restoration trajectory' look like in the long term? Since little work has been done on actually measuring succession and the weed component of that process in the Lake Tahoe Basin, this question has yet to be answered. However, the studies currently underway are likely to shed light on this question in coming seasons.

As is usually the case, further work is needed. However, as this presentation indicates, we have made great strides forward in both our understanding and our ability to apply that understanding of how to restore ecological function to drastically disturbed, sediment producing sites in and beyond the Lake Tahoe Basin. And not the least of this understanding is our ability to better comprehend and address weed issues, especially those such as cheatgrass and other insidious weed species. As our understanding of soil biological, hydrological and energy cycles increases, so do questions regarding the dependant variables of those cycles. Through the process of adaptive management and the cooperation of a great many entities and individuals, we hope to continue to address questions as they arise and through this process, increase our ability to restore disturbed sites to full function.

Managed Goat Grazing – It Works

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We have had goats since 1978 and have been in the commercial goat business since 1992. We use goats from many different breeds, but the Boer cross seems to work the best for us. Goats will browse at 3 to 5 miles per hour on the open range. The number of goats needs to be scaled to the project. The goats are trained using the psychology of goats and they are focused on the target species. Open range herding techniques allow for lower impacts to other vegetation; if fencing is used, bare ground is the result. Goats are browsers, not grazers, and many vegetation problems are the result of over grazing, no grazing, fire, or no fire. Managed open-range herding of goats will actually enhance wildlife values and bring back native vegetation. Natives are always the best suited to provide competition for noxious weeds. If none are present, seeding is sometimes required. Any competition must be regarded as competition and not as "wasted feed." Integrated weed management is always

the best approach to a noxious weed problem. We have had great success in Idaho, California, Oregon, and Nevada. It takes management and time, but in less than five years we have turned around situations where land had totally lost its usefulness and given the landowners their land back.

Imazapyr (Stalker® or Chopper®) Herbicide: Effective and Responsible Use for the Control of Invasive Plants

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Imazapyr is the active ingredient in Arsenal®, Stalker® and Chopper® herbicides. This chemistry has been available for commercial use in the United States since 1987. Among its many uses, imazapyr has proven very effective in the control of exotic and invasive plants through out the U.S. Melaleuca and tamarisk are two species that have established imazapyr as a important tool in the exotic plant control arena. In 1999, Imazapyr was registered for use in California. Along with tamarisk, imazapyr has shown promise for the control of arundo, palms, spartina and other species. Exotic plant control is a means to an end, and Imazapyr must be used within the context of ecosystem restoration. Understanding its toxicological and environmental properties will help vegetation managers in deciding when to use herbicides with the active ingredient imazapyr.

Session 5: Monitoring and Evaluating Recovery Progress

Defining and Evaluating Recovery

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Ecosystem recovery following exotic species invasion involves eliminating the invasive (or reducing its abundance to acceptable levels), and restoring or maintaining a sustainable ecosystem. Because invasives, and disturbances that facilitate invasives, can alter ecosystem processes and properties, restoration objectives and measures of recovery must be based on the current, not historical, capacity of a site to support a given ecosystem type. Specific definitions of recovery and methods for its evaluation depend on many factors: the type of ecosystem and its environmental characteristics, the stage of invasion, the types of treatments, and individual species life history characteristics. In general, information is required on the population abundance and dynamics (all life stages) of the invasive species. Depending on the nature of the removal and restoration treatments, evaluating recovery requires information on community species abundance, composition and diversity, and on the soil's physical and chemical properties. Monitoring over a sufficient time period to evaluate community resistance to invasives over the normal cycle of disturbance events is necessary to insure restoration of sustainable ecosystems. Adaptive management and, in some cases, repeated treatments are an integral part of a successful recovery program.

How Do I Use My Monitoring Tools?

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By defining recovery for restoration or rehabilitation projects, managers are also setting project objectives. Objectives dictate the monitoring tools they will use to track recovery. Monitoring tools may range from qualitative to quantitative techniques. They may include both plant and soil surface measurements. Common techniques include photographs, ranked dominance or abundance, and measured cover, density or frequency by species or category. They may range from unreplicated to replicated studies. When the objectives include invasive plant control and recovery of desirable plants, managers should track both the level of control and recovery. Unless effectiveness of control and recovery techniques is known, managers should monitor some untreated areas to provide evidence of the effectiveness. Generally, monitoring successful recovery requires some knowledge of the pretreatment status in addition to the trend of the post-treatment status for desirable and undesirable species or conditions. When developing monitoring plans, managers are aided by placing reality checks in the development process. During plan development, they need to gather information on the size and extent of the treatment area and ask several questions. What plants will be controlled and rehabilitated? What soils and landscapes will be treated and what are the recommended techniques? The first reality check enters at this stage. What resources are available for monitoring recovery? The resources may dictate the intensity of the monitoring effort. Qualitative techniques are less likely to detect small changes in recovery than are quantitative techniques. Thus control techniques that might take a number of years to be seen, such as some biological control methods, might be monitored more effectively with quantitative than qualitative techniques. Plans should budget for data entry, analysis, and reporting. The final reality check is to field test your monitoring methods and to adjust techniques as necessary to fit the resources and recovery objectives.

A Decade of Dune Restoration at the Lanphere Dunes

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The Lanphere Dunes Unit of Humboldt Bay National Wildlife Refuge is located on the upper North Spit of Humboldt Bay in northwestern California. The property encompasses 475 acres of dune and estuarine habitats including foredune grassland, dune mat, dune swale, open sand, riparian and coniferous forests, freshwater swamp, brackish marsh, salt marsh, and intertidal mudflat. The core of this diverse and unique area was protected in 1974 by The Nature Conservancy (TNC) as the Lanphere-Christensen Dunes Preserve, which was later augmented by several adjacent acquisitions to the south. In 1998 TNC donated the land to the U.S. Fish and Wildlife Service, and it became the Lanphere Dunes Unit of Humboldt Bay National Wildlife Area, a 3,500-acre refuge distributed around Humboldt Bay.

Ecological management of the Lanphere Dunes has always centered around the control and eradication of invasive plant species and the restoration of dune habitats and endangered species.

Dunes are a naturally disturbed and open ecosystem, making them particularly susceptible to invasion. When the original 140 acres was preserved in the 1970s, it had already been invaded by European beachgrass (*Ammophila arenaria*), iceplant (*Carpobrotus* spp.), and yellow bush lupine (*Lupinus arboreus*), the latter native to central and southern California dunes where a scrub community exists. The very earliest management efforts were actually initiated in the early 70s, prior to TNC acquisition, when the Northcoast Chapter of the California Native Plant Society began annual volunteer "lupine bashes" on the property. Early management by TNC in the 1970s-80s focused on education, public use, the exclusion of off-highway vehicles, removal of yellow bush lupine, and early experimentation with eradication techniques for European beachgrass. Volunteers were organized under the auspices of Friends of the Dunes and provided labor for pilot projects, and a 3-year research initiative was conducted from 1998-1990 in cooperation with Humboldt State University. By 1990 successful manual methods had been developed for eradication all three major invasive species and the restoration of the dune mat community.

Large scale restoration began in 1992 with a TNC-funded initiative to eradicate 10 acres of European beachgrass occurring within the 70-acre dune mat habitat. Restoration proceeded in three phases from 1992-1997, in accordance with the timing of available funding. Labor was contracted from the California Conservation Corps (CCC), with supplemental labor provided by volunteers and the Sheriff's Work Alternative Program. Labor was carefully tracked by task to provide accurate cost documentation. Removal was accomplished by crews "digging" beachgrass to approximately 30-40 cm, removing as much of the rhizome as possible. The initial dig, scheduled just before plants emerged from dormancy, was most time-consuming. Treatments were repeated to remove resprouts up to seven times during the growing season. Two growing seasons were required to eradicate plants. This manual method enabled crews to leave behind relict native species growing among the beachgrass. Released from competition, these plants rebounded and spread, so that no revegetation was required. Over the five-year restoration period, native plant cover steadily increased, and by 2002 native cover in restored areas had reached that of control areas and included the endangered *Layia carnosa*, which volunteered in the area. The total cost of this restoration was $350,000.

Iceplant (*Carpobrotus edulis* and *C. edulis* X *C. chilense*) was removed from 70 acres of dune mat habitat between 1996-2002. Initially, funding was constrained and only dense, clonal occurrences were targeted. These were repeatedly manually pulled over a three-year period, and like beachgrass areas, did not require revegetation. Less concentrated iceplant occurrences were eradicated from 1999-2002. Labor sources included paid CCC crews, volunteers, and inmates from the California Department of Forestry and Fire Protection (CDFFP). Funding was obtained both in-house and from grants awarded by the National Fish and Wildlife Foundation.

Yellow bush lupine was completely removed as an above-ground plant on the main contiguous property by 1995 using volunteers and contributed CCC labor. However, a prolific and long-lived seed bank continues to generate new plants, and two smaller disjunct parcels are still being restored. An annual lupine bash continues to be held, supplemented by Spring-Breakaway youth crews provided by Friends of the Dunes. True eradication (including exhaustion of the seedbank) has only been accomplished in areas where lupine infestation was never heavy. Areas of heavy infestation that have been annually treated since 1987 (16 years) continue to generate seedlings, although densities have declined significantly over time.

Attention shifted to the forest communities in 1998 when explosive spread of English ivy (*Hedera helix*) was detected. Lacking a single major funding source, this eradication effort has been the most challenging. Grant funding has been obtained in small but continuing amounts through the Service's Challenge cost-share initiative, the National Fish and Wildlife Foundation, and State Coastal

Conservancy. The labor intensive nature of manual removal (pulling of vines, girdling of aerial occurrences) has made volunteers only marginally effective, however labor received from CDFFP provided significant assistance. A major boost was the award in 2002 of $87,500 from NFWF for removal of ivy as well as related restoration and the completion of a cultural resources survey (much of the ivy grows in culturally significant areas). A final challenge was the removal of ivy in poison oak (*Toxicodendron diversilobum*) infested areas. In 2003, goats were used in these areas, but while proving to be cost effective in other local ivy-infested areas, they were very costly in our remote site. Site preparation (including clearing for fences) and the cost of the goats as well as follow up treatments totaled almost $30,000 for a combined occurrence of one acre (scattered over several areas). As of the end of 2003, our forest restoration (which includes the additional invasives English holly (*Ilex aquifolium*), pittosporum (*Pittosporum tenuifolium*), and cotoneaster (*Cotoneaster franchettii*) is nearing a maintenance stage.

In the late 1990s new infestations of exotic annual grasses were observed, including *Bromus diandrus*, *Vulpia bromoides*, *Aira praecox*, and *Aira caryophyllea*. Experiments revealed that manual pulling, burning, and especially duff removal (if present) were all effective treatments. As of 2003 all infestations have been mapped, those in endangered plant areas have been manually treated and most others flame-torched, although follow-up treatment is still needed.

All restoration efforts have been documented, first in restoration plans, then in monitoring reports and when completed in final reports. Monitoring has been essential in to respond to adaptive management needs. Because Humboldt Bay NWR has not yet been scheduled for its Comprehensive Conservation Planning effort, plans and reports are assembled in a "living" document that compiles and organizes reports, maps, and data by major ecological communities. This serves as a management plan until a CCP is completed.

New infestations will occur, and maintenance of past efforts will continue at appropriate intervals (for example, the annual "*Ammophila* sweep" where a dozen volunteers sweep in line formation through the open dunes looking for any new beachgrass). However in the near-decade between 1992 and 2003 the upland habitats of the Lanphere Dunes have been largely successfully restored through the eradication of invasive species and recovery of native communities. A major challenge remains in addressing the long-established invasive dense-flowered cordgrass (*Spartina densiflora*) in salt marshes, and research has begun to address its ecology and treatment. Significantly, a number of invasive plants were detected and eradicated before becoming established in significant amounts. These include bull thistle (*Cirsium vulgare*), Scotch broom (*Cytisus scoparius*), purple ragwort (*Senecio elegans*), kangaroo apple (*Solanum aviculare*), periwinkle (*Vinca major*), and jubata grass (*Cortaderia jubata*). Additionally, through ongoing relationships with Friends of the Dunes, other federal, state, and local agencies, and community groups, a true, community- based ecosystem management approach has been adopted in the region.

Contributed Papers

Session 6: Management

Experimental Revegetation Strategies and Technologies for Restoration of Native Shrub/Grass Communities on Saltcedar (*Tamarix* spp.) Infestation Sites

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Critical knowledge gaps exist regarding vegetative recovery in xeric, monotypic saltcedar (*Tamarix* spp.) stands with no (desirable) understory. On sites not subject to seasonal flooding, shallow water table or irrigation, recovery of desirable vegetation may be the most limiting factor for site stabilization following control measures. Formulation of revegetation strategies that provide site stabilization, resistance to further saltcedar and secondary weed infestation, and acceptable habitat values for affected wildlife species becomes particularly problematic in monotypic saltcedar stands under biological, fire and herbicidal (i.e., non-mechanical) control scenarios. Amount and density of standing biomass (live and dead) remaining after control poses limitations in relation to seeding and planting techniques, seed interception in aerial (broadcast) applications, and seedbed preparation methods. Undisturbed soil surfaces impacted by saltcedar leaf litter accumulation, salinity, hummocky micro-relief, and nutrient limitations restrict potential for successful revegetation. Long duration of saltcedar occupation may deplete needed microbial communities, particularly arbuscular mycorrhizae (AM) symbiotic and host-specific to native revegetation species.

Results of innovative revegetation strategies and technological approaches at study sites on the Rio Grande (near Socorro, NM) and the Colorado River (near Blythe, CA) will be discussed in light of interagency research on biological control and restoration of saltcedar infestations funded by the Cooperative State Research, Extension and Education Service (CSREES) and the Initiative for Future Agriculture and Food Systems (IFAFS). These approaches include (1) soil surface and rhizosphere manipulation methods to facilitate removal of standing dead biomass, increase precipitation capture, improve soil moisture retention, and create micro-sites exhibiting lower salinity and increased protection from environmental extremes for improved seed germination; (2) salinity remediation using HydraHume™, (3) seeding methodologies, including use of seed coating techniques, and (4) mycorrhizal inoculation methods. Influence of pre-treatment soil parameters will also be reviewed, including surface and subsurface texture, pH, sodium adsorption ratio (SAR), electrical conductivity (ECe), and major nutrients.

Tall Whitetop Eradication and Native Plant Community Restoration

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Abstract

Tall whitetop (*Lepidium latifolium)* is a member of the mustard or Brassicaceae family. It is a native of southeastern Europe and southwestern Asia and probably came to the United States in sugar beet seed in about 1900 (Newlands Project, Fallon, NV). It is an invasive species that has spread to thousands of acres in Nevada, including about 25,000 acres in the Truckee River Watershed. Ranchers and farmers are losing thousands of acres and millions of dollars annually to this pestiferous weed. Eradication efforts to date have focused on use of herbicides and controlled grazing. However, eradication of TWT and restoration of native floodplain plant communities has not been accomplished to date. Previous attempts to eradicate TWT have overlooked the simultaneous restoration of beneficial soil microbes that support native vegetation. TWT, like other members of the mustard family does not form a symbiosis with soil fungi called mycorrhiza, as do most native plants. One hypothesis is that soils dominated by TWT have lost these essential symbionts and are no longer available to colonize native plants. The hypothesis being tested is to revegetate infested areas, after the TWT is eradicated by mowing and herbicide applications, with native seed treated with mycorrhiza (hyphae and spores), and activated charcoal (neutralizes the herbicide). In this effort, a one-acre demonstration plot has been established at the 102 Ranch along the Truckee River near Tracy, Nevada, in cooperation with Truckee River Investors, Reforestation Technologies Inc., BASF, Western Botanical Services, Great Basin Earthwork, and Juniper Rose. The project is anticipated to last for thee years, and funding sources are being explored.

The demonstration plots will consists of the following treatments:

- 2 Irrigation Levels - No Irrigation and Supplemental Irrigation
- 2 Seed Treatments- Control (untreated seed) and Treated (mycorrhiza + activated charcoal)
- 2 Herbicide treatments – Treated with Plateau and untreated.

To date the plots has been mowed and treated with 8 oz/acre Plateau

Introduction

By Nevada law (NRS 555.005), a "noxious weed" is "any species of plant which is, or is likely to be, detrimental or destructive and difficult to control or eradicate." Tall whitetop (*Lepidium latifolium),* (TWT), aka Perennial pepperweed, is a member of the mustard or *Cruciferae* family and is listed by the State of Nevada at the top of their noxious weed list. It is a native of southeastern Europe and southwestern Asia and probably came to the United States in sugar beet seeds in about

1900 (www.newlands.org/whitetop). According to the University of Nevada Agricultural Experiment Station Bulletin No. 170, dated June 1944, the tall whitetop problem has been around since at least 1938. "Experiments in the control or extermination of Whitetop have been conducted since 1938 in the Fallon, [Nevada] area." The methods discussed include cultivating, smothering with other crops, use of chemicals, burning or searing, and flooding.

It is one of a number of noxious weeds that have infested 17 million acres of public rangelands in the Western United States. Dealing with these noxious weeds is estimated to cost more than $123 billion a year. Tall whitetop is an invasive species that has besieged thousands of acres of Nevada's lands, including about 25,000 acres in the Truckee River Watershed. Ranchers and farmers are losing thousands of acres and millions of dollars annually to this pestiferous weed.

Tall whitetop is particularly productive when it can overrun water areas such as streams, rivers, ponds, and wetlands where its negative influence on water quality is devastating. It invades sensitive stream areas and chokes out native plants that help prevent stream bank erosion. It is also quite capable of withstanding adverse water and weather conditions, and is frequently found in salty soils, meadows, abandoned agricultural lands, pastures, hayfields, residential areas, and along roadsides. Tall whitetop out-competes native riparian vegetation, leaving unstable riverbanks subject to erosion and thereby diminishing water quality. There is some evidence that the plant can actually alter soil chemistry, additionally altering native soils and communities that stabilize soils. Large dense stands of tall whitetop limit recreational access to the Truckee River. It replaces willows and other woody species that provide cover for wildlife and fisheries.

Because it appears to some as a pretty plant with clusters of fluffy, delicate white flowers, many people do not recognize it for the villain it is. It spreads by underground roots (rhizomes) which may grow to a length of 3 to10 feet or longer, and which send out shoots to form new plants. Tiny, reddish seeds -- as many as 10,000 seeds per plant or 6 billion seeds per acre -- also propagate it. In ideal conditions, such as wetlands, it may flower twice in a season.

According to the Washoe-Storey Conservation District, tall whitetop:

- Drives out and replaces the beneficial vegetation along creeks, rivers and irrigation ditches.
- Causes riverbanks to slough off during flood events.
- Creates a monoculture of itself and restricts and destroys diverse wildlife habitat.
- Pulls salts out of deeper soils and deposits them on the surface of the ground.
- Limits the germination of seeds of beneficial plants.
- Provides an excellent breeding ground for mosquitoes.

The Nevada State Legislature considered it such a threat to Nevada's agricultural and recreational lands that in 1999 the University of Nevada Cooperative Extension Agency was asked to head up a two-year tall whitetop program. "Now is the time to tackle the alien weed problem before it becomes outrageously expensive and harmful to the environment and our water quality," (www.unce.unr.edu/tallwhitetop/).

To date, a number of studies have been done regarding the control of tall whitetop. Eradication efforts so far have focused on use of herbicides in combination with mowing, and controlled grazing. However, control of TWT and restoration of a native floodplain plant community has not been attempted. Seeding of test plots at the 102 Ranch in 2002 with tall wheatgrass (*Elytrigia elongata*) following mowing and herbicide application in various combinations has not yet resulted in any seedlings. It resists the reestablishment of desirable vegetation after treatment and returns with a

vengeance. Previous attempts to revegetate areas where TWT has been partially controlled have overlooked the simultaneous restoration of beneficial soil microbes that support native vegetation.

TWT, like other members of the mustard family (*Brassicaceae*), does not form a symbiosis with soil fungi called mycorrhiza, as do most native plants. One hypothesis is that soils dominated by TWT have lost these essential symbionts that are no longer available to colonize native plants. It appears that the one possible way of controlling this noxious weed is to revegetate the infested area after the TWT is eradicated, with seed treated with mycorrhiza propagules and activated charcoal. Activated charcoal attaches to substances by chemical attraction. When certain chemicals pass next to the carbon surface, they attach to the surface and are trapped.

Goals and Objectives

- To develop the best possible management practices and most innovative and successful techniques necessary to locate, control and revegetate acreage in the Truckee River Watershed infested with tall whitetop (TWT), aka perennial pepperweed, (*Lepidium latifolium),* and to do so in a fiscally responsible manner. This can be considered a Best Management Practice demonstration project.

- To evaluate the effectiveness of several possible management techniques for the control and revegetation of water resource areas infested by tall whitetop.

- To determine performance of native species under diverse treatments.

Site Description

The 102 Ranch lies along the north shore of the Truckee River in Washoe County, adjacent to Interstate 80 (T 20N, R 22E) at the Patrick exit. It consists of approximately 180 acres including upland sage and saltbrush scrub. Much of the site is unvegetated and disturbed due to previous land uses. Approximately 60 acres in the floodplain consists of an almost solid stand of tall whitetop. The previous owner, Hoss Equipment of Nevada, had planned to develop the property into Golf Course. Toward this end, they drilled a well and planted numerous trees along the northern property line by I-80. Approximately 10 years ago, one of the fields (alfalfa), including a small stand of TWT was leveled and plowed, resulting in the current dense stand of the plant. Peter Morgan, one of the property owners and a personal friend of Julie Etra, was approached in 2002 with the project proposal.

Project Design

A series of demonstration plots were established in the spring and summer of 2003 to evaluate the effectiveness of several management techniques for tall whitetop at the 102 Ranch along the Truckee River in Storey County. Plots were mowed on June 16, 2003 during peak flowering, and then sprayed when flowers were in full bloom.

The plots will be divided into six treatment types and revegetated in the winter of 2004. Follow-up monitoring will continue for a period of three years. The treatment types are as follows:

Two Irrigation Levels - No Irrigation and Supplemental Irrigation
Two Seed Treatments- Control (untreated seed) and Treated (mycorrhiza + activated charcoal)

Two Herbicide treatments – Treated with Plateau and untreated.

Project Materials

1. Herbicide

PLATEAU® herbicide for weed control, native grass establishment and turf growth suppression on pastures, rangeland, and noncrop areas**.** (See appendix ___ for complete information.)

Active ingredients consist of Ammonium salt of imazapic (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid*23.6%.
Inert ingredients 76.4%, for a total of 100.0%

*Equivalent to 22.2% (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-methyl-3-pyridinecarboxylic acid. (1 gallon contains 2.0 pounds of active ingredient as the free acid)

2. Mycorrhiza Inoculants: Background, Specifications

Mycorrhiza are fungi that dwell in the soil and form symbiotic associations between the roots of most plant species and the fungi. Mycorrhiza is localized in a root or root-like structure in which energy moves in a two-way manner, primarily from plant to fungus, while the inorganic resources and water move from fungus to plant. The main responsibility of mycorrhiza is to increase the efficiency of mineral uptake and water in soil. Once the soil becomes disturbed from its native state, the mycorrhiza do not persist without the symbiont and the soil has difficulty supporting native species since the root system is reduced. Mycorrhizal inoculation can improve plant establishment, nutrient and water uptake, plant vigor, yield and growth, and disease resistance. It will also reduce transplant shock and drought stress. Mycorrhizal plants are often more competitive and better able to tolerate environmental stresses than are non-mycorrhizal plants. About 95% of the world's land plants form the mycorrhizal relationship in their native habitats. TWT is one of the 5% that does not form this relationship.

Thus, when attempting to revegetate disturbed soils, it is advisable to use a mycorrhizal inoculant as will be shown in this study.

The benefits of mycorrhizal inoculation are:

- A Natural functioning ecosystem with a strong mycorrhiza presence may force out nonmycorrhizal species such as "Whitetop".
- Greater resistance to invasion by noxious weeds.
- Improved soil structure.
- Improved plant growth rate.
- Protection from pathogens.
- Increased seedling survival.
- Higher species diversity.
- Increased drought resistance.

The three species of mycorrhizal inoculants used in this study are *Glomus intraradices, G. mosseae,* and *G. aggregatum.* All three species were originally collected in the western United States and isolated and identified at the International Culture Collection of Vesicular Arbuscular Mycorrhizal Fungi (INVAM) located at the University of West Virginia. These three species were chosen because of their widespread occurrence in arid environments and ability to colonize and affect plant growth under a wide range of environmental conditions.

Methods for the production of mycorrhizal fungi inoculum have been widely known in the academic world since the early 1970s. Soon following the establishment of these methods, the academic community documented the plant establishment and growth benefits of using mycorrhizal inoculum in agriculture and land restoration. However, the commercial production of mycorrhiza inocula was limited, at first, to a few isolated commercial forestry nurseries. The limited market for commercial production of mycorrhiza inocula silenced innovation and large-scale production of high quality inocula until the 1990s. The market and need for large-scale commercial production of high quality mycorrhizal inocula quickly expanded with the increased use of native plants in erosion control and restoration of disturbed lands. Now there are over ten companies in North America who commercially produce mycorrhiza inocula. Innovations in inocula production, quality assurance and control, and application methods are driven by consumer education and testing under "real world" field conditions. The academic world has proven that mycorrhizal fungi are extremely important to plant growth but it will take a unique partnership between producer and consumer to find the most cost effective and beneficial use of mycorrhiza inocula in large-scale field projects.

3. <u>Seed Mix</u>

The following species were selected based on their presence in remaining floodplain communities and similar soil types, their ability to establish rapidly and competitively, and their known association with mycorrhiza. With the exception of ryegrain, Baltic rush and four-wing saltbrush, all species are mycorrhizal, with varying degrees of dependence on the symbiosis. The cereal crop was added as a nurse crop to provide shade for species slower to germinate and establish. Tall wheatgrass, the other non-native, was included since it is a competitive, rapidly establishing species adapted to fluctuating water tables and soils that occur on the project site. Big sagebrush and rabbitbrush, both in the family Asteraceae, produce an abundance of short-lived seed and are excellent colonizers. Inland saltgrass, however, has a known record of poor establishment from seed due to dormancy mechanisms. It has been included since it is a major component of the Truckee River floodplain community. It will be interesting to examine if better germination and establishment is accomplished with the inoculant. Creeping wildrye is also a dominant species in these communities.

Botanical Name	**Common Name**	**PLS Lbs/Acre**
Artemisia tridentata ssp tridentata	**Big sagebrush**	0.50
Atriplex canescens	Fourwing saltbush	2.00
Distichlis stricta	Inland saltgrass	3.00
Chrysothamnus nauseosus	Rubber rabbitbrush	0.50
Elymus cinereus	Great Basin Wildrye	3.00
Elytrigia elongata	Tall wheatgrass, 'Jose'	4.00
Juncus balticus	Baltic rush	0.25
Leymus triticoides	Creeping wildrye,	5.00

	native	
Ryegrain, Cereal		2.30
TOTAL		18.55

4. Activated Charcoal- Background and Specifications

The activated charcoal is used in the seed coating to sequester the active ingredients that are present in the soil, which has resulted from the application of the BASF herbicide "Plateau". The herbicide will stop any of the undesirable seeds present in the soil such as "Whitetop" from germinating and the "activated charcoal" present in the seed coating of the desirable seeds that have been treated with charcoal and mycorrhiza in combination should germinate and become established on the site.

Methodology
The demonstration plots will consist of the following combination of treatments:

- Two irrigation Levels - No Irrigation and Supplemental Irrigation
- Two seed treatments- Control (untreated seed) and Treated (mycorrhiza + activated charcoal)
- Two herbicide treatments – Treated with Plateau and untreated.

1. Application Data

A reference site of a healthy native floodplain community will be selected as an outside control.

The one-acre demonstration area was mowed using a brush hog mower at the peak flowering stage of tall whitetop. When tall whitetop had re-grown to the full flowering stage, Plateau was applied on August 6, 2003, between 8:00 am and 8:30 am through a boom sprayer on an ATV, utilizing TeeJet flat fan nozzles, 8004, applying 20 gallons of water per acre, at 8 fl ounces per acre with one quart per acre of methylated seed oil. Weather was clear, winds were 1-2mph from the west, temperature were 65°F with a relative humidity of 43%.

Plots will then be tilled and broadcast seeded in the winter of 2004. The seeds will be applied by a seeder and gently raked in so to create an interface between the soil and the seeds.

2. Monitoring

Sampling will begin in the spring following winter seeding.

a. Vegetation Sampling: (Western Botanical Service Inc.)

- Germination will be measured within a 2 x 2 ft randomly selected area within each plot. This will be accomplished by a 100 percent count of all species germinating within the sampled area.

- Cover, frequency and diversity will be determined by the point- intercept methodology along permanently located transects.

- Establishment, vigor, vitality (reproduction) will be determined qualitatively.

- Permanent photo-points will be established and monitored.

b. Mycorrhiza monitoring: (RTI)

- Root sampling for mycorrhiza colonization will be done for selected plant species using a stratified random sampling method. Root sampling will start at the third leaf stage and continue biannually during the spring and fall of each growing season.

- Roots are cleared with 10% KOH and stained with 0.15% Acid Fuchsin using procedures from Kormanik, P.P., A.C. McGraw, and R.C. Shultz. 1980. Procedures and equipment for staining large numbers of plant roots for endomycorrhizal assay. Canadian Journal of Microbiology 26:536–538) and results are given as the proportion of the root colonized by mycorrhizal fungi determined by the grid-line intersect method (Giovannetti, M. and B. Mosse, 1980. An evaluation of techniques for measuring vesicular-arbuscular mycorrhizal infection in roots. New Phytologist 84: 489-500).

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c. Soil fertility

- Soil sampling for nutrient analysis will be taken in the spring and fall of the first year of growth. Samples will also be taken from an adjacent representative area as well as the control.

d. Soil microbiology: (Soil Food Web)

- Sampling for soil bacteria and fungal presence, diversity, and activity will be taken in the spring and fall of the first year of growth. Samples will also be taken from an adjacent representative area as well as the control.

Management and Contingency

This may include spot or broadcast applications of herbicides, mowing and pruning, seeding, and re-application of inoculants. Additional new technologies will be evaluated for incorporation into existing or additional plots. Every attempt will be made to complete the project as proposed. Changes to the work plan will be reviewed and approved by NDEP prior to implementation.

MEASURE OF SUCCESS

Success will be determined through monitoring of plant establishment in conjunction with evaluating root colonization and soil biology and chemistry. This will be compared to a 'control' site with healthy floodplain species. Replacement of TWT with a native plant community is the criteria for success.

The Abundance and Distribution of Non-native Woody Species in Sacramento Valley Riparian Zones

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Abstract.

For a 2003 study of wildlife in riparian zones, we recorded the species composition of riparian vegetation in one hectare plots at 47 locations distributed across 16 streams in the Sacramento Valley and adjacent foothills. Non-native woody species were an important component of the shrub layer at

the majority of locations and occasionally were an important component of the tree layer. Combined non-native species accounted for > 10% of plant cover in the shrub layer at 52% of locations and in the tree layer at 15% of locations (23% of locations if California black walnut, *Juglans hindsii*, is considered non-native). The importance of non-native species in the shrub layer was due to Himalayan blackberry (*Rubus discolor*), which the most widely distributed and abundant species, non-native or native, and accounted for about half of all plant cover in the shrub layer. All other non-native species had < 10% cover in the shrub layer at all locations, and only tree-of-heaven (*Ailanthus altissima*) and mulberry (*Morus alba*) accounted for > 10% in the tree layer of any plot. Except for Himalayan blackberry and tree-of-heaven, species were not present in plots on more than one stream. Mulberry, in particular, appeared to have a localized distribution. It was present in all 5 plots along Deer Creek but absent elsewhere. In other studies, several non-native species (mostly ones absent from our plots) have been locally abundant along the American, Cosumnes and San Joaquin Rivers. This suggests that the number of non-native woody species will increase along individual streams even in the absence of additional species naturalizing in the Sacramento Valley.

Introduction

The riparian zones of California's Central Valley provide excellent opportunities for the establishment and spread of non-native species. In general, riparian zones are frequently invaded by non-native species. This is due, at least in part, to the frequent disturbances associated with riparian zones. In the riparian zones of California's Central Valley, the availability of water during the summer dry season, and seed sources in adjoining agricultural and urban areas also may contribute to the establishment of non-native species.

Over 20 species of woody non-natives have been reported from these riparian zones (Table 1). However, the distribution and abundance of these species is not well documented. Our study provides a regional data set for assessing distribution and abundance of non-native woody species in the riparian zones of the Sacramento Valley's streams and small rivers.

Methods

We collected data on riparian zone attributes and vegetation structure at a subset of accessible sites along streams and small rivers in the Sacramento Valley. Potentially accessible sites included over 1,000 locations at which the Point Reyes Bird Observatory had collected bird data and additional sites in Placer County for which access was arranged by the Placer County Planning Department. From this pool of potential sites, we eliminated sites along the Sacramento River and its larger tributaries. The remaining sites were divided into 5 width categories (0-20, >20-40, >40-60, >60-100, and >100-160 m) and a random sample of 10 sites was drawn from each. During our study, access to 3 sites was revoked leaving a data set of 47 sites.

At each site we located a 1 ha plot (100 m by 100 m) with one side along the bank of the adjacent watercourse. Within the plot, we recorded information on surrounding land use, general riparian zone attributes and the structure of the riparian vegetation. The cover of developed, agricultural and natural vegetation within 250 m of the plot was estimated, as was the distance to the nearest road. Within the riparian vegetation, or the remainder of the plot, we recorded the presence of roads, levees or other infrastructure and evidence of disturbance (e.g., overbank flows, dumping, tree or brush cutting). For the riparian vegetation, the total cover of the herb, shrub and tree layers was recorded, as was the cover of woody species within the tree and shrub layers.

Results

Riparian Zones Attributes

Riparian zone attributes include surrounding land use, presence of infrastructure (e.g., roads, canals, power lines, levees), and evidence of disturbance (e.g., incision, overbank flows, tree cutting dumping). The land cover surrounding riparian zones was a mosaic of natural, agricultural and developed land cover types. On average, surrounding land was 43% natural, 38% agricultural and 18% developed land cover types. Only 17% of plots were surrounded entirely by natural vegetation.

Infrastructure was frequently present in riparian zones. Over half of the plots had infrastructure within them. The mean distance to the nearest road was 139 m from the plot center (or 189 m from the channel bank). However, the distribution of these distances was highly skewed with over 45% of plots containing roads. Levees or bank protection were present in < 20% of plots.

Riparian zones were typically disturbed. There was evidence of overbank flows in 57% of plots, and the channel was incised at 62% of plots. Evidence of dumping was in nearly 20% of plots. However, evidence of tree or brush cutting was scarce, being present in only 6% of plots.

Riparian Zone Vegetation

Riparian vegetation was in relatively narrow bands with an open, discontinuous canopy. Widths at plots averaged 36 m. However, our sample was stratified by width and included a larger proportion of wide riparian corridors than were in the set of potential sites. Thus, the average width of riparian vegetation along streams and smaller rivers of the Sacramento Valley is narrower than the 36 m average for our sample. Within these riparian corridors, mean tree cover was just 46%, shrub cover 41% and herb cover 76%.

Native species dominated the riparian tree layer (Figure 1). Native species (not including Northern California black walnut) accounted for 41 ± 3% cover (mean ± 1 SE) versus 5 ± 1% for non-native tree species. Interestingly native oak species (*Quercus lobata*, *Q. wislizenii* and *Q. kellogii*) averaged 26 ± 4% cover, which was more than members of the willow family (16 ± 3%) which included four willow species (*Salix lucida*, *S. lasiolepis*, *S. exigua*, and *S. laevigata*) and Fremont's cottonwood (*Populus fremontii*). This is interesting because the Central Valley's riparian vegetation is generally described as being dominated by Fremont's cottonwood and the willow species, and this has been documented along the Valley's major rivers (Conard et al. 1980). Tree-of-heaven (*Ailanthus altissima*) was the most abundant non-native species occurring in 21% of the plots with a mean cover of 8% in those plots (Table 2). Non-native species also included stone fruits (*Prunus* species), mulberry (*Morus alba*), and seven other tree species.

Northern California black walnut was widespread (in 34% of plots with a mean cover of 4%) and could be considered a non-native in the Sacramento Valley. Its historical distribution is relatively well documented and did not extend into the Sacramento Valley beyond Walnut Grove in the Sacramento-San Joaquin Delta (Smith 1912). However, it was widely planted as an ornamental in the latter 19th and early 20th centuries and also used as the primary rootstock for English walnut (*Juglans regia*), which is cultivated on tens of thousands of acres in the Sacramento Valley. It subsequently became widely established in the Valley's riparian zones (and as an urban weed tree). Also, because it hybridizes freely with the English walnut and Eastern black walnut (*Juglans nigra*), and hybrid seedlings are frequently observed (McGranahan et al. 1988, J. Hunter, personal observation), introgression has occurred, possibly to the extent that the true native Northern California black walnut could be considered extinct. If the black walnuts of the Sacramento Valley are considered non-native, then they are the most widespread non-native in the Valley.

Unlike the tree layer, the shrub layer of Sacramento Valley riparian zones is not dominated by native species. Rather, the non-native Himalayan blackberry (*Rubus discolor*) is the typical dominant of well-developed shrub layers. This species was in 70% of our plots and averaged 34% cover where present. It accounted for over half of all the shrub cover in our 47 plots. Unlike the most abundant native shrubs (*Rubus ursinus*, *Rosa californica* and *Toxicodendron diversiloba*) Himalayan blackberry is evergreen, and thus its spread represents a change in growth form and hence in vegetation structure that likely affects wildlife habitat.

Discussion and Conclusions

Our results and other surveys (Butler 2000, Stillwater Sciences 2001, Moise 2002) indicate that a large number of non-native woody species currently have a patchy distribution and are at low abundance in California's Central Valley. This pattern of distribution could be the result of three very different scenarios. These are:

1) repeated establishment from ornamental plantings of individuals and transient small populations that are not spreading and would become extirpated in the absence of ornamental plantings,

2) naturalized populations (that do not depend on a subsidy of propagules from plantings) and are not increasing in size substantially, and

3) naturalized populations that are expanding in size and distribution.

While the first two of these scenarios probably apply to several of the observed species, a number of non-native woody species probably are expanding their ranges and increasing in abundance, or are likely to do so in the near future. For some of these species (e.g., *Ailanthus altissima*, *Sapium sebiferum*, *Sesbania punicea*, *Tamarix* species), their successful invasion of other regions is a strong indication of their probable on-going spread in the Central Valley.

For example, scarlet wisteria (*Sesbania punicea*), a successful invader of South Africa and the southeastern United States, has a restricted distribution in the Central Valley, but this distribution appears to be rapidly expanding, and scarlet wisteria may soon be beyond control at the regional scale. This species was cultivated in California prior to 1930 (Bailey 1929) but was not reported from natural vegetation until 1987 (Oswlad and Ahart 1994). By 2001, the species had been reported from multiple localities (Ondricek-Fallscheer et al. 2003). It is currently abundant along the lower American River and the San Joaquin River near Fresno. The spread of this species can alter riparian ecosystems because it can establish within herbaceous vegetation and on gravel bars in the absence of flows that would satisfy the requirements of Fremont's cottonwood and willow species. Thus, it replaces open and herbaceous vegetation with a dense cover of shrubs. This not only alters habitat but also increases roughness.

Similarly, other species that are present as isolated individuals or are only locally abundant in the near future may increase in abundance and become more widely distributed. For example, mulberry was present in all of the plots along Deer Creek but did not occur in plots located along the 15 other waterways included in our sample. However, this species has been reported from along the San Joaquin, Merced and American Rivers and already may be widely distributed albeit at a generally low abundance. Thus, under favorable conditions its abundance could increase rapidly throughout the region effectively placing it beyond control at watershed and regional scales.

As these species spread and increase in abundance, it will no longer be feasible to control them at watershed and regional scales, and the ecosystem alterations they cause will effectively be irreversible. Therefore, removal of all non-native woody species, while they are still relatively uncommon and locally distributed, is a prudent measure that would prevent the ecosystem alterations that otherwise would be caused by a subset of these non-native species.

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Table 1. Non-native woody species reported from riparian vegetation in California's Central Valley.

Common Name	Scientific Name	Reported Locations	Source
Acer saccharinum	Silver maple	American River, Merced River	J. Hunter pers. obs., Stillwater Sciences 2001
Ailanthus altissima	Tree-of-heaven	American River, Cosumnes River, Sacramento River	Butler 2000, R. Waegell pers. comm., SRAC 2002
Carya illinoiensis	Pecan	Merced River	Stillwater Sciences 2001
Catalpa bignonioides	Catalpa	American River	J. Hunter pers. obs.
Eucalyptus globulus	Eucalyptus	San Joaquin River	Moise 2002
Ficus carica	Fig	Cosumnes River, Merced River, Sacramento River, San Joaquin River	R. Waegell pers. comm., Stillwater Sciences 2001 SRAC 2002, Moise 2002
Gleditsia triacanthos	Honey Locust	Cosumnes River	Randall and Meyers-Rice 1997
Maclura pomifera	Osage orange	Cosumnes River, Merced River, Sacramento River	R. Waegell pers. comm., Stillwater Sciences 2001, SRAC 2002
Morus alba	Mulberry	San Joaquin River	Moise 2002
Nerium oleander	Oleander	Sacramento River	Keeley 1992
Nicotiana glauca	Tree tobacco	San Joaquin River	Moise 2002
Platanus acerifolia	London plane tree	Merced River	Stillwater Sciences 2001
Prunus armeniaca	Apricot	Cosumnes River	Conard et al. 1980
Prunus cerasifera	Cherry plum	American River	Butler 2000
Robinia pseudoacacia	Black locust	American River, Cosumnes River, Sacramento River	Butler 2000, R. Waegell pers. Comm., SRAC 2002
Rubus ulmifolius var. inermis	Thornless blackberry	American River	Butler 2000
Rubus discolor	Himalayan blackberry	American River,	Butler 2000, Stillwater

		Merced River, San Joaquin River	Sciences, Moise 2002
Sapium sebiferum	Chinese tallow tree	American River	Butler 2000
Sesbania punicea	Scarlet wisteria	American River, Little Chico Creek, Sacramento River, San Joaquin River	Butler 2000, Oswald and Ahart 1994, Moise 2002
Tamarix parviflora	Tamarisk	Sacramento River	SRAC 2002
Tamarix ramosissima	Tamarisk	American River	Butler 2000

Table 2. Non-native woody species observed in Sacramento Valley riparian plots.

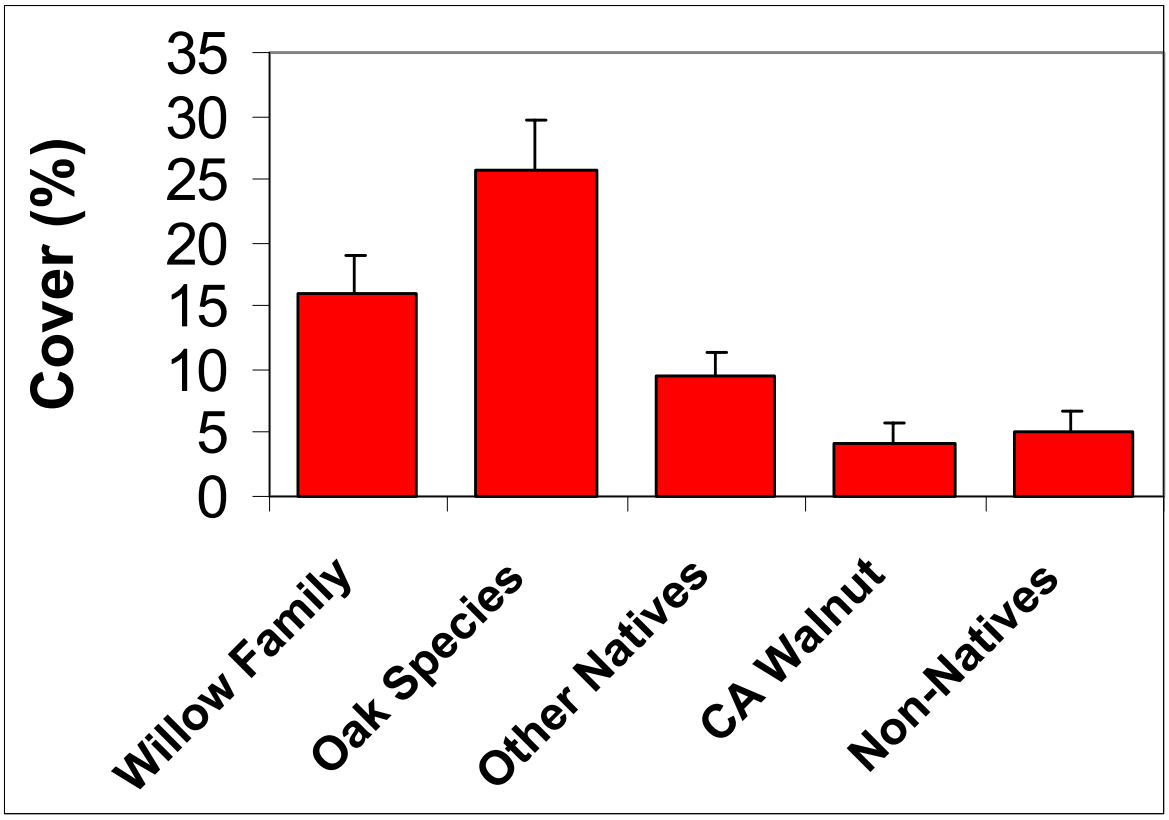
Species	Frequency[1] (%)	Mean Cover[2] (%)	Range (%)
Rubus discolor[3]	72	34	0.5-85
Ailanthus altissima	21	8	0.5-37.5
Prunus species	15	3	0.5-15
Morus alba	11	15	2.5-37.5
Tamarix species	9	5	0.5-15
Eucalyptus globulus	4	8	0.5-15
Maclura pomifera	4	0.5	-
Ficus carica	4	1.5	0.5-2.5
Catalpa bignoniodes	2	2.5	-
Olea europea	2	2.5	-
Ulmus species	2	0.5	-

Notes:

[1] – Total number of plots was 47.

[2] – Mean absolute cover in plots where present.

[3] – Present in shrub layer only.



Getting the Job Done: Working Within the Regulatory Environment at Lake Tahoe to Manage Weeds

Susan Donaldson, Wendy West, and Kirk Taylor

Working within the Lake Tahoe Basin presents some unusual challenges. The watershed spans two states, five counties, several cities and unincorporated areas, and is subject to many regulatory mandates designed to protect water quality and clarity. At the same time, the Basin has been invaded by a number of troublesome weed species. In 1998, the first instance of the noxious weed perennial pepperweed (*Lepidium latifolium*) was documented in Incline Village, Nevada. Perennial pepperweed is a non-native weed from Eurasia that has invaded sensitive wetland and riparian sites in the western United States. The unchecked invasion of riparian areas along the Truckee River east of Reno raised concerns that similar areas at the lake could also be lost to tall whitetop, with resultant increases in erosion due to its non-fibrous root system and impairment of water quality. Current research suggests

that the lake is phosphorus limited, with erosion and sediment transport increasing phosphorus loads to the lake. Researchers agree that limiting erosion and sediment inputs into the lake is essential to limiting further losses in lake clarity.

During the 1998 field season, 35 verified infestations of perennial pepperweed were mapped. It was clear that it would be necessary to apply herbicides to control the weed. As there were concerns about the potential application of fines for the use of herbicides, a series of meetings and trainings were held to reach group consensus that the use of herbicides was warranted. Permission was granted to apply chlorsulfuron to control terrestrial infestations at least 25 feet from any open water surface. This approach was successful in controlling the vast majority of infestations. However, it soon became obvious that perennial pepperweed was not the only invasive weed species in the Basin.

Following the hiring of a botanist for the Lake Tahoe Basin Management Unit of the U.S. Forest Service, the Lake Tahoe Basin Weed Coordinating Group (LTBWCG) was formed in 2002. The group's goals are to find, map, and control these weeds while providing education and outreach to land managers and the public. The group identified sixteen weed species of concern within the watershed. Weed mapping data for the priority species is provided below. This data set is not all-inclusive, but represents those infestations for which mapping data is available.

Species	Infestations Mapped
Perennial pepperweed	165
Bull thistle	144
Dalmatian toadflax	58
Spotted knapweed	42
Diffuse knapweed	28
Klamathweed	17
Oxeye daisy	10
Scotch broom	8
Yellow toadflax	3
Yellow starthistle	2
Eurasian wwatermilfoil	2
Canada thistle	1
Musk thistle	1
Russian knapweed	1

Control of these weed species requires a variety of integrated weed management methods. During the December 2002 meeting of the weed group, the following methods and priorities were developed for the 2003 field season:

Immediate control by mechanical methods:

- Musk thistle
- Scotch thistle
- Yellow starthistle
- Diffuse knapweed

Immediate control by chemical methods:

- Canada thistle
- Russian knapweed
- Spotted knapweed
- Tall whitetop (or perennial pepperweed)
- Dalmatian toadflax
- Yellow toadflax

Practice containment to prevent expansion of existing populations:

- Bull thistle
- Klamathweed
- Oxeye daisy

Public education needed to stop intentional planting or spread

- Scotch, French, Spanish brooms
- Eurasian watermilfoil
- Oxeye daisy
- Dalmatian and yellow toadflax

Six species were prioritized for chemical control. However, the Lahontan Regional Water Quality Control Board (LRWQCB), which has primary responsibility for the protection of water quality in California in the Lake Tahoe area, has established standards for pesticide residues in water, sediment, and aquatic life. The Basin Plan for the Lahontan Region states that "Pesticide concentrations, individually or collectively, shall not exceed the lowest detectable levels, using the most recent detection procedures available." Failure to abide by the plan carries stiff penalties of up to $10,000.

The LTBWCG worked with LRWQCB to create a tiered process under which selected herbicides could be applied to six priority weed species with varying levels of consultation required. Major considerations include plant species, distance to water, cover class and infestation size, and application method.

Proposal Details:

We proposed to use one of three herbicides to effectively control infestations of Canada thistle, Russian and spotted knapweed, and tall whitetop that cannot be treated by hand-pulling: glyphosate (Rodeo®), which can be used adjacent to water and provides some control of all four target weed species; chlorsulfuron (Telar®), which provides excellent control of tall whitetop; and clopyralid (Transline®), which provides excellent control of knapweeds and thistles. These products offer a number of advantages. Rodeo is labeled for appropriate use adjacent to waterbodies, and has low aquatic toxicity and little potential for migration due to its large organic carbon coefficient. Transline and Telar are extremely effective on the target species at very low rates (as little as 1 – 1.5 ounces per acre), and have low toxicity to aquatic animals, birds, and mammals. While their chemical properties suggest these two herbicides could be mobile within the soil, no case of extensive off-site movement has been documented. Neither chemical is registered for use in or adjacent to aquatic systems.

Chemical Properties

Product Name Examples	Active Ingredient	CAS Number	Toxicity Class	Half-life in soil, days	Half-life in water, days	K_{oc} (mL/g)	Solubility (mg/L)
Rodeo® Aqua-master® Others	Glyphosate, isopropylamine salt	1071-83-6	III (caution)	2 – 174 (average 47)	12 – 70 (in pond water)	24,000 (average) range 884-60,000	900,000 (at pH 7)
Transline®	Clopyralid monoethanolamine salt	057754-85-5	III (caution)	12 - 70 (average 40)	8 - 40	6 (average) ranges to 60	1,000
Telar®	Chlorsulfuron	64902-72-3	III (caution)	30 – 90 (average 40; pH dependent)	NA	40 (at pH 7)	31,800 (at pH 7)

Data from the Herbicide Handbook of the Weed Science Society of America and product labels/MSDS

Specimen labels, material safety data sheets, and additional information on these products were added to the appendix.

We proposed the following set of criteria for the use of the three target herbicides to control the six priority weeds. The best management practices that will be followed when any spray applications are made include the following:

- Applicators will follow label directions for personal protective equipment (PPE) including long-sleeved shirt and long pants; waterproof gloves; and shoes plus socks.
- Herbicides will be measured accurately.
- Only the amount needed for the job will be prepared.
- Spray tanks will not be over-filled.
- Applications will not be made during gusty conditions, or if rain has been forecast to occur during a 24-hour period following the application.
- Equipment will be adjusted to produce large droplets (>150-200 microns) to minimize drift potential
- Applications will be made only to target vegetation, and desirable vegetation will be carefully avoided.
- All label directions will be followed.

We felt that by following these criteria and BMPs, the weeds could be effectively controlled while minimizing the risk of water contamination.

Categories of Infestation (based on size and weed density)

Category I—No notification/consultation to LRWQCB required prior to treatment if below criteria are met.

Size and Cover Class Criteria for Category I. Infestations that are less than ¼ acre in size and less than 25% total weed cover. The majority of infestations in the Lake Tahoe Basin fall within this category.

For these small infestations, we propose to meet the following guidelines for herbicide applications:

- Strictly terrestrial applications (no aquatic applications are proposed)
- Application made a minimum of 25 feet from the water surface edge of perennial streams and other water bodies
- Spot spray application only
- Application made a minimum of 50 feet from the nearest known and surveyed Tahoe yellow cress plants.
- If herbicide application on any beach is proposed, TRPA staff, U.S. Forest Service (LTBMU) botanists, or California Tahoe Conservancy staff will be consulted for information on yellow cress occurrence prior to proceeding. Only the water-labeled formulation of glyphosate would be applied in beach areas, following label directions (see sample label for Rodeo). No spraying would be conducted; instead, wipe applicators or direct application clippers would be used to prevent the possibility of spray drift occurring.

Under these conditions, we felt that no further notification or consultation with LRWQCB should be necessary.

Category II—The LTBWCG may request 48-hour response from LRWQCB prior to treatment, if deemed necessary to prevent seed production.

Size and Cover Class Criteria for Category II: Infestations that are up to 1 acre in size and any cover class:

In the case that it is necessary to move quickly to prevent seed production from a newly discovered infestation where seed set could occur within a two-week period, and the infestation does not fit Category I criteria, we will send a letter requesting a 48-hour turnaround time for comment from the lead or acting lead of the Lake Tahoe Unit of LRWQCB. Rapid control is critically important to minimize the seed bank and ensure future herbicide applications will likewise be minimized. This rapid turnaround time will be requested prior to the use of herbicides on infestations that are up to 1 acre in size **AND** any cover class/plant density, excluding Category I (>1/4 acre and >25% cover).

All other criteria and BMPs listed above will be followed when applying controls. A letter requesting comment will be submitted to LRWQCB that will include information on the location of the infestation, the weed species, the growth stage of the weed, the herbicide to be used, and the size and density of infestation.

Category III—Full consultation with LRWQCB required prior to treatment.

Size and Cover Class Criteria for Category III: Infestations that are greater than 1 acre, or within 25 feet of a water surface; or infestations from ¼ to 1 acre not requiring rapid consultation for seed production control.

Extensive notification and consultation with LRWQCB will occur for treatment of all infestations with proximity to surface water, for infestations of ¼ to 1 acre in size not requiring a Category II rapid consultation, and for large, established infestations of one acre or greater in size.

Summary of Categories Applicable to Different Projects

	<25% weed cover	**>25% weed cover**
<1/4 acre	**I**	**III or II***
1/4 to 1 acre	**III or II***	**III or II***
> 1acre	**III**	**III**

*In these cases, the LTBWCB may exercise the option to request 48-hour response from the LRWQCB, if deemed necessary to prevent seed production.

Results

This proposal was accepted by Lahontan Regional Water Quality Control Board in June, 2003, and herbicide applications were made to sites during the summer 2003 field season. Most infestations were less than ¼ acre in size. One consultation was made with Lahontan prior to treating 1.5 acres infested with Russian knapweed.

This methodology allowed those involved in weed management activities within the Tahoe Basin some measure of confidence that herbicides can be carefully and appropriately used to treat weed infestations with broad agreement from involved parties. The approach may serve as a useful model in areas with similar environmental sensitivities.

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Tilling Shows Promise for Controlling Himalayan Blackberry in Yosemite Valley (California)

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When the first European-American settlers arrived in the Yosemite Valley in the mid-1800s, they began farming extensively in order to stake their claim to the land. Today, large infestations of exotic Himalayan blackberry, *Rubus discolor*, on 30 acres (12 ha) in Yosemite National Park are a legacy of the valley's agricultural past (Hood and Hood 1971). In some areas of the park, blackberry--which can expand 10 feet (3 m) or more a year (BLM undated)--seriously threatens the survival of native riparian vegetation and degrades wildlife habitat.

We have used various weed control treatments, including digging/hand-pulling individual plants, mowing thickets with brushcutters, and cutting and daubing the two-year-old blackberry canes with glyphosate (see Makarick 2001). These techniques help reduce the spread of Himalayan blackberry, but are very labor intensive and are not practical for treating large, infested areas. For this reason, we have begun experimenting with tilling.

According to the University of California Statewide Integrated Pest Management Program, repeated tillage prevents wild blackberry from persisting on agricultural lands (UCIPM 2002). To test this method, we used a bobcat with a ripper attachment to till blackberry-infested sites in two perpendicular passes. Immediately after tilling, we manually removed the remaining, exposed blackberry roots. For our initial experiment, we selected five sites in two closed campgrounds according to the amount of blackberry cover, previous weed treatments, accessibility to existing roads, distance from native vegetation, and size. All sites are very small in area, with the largest measuring 0.25 acre (1 ha). We had previously treated one of the selected sites in summer 2001 (digging/hand-pulling and brushcutting). The blackberries on the other four sites had never been treated, and formed thickets 4 to 5 feet (1.2-1.5m) in height.

In fall 2001, we measured blackberry cover on the sites just prior to the initial tilling. Cover ranged from 25 to 50 percent on the previously treated site, and from 75 to 100 percent on the

untreated sites. We then tilled each site once that fall and planned to continue tilling once a month throughout the next growing season, recording percent cover prior to each tilling. Unfortunately, the sites were inaccessible for tilling during the summer of 2002 because of wetlands delineation and surveying work. We were forced to treat the sites by digging/hand-pulling. In fall 2002, we were finally able to till the sites a second time, and once again manually remove exposed roots.

As in 2001, we recorded blackberry cover at each site before the second tilling. A comparison of the two annual cover measurements showed that blackberries had decreased by 50-75 percent on the four sites that had received no treatment prior to the first tilling, and by 25 percent on the site that had been treated prior to tilling. Although these are a result of tilling *and* hand pulling treatments, the majority of cane and root mass was removed on all sites during the initial tilling operation (Schweizer 2001).

For all the treatment sites, one tilling greatly reduced cover and, therefore, reduced the follow-up manual treatment needed when compared to similarly infested areas. We plan to repeatedly till these same areas throughout the 2003 growing season, although we suspect that manually removing roots may be unnecessary. We also plan to seed native grasses into the tilled sites to increase competition with any remaining blackberry plants and other exotic plants.

In the future, we hope to use this technique to eradicate large infestations in critical areas. However, sites appropriate for tilling would need to meet certain criteria, including blackberry cover greater than 50 percent, relatively level ground, access for the bobcat, and absence of buildings, trees and shallowly buried utility lines.

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Alternatives to Chemical Stump Treatment of *Acacia dealbeta*

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Controlling re-sprouting of cut Acacia dealbata (Green Wattle) stumps has traditionally been done by chemical (herbicide) and mechanical methods (stump grinding). In 2001 the Natural Resources and Employment Program (NREP) began a project to introduce a third method of stump treatment, tarping.

Site Description:

The site is known as the Olympia Sand Quarry, located approximately 6 miles north of the City of Santa Cruz in the Santa Cruz Mountains. This site is an old sand quarry, which is currently owned by the San Lorenzo Water District. The quarry was closed before passage of the Surface Mining Control and Reclamation Act (SMCRA). It is believed that the mining activities initially disturbed the soils and brought in the invasive species. This watershed is one of the primary supplies of water to the San Lorenzo Water District, which supplies all of the water for several communities and a substantial population in the Santa Cruz Mountains area known as the San Lorenzo Valley. Restoration of any and all areas of this watershed provides lasting positive benefits for the habitat of wildlife and the human population at large.

In this tract of approximately 40 acres of watershed land, invasive species of Acacia, along with French Broom were rapidly overtaking native species. There were several thousand Acacia trees removed, along with a substantial French Broom population. Removal of these invasive species should allow the native species to flourish again. . Native tree species that benefited from the project included California Live Oak, Ponderosa Pine, Redwood, Cottonwood, Willow and Douglas fir.

This is a unique and critical habitat for the rare and endangered Mount Hermon June Beetle (*Polyphylla barbata*). The unique mix in this area is of sparsely vegetated sandy soil supporting Ponderosa Pines and a variety of grasses and herbs. This soil series is unique to the areas of Felton, Zayante, Ben Lomand, Mount Hermon and Scotts Valley. All of these sites are located in Santa Cruz County California.

The threat to the area derived from a shift in plant communities including the encroachment of Acacia, and French Broom. These invasive species cast substantially more shade and increased nitrogen content in the soil reducing the habitat for the Mount Hermon June Beetle. An additional endangered species, the Zayante band -winged grasshopper (*Trimerotropis infantilis*) is also unique to this very specific area. Neither species has been found in sites dominated by acacia or broom.

The Project:

During the project all acacia trees were cut down. After the initial acacia removal, the stumps were re-cut to a height no greater than 4 inches above grade. Cut material was disposed of by burning. French Broom was pulled out by hand.

On stumps designated for tarping a trench was dug to a depth of 12 inches deep. This trench was dug in a circle around the stump at a distance of two feet from the edge of the stump. Three layers of 6-millimeter black plastic were then installed over the stump and in the trench. The trench was then backfilled. Most of the stumps that were tarped did not grow sprouts through the black plastic. On a

tarp installed in 2001 one sprout did grow up through a pre-existing hole in the tarp. Close examination of the hole revealed ragged uneven edges suggesting rodents had created the hole. No further holes in any tarps have been subsequently found. The plastic is prescribed to remain in place for two years.

Remaining stumps were treated with a 2% solution of Roundup® during 2001 and Garlon 4® during 2002. These herbicide treated stumps were cut to within 4 inches of grade less than 1 minute before the herbicide was applied. The stumps treated with the 2% solution of Roundup® in 2001 re-sprouted within 6 months. Roundup may work in stronger concentrations. Several Garlon 4® treated stumps grew small sprouts within 2 months or treatment but these sprouts soon died.

Results:

Both tarping and herbicides proved very effective in controlling stump re-sprouting. Both methods resulted in kill rates of over 95% of the subject stumps. The permit issued by US Fish and Wildlife required that the herbicide be applied by paintbrush as opposed to spraying. The soil surrounding the stumps also had to be covered with plastic tarping temporarily to avoid accidental spills. Both of these permit requirements increased the amount of time and therefore the cost of using the herbicide.

Trenching to install the tarp may play an important role in stump control. Many experts agree that cutting roots within the drip line of a tree can have detrimental effects on the trees growth and vigor. The British Standards Institute recommends trenching at least a minimum distance of ½ foot for each inch of trunk diameter measured 4.5 feet above grade. The American Society of Consulting Arborists recommend a minimum distance of 1 foot for each inch of trunk diameter measured at 4.5 feet above grade. Cutting the acacia roots two feet from the stump, well inside the drip line, while trenching deprives the stump of much of its water, nutrient and oxygen uptake as well as slowing the stumps ability to synthesis cytokinins, amino acids and other organic compounds necessary for growth.

Economic Discussion:

The costs of tarping as compared to Garlon 4® as a stump treatment was surprisingly close. It cost an average of $10.37 per stump to tarp each stump. It cost an average of $9.50 to treat each stump with Garlon 4®. The Acacia trees were initially cut leaving stumps approximately 18" high. Stumps to be treated with the tarping method were re-cut to a height of no greater than 4 inches above grade before the tarp was installed. Stumps to be treated with Garlon 4 were re-cut approximately one minute before the herbicide was applied to the cambium layer of the bole. These stumps were also cut to a height of no greater than 4 inches above grade. Each of the two cost evaluations included the time needed to re-cut the stumps.

The cost of treating each stump using the tarping method averaged $10.37 per stump. This was calculated by taking the cost for each employee working on the installation and multiplying by the number of hours worked. This total was then divided by the number of stumps treated to arrive at an average cost per stump. A different way of examining the costs is to compare the total crew hours needed to complete the project and dividing by the number of stumps treated. This number works out to an average of one hour per stump. This method will allow managers the ability to project costs based on their own payroll data.

Another factor worth considering is soil compaction. The Olympia site was a sand hills environment with loosely packed soil which was easy to dig through. Other sites with denser soils may take longer to trench thereby increasing time and money needed for the tarping installation.

Removing the tarping is projected to be $5.00 a stump at the end of the project. This represents the expense of digging up and disposing of the tarp after the two-year period.

The cost of treating each stump with Garlon 4® averaged $9.50 per stump. This was calculated by adding up the cost of the Certified Pest Applicator, the cost of the crewmember and chainsaw to re-cut the stumps, and the cost of the herbicide. This sum was then divided by the number of stumps to arrive at an average cost per stump. Please note this cost does not include the cost of the Certified Pest Control Advisor who's time was donated by Davey Tree Surgery. The Garlon 4® was applied by a Certified Pest Applicator. Because NREP did not have an Certified Applicator on staff it was necessary to sub-contract the work. Having a Certified Applicator on staff could greatly reduce this cost.

Conclusions:

Results have shown that tarping can be as effective as herbicides as a stump treatment. Eliminating the acacia's ability to photosynthesis effectively kills the stump. Trenching when installing the tarp may also inhibit the stumps ability to re-sprout. Cost comparisons show that both treatments may fall in approximately the same price range depending on permit restrictions.

Herbicides may prove to be more cost effective when treating a large number of stumps. If only a few stumps need to be treated it may be more cost effective to use tarping. Tarping does not require certified personnel to install. This can lead to cost savings when the cost of a Certified Pest Advisor or Certified Pest Applicator is compared to an uncertified worker. Another factor to consider is the availability of volunteers who can be trained to install the tarping. Many volunteer groups do not have the capacity to advise or apply herbicides on their own. Tarping is easy to learn and requires no specialized training.

This technique may be transferable to other invasive species such as Tasmanian Blue Gum (*Eucalyptus globules*).

Team/Resources:

The project was funded by the San Lorenzo Valley Water District Water District and the U.S. Department of Fish and Wildlife. Other partners and collaborators included Davey Tree Surgery and the Natural Resources and Employment Program.

Nitrogen Deposition Impacts on a Nutrient-Poor Grassland Ecosystem: Conservation, Management and Restoration

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Humans have greatly increased the flux of reactive nitrogen in the biosphere, altering many terrestrial and aquatic ecosystems. In the San Francisco Bay Area, grasslands on nutrient-poor serpentine soils are being invaded by nutrient-demanding introduced annual grasses (*Lolium multiflorum*), driven by dry N-deposition on the order of 10 kg ha^{-1} yr^{-1}. These grass invasions threaten the rich native biodiversity of serpentine grasslands, including the federally-protected Bay checkerspot butterfly and several endemic plant species. A passive monitoring network for reactive nitrogen gases (NO_x, NO_2, NH_3, HNO_3, and O_3) has been set up to investigate regional and local N-deposition gradients. The regional gradient extends from clean coastal

areas to downwind of the highly urbanized Santa Clara Valley, driven by prevailing NW winds. A local gradient extends upwind and downwind of an 8-lane freeway carrying 100,000 cars/day, located in a near-coastal area. NH_3 emissions from vehicles drive local N-deposition patterns. *Lolium* was denser closer to the freeway, but only on the downwind side (controlling for soil depth, the other main factor affecting grass density). Grassed-over areas build up thatch that suppresses native plants. Restoration experiments include mowing, goat grazing, and prescribed fire. Carefully-timed mowing was an effective treatment. Additional NO_x and NH_3 sources planned for the region include a 600 MW natural gas fired power plant, industrial parks that may eventually draw 20,000 to 50,000 additional cars per day, 25,000 housing units, and associated highway improvements. Mitigation proposals include purchase and long-term management of hundreds of hectares of habitat. Management of the larger areas necessitates continued moderate cattle grazing. Cattle selectively crop nitrogen-rich annual grasses, and remove N from the system, while redistributing N within the system as feces and urine. This case study highlights the complexities of habitat management in the face of N-deposition and invasive species.

Session 7: Biology and Biological Control

Biological Control as a Tool for Ecosystem Management

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Biological control is proposed as a tool useful for ecosystem management and compatible with the goals of often competing interests regarding the restoration and maintenance of ecosystems. I summarize the effects of introduced species on ecosystems in three broad groups: insects, vertebrates and weeds. The role and reasonable expectations of biological control methods are discussed for each. Of the three groups, biological control of weeds appears to have the best chance for success in ecosystem management. Case studies will be used to illustrate major points. A discussion of future trends and funding will close the presentation.

The European Biological Control Laboratory: Contributing to Successful Management of Invasive Species in the U.S.

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The European Biological Control Laboratory (EBCL) is an overseas laboratory of USDA/ARS with its main laboratory located in Montferrier sur Lez, France and two substations in Rome, Italy and Thessaloniki, Greece. The primary mission of EBCL, established in Europe since 1919, is to conduct research on biological control of weeds and insects. EBCL scientists (one plant pathologist, one insect pathologist, one plant physiologist/weed scientist, one molecular biologist and six entomologists) conduct foreign exploration to search for agents, taxonomic studies for identification of the agents, host-parasite interaction studies to understand the agent and its effect on the host, and host range studies to determine the specificity of the agent and its safety for eventual release in the U.S. More than 80% of biological control agents introduced into the

U.S. originate from EBCL. Some important current targets include: giant reed, yellow starthistle, saltcedar, olive fruit fly, Asian longhorn beetle, and the Formosan subterranean termite. Scientists at EBCL work closely with collaborators in the U.S. (Federal Agencies, including USDA-APHIS, State Departments of Agriculture, and Universities) providing agents for testing and field implementation and information that could be useful against a specific target.

The Use of Remote Sensing to Assess Biological Control Impact on Saltcedar in, Nevada

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Saltcedar (*Tamarix ramosissima* and *T. parviflora*) is a major invasive weed problem throughout the United States and Mexico. Introduced to the United States in the 1800s, the plant infests riparian areas where it displaces much of the native vegetation, increases fire hazards and causes extensive damage to agricultural and natural ecosystems. Saltcedar also causes extensive water loss, causes floods and requires costly chemical and physical control efforts. Beginning in 2001 researchers from the United States Department of Agriculture and cooperating agencies including the Nevada Department of Agriculture and the University of Nevada at Reno released a Chinese leaf beetle (*Diorhabda elongata*) in six states as part of a project aimed at developing effective biological control agents for saltcedar. This insect is now doing well in several field sites, particularly in areas of Nevada near Reno. Hyperspectral imagery from remote sensing has been successfully used to monitor this biological control effort, documenting substantial impacts of the beetles in Lovelock, Nevada. Efforts are now focusing on the use of ground sampling and hyperspectral remote sensing to quantify *Diorhabda* impact, defoliation dynamics, insect population growth and movement within saltcedar stands found at this site.

Rapid Evolution of Invasive California Poppies

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When non-native species disperse to a new environment, their invasiveness will be determined by their ability to grow in a new environment that has different biotic and abiotic conditions from their home range. Two of the possible mechanisms that allow non-native species to invade and persist in new environments are phenotypic plasticity (i.e. the "general purpose ecotype") or local adaptation by natural selection. I will present results from studies on the California poppy, *Eschscholzia californica*, designed to test for genetically controlled differences between native populations and populations that are invasive in Chile. There are both divergent and convergent traits in the native and invasive populations: like their native counterparts, traits of invasive populations vary in a similar way along geographic and climatic gradients. In contrast, invasive populations grow larger and produce more seeds than native populations, but only when plants are grown in disturbed environments with reduced competition from other plants. And finally, invasive populations tend to be more resistant to herbivores than native populations. Finding this type of genetic change in invasive populations is noteworthy, in part because of the rapid rate of evolutionary change. If this type of rapid evolution is pervasive, it will

complicate efforts to screen for invasibility in plants.

Prediction of *Cynara cardunculus* Seedling Development Using a Degree-Day Approach.

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Efforts to control invasive plant species must be timed correctly to occur at specific stages of development in order to maximize the effect of the treatment and minimize the input of labor and funds. A controlled phenology experiment and a germination experiment were combined with field observations to construct and verify a degree-day model for *Cynara cardunculus*, artichoke thistle. The phenology experiment was conducted at the Agricultural Experiment Station at UC Riverside in 1998-1999. *C. cardunculus* seeds were planted monthly and growth data were recorded twice weekly for 18 months. In the germination experiment, *C. cardunculus* seeds were germinated in petri dishes on a temperature gradient bar. Regression analysis was used to estimate a base temperature below which germination is inhibited. This information was used to construct a chart of degree-days using various temperature and upper cutoff method combinations. Using the median days to emergence of block averages from the phenology experiment, a best-fit temperature and upper cutoff model was chosen. To validate the model, temperature and phenology data were collected during the 2002-2003 field season at a field site in Crystal Cove State Park in Orange County, CA. The observed phenology data was compared to predicted phenology data determined by the selected model. By predicting when desired stages occur, land managers can schedule control timing to be most effective.

Patterns of Seedling Establishment in Artichoke Thistle, *Cynara cardunculus*

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Seedling establishment is a necessary step in plant invasion, and understanding the factors that control seedling establishment can be important to preventing the further invasion of weed populations. *Cynara cardunculus*, or artichoke thistle, is a perennial invader of coastal grasslands throughout California. Since artichoke thistle plants are perennial, targeting seedlings in their first year may be a more successful means of control than targeting only adults. Artichoke thistle seedlings are commonly observed close to mature adult rosettes in natural populations, suggesting that seedling establishment is influenced by seed dispersal, by adult rosette facilitation, or by an interaction between the two factors. In this study, the facilitation hypothesis was tested by planting seedlings at distances up to two meters from adult plants in a natural population. The adult rosettes were subjected to four treatments to determine how adults might influence seedling emergence and survival. The treatments removed A) dead litter only, B) live rosette leaves only, C) both leaves and litter, or D) no removal treatment as a control. The emergence and survival of planted seedlings were followed over the course of one growing season. Preliminary results show that rosette treatments have no significant effects on emergence at any distance from the adult, but that treatment may have an effect on survival. Survival, measured by senescence date, shows an increasing trend

with live rosette removal treatments. The trend is most pronounced closest to the rosette, suggesting that establishment facilitation is not at work in artichoke thistle, and that seedlings survive best without the influence of adult rosettes. Current and future work includes studies on the dispersal patterns of artichoke thistle, and the natural distribution and survival of its seedlings. By understanding the relationship between dispersal and establishment patterns of artichoke thistle, land managers may be able to predict the areas of greatest recruitment for artichoke thistle, and modify control efforts accordingly.

Invasibility of Experimental Riparian Communities by *Arundo donax*

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As invasive plants enter new areas, they necessarily interact with resident plant communities. Several researchers have found a link between the functional diversity of a resident plant community and its invasibility. This study investigates the role of functional diversity in experimentally constructed riparian communities in regulating invasibility by *Arundo donax* L. Two experiments, differing only in planting density, were conducted simultaneously in an agricultural field at the University of California, Riverside. Three native riparian species (*Salix goodingii*, *Baccharis salicifolia*, and *Scirpus americanus*) representing three putative functional groups, were planted six to a plot in all combinations (seven community treatments). These communities were allowed to establish for 14 months before *A. donax* rhizomes were introduced into half of the plots in each experiment. *A. donax* was expected to invade more readily into single-species low-density plots and less readily into three-species high-density plots. Shoot emergence timing and shoot height for *A. donax* were monitored until senescence. In the first season, *A. donax* shoot emergence timing was not different when the two experiments were compared. Number of days to shoot emergence was significantly different among community treatments ($p=0.008$), and was greatest in single- or two-species plots containing *B. salicifolia*. Shoot growth rate was significantly greater ($p=0.04$) in the low-density experiment than in the high-density experiment, and was lower in single- or two-species plots containing *B. salicifolia* than in all other plot types. *A. donax* shoots emerged quickly and grew rapidly in "diverse" plots containing all three species. These data suggest that the establishment of *A. donax* is influenced by community composition, and that diverse communities may be more invasible than some simpler ones. The poor performance of *A. donax* in plots containing *B. salicifolia* may provide support for use of this species in riparian restoration following *A. donax* removal.

Seasonal Activity and Impacts of *Arundo donax*

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The seasonal physiological activity of *Arundo donax* and its impact on riparian systems was studied using both common garden experiments and a field survey. *A. donax* is a perennial species that exhibits a high rate of growth. To quantify its seasonal physiological activity, *A. donax* was collected from the northern, central, and southern regions of California and planted in a common garden experiment at the University of California at Riverside. The photosynthetic rate of *A. donax* was measured twice a month for eight months. *A. donax*'s average carbon assimilation rate varied from a low of 16.713 μmol $CO_2/m^2/s$ to a high of 39.358 μmol $CO_2/m^2/s$ and, to this point, appears to correlate ($R^2 = 0.8446$) more closely with the low temperature on the day that it was measured rather than the high temperature or calendar date. To test the hypothesis that *A. donax* alters the abiotic conditions of the environment, which in a manner that favors its own success, a field survey was conducted along two watersheds in southern California. Six permanent transects were set up perpendicular to the river at each site. Monthly measurements of soil temperature, soil moisture, vegetation cover, and light intensity displayed little difference between points with and without the presence of *A. donax*. Thus, data collected to date indicates that *A. donax* can remain physiologically active throughout the year. Research is ongoing to identify its physiological impacts in riparian habitats.

The Potential Contribution of Natural Enemies from Mediterranean Europe to the Management of the Invasive Weed *Arundo donax* (Graminae; Arundinae) in the U.S.

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Summary
1: Extent of problem:
Arundo is devastating watercourses in southern California, Texas, New Mexico and Arizona.

2: Damage and current control costs
Environmental damage consists of displacement of native plants, uniform stands of low wildlife value, increased flood and fire risks and extensive use of herbicides. Estimated clearance costs (cutting and herbicide application) are about $US25000/hectare (Santa Ana River, southern California initial clearance costs $US80million).

3: US customers:
Team Arundo del Norte (multi-stakeholder consortium in California), Watershed authorities in California, Texas and New Mexico, and the Texas Parks and Wildlife Department.

3: Potential biocontrol agents:
In the Mediterranean area 3 Diptera species possibly associated with a fungus *Nigrospora* sp.impact *Arundo* by attacking and killing developing canes above and just below ground level, an armored scale kills mature canes and 2 Diptera species mine leaf sheaths.

4: International Cooperative Links:
Biocontrol practitioners in a Mediterranean Network (set up recently by ARS) covering Spain, Sicily and Crete all good climatic matches with *Arundo* infested areas of the US, have already delivered several promising agents. The ARS laboratory in Brisbane is well positioned to survey the closely related grass *Monochater paradoxus* in Australia.

5: US cooperators:
The ARS laboratories at Albany, California, Temple, Texas and Las Cruces, New Mexico, are a strong base on which to build a successful program.

Abstract
Arundo donax, Giant Reed, is a widespread invasive weed in California and south western U.S. Outside the U.S., it ranges from the Canaries to northern Myanmar. It is a biocontrol target because of its intransigence to cultural and chemical control and its disastrous impact on the local ecology. Foreign exploration in Nepal and India revealed little sign of natural, control whereas collections made around the Mediterranean resulted in 3 Hymenoptera, 5 Diptera, a scale species and several plant pathogens, which cause death of shoots, tips and dormant buds. On the average, 56% of an *Arundo* stand is dead in the region around Montpellier France. Preliminary results suggest mortality may be attributed to Diptera (38%), and scale insects (14%), with Hymenoptera and fungal pathogens also playing a role. Infested

areas of California and parts of the Mediterranean basin are excellent climatic matches. These results suggest that the Mediterranean is likely to be a profitable area to explore for natural enemies. Characterization of *Arundo* samples from Europe, Africa, Asia, North America and Australia may elucidate its center of origin and the origin of the *Arundo* stands in the U.S.

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Introduction

Arundo donax, Giant Reed, is a tall, 2-10 m perennial grass found naturally from the western Mediterranean to India. (Duke, 1984). The potential distribution of *Arundo* in the U.S. would include nine States from East to West (Figure 1).

Giant reed tolerates salinity and is drought and inundation tolerant (Perdue, 1958). Dudley and Collins (1995) note that the densest growth of *Arundo* occurs along the coastal rivers of California. In California, large areas of giant reed constitute serious ecological and flood management difficulties by displacing native vegetation (Vartanian, 1998). Currently, *Arundo* is managed by costly mechanical and chemical means. (Vartanian, 1998).

The damage caused by giant reed in California far outweighs the small economically beneficial uses. It has a growth rate up to five times faster than native plants (e.g. willows), in the same habitats on southern California coastal rivers (Rieger & Kreager, 1989). *Arundo* is flammable but the rhizomes are resistant and sprout after fires, while native plants are much slower to recover (Bell, 1997). The major *Arundo* control method is the use of broad spectrum herbicides such as Roundup. Costs of this method are from $22000-$46000/hectare based on removal costs in an eradication program in the Los Angeles County Flood Control District and along the Rio Hondo. (Vartanian, 1998). Such costs may prove unacceptable when it is considered that along the Santa Ana River there are 4000 hectares of *Arundo*, which at $20000/ hectare would reach $80 million. Classical biological control of weeds has been used against 35 invasive weed species in the U.S., and against many weed targets in 70 countries worldwide; about 33% have been successfully controlled (Julien 1999). Classical biological control of weeds has a fine safety record; more than 350 natural enemy species have been utilized over the last 100 years and only eight of these have been documented as causing minor damage to non-target plants (Julien, 1999). Several major water weeds considered unpromising targets initially have been successfully controlled; ultimately the same may be true for grassy weeds (Julien, 1999). Tracy and DeLoach (1999) and Cummins, (1971) list 21 insect species, five mite species, one nematode species and 21 fungal pathogens from *Arundo*. Of these one insect species is considered monophagous, zero mites and nematodes, and four fungal pathogens; the others are oligophagous or polyphagous

Recent work at EBCL

Fifty cm square quadrats have been taken from *Arundo* stands each week for 15 weeks (starting May 5 2003) in the Montpellier and Perpignan areas of southern France. All *Arundo* within the quadrats was cut, taken back to the laboratory, examined, dissected and documented. Organisms found were, when possible, reared to adults and passed on to appropriate taxonomists.

At least 3 Diptera: Chloropidae species probably of the genus *Cryptonevra* (currently being studied by Taxonomists) have been reared from dead or dying *Arundo* shoot tips, developing canes and cane tips. These are the first records of Chloropidae from *Arundo (*Tschirnhaus pers. comm.. J. Tracy). The flies oviposit into the tight whorl of leaves of new shoots that develop into mature canes and descend to the growing base. This is damaged by the larvae feeding along the fibres. The shoot yellows, and eventually becomes a dried brown husk. The fungus *Nigrospora oryzae* is associated with this damage and probably with the Cryptonevra larvae.

EBCL has collected fungal pathogens from *Arundo* rhizomes in southern France. Buds were often observed to be decaying before opening. Fungal pathogens of *Arundo* leaves have also been collected in France, Greece, Nepal and South Africa (preliminary collections).

However, the effects of fungal pathogens on giant reed are unknown. Further surveys for pathogens of *Arundo* in Europe are needed if the full potential of natural enemies for biocontrol is to be realized.

More than 80% of *Arundo* canes from the 0-100cm class are dead in *Arundo* stands in southern France, (Table 1). Total mortality within stands is 56%; mortality within the 0-100cm class contributing 38% of total mortality. The effect of this mortality is to remove canes from within a stand. These are replaced inside the stand by new canes thereby reducing invasion out of and expansion of the stands.

Mortality within classes from 101-300cm is mainly attributable to damage caused by an armored scale (species as yet unknown), which results in these mature canes dying. The witches' broom effect on these canes results from pad like deformations caused by intensive feeding. Effects on the *Arundo* rhizome are probably severe and the stressed canes eventually die.

Tetramesa romana of the Hymenoptera Family Eurytomidae is recorded only from giant reed in Mediterranean Europe. It causes elongate galls around side shoots and induces internodal shortening. A new species of *Tetramesa* has been collected by EBCL scientists from *Arundo* in southern France (as yet unidentified). It induces elongated galls which coalesce into large swollen patches; internode length is reduced also. Studies on the impact of *Tetramesa spp.* on giant reed are needed as this genus of Hymenoptera is the only monophagous insect currently known.

Other organisms found that have visible effects include a Diptera: Cecidomyidae species which massively attacks and destroys leaf sheaths of early canes; a Diptera: Agromyzidae species *Cerodontha* sp. which mines leaf sheaths and a Lepidopteran species that feeds on growing tips causing malformations. Less obvious, but not necessarily less important are a subterranean Homoptera: Aphididae *Anoecia* species feeding on underground buds and a mite, *Siteroptes* sp., present in dying side shoots.

The exact center of origin of *Arundo* is not clear. *Arundo* samples have been collected from 14 countries and will be genetically characterized to elucidate this question.

Discussion

As stated by Tracy & DeLoach (1999), classical biological control of giant reed in the U.S. is justified. Tracy and DeLoach (1999), using the scoring system of Peschken and McClay (1995), rated the suitability of *Arundo* for classical biological control slightly behind the major weeds *Centaurea solstitialis,* Yellow starthistle, and *Hypericum perforatum,* St. Johnswort, in California. Giant reed has little economic value and its aggressive, invasive nature, makes it a formidable competitor with native vegetation. Expensive environmentally harmful methods of mechanical and chemical control, would be reduced as a result of successful established classical biocontrol using specific insects and pathogens.

The goal of this proposal is classical biological control of *Arundo* in the U.S. that would consist of foreign exploration for natural enemies, evaluation, and selection of currently known natural enemies and new natural enemies found during the surveys.

Based on climatic matching with *Arundo* infested areas in California (using CLIMEX), surveys will be made in appropriate areas of Spain, Portugal, Canary Isles, Italy, Greece Turkey ,North Africa and Australia.. Barker & Linder (1995), determined phylogenetic relationships between various lineages in the grasses and showed that *Phragmites* is not closely related to *Arundo* and that the little known monotypic genus *Monochater* in Queensland Australia is closely related. The ARS Australian Biological Control Laboratory in Queensland is well placed to investigate the natural enemies of *Monochater* tha*t* may have potential for use against *Arundo* in the U.S. Initial surveys will take place in fall, second year in summer and the third year in the spring to cover the most important growth periods. Site details, locality, altitude, GPS position will be recorded. Giant reed rhizomes will be unearthed and dissected at each site for natural enemies. Lengths of rhizome and cut stems and leaves will be placed in moisture absorbent bags, cooled, and returned to the EBCL quarantine for emergence. As many sites as possible will be surveyed during visits to each area. In addition,; plant samples will be put in tubes over silica gel and stored for future genetic characterization.

Milestones in the first year will be the emergence of natural enemies from collected material and their identification. This will allow further surveys to be prioritized in those areas with the most abundant damaging natural enemy complex. In the second and third years, successful rearing techniques and the initiation of specificity testing will be important milestones leading to selection of the most efficacious natural enemies for giant reed control in the U.S. Specificity testing and evaluation would be carried out in the ARS quarantines in Las Cruces, New Mexico and Albany, California.

Progress will be measured by the number of new natural enemies found, successful rearing, completed evaluation leading to prioritization and selection of the most efficacious natural enemies. After rigorous specificity testing and authorization the selected natural enemies would be released into the US (Appendix1).

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Figure1
Potential distribution of *Arundo donax* in North America (map courtesy National Park Service).

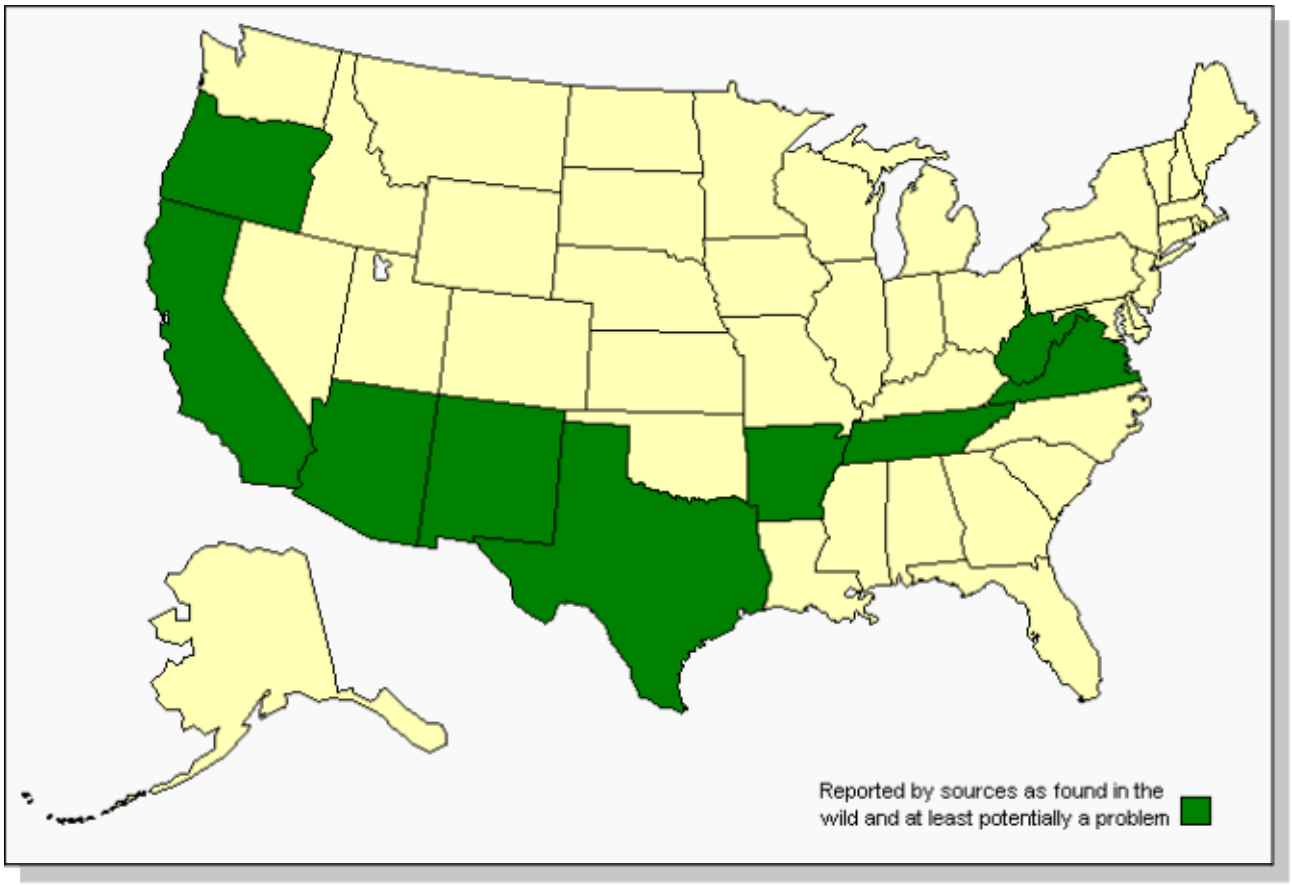

Table 1
% mortality of *Arundo donax* in southern France. Results based on 15 50X50cm quadrats

Class length (cm)	0-100	101-200	201-300	301-400	401-500	501-600
No. Canes/class	217	44	120	87	21	1
No. Canes (dead-alive)	187-30	29-15	40-80	13-74	6-15	0-1
% mortality in class	86	66	33	15	29	0
Total % mortality	56					
Class contribution to % mortality	38	6	8	3	1	0

Appendix 1

BIOLOGICAL CONTROL OF ARUNDO MODEL

"Conception to Success" approach: Definition: Application and implementation of an entire biocontrol program from start (selection of a target pest) to finish (solution of the problem, i.e. management of the target pest) by a coordinating action team from all interested parties, assembled for the duration of the project.

BIOLOGICAL CONTROL PROGRAM

Cost Benefit Analysis
Foreign exploration for natural enemies of *Arundo* and the resulting biocontrol organisms discovered driving the following areas in a biocontrol program.
Taxonomy
Genetic characterization
Habitat characterization
Population Dynamics includes pre-release studies of *Arundo* and its natural enemies in the area of origin and in the exotic invaded areas.
Quarantine activities
Evaluation
Selection
EPA environmental impact document
Mass rearing
Release
Post release impact studies

ACTION TEAM

NPS, OIRP, USDA ARS, USDA APHIS, Universities, State Depts. of Agriculture ,Industry, End-Users, Other biocontrol groups.
Steps in the construction of such a team would begin with a preliminary meeting of people from the above.
OBJECTIVES OF THE MEETING
Select Coordinators
Devise an action plan with regular progress meetings
Set up a network
Designate people to carry out specific studies/tasks
Set a time limit 5 years for selection and release of safe efficient natural enemies**.**

ACTION PLAN

COST/BENEFIT ANALYSIS of the program (USDA or University economist**)**
FOREIGN EXPLORATION by EBCL and foreign and US cooperators
TAXONOMIST, identifications (USDA or cooperator)
GENETICIST, elucidation of biotypes of pest/weed and natural enemies (USDA or University)

ECOLOGICAL STUDIES at EBCL and overseas including field evaluations in areas of origin and field evaluation and selection
QUARANTINE EVALUATION of natural enemies in US
SELECTION of natural enemies in QUARANTINE

ENVIRONMENTAL approvals
PILOT MASS REARING of natural enemies
FIELD evaluation
RELEASE of natural enemies
IMPACT studies after release (A USDA/ ARS CRIS based on this topic?)
COMMERCIAL mass rearing of natural enemies/development of distribution methods **(A**

	TIME SCALE
COST/BENEFIT ANALYSIS	**Year 0**
FOREIGN EXPLORATION	**Years 1-4**
TAXONOMY	**Years 1-4**
GENETICS	**Years 1-4**
QUARANTINE	**Years 1-5**
EVALUATION	**Years 3-5**
SELECTION	**Years 4-5**
REARING	**Years 4-5**
ENVIR. APPROVALS	**Years 4-5**
RELEASE	**Years 4-5**
DEMONSTRATION	**Years 3-5**
COMMERCIAL REARING	**Years 5---**
DELIVERY SYSTEMS	**Years 1-5**
IMPACT STUDIES	**Years 5---**

MEETINGS annually to discuss progress and communicate results.
DEMONSTRATION MEETINGS with end users to present methods of rearing and of application of natural enemies in the field.

Working Groups

Working Groups I

Nurseries: Working with Industry on Invasive Plants

Facilitator: Alison Stanton, *BMP Ecosciences*

Introductions took about 1 hour. Participants had wide diversity of experiences with invasives in nurseries. Several participants currently operate or work at nurseries, some had experience with approaching local nurseries to ask them to stop selling an invasive.

John Randall, TNC, gave a summary of the Linking Ecology and Horticulture meetings that led to the development of the Missouri Botanical Garden Codes of Conduct. Several national level organizations have endorsed the codes, including ANLA and ASLA. The codes provide voluntary guidelines for invasive plant management for different stakeholders, including government, nurseries, gardeners, and landscape architects.

On the national front, both Massachusetts and New Hampshire are developing programs to test and label invasive species. No regulations are currently in place, but Mass. Is working on regulation to prohibit the sale of invasive plants.

John also mentioned that Mandy Tu will be working with Schmidt Nursery in Oregon on adoption of the codes. TNC is involved in a effort to make nurseries aware that endorsing the codes could be positive for public relations.

Jeff Hart, from Hartland Restoration and Nursery, is developing a propagation program for native wetland aquatics at the nursery in Walnut Grove. He sees an emerging market in restoration using native aquatics as people are becoming more aware of the problems associated with invasive aquatics.

Marie Jasieniuk, UC Davis Weed Science, is looking at the spread of pampasgrass into interior regions of CA using molecular markers. Her lab is also trying to identify other invasive Cortaderia cultivars.

Carl Bell, UCCE San Diego, has produced separate brochures for five regions in the state that identify 3-5 invasive ornamentals in that regions. Master gardeners will serve as the main point of distribution. He mentioned Greenley Nursery as a source of invasive grass species and a possible nursery that we should approach.

Sue Gardener, Parks Conservancy GGNRA, has developed a list of acceptable landscaping plants for homeowners adjacent to the park. Homeowner literature includes information about weeds and weed control.

Ann Howald, Garcia and Associates, is teaching Master Gardener classes and sees the new alternatives brochure as a useful teaching aid.

Maria Alvarez, GGNRA, has gone door to door in Mill Valley to encourage people to stop planting brooms. She runs an active weed management program at GGNRA.

Carolyn Martus, CNPS, successfully rallied Wal-Mart to get pamapsgrass off their shelves. She is trying to bring growers to the table in San Diego to discuss non-invasive alternatives to known invaders.

Alison Stanton, BMP Ecosciences, unveiled the new "Don't Plant a Pest" brochure. It will be distributed through WMA's Master Gardeners, and some local Bay Area nurseries. Alison and Bethallyn Black , Master Gardener Coordinator for UCCE Contra Costa, are going to work together to develop an educational workshop aimed at training Bay Area Master Gardeners on how to successfully use the brochure to approach nurseries. All viewed Master gardeners as a valuable resource for getting the message out about invasive landscaping plants on a grass roots level. The workshop will be planned for sometime early next year.

Sloat Garden Centers, with 5 or so outlets in the Bay Area has a monthly newsletter that might be a good place to advertise the brochure. A representative from Sloat participated in meetings to develop the brochure and they are acknowledged on the back of the brochure.

CNPS has native plant planting protocols on their website, but no specific information about alternatives to invasive landscaping plants. Cal-IPC could provide them with website content addressing invasive ornamentals.

Working Group Attendees:

Attendee	Affiliation
Alison Stanton	BMP Ecosciences, CalEPPC
Beth Leger	UC Davis
Bethallyn Black	UCCE Contra Costa
Jeff Corbin	UC Berkeley
Dan Songster	CNPS
Bob Hass	Sonoma Ecology Center, CNPS
Carolyn Martus	CNPS
Dawn Rafferty	NV Dept. of Agriculture
Jake Sigg	CNPS
Jeff Hart	Hartland Nursery
Kathleen Teare	Rosendale Nursery
Marie Jasieniuk	UC Davis
Carl Bell	UCCE San Diego
Beth Brenneman	USFS LTMBU
Peter Brastow	NPS, SFWMA, CNPS
Sue Gardener	GGNRA
Ann Howald	Garcia and Associates
Asha Setty	GGNRA
Kay Panek	BLM Ft Ord
Marie Alvarez	GGNRA
Crystal Ritchie	CA State Parks
John Randall	TNC

Mapping: Setting Priorities and Communicating Scope

Facilitator: Steve Schoenig, *California Department of Food & Agriculture*

The group discussion focused on the need for mapping, mapping techniques, and some of the problems encountered in existing programs.

Mapping protocols – Although there is no single method considered "correct," there are agreed upon conventions. These mapping protocols can be followed to initiate new or streamline existing programs, map native and invasive species, and improve program efficiency. The California Weed Mapping Steering Committee prepared the California Weed Mapping Handbook (*available from CDFA*) to assist WMAs in their mapping efforts. The Handbook uses globally accepted standard elements (NAWMA fields on page 4-4 of the Handbook).

Mapping for Strategic Planning – An initial inventory is an important component of weed management, and spatial distribution of species is necessary to manage at the regional level, and to prioritize and track successes of weed programs. At the regional level, a data dictionary may be required; however, one-meter accuracy is probably not necessary. Similarly, for heavy infestations, mapping at the township level is probably sufficient. Finer, more detailed mapping is required at

boundaries and outlying infestations. Managers need a flexible strategy to determine when and how to GPS. Remote sensing to acquire data is in the pilot phase for weed mapping, and is probably not suitable for important sporadic weed locations.

Data collection forms – Many of the problems encountered by the group concern development of forms for tracking treatments, monitoring infestations, and database integration. The forms developed and used by *Team Arundo del Norte* (Observation Form, Treatment Form, and Post-Treatment Form) may be adapted for use by other WMAs. Another problem, which may require a different approach, is dealing with sites that change over time (i.e., get larger or smaller).

A meeting in Sacramento was suggested to demonstrate some of the different databases in use (e.g., CDFA's A-rated weed population database). An Arc View class may also be scheduled to assist WMAs with training and development of their mapping programs.

Volunteer Mappers – Several participants provided examples of successful mapping efforts using volunteers. Some of their strategies include:

- "Para" botanists who are trained to identify a few target species
- Training public employees who work in the field
- Instruct volunteers to mark locations on assessor's parcel maps
- Perform follow-up visits to "suspect" sites to ensure quality control

The group agreed that mapping where weeds are <u>not</u> found is also necessary for an effective mapping program. It was also noted that there is a need to acquire "full flora" mapping data, not just invasive species data.

Working Group Attendees:

First Name	Last Name	Organization	Email
Deanne	DiPietro	Sonoma State University	deanne.dipietro@sonoma.edu
Gail	Kuenster	CA Dept Water Resources	kuenster@water.ca.gov
Catey	Ritchie	GGNPC - Site Stewardship	
Samuel	Valdez	Official Trip Reports	caleppc@trip-report.com
Katy	Zaremba	Invasive Spartina Project	kzaremba@scc.ca.gov
Jennifer	Langford	Jenesis Ecological Services	scojen@charter.net
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Fire: Prescribed Burning as a Management Tool

Facilitator: Joe DiTomaso, *University of California at Davis*

Questions/discussion from the group:

1) Chris was looking for information on effects of reintroduction of fire on invasive species in the Plumas NF. Jon Keeley's work in southern Sierra is not totally relevant – cheatgrass is not a big problem on Plumas. Someone replied that she has some results from Lassen NF – mullein and bull thistle have come in where there was high level of canopy mortality.

2) Someone else tried to do some Rx burns on serpentine to control annual ryegrass – got shut down 3 times for various reasons. In Marin County, haven't been able to burn in winter because of Tom Parker's research. But summer burns get shut down too often – need to explore other windows for burning.

3) Burning in Bishop area – hot burns over moist soil resulted in good regeneration of natives, but hot burns over dry soil killed soil bank. Kind of opposite of chaparral research.

4) Maritime chaparral Rx burns – got increase in veldt grass. Burn looked really good at first, but there was a seed source at a seep that wasn't killed by the fire.

5) Bill Winans encountered Robin Wills' experience at Santa Rosa Plateau – burned in spring to eliminate nonnative annual grasses, while maintaining perennial grasses. Dawn Lawson reported that

in ordinance-burned areas on Camp Pendleton (which burns in spring), native perennial grasses are favored over annuals. Concern over effects on native forbs from spring burning. Dawn reported concern for native animals with every year spring burns.

6) Carla D'Antonio – did meta-analysis on fire in grasslands in California (will report on this tomorrow). Found that burning annual grasses is effective for one year – if burning is not continued, annual grasses tend to come back. Also, many exotic forbs increase significantly with fire. So your goal should determine what kind of burning program you use. Someone else mentioned that fire tends to increase nonnative perennial grasses also (didn't type fast enough to get list of species). Wind dispersed weeds tend to come in after fire also.

7) What about leaving islands for wildlife? Irregular boundaries help; in larger burns, there are usually less-intensely or unburned patches. Dawn L – need to spell out your objectives for a Rx burn, can't recreate natural fire regimes, esp. in So Cal. Some studies Carla reviewed found that adding grazing after fire helped keep the annual grasses suppressed.

-- Problems with studies she reviewed: no controls in a lot of them; only followed vegetation for 1 or 2 years after fire.

8) Agricultural burning – stubble and ditches – is done to help control weeds. But the fire air currents might actually help spread the seed? Dale Schmidt answered: "It depends" (has apparently seen some seed spread this way).

9) With our litigious society, have to do prescriptions and analysis for every Rx burn. There aren't fuel models for perennial pepperweed or for burning tules at 4% humidity, for example. Too easy to get out of prescription using a model from somewhere else. Need researchers to help build these models for us. Bill Winans recommends writing a very broad prescription to make it easier to stay within.

9) Question about air quality and getting AQMD permits to do Rx burns. How do we convince air regulators to let us burn? In Central Valley, there is a LOT of public interest in burn programs – have had lots of smoke affecting people in the area. AQMD has to respond to public health issues as well as general air quality. Compare smoke output from Rx fire to wildfire – but it is hard to compare scheduled event to unpredictable "act of god" – no data on this.

10) Plea – when you do a burn, set up control plots. Take data. Measure attributes of the fire itself – intensity, severity, duration, flame length, etc. Doesn't have to be research-quality study. Collecting data costs money, also. Suggestion: someone produce a simple guide to how to make your burn meaningful in terms of data. Mostly we are looking for large effects from fires – not that complicated to collect data for this level. Suggestion – take advantage of local university personnel, data available from agencies. Most important characteristics: amount of fuel consumed; soil moisture; fuel moisture; seed head conditions; estimate of intensity from duff layer consumption, etc. Noted that DATE of burn is not a good indicator of season – depends on meteorological conditions that year. Phenological stage of key plants is more important. National Park Service Fire Monitoring Handbook (available on the web) has good set of measurements that NPS uses when conducting Rx burns. Linnea Hanson (Plumas NF?) reports that their Rx fire folks are very cooperative about collecting information.

Moving on to another topic….

How to reduce the risks of Rx fires escaping? Foam line in grasslands; backline; hoselay and wetting down adjoining vegetation thoroughly; lighting pattern has some effect. Question about effects of timid line burn vs larger broadcast burn – aren't going to be ecologically equivalent.
Q: What is in the Foam? A: Class A foam (like a soap).

Control of woody species using Rx fire:

Example: Broom control – burn reduces broom, stimulates seed bank; then cut new broom, burned it. Had less than desirable results. Madrone eliminated from system, coast live oak looks bad; annual grass is real sparse; but broom is still there. Didn't end up with the diverse oak woodland that they wanted. Will have to replant some of the native species. Mowing and burning once worked well, but need a different second treatment (wishes she could use herbicide – but can't because it is water district land). Others report similar experience. Some discussions about using flaming torch to kill new seedlings (rather than another Rx fire). Only seems to work on small plants. Mentioned some kind of New Zealand implement (very expensive – only leased the machinery). Coconut-sugar extract mixed with superheated water – basically "blanches" the weeds. Works from truck-mounted unit – limits operating area to roadsides. Foam disappears in about 10 minutes. It cost $20,000 for the trial use.

What about fire – other method combinations (integrated control):

Biocontrols for yellow star-thistle achieve only about 50% seed kill. Biocontrol agents seem to recover quickly from fire.

Someone mentioned an area of star-thistle that recently burned in a wildfire – hesitant to use Rx fire because of public concerns (it is WUI situation). Joe DiTomaso mentioned that fire alone had pretty good impacts on medusahead. Plateau (herbicide) yielded. Q: How large were Rx burns? A: 100 by 100 feet (1/4 acres) – pretty small plots.

Bruce McArthur – has seen examples of herbicides that wilted stuff down (make it easier to burn). FS used to do "brown and burn" – but less use of herbicide in NF now.

Q: does treating star-thistle increase medusahead? Sometimes (herbicide, not Rx fire). Ripgut brome doesn't like to be burned. *Vulpia* does like it (also nonnative forbs like *Erodium*).

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Riparian Invaders: A Multi-Species Approach

Facilitator: Tom Dudly, *University of Nevada, Reno*

Tom Dudley was the moderator of the workshop. He started if off with people briefly introducing themselves and identifying their particular association.

Tom asked about the big weeds that people deal with:
Arundo, Tamarix ramossima, tree of heaven, Vinca, Smilo, silver lace vine, cape ivy, Himalayan blackberry, and pokeweed were mentioned.

Everyone at the workshop appeared to deal with more than one species and felt that single species removal is a limited approach.

Mike Kelly from SDR is mapping all exotics and plans to remove them all (from what area?) these include eucalyptus, Arundo, palm trees, elms, ashes, carrotwood, cape ivy, lepidium etc..

A general problem mentioned is that most removal plans focus on a single species, also funders often just want to fund removal of only the most prominent invaders. Land managers can use a single species that is problematic to fund removal of others. Weed control programs often are not funded to maintain removal efforts.

The question of how much control costs was asked: Jason @ Santa Marguerita (?), estimated costs of 11,000/acre for mowing and 1,000-1,500/acre for replanting. Again the problem is to find funding to sustain efforts.

There was a question on which natives compete well with Arundo and Lepidium. No one was aware of any.

Discussion shifted to the potential effectiveness of mixing herbicides. Mixing can target multiple biochemical pathways and therefore be more effective, however mixtures work differently at different sites. Someone mentioned that Cape ivy can be sprayed when willow is dormant. Someone mentioned that Carla Bossard did some testing with mixture effectiveness on Cape ivy. Some discussion on the lack of impacts of Telar on natives and its effectiveness on Lepidium. Someone mentioned that care is required when using Telar near grasses.

Tim Widmer of the USDA biocontrol facility in France, asked a question about the opinions of the group towards biocontrol.

Mike Kelly said that Cal -IPC supports classical biocontrol not “cowboy” biocontrol.
Someone mentioned that The Nature Conservancy is generally opposed to biocontrol.
Someone mentioned that in Lodi, CA IPM was used, but there were concerns about private land owners and biocontrol agents spreading to their lands. Alan Kirk, also of USDA in France, mentioned that biocontrol is often used as a last resort when other methods are ineffective. He also pointed out that biocontrol is about controlling,not eliminating, an invader. He mentioned that Lepidium, for example, is very rare in Europe. Someone mentioned that discussions of this sort happen on the CalWeedTalk list serve. Someone mentioned that Cacto blastus could impact the native Opuntias in Florida. Alan Kirk replied that a parasitoid might be available to help deal with

Cacto blastus. Tom Dudley asked about the potential for a biocontrol agent of Sesbania because efforts in S. Africa appear to be successful. No one had heard anything about it in CA.

Ray Carruthers was asked about potential biocontrol agents in the works. He mentioned that a beetle is working well on Tamarix, a rust has been introduced for yellow starthistle, Russian thistle has an agent in the works, as does medusa head rye, Lepidium (genetics are being worked on in Reno and Australia) and broom.

Tom asked Ray about Sesbania biocontrol and Ray replied that resources for overseas projects are difficult to obtain.

Someone suggested that Sesbania might be more effectively controlled by spraying.

Mark Lea asked about Cape ivy in riparian areas. He mentioned that it seems impossible to get rid of in riparian forests. No one mentioned any effective control programs for it other than focusing efforts towards satellite populations.

Potential Problem Plants was brought up again. Smilo, Sliver Lace Vine, and stinkwort (stink weed) could be big problems. It apparently was first noticed in 1984 in San Jose. It is problematic in San Diego. It is easily pulled out of the ground. Someone mentioned that the TNC website has red alerts for weeds.

Mike Kelly suggested that it would be a good idea to get local Planning Departments to adopt a Cal-IPC list and to ban the sale of noxious weeds. The American Society of Landscape Architects are another group he suggested talking to. Someone mentioned that talking to growers is a good idea because removal of invasive plants may not detrimentally impact their profits. Someone mentioned that private land owners are more likely to be receptive to a group such as Cal-IPC than a government organization. Water districts have distributed plant lists to private land owners. MWD has formed partnerships with Tree of Life nursery to plant natives. Many invasive plants get their start in landscaping. A potentially big problem is the planting of non-native species used in xeric landscaping and their escape into the surrounding landscape.

One problem that was mentioned was that riparian areas should not be restored to the point of being too mesic and then need to be restored to the “natural” xeric state.

Another issue was development leading to more flashy water in riparian areas. Several studies have shown how this increases the surface area of riparian areas.

While not a riparian invader, Calerpa taxifolia was mentioned as being under control and potentially eradicated at a cost of $3 million.

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Volunteers: Engaging the Public

Facilitator: Sue Donaldson, *University of Nevada Cooperative Extension*

We began with a round of introductions and description of interest in the subject of volunteers. Several common interests emerged:

- How do we find volunteers?
- How do we retain volunteers?
- How do we find new volunteers to add to an existing group?
- Engaging the public
- Communication with volunteers
- Attitudes – why do people volunteer? Existing surveys, etc.
- Volunteer coordinators
- Volunteer paid camping opportunities

Kari Norgaard shared information on her research into successful groups. She studied a unique area consisting of largely public land and populated by 250 residents. They had an initial interest in weed control that dated to spraying during the 1970s which had resulted in health concerns. Indian basketweavers were also concerned about herbicide exposure.

Kari learned:

- People become involved for the social aspects – getting to know their neighbors and their area (their community)
- They're motivated when they see someone they know as a model
- Having a standard time to come and grub weeds facilitated the process
- Residents feel an attachment to their land, and a desire to keep it pristine
- Desire to protect salmon resulted in concerns over herbicide use along the river; since they don't want spraying to occur, they feel responsible and are willing to work at hand removal
- There's a sense of community leading to community-based stewardship

Golden Gate Natural Resource Area has a huge dataset on volunteers. They had 215,000 volunteer hours last year! They've found that:

- There are many different reasons for volunteering, including:
  - A sense of place
  - Food

    - An opportunity to say "yes" about something
    - An opportunity to get free education
- Volunteers are a very diverse group; not exclusively white, urban, well-to-do, etc.
- Stewardship is recreation

Other thoughts on finding volunteers:

- Many high schools have requirements for community stewardship or service projects
- Other groups such as Lions and Kiwanis may want to be involved
- Adopt-a-Mile Stewardship program
- There are tradeoffs needed for those coordinating the volunteer event – we need to balance recreation/education/stewardship with the need to get the work done
- Work with University Parks and Recreation departments – they're often willing to hand out flyers, etc.
- Find out which University departments have mandatory service hours
- Religious groups
- Fraternity and sorority community service days – take photos of projects and email them to the volunteers

Suggestions for keeping in touch with and retaining volunteers:

- Advertise in newspapers and on radio; try to develop readership/listeners by targeting a fixed time or day of the month
- Use brochures advertising standard meeting times (the first Tuesday of the month, 9 am – 11 am, etc.)
- Newsletters to group members
- Have weed parties
- Personal outreach to visitors
- Make sure newcomers don't feel excluded
- Use booths and other methods to educate folks; make it fun, and give them materials to take home for free
- Have samples of plants available so people can learn why they're problematic, and what they look like
- Get a reporter involved; media recognition of volunteers
- Adopt-a-Site
- Recognize your volunteers for their contributions
- Provide many different types of jobs, and let people switch jobs periodically to prevent burnout. Avoid putting too much pressure on volunteers
- Remember to have fun!
- Have a "stewardship" workday that includes multiple activities, not just weed pulling. Consider interfacing with Make a Difference Day (see "Points of Light" website)
- Work with teachers to give students extra credit
- Need to have regular communication and coordination of who is doing what
- For those who can't meet on a regular schedule, let them adopt a small site and work on their own
- Remember that we need to focus on what the <u>volunteer</u> is getting out of the experience, not just what we want to accomplish

There was broad agreement that it is essential to have a paid volunteer coordinator with the following qualities:

- Charismatic
- People-oriented; likes working with people
- Upbeat
- Open
- Friendly
- Enthusiastic
- Experienced

There is a perceived need to get agency buy-in to work with volunteers. There is often a perception that volunteer efforts are not sustainable, and a misbelief or mistrust that volunteers will be able to get a job done, therefore it is preferable to pay someone. Also, there is a fear of losing jobs to volunteers who can do the same job.

There was discussion about involving agency folks in volunteer weed efforts given how busy they are. Agency administration must be convinced that weed issues and volunteer projects are important. Some suggestions:

- Put them on the board as mentors
- Circulate among the RC&Ds
- Include the flood control folks
- Write grants
- Partnerships with schools
- Develop relationships with folks about to retire – both from agencies and schools/universities – as they are potential volunteers.

How can Cal-IPC help our volunteer efforts?

- Create a depository of materials
- Provide a booklet on the website that includes information on working successfully with volunteers (see the TNC website)
- Create a volunteer guidebook – everything a volunteer needs to know to start a project – liability issues, property ownership, a flowchart of regulations, the ABCs of weed management, etc.
- Provide a basic article on "Why weeds are bad, and what you can do" that can be give to volunteers or newspapers to assist in recruiting volunteers
- Maintain a catalog of available resources
- Simple colored photos to identify problem weeds vs. native plants
- Assistance in grant writing and examples of successful funded grants (10-15) on the website
- Local fundraising and promotional info and ideas – what does it cost to purchase promo items such as caps, vendor information, and feedback on impacts
- Sources for free items
- Case studies of problems and their solutions that can be posted on the website and updated in real time
- An email list of people working on volunteer projects
- List of organizations that can provide volunteers for remote locations

Ideas for future working groups on volunteer issues:

- Present case studies of problems and their solutions
- Discuss sources for materials: names, phone numbers, email, websites

Generate a resource list

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Revegetation: When and How

Facilitators: Ken Lair, *Bureau of Reclamation* ***and***
Maria Ryan, *University of Nevada Cooperative Extension*

- Discussion initiated addressing the need for salvaging plants for restoration and rehabilitation purposes. Many sites slated for development are candidates for salvaging desirable plants. Working with developers, municipalities, power departments, etc. to inform them of the need for such plants is helpful. One problem identified is that storage of plant materials until they are needed can be problematic. Nurseries and perhaps NRCS PMC's can be contacted to store plant materials (seeds included).

- A nursery perspective on growing native plants was that growing natives is expensive and often slow, and there isn't the commercial demand that justifies the investment. What the public typically wants are native cultivars. Revegetation projects often need plant materials, but many times too much material is needed on short notice (they don't keep enough in

stock), and it is requested too late in the season. This leaves the nursery industry either too short or too long on supply.

- Discussion considered what is "native" for a particular area. Examples of California black walnut and yellow lupine were given as needing to be considered as more of a regional native rather than a site-specific (endemic) plant. One issue raised was that non-natives might be used as opposed to natives from another region to decrease the possibility of contaminating the local gene pool (Monterrey Pines and Cypress were examples that are probably now more relicts from previous eras.)

- Further discussion related to the establishment of locally endemic natives that may be found on harsh sites and difficulty of establishment. Little emphasis is placed in the seed mix for both early and late-seral species with the recognition that altered sites may need some time to move successionally. The approach should be stepwise to get us to the late seral composition instead of trying to force late seral species to become established without the site naturally recovering.

- Eco-bridge species were discussed as being an alternative to stabilizing sites until more desirable species can be established. These species are not competitive, establish quickly, and increase the functionality of a site.

- Understanding the history of the site to be revegetated is key, but discussion tended toward consideration of what's "historical." The site must have a resource assessment to determine if prehistoric (or even historic) conditions are feasible for restoration. Conditions may have been so greatly altered that restoration to these former states may be impossible. An example given was the desire to restore the tidal salt marshes under CALFED projects in areas where the conditions are now constrained to a freshwater environment. Discussion examples included attempts at reintroduction of *Frankinia* into Mission Bay that probably won't be successful because the targeted historical time frame of occurrence of this plan is now not reasonable. Also, Torrey pines are currently being planted into coastal sage scrub communities and because conditions have changed, the survivability is low.

- Various scales need to be considered when attempting restoration, and plasticity needs to be integrated into choices. Limitations (site, political, economic, etc.) must be identified given the extremely altered systems we face, to determine what historical period can reasonably be targeted if efforts are to succeed. The immediacy of the situation should be considered. Goals should be set and stepwise restoration efforts may be necessary, but focus should be on preserving native habitats.

- Overseeding of natives into sites where non-natives are colonizing is an option. The herbicide Plateau was recommended to target annuals while preserving perennials. Different levels of competition exists, therefore various planting methods and rates should be tried.

- Funding for maintenance of restoration projects is not easy to obtain. Consideration of maintenance of a project through time is very important, but not always considered. If maintenance isn't conducted, money is essentially thrown away on the initial project.

- There is a need for more research regarding propagation of forbs. Much information is already available on grasses.

- More money needs to be made available for research to better understand our natives.

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Working Groups II

Risk Assessment: Using the New Cal-IPC Weed Listing Criteria

Facilitator: ***Peter Warner,*** *California State Parks*
Note Taker: Deanne DiPietro, Sonoma State University

- Peter provided background on the origin and purpose of the weed list, and then the idea of the ranking of the species. Now wants to open the process to review.

Questions and answers ensued- some highlights:

-
- 20 have been done; it is a slow process.
- Once they're completed they will be posted on the website.
- Q- How well have you been able to get ranges? A-That has been difficult; need more input from people on distribution, impacts, and invasiveness.
- Still developing criteria, so to do that and finish the list will take ~ 2 years. In the meantime, what has been done is already useful for management decisions because it's completely open to review.
- Q- If you want to add to one of them, how does one do that? A- Contact P. Warner and Doug Johnson dwjohnson@cal-ipc.org, send all the info you have about how the plant effects wildland systems.
- Q- Regarding expertise: field observations are useful but what if you don't think you are an expert? A- You can still contribute by sending your info in.
- Q- Natives? A- There are a few natives being reviewed.
- Q- Is the ranking system broken out in zones? A- The first weed list is a statewide list, but we hope to move toward bioregional lists, and this will move more quickly with the initial info done.
- Q- CEQA applications? A- We're hoping it can be used in CEQA documents, by citing the info therein. It would be nice if these documents could help with detection, but how to bridge with CDFA's list?
- Much discussion followed about flagging the invasives in an EIR. Anne Howald said you can set up your EIR so that weed invasion is a significant impact by defining what you mean by significant impact and saying that whatever is on the Cal-IPC list is a problem.
- Can also work with your county to ban certain plants- the Ag. Commissioner's office can be asked to exert pressure on places selling these listed pests.

Review of the criteria: Some points-

- Categorizing, not really ranking
- Economics not considered Constraints on management

Short course on using the form:
Must do a thorough literature search (not just the WWW), document and then rank the documentation. First become familiar with the questions, then find and score the documentation, then go back and use the info to answer the questions. You can in some instances use info about a related sp. when it is defensible and helpful (ie.when there is a lack of info). The reasoning is documented in the rationale section.

The process for arriving at the conclusions is transparent, so people can judge for themselves its usefulness. You should cite primary literature sources (rather than citing the Cal-IPC review-type book, this is somewhat circular, because we're citing ourselves). Or, if the sp. has little peer-reviewed info, and it's in the Cal-IPC book, you might cite the book and rank the documentation accordingly. This helps identify gaps in information- an intended purpose of the effort. When we know little or nothing about a sp., this is important to know; it creates research opportunities.

Example section- Impacts on ecosystem process

- Sometimes it's difficult to know, and can be very subjective, but it's an iterative process, and open in nature. Your input will be reviewed by experts on the review committee and augmented.

You can sort the list online so you can look by common name and find out the scientific name.
Species outside CA are considered, with info from out of state, for planning for possible problematic spp. by looking at same or similar ecosystems, especially when there is a species that appears to be spreading rapidly but is still in small populations.

Primary products:
- Hoping to revise the list
- Hoping to motivate other states to do the same thing.

The list does not have regulatory authority because Cal-IPC has no power to regulate or enforce. There probably won't be a direct relationship with the CDFA list. An agency can decide to use the list as the basis for their policy. Making it a regulatory tool or enforcement mechanism would require stakeholder involvement.

If you have questions, contact Peter Warner.

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Annual grasses: Status of Biology and Control

Facilitated by: Carla D' Antonio, *USDA-ARS*
Primary note taker, John Gerlach; secondary note taker, Carla D'Antonio

Please Note: it was difficult to keep tract of the discussion because of the large group size so John and Carla apologize if comments were missed or anyone was not cited properly.

Question initially posed…

1) Should exotic grass research be separated by habitat? For example shrublands vs. valley grassland vs. coastal grassland? Would this make it easier to have a good discussion given the large number of people in this working group?

(response…most respondents said they would rather stay in a large group and focus on bigger conceptual or management issues)

2) Example of one of these over arching issues….How important are the effects of atmospheric nitrogen deposition for successful invasions by annual grasses? This is clearly important in serpentine grasslands in CA, in drier southern California shrublands (E. Allen's work), and the Mojave desert (M. Brooks' work) where N deposition is causing increases in annual grasses and loss of native forbs and perennials. Maybe it is an overarching issue that affects a large part of the west? (how do you manage or restore in face of all this N? Stu Weiss has done lots of work on this issue in serpentine grasslands in the south Bay Area—with some

successes…mowing can reduce biomass of the exotic grasses and help to promote the natives).

3) Will the elimination of exotic annual grasses from an ecosystem lead to invasion of the ecosystem by exotic perennial grasses or exotic forbs? It was suggested that maybe exotic annual grasses aren't as bad as many exotic forbs or exotic perennial grasses, so if we are going to manage against one group we need to know what we may end up with.

4) Are invasions by exotic perennial grasses only an issue in coastal areas? (Folks representing the coast region stated that Holcus lanatus, Festuca arundinacea, and Phalaris aquatica are huge problems for them. Kim Cooper at Pt Reyes finds that in areas where they have been trying to control broom they are increasingly getting these exotic perennial grasses, which appear to be very bad for native species. A group from Sonoma and Marin counties said that these exotic perennial grasses are some of their biggest threats. Matt Brooks shared that exotic perennial grasses such as fountain grass are increasingly a problem in the Sonoran desert and may be moving into some parts of southern California. We shouldn't write them off as just a coastal problem. One of these grasses is *Cenchrus ciliaris* –buffle grass, which is destroying the Sonoran desert through fire. Will it be restricted to warmer regions with summer rain or will it spread further north into colder or drier deserts? John Gerlach has found they are an increasing problem in Yosemite. Maybe we need more networking among folks trying to deal with exotic perennial grasses (web chat page??).

5) How can the management of exotics be streamlined among governmental agencies to prevent disconnects?

6) Folks from several coastal areas (Jake Sigg from San Francisco and others from southern California) have noted a large expansion of the annual grass Brachypodium distachyon. Are the recent observations of increased densities of Brachypodium distachyon indicative of a recent increase in invasiveness? Is this grass a threat to native biodiversity? It can become quite dense and some participants noted that it forms very dense litter that lies thick on the soil surface…suggesting it would not be good for native species. It was suggested that managers interested in this grass try to conduct similar experiments aimed at controlling it in different regions of the state to see how control varies with environment.

7) Shouldn't goal of controlling exotics be restoring with natives that have some sort of resistance to invasion? Can native communities be resistant to exotic species or will we sometimes need to use exotics to limit the impact of other exotics that we consider to be worse. Example, crested wheat grass has long been used in reveg of shrublands burned in Bromus tectorum fires. It does suppress B. tectorum. But can we get natives to do this instead?
   This led into a long discussion on how to establish native grasses with reporting of successful approaches and workshops available to learn about this from CNGA (California Native Grass Association)-see participant Kent Reeves. Lots of questions though about almost single minded focus of restoration on native grasses with little attention to forbs (or even woody species).

8) Do we need better data to address issue of benefits of native perennial grasses over exotic perennial grasses in terms of long-term sustainability of production? Ability to support native diversity (in forbs) and so forth? John Gerlach suggested that such data exist and have existed

for a long time and they show that exotic perennial grasses don't provide long-term sustainability.

9) Can management tools such as livestock grazing push a community towards a particular goal? How can grazing be managed to achieve more than one goal (reducing bad exotics while promoting certain natives or sets of natives)? Are we too single minded in our goal setting? Several recent studies (G. Hayes-Conservation Biology) and in a progress review by C. D'Antonio (and collaborators) suggests that grazing can promote some native species but not others and may also promote some exotic forbs. It does not appear to successfully reduce exotic annual grasses. So effects are very group or even species specific—no easy solutions. Careful work across sites needs to be done and setting of management objectives probably should not be focused on single species.

10) What can be done to reduce the cost and increase the availability of native grass seed? This led to a long discussion about native seed production (including native forb seed production) including where is it being done? how to do it on a local or regional scale? how to make it cost effective? role of different agencies?

11) Can comprehensive cost benefit analyses be used to set management priorities and thresholds?

12) Do approaches to managing natives and exotics need to be more site specific? Factors to consider might be precipitation, soils, and other attributes.

13) How do we acquire more basic biological information for natives and exotics?

14) NRCS is conducting research using different genotypes of native species and in some cases such as Panicum virgatum, they are spreading invasive genotypes. How do we resolve these sorts of conflicts? Examples of current research are the BLM Great Basin restoration project, the IAFAS project, field trials through NRCS, and the CNGA.

15) What are the risks due to potential genetic pollution of seed production? This might occur in cases where farmland is removed from production and the owner is required to enter into a native species seed production contract. Should seed production be decentralized? Is there federal support through the BLM for seed production? How do we get more support for services rendered by native seed producers even in years when BLM or other agencies don't need to reveg a lot of land?

16) How do we encourage support for these issues? People were reminded that weeds are a bipartisan issue and that representatives and senators are fairly interested in these issues right now. write to your local reps and encourage funding for research and control efforts. Plus working on consortia, or region wide groups is effective.

17) One of final questions raised was specific request for information on scraping…does scraping a thin layer of soil from the surface of sites benefit natives more than exotics? Several people reported very positive effects on native perennial grasses when a thin layer of surface soil was scraped from weed infested spots…Jaime Marty working on this in Central Valley, a person from Santa Cruz reported great stimulation of desired tarweed species with this technique.

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Perennial Pepperweed: What Works?

Facilitated by: Rob Wilson, University of California Cooperative Extension

Biology
The question was asked if Lepidium latifolium was producing viable seed. A UC researcher stated that the seed has been shown to germinate well in the lab. Other participants said that field observations confirmed this. The question was asked if the seed passed through cattle and if this could be a vector for expansion. One participant from a cattle grazing operation that is also controlling Lepidium answered yes and that for that reason they quarantined their cattle for two days in a sanitizing staging area. This allowed enough time for any grazed seed to pass through.

Control
1. Sheep have been used along the Truckee River to effectively control Lepidium. They eat both old and new plants right into the ground. However, the density of Lepidium was so great the sheep were unable to penetrate the big stands. Given this, cattle were then enticed to enter and trample down big Lepidium stands (by spreading good hay inside Lepidium areas). After the trampling by the cattle, the sheep had the access they needed. It took three heavy grazings by the sheep to reduce the Lepidium to bare ground. Sheep were also used as a follow-up in the second year. New plants were sparse by the third year, and herbicide treatment was easy to carry out.

"Goats R Us' also reported effective control of Lepidium with goats.

A UC researcher reported that field trials they conducted with both sheep and goats showed that once the grazing pressure was off the Lepidium came back. The take home message seems to be that both goats and sheep do a good job of reducing the biomass, knocking back the mature plants, but follow-up with herbicide to kill the roots and rhizomes is needed.

2. Flooding has been shown to be effective in killing Lepidium, but it needs to be inundated for at least 6 months, and perhaps as much as 8 months.

3. Timing. Several participants indicated that the "common wisdom" that herbicide treatments must take place at the budding to seed set stage for effective control is not accurate and too restrictive. Mike Krebsbach of Monsanto said that he thought spraying with glyphosate could start much sooner and be effective. Participants from L.A. Water & Power indicated that in the Owens Valley they are treating Lepidium almost year round with success. Telar seems to be effective at all stages of the plants' growth, while 2,4-D is most effective at flower bud stage. Roundup (glyphosate) has been reported as most effective at bud and flowering stages, but new information indicates it can be effective when applied at earlier growth stages.

4. Vectors. A number of people reported on agricultural vectors for the spread of Lepidium. These included contaminated nursery stock, where Lepidium roots and plants were contaminants in pots of both native and non-native plants, including popular Sago Palms, from a nursery in the San Pascual Valley in San Diego County. Lepidium as a contaminant in hay has been observed in a number of areas, again including San Diego County.

Many people were shocked to hear that Lepidium is an important part of the cut flower trade in California. Merchants from the Bay Area are confirmed to have traveled all the way into Nevada in search of large quantities of cut Lepidium blooms. In San Diego, one merchant was observed cutting large quantities of the blooming plants, was confronted in an educational fashion by an employee of one of the workshop's participants (this note taker), who tried to explain the dangers of moving this plant around, but was told it was an "important" part of their income. Another researcher present doubted that seed was actually being spread this way, but granted that the plant was being harvested at different stages of bloom and seed set. This suggests an interesting inquiry into whether the cut flower trade could be moving seed around. Any grad student interested out there?

5. Resources. The Nature Conservancy and WEEDRIC (UC Davis) both have stewardship papers et al on Lepidium.

6. Ecological impacts. It was reported that the shrub part of the native community along the Truckee River was knocked out by Lepidium in only 4 - 5 years. Contrary to some popularly held opinions about Lepidium and soils, research was reported to have shown that Lepidium's root system is not structured to bind soil and is not good at preventing erosion. Lepidium has been shown to remove salts from the soil, hence an alkaline soil with a long term Lepidium infestation may be less alkaline after the infestation has been controlled and removed.

7. Sanitary methods. San Diego County is writing sanitizing requirements into their Lepidium contracts to avoid spread by spraying contractors. This is necessary when the seed is setting. Others reported establishing a staging / sanitizing area for their vehicles where they would be inspected and washed down. One operation used the same area for quarantining their cattle (see above).

8. Telar. Mike Kelly of San Diego reported the successful use of Telar in alkaline marshes. No water was present since a prolonged drought had caused Lake Hodges, where the largest infestations in San Diego occur, to withdraw its open water more than a mile downstream from the infestations. This is important since Telar is not approved for aquatic use. Lepidium was effectively controlled in these marshes while native plants such as Frankenia salina (Alkali Heath), Anemopsis californica (Yerba mansa), Isocoma (goldenbush) spp., Ambrosia (ragweed) spp., Scirpus spp., and Typha spp. were not killed. Occasionally a branch on an Isocoma seemed tinged, possibly from the Telar. Telar was deliberately "sprayed to wet" on several Baccharis salicifolia (Mule-fat), since this shrub is common in Lepidium areas around Lake Hodges. A few branches showed some yellowing of some leaves, but the shrubs otherwise appeared quite health. Salix spp. (willows) and mule-fat with Lepidium growing

under them were treated with Telar without any noticeable detrimental impacts on the former, even after a year had passed. This is significant since Telar remains active in the soil and is supposed to have a preemergent effect in the second year.

9. Competing with and displacing Lepidium. There was one report of the successful use of Distichlis spp. (salt grass), Juncus balticus, and a Leymus triticoides (creeping wild rye) variety developed by Hedgerow Farms planted in an area where Lepidium was being controlled doing quite well in keeping the Lepidium out.

Another report indicated that Lepidium, like other mustards, doesn't seem to have symbiotic associations with mychorrizae. This led to successful plantings of seed that was coated with carbon and inoculated with a commercial mychorrizae preparation. The carbon inactivates any Telar or other herbicides persisting in the soil.

10. Starving the root by mowing, disking, etc.. No one could report successful "starving" of the roots. Several researchers pointed out this was unlikely to work since any small piece of rhizome that is cut is capable of starting a new plant. No one had tried tarping after cutting.

11. White rust. A white rust has been seen on Lepidium in different parts of its range. UC researchers reported it is not an effective control and seems to be part of the natural cycle of the plant and has little hope of being an effective biocontrol.

12. Birch wet blade. This cut and simultaneous coating with herbicide was reported to be effective on Lepidium.

13. Grants and contract lengths. It was agreed by many that 2-3 year long grants are not long enough to allow for effective control or eradication of Lepidium, but that most grants for Lepidium or other exotic controls are rarely longer than 2-3 years. San Diego reported asking for and receiving one California state grant for a 6-year Lepidium project. It was suggested that grant applicants try to educate the grantors about the need for longer grant cycles extensions of grants when needed.

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Biocontrols: Progress and Ongoing Needs

Facilitated by: Ray Carruthers, *USDA-ARS*
Note prepared by: Joel Buettner, Cache Creek Conservancy

Following brief introductions, Ray Carruthers opened the session with an overview of some biocontrol issues, and then outlined the purpose of developing an action plan for Cal-IPC as it relates to existing, new, or needed biological control projects. Ray asked the group to brainstorm projects of interest and Cal-IPC needs. In an effort to present the material discussed in this workgroup in a usable manner, the following notes are arranged by topic in alphabetical order.

Arundo

- Alan Kirk reported that Arundo biocontrol is in the exploration phase. Current areas being investigated in Asia are in Nepal and India, and in Europe from Turkey to Spain. In Montpellier, France they have found 6-8 organisms that have an effect on Arundo at some point in its life cycle. There is a need to look in other areas between India and the Mediterranean (e.g. Iran, Iraq, Pakistan). It is difficult in these areas since Arundo is heavily used by local inhabitants. Labs in Greece and Rome are also looking in other places in the Mediterranean.

- Preliminary observations indicate that what look like large impenetrable stands of Arundo in Asia and Europe, are not. Many dead canes are present in the stands that limit their growth and spread. This may be attributable to four different organisms: a fly, a hymenopteran, a scale insect, and a mite. The mite seems to interact with a fungus to cause other damage and also a fly may interact with the fungus as well. There is need for taxonomists to work on identifying these organisms to

the species level, as well as a geneticist to determine the genetics of different Arundo populations. Alan Kirk stated that based on preliminary observation there is a good chance that decrease in size of stands and spread of Arundo can be achieved. He added that it is unlikely that biocontrol alone will be able to eradicate Arundo, but it may work in conjunction with other methods, through a general decline in the competitive nature of the Arundo.

- Tim Widmer reported that his lab is looking for agents that specifically attack 1) the rhizome (would be the best but not found yet) 2) the growing point (an agent has been found) and 3) the leaves (an agent has been found). There is need to look in North Africa and the Middle East for more possible agents, as well as further study into a rust found in China and Japan. A rust fungus found on Phragmites spp. could be a possibility, but Tim did not know the details. The fungus associated with mites or flies needs to be studied further, as does the fungus associated with a hymenopteran carrier. Tim also noted that there is a nematode known to attack the banana rhizome but it has been not studied in Arundo. Alan Kirk added that there is a subterranean aphid that may work on the Arundo rhizome, but safety may be an issue.

Cape Ivy

- Ray Carruthers reported that the Albany, CA and South Africa labs are working on this project. Exploration over the past five years has revealed two prospective biocontrol agents: 1) a Tephridid fly that attacks the growing point, creates a gall and results in decreased growth, and 2) a Lepidopteran that bores into the stem causing stem mortality beyond the boring point. Lab studies indicate that these agents may be effective. One challenge to doing large-scale studies overseas is that natural predators of the agent are present. This next year, ARS hopes that these agents will be ready to go to the TAG for approval. The main concern with Cape Ivy is its movement inland.

Funding for European labs and other biocontrol research

- Walt Decker asked about the limitation of the European labs, and if there is a need for more coordination between research and other interests in biocontrol. Ray Carruthers replied that these issues have been discussed for years. The primary factor is funding for the European labs. Because they have no congressional representation and foreign currency exchange rates fluctuate, they are primarily funded by special interests. These labs have good facilities but tend to be understaffed especially with regard to technical support. All research done in these labs is linked to US applications, not just in California, but in all states.

- In terms of the flow of funds from US interests to the European labs, the general consensus was that the current system is working. Ray Carruthers pointed out that while the USDA is unable to allocate funds directly overseas, they can be involved with directing other funds raised by individual interests into overseas research efforts. Alan Kirk mentioned that the success of the whitefly biocontrol project was instrumental in getting a biocontrol program in the US, and was an example of coordination between domestic and overseas labs. He noted that in this case, as involvement in a project increased, so did funding. His concern is that having too many projects may dilute funding. He suggested that focusing efforts on the completion of fewer projects would be a better way to use limited resources.

- Jim Johnson asked about the state of funding for biocontrol in general. Group members felt that there is a need for interested parties to keep pressure on the federal government to maintain and increase funding. Currently, some projects are being cut while others are seeing increased funding. This is a function of funding coming from add-on legislation supported by sympathetic

legislators. It was further explained that the funding for USDA labs abroad get support from the USDA, but do not have the same level of legislator support as domestic labs. Ray encouraged anyone to visit both foreign and domestic ARS labs and report back to their agencies to gain additional domestic support for the programs at these sites.

- Ray Carruthers commented on the importance of organizations such as Cal-IPC and others in their efforts to keep biocontrol research going. Even though specific projects may be resource-limited, the overall direction of biocontrol research is ready to boom. Many successful projects are currently underway and others may soon follow as interest in invasive weeds is at an all time high.

- Ray Carruthers mentioned that a new facility at UC Davis is being constructed that will be able to house researchers needing plant pathogen quarantine facilities and entomological labs. He estimates the cost for using the facility will be approximately $20,000 per year.

Red Sesbania (Sesbania punicea**)**

- Tom Dudley reported that agents from Argentina have been successful in S. Africa in controlling red sesbania. He asked if we could use the South Africa experience and data to address US infestations. Ray Carruthers replied that success abroad supports efficacy and safety but does not directly ensure it in domestic systems. Currently it takes at least four years to get agents ready for release. Part of this process is conducting extensive safety studies and having them reviewed by the APHIS Technology Advisory Group (TAG) prior to release. Except for extreme cases, we need to do this research domestically. Due to a lack of political support, the USDA does not have the authority to take on a red sesbania project at this time.

Tamarix

- Dawn Rafferty asked how many times Tamarix needs to be defoliated before it dies. Ray Carruthers responded that in cage studies, 2-3 years of defoliation was effective. In natural environments it is unclear due to movement of the beetle populations, and the possibility of incomplete defoliation in one or more years. Field studies are projected to help provide this information in 2004.

- Tom Dudley stated that he has observed the first generation of the agent skipping the target completely, but coming back to defoliate it later in the season. He believes that day-length, rather than predation, is the likely cause of this delay. He stated that other species may be better suited to certain latitudes, and that impacts to Willow Flycatcher habitat are not an issue north of 38^{o} Latitude.

- Caroline Cox asked if water regime control is necessary in conjunction with biocontrol. Ray responded that in some areas, such as Arizona, this is probably true. Other areas, however, can be revegetated without hydrological manipulation. Ken Lair commented that in the southwestern US, hydrology is a big deal and must be addressed in conjunction with any restoration plan. For example, in Las Cruces, along the river, old levees had been breached to increase Willow Flycatcher habitat. Willows have become established in the channel as a result of this, and provide very good habitat at low water levels. However, the Bureau of Reclamation is concerned that when water levels rise, this new habitat will be impacted and mitigation will be necessary. As a result, these willows may be removed to prevent the need for mitigation.

- Ken Lair also stated that due to deep channel incision in areas with high Tamarix infestation, restoration to cottonwood and willows would be difficult for hydrologic reasons. Ray commented that for these reasons, agencies need to work together to address all aspects of a control/restoration project.

- Larry Klaasen asked if the Diorhabda beetle will effect the Athel tree (Tamarix aphylla). Tom Dudly responded that Diorahaba will feed on it a little. Further, there is evidence that T. aphylla and T. ramosissima. hybridization may affect susceptibility to Diorhabda. Ray added that the process is designed to accept minimal Athel damage below a population control level. In some areas, like northern Mexico, this is not acceptable. In these cases, other agents are being studied and results are expected within the next year.

- Ray stated that the original Diorhabda beetles are from China at a latitude similar to Wyoming. Now there are a total of seven strains that are adapted to lower latitudes. The main challenge for this agent is the synchronicity of the beetle life cycle with the target (a diapause problem). Using Diorhabda beetles from Crete, over-wintering has been successful for populations in southern Texas. Again, safety of the agent is of utmost importance and tests are proceeding to ensure that all strains used in the field have a combination of laboratory and field host specificity testing completed before open field releases are conducted.

Whitetop (Lepidium spp. / Cardaria spp.)

- Alan Kirk reported that there is a post-doc in Europe looking for organisms near Montpellier. A concern with this effort is that field observations are not consistent with the range of Lepidium described on available distribution maps. This discrepancy gives rise to the questions: Has Lepidium been controlled outside of these habitats? Has some sort of environmental change caused a change in the distribution of Lepidium.

- Other work is being done to study a weevil (Pseudorhynchus spp.) that attacks the roots of Cardaria, and produces root galls. Cabbage and other Cruciferids do not seem to be affected.

- Tim Widmer pointed out the name change of Cardaria draba to Lepidium draba.

- Alan Kirk also noted that the Diamond-backed moth (Plutella spp.) might be effective; however safety is an issue since it is also an agricultural pest. A possible approach may be to utilize a parasitoid to kill the agent prior to reaching the agricultural pest life stage. This was done with a biocontrol agent targeting kudzu.

- Ray Carruthers added that there are studies underway in the US and Australia investigating the genetics of similar agents. The similarity of some of these agents to native species is a complicating factor. The ultimate goal is to develop safe and effective agents with minimal non-target effects.

- Ken Lair asked about the increased occurrence of Lepiduim in Owens Valley, CA after herbicide treatment of Tamarix. In response, Alan Kirk stated that there is an issue with too many targets, and proposed that focusing on one target species at a time will work better than trying to do too many projects at once.

Yellow Star Thistle

Marc Lee asked about our ability to assess dispersal and effect after release of the Yellow Star Thistle biocontrol agents. Ray responded that in hindsight, more could have been done in the original study/process to give us an idea of how to do this. The synchronicity problem might be addressed by adding growth factors such as nitrogen to the target weeds in border areas to change their bolting time, or by developing a new agent with better synchronicity. This might allow population bottlenecks to be eliminated so that the natural enemy populations could be more effective later in the season. The current process of approving agents for release is more comprehensive and provides better data than that which was used for the Yellow Star Thistle agent. New agents are being studied.

Cal-IPC action items that resulted from this work group were:

1. Consider initiating a new Cal-IPC Working group on Arundo biocontrol with the goal of gaining increased funding for foreign exploration at the European Biological Control Lab.
2. Continue high support for the International Broom Initiative to ensure that adequate funding is obtained for CSIRO, ARS, and associated labs in California, Oregon, and Nevada.
3. A potential disease of Ailanthus was observed in coastal California and ARS agreed to visit these sites in the spring and attempt to obtain isolates of any pathogen material that might be present.
4. Continue supporting Cape Ivy Biocontrol and speed any TAG petitions into the regulatory process.
5. Encourage the ARS European biological Control Lab to continue Lepidium spp. biocontrol investigations and to continue cooperation with ARS Reno in conducting genetic assessments of both native and introduced Lepidium spp.
6. Consider castor bean biocontrol in the future.

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Aquatic Weeds: Policy, Prevention, and Control

Facilitated by: Lars Anderson, *USDA-ARS*

Summary of Issues

Two main discussion areas were developed:

1. List of species of most concern to participants
2. Broader issues that encompass prevention, responses to and management of aquatic/riparian weeds.

Species of most concern (Note: priorities were not assigned)

1. Bulrushes (*Scirpus spp*.)
2. Cattails (*Typha spp.)*
3. Caulerpa (*Caulerpa taxifolia*)
4. Egeria (*Egeria densa*)
5. Eurasian watermifoil (Myriophyllum spicatum)
6. Parrotfeather (*Myriophyllum aquaticum*)
7. Pennywort (Hydrocotyle
8. Spartina (*Spartina alterniflora*)
9. Waterhyacinth *(Eichhornia crassipes*)
10. Waterprimrose (*Ludwegia peploides/ L. spp*)
11. Undaria (*Undaria sp*.- marine alga)

Crosscutting Issues Discussed: (Note: We focused on two major issues that were considered both highly important and those on which Cal-IPC could facilitate or encourage action. Each Item is summarized and potential action by Ca-IIPC is stated.

1. **NPDES** (National Pollution Discharge Elimination System) Permits
   The current General NPDES permit for aquatic pesticide application expires Jan, 2004. The state Water Resources Control Board is reviewing a draft for new permit. With discrepancies and inconsistencies among US states' regulatory requirements for these applications, Cal-IPC Board may encourage resolution of the matter through a letter to US EPA, CalEPA –DPR, and to the Water Resources Control Board, and to the head of the California Resources Agency stating the extra burden placed upon western state plant managers and citing the recent memo from EPA which states that agency's opinion that an approved label is sufficient to comply with the Clean Water Act. This letter needs to point out that there is ample existing data on these products and that this data has led to their approval at the federal US EPA level and the DPR level as well. The letter should urge the timely review of newly developed monitoring data generated via San Francisco Estuary Institute (SFEI) during the past two years. Lastly, the letter needs to indicate the need for permit coverage for private stakeholders who were not included in the prior NPDES permitting process.

2. **Endangered Species Act (ESA)** Compliance *and* Ability to Prevent Spread and Ecological Impacts of Invasive Species.

Several participants provided examples of delays and inconsistent policies in trying to meet obligations to the ESA while also implementing effective controls of invasive weeds, which is supposed to be facilitated according to Clinton's Executive Order on Invasive Species. The following are examples of problems:

a. Agencies responsible for the ESA (US Fish and Wildlife Service and NOAA-Fisheries) have only a short-term perspective on what may or may not impair listed species and their habitat. Longer-term implications (e.g. 3 to 10 year periods) are not weighed in the "risk/ benefit" analyses when considering actions to eradicate or manage invasive species. For example, acceptance of the need for short term, spatially confined, temporary loss of habitat to yield long-term preservation and expansion of habitat is not considered. This has stymied attempts to successfully reduce or eliminate invasive species that currently affect limited ranges of critical habitat. The effect is to allow the expansion of these detrimental impacts in order to ostensibly comply with "no-loss" of habitat under short-term perspectives. (It is analogous to preventing use of water to fight fires because the water might damage some property or belongings. Does a neighbor have the right to stop firefighters because his/her possessions will be subject to water damage?)
A specific example is the "use" by listed species of non-native, invasive species habitat (e.g. Spartina alterniflora/ hybrids). This "use" does not take into account the full life cycles of listed species, nor impacts to other important species currently not "listed."
b. Insufficient analysis of a "no-action" option and associated risks. This relates to the "short-term/long-term" issue, but would specifically address the full range of consequences of not being able to act against invasive species.
c. Personnel within the ESA-Regulatory agencies are insufficiently trained in the biology, ecology, impacts, and management of invasive species. These staffers are continually asked to review and make recommendations in areas that are neither in their competence nor experience. They are also poorly supported with adequate staff and resources to even attempt to "get up to speed" on these issues.
d. The extreme workload on regulatory agencies has led to very high burnout and turnover rates. This, in turn, has perpetuated staffs with little or no experience in invasive species and has, in effect, set back progress made by prior employees in their negotiations with the affected action agencies and groups that are attempting to reduce impacts from invasive species.

Proposed Action by Cal-IPC related to ESA Issues:

1. Draft a "white paper" defining the basis for management of invasive species as part of protecting endangered species' habitat. This document would provide adequate but succinct background and basis so that elected officials and regulatory managers would understand the full implications of action/inaction and strategies for both successful reduction of impacts form invasive species and for compliance with the ESA.
2. Facilitate and jointly organize a 2-3 day training workshop for federal, state, and local regulatory agencies to provide a means for educating managers and staff who are assigned to ESA issues. Sessions would include real-world, specific examples and open problem-solving sessions. The outcome would be (a) better understanding by regulators of invasive species issues and options, (b) a set of recommendations for assessing risk/benefit of actions where control of invasive species may affect habitat for listed species, and (c) continued facilitation of training for staff who are responsible for implementation of ESA and CEQA.
List of tentative participants:
US EPA,Cal EPA, US Fish and Wildlife Service, NOAA- Fisheries (NMFS)
CDFA, CDFG, Water agencies, USDA-APHIS, State/Regional Water Boards, Water Keeper, League to Save Lake Tahoe, etc., TNC

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Advocacy: Reaching Policy Makers

Facilitated by: Wendy West, *El Dorado County Agricultural. Commissioner's Office*
Note taker: Lori Bellis, Nevada Department of Agriculture

Attendees want info on the following topics regarding advocacy/awareness of invasive weed issues:

How to handle "high profile" projects – awareness and public relations
Improve presentations to policymakers and legislators
General public education
How to handle sensitive issues
Herbicide use on Federal lands – advocacy at the national level
How to keep issues visible
How to improve county and state levels of involvement
Promoting environmentalism
Use of volunteers to act as advocates
Creation of a coalition for outreach/education
Importance of policy level decision-making and how to stay in that process

Who is missing from policy maker/awareness discussions?

- Caltrans
- Some NGO's
- Resource Agency

How can we increase advocacy and awareness at the local level?
With water districts:

- Via the Pesticide Use Enforcement function of County Ag offices
- Try to reach board members

Other agencies:

- Work through local fire chief
- Engage in the Federal Energy Regulatory Commission (FERC) relicensing process for local water projects

Need to increase organization and coordination of education/awareness and advocacy statewide:

- Need an action/alert statewide system
- Need a statewide coordinator
- Continue to engage diverse groups i.e. Real Estate agents (they have a disclose re: invasive weeds in Montana)
- California Invasive Weed Awareness Coalition (CALIWAC – private companies, Non-Governmental Organizations (NGOs) and statewide organizations) and California Interagency Noxious Weed Coordination Committee (CINWCC – state and federal agencies) are two statewide organizations

How to tie impact to interest?

- Strengthen coalitions to increase visibility
- General education/awareness function – we need more
- Always remember to start from a beginner level when beginning an educational/awareness effort

- Always remember to connect "why are invasive plants important to ME?" to a person you are educating – how do invasive weeds affect THEIR lives?

What "bottlenecks" do we see out there that impact education/awareness?

- Cooperative Extension and University classes often giving out conflicting information – lacks coordination
- Money and funding driving the focus
- Gaps between nursery, horticulture, and landscape industry re: invasive issues
- "bottom up" education more effective than "top down"
- Education needs to come before regulation

What gaps to we see with agencies?

- Erosion control work
- Permitting
- RCD/NRCS recommendations
- Regulatory agencies won't cooperate
- Impacts on planning mitigation at the local level

What other partners should we be considering?

- Farm Bureau
- Cattlemen's Association
- Girl and Boy Scouts (add to merit badge system)
- Additional environmental organizations i.e. Sierra Club
- Backyard Conservation Program conducted by Resource Conservation Districts
- More work with local California Native Plant Society Chapters

Other comments:

- Must link solution to the problem
- We are losing traditional advocates because of increased environmental restrictions (i.e. Cattlemen's, Farm Bureau, nursery industry)
- Make sure local level partners get the message "up the chain"
- Respond to editorials and commentaries that contain misinformation
- Always build relationships and partnerships – strength of work is in partnerships of diverse groups
- Increase funding to hire someone to work on education and advocacy – Montana demonstrated to legislators that roadways and vehicles were a major conduit of weed spread and got a 50 cent portion of each vehicle registrations, which goes back to the counties for weed control/eradication
- How to increase newspaper exposure? Ask for a weekly column (Master Gardeners could write one and incorporate invasive weeds) and cultivate relationships with natural resource/ag/environmental staffer
- Increase PR pieces – success stories, how-to booklets, etc.

Center for Invasive Plant Management (CIPM) is a good resource for outreach information (www.weedcenter.org)

Working Group Attendees:

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Poster Titles and Abstracts

Integrating Weed Control and Restoration on Western Rangelands

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Although cheatgrass (*Bromus tectorum*) has been widely distributed across western rangelands for >70 years, the full ecologic and economic impacts of this non-native invasive plant have not yet occurred. Furthermore, the invasion and spread of a number of emerging secondary weeds is coincident with cheatgrass infestation. Thus to control the spread of these secondary weeds, we must first control cheatgrass. Competitiveness and prolific seed production allow cheatgrass to invade both disturbed and intact native communities and to dominate after wildfire. Thus, efforts to control cheatgrass need to focus on these biological characteristics while simultaneously restoring native plants on Great Basin rangelands. Our goal is to identify concepts and management strategies to control the spreading dominance of cheatgrass and other weeds on Great Basin rangelands, and to restore native species and increase biodiversity. We are addressing this goal using a series of common experiments across

the Great Basin. These will test management techniques for controlling cheatgrass and other weeds, establishing native plant communities, and restoring ecosystem structure and function while reducing the cost of restoration. We hope our research will provide an ecological understanding of why restoration techniques succeed or fail, and help us develop conceptual and economic bases for choosing appropriate management techniques. By combining expertise and sharing resources, our multi-state, interdisciplinary consortium of research, education, extension, and agency personnel is poised to identify ecological principles and fundamental knowledge needed to manage invasive weeds and facilitate native plant restoration on Great Basin rangelands.

Control of *Ageratina adenophora* in the Marin Headlands, Golden Gate National Recreation Area

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A three year project was implemented in the Golden Gate National Recreation Area to control eupatory (*Ageratina adenophora*) within the Marin Headlands. The purpose was to improve the habitat of the federally endangered mission blue butterfly (*Plebejus icaroides missionensis*). Eupatory is a perennial shrub native to Mexico that has become widely naturalized in California. A control strategy was created by prioritizing patches based on the distance from the mission blue butterfly host plant patches, presence or absence of rare or threatened species or communities, the size of the patch, and the potential for patch expansion. The goal was to remove outlying populations and reduce all infestations totaling 45 acres when re-mapped in 1998 down to its originally mapped 1987 level of 9.5 acres. Manual removal, brushcutting, herbicide, and mulching were methods employed in order to reduce and remove the infestations impacting butterfly habitat. Removed plant material was composted on site. Native plant species replenished most sites voluntarily from an existing seed bank. The reduction of eupatory within the Marin Headlands was achieved through the efforts of volunteers, NPS and Parks Conservancy staff, Marin Conservation Corps, and outside contractors. The efforts to reduce this invasive plant proved successful, but future funding and long term follow up efforts are required to achieve extinction within the mission blue butterfly habitat and all of the Marin Headlands.

Killing Olive (*Olea europea*) Root Sprouts with Imazapyr and Glyphosate

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The Santa Rosa Plateau Ecological Reserve in Murrieta, CA is one of the best examples of restored native grassland in the state. Among the non-native plants that are being removed as part of this restoration are several olive trees that were part of the original ranch property purchased by The Nature Conservancy for the reserve. These trees, with base diameters of four to six feet, were cut down to soil level several years ago, but have continued to produce sprouts from the crown and roots annually. Attempts have been made over the intervening years to kill these re-sprouts with mechanical and chemical methods. This experiment reports the successful control of these re-sprouts with imazapyr and a combination of imazapyr plus glyphosate applied as a foliar spray in September 2002.

Salmon River Cooperative Noxious Weed Program for 2003

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Since 1994, the Salmon River Restoration Council, a community based 501c(3) non-profit, has worked with various partners (agencies, tribes, landowners, schools, resource users) to control several prioritized species of noxious weeds throughout the almost half million-acre Salmon River watershed. Although we've received approximately $60,000 from various sources, we've relied largely on volunteer support, provided predominantly by members of our small community of 250 residents. The SRRC has coordinated over 12,000 volunteer hours to aggressively control hundreds of populations of invasive plants in this wildland ecosystem using manual techniques. We're managing several species, but are primarily focusing on eradicating *Centaurea maculosa* and *Centaurea diffusa* from the Salmon River, which is 98.7 % National Forest lands. These two species are the only known state listed "Class A" noxious weed species present in our watershed. The Salmon River is identified as having the second largest infestation of *Centaurea maculosa* in California. A protocol for determining eradication effectiveness was developed by the US Forest Service and is being applied annually. The SRRC has completed a draft management plan that includes 13 goal areas: Cooperation/Coordination; Planning; Education; Prevention; Inventory; Tracking; Groundwork; Adaptive Management/Research; Revegetation; Monitoring; Evaluation; Reporting; and Support/Funding. To expand our Program, we're formalizing a Weed Management Group specifically for the Salmon River. The SRRC is a member of the Siskiyou County Weed Management Area and is promoting similar volunteer efforts elsewhere in neighboring watersheds.

BLM's Integrated Weed Management Program at Ford Ord, Monterey, California

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Since 1995 the Bureau of Land Management has conducted a weed management program on the former Fort Ord army base, Monterey County, California. 7,200 acres of BLM-administered Fort Ord Public Lands and 8,000 acres of Army-administered lands are regularly patrolled and treated with weed abatement for approximately 20 weed species. Manual, domestic sheep, and chemical applications are commonly used. A year round 2-4 person "weed crew," twice-weekly volunteer events, a winter habitat restoration program, a year-round weed education outreach internship program, and an annual Fort Ord Weed Symposium comprise the weed efforts on Fort Ord Public Lands. Major progress has been made toward eradicating jubata grass, French broom, Klamathweed, and yellow star thistle. Moderate to low success has been accomplished with various other weeds such as the bunchgrass *Tribolium obliterum*, a perennial South African bunchgrass for which Fort Ord is the only known location in the Western Hemisphere that has the potential for spreading to other central Californian areas.

Mapping and Inventorying Invasive Weeds in Orange County, California: Methods and Applications for Land Managers

Melissa Ervin, Jennifer
Naegele, and Trish Smith
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The Nature Conservancy, working with various partners, developed a program for mapping and inventorying weeds of management and monitoring concern for the

Nature Reserve of Orange County. This program provides guidance for land managers to effectively implement restoration and enhancement activities on the Reserve. Individual weed polygons were created based primarily on exotic species type and cover. Additional information collected at each site includes: 1) disturbances, 2) access, 3) erosion potential, 4) native habitat type and cover, 5) diversity of native plant species and 6) observed sensitive species. Each polygon was photo-documented and additional notes or observations were recorded. Collected data were entered into an Access database and then imported into a Geographic Information System (GIS) database. Data can be queried based on restoration and enhancement goals, allowing land managers to identify and prioritize potential treatment areas. The GIS database will eventually link to polygon photographs, as well as site-specific activities, including research projects and restoration treatments.

Marin-Sonoma Weed Management Area: Putting the 'We' in Weed Management

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The Marin-Sonoma Weed Management Area is a cooperative organization that brings together landowners, natural resource managers, and others to share expertise and coordinate efforts to control invasive non-native plants in the two-county region. In just a short period of time, the MSWMA has assumed an important role as the most visible and effective cooperative organization addressing the breadth of invasive plant issues across the two counties. The MSWMA is effectively uniting weed practitioners to plan weed removal efforts and share techniques, is increasing public awareness of invasive plants, and is making resources available for landowners and agencies to control weeds. As a consequence, weeds are being killed. This poster presents insights and lessons gleaned from several current MSWMA projects, including: extensive work controlling distaff, purple starthistle, and French broom; GIS mapping of priority weed species; experimental assessment of *Ehrharta erecta* control methods; and outreach efforts to educate citizens and land managers about problematic invasive plants and appropriate control techniques.

Spatial Analysis of Perennial Pepperweed Infestation in a Seasonal Floodplain

Ingrid Hogle, Joshua H. Viers, James F. Quinn, Mark W. Schwartz, Becky Waegell, and Kaylene Kelle, Information Center for the Environment, University of California at Davis, ibhogle@ucdavis.edu

Rapid on-going expansion of *Lepidium latifolium* (perennial pepperweed) populations threatens to create vegetation monocultures in riparian and wetland habitats throughout California. Understanding site characteristics that promote spread of *Lepidium latifolium* can help resource managers target and prioritize areas for weed control and future habitat restoration. We are developing a site-specific, GIS-based model that can be used to identify and examine correlations between rate of *Lepidium latifolium* spread, hydrological characteristics, disturbance regime and existing plant community types. Here we present our results from two years of monitoring *Lepidium latifolium* on a recently restored seasonal floodplain at the Cosumnes River Preserve in Sacramento County. These monitoring data are overlaid with elevation, moisture regime, and soil type coverages using ArcGIS to assess patterns of *Lepidium latifolium* infestation. Physical site characteristics can then be used to assess future infestation risk and to target areas for management.

Invasion Resistance to Non-Native Annual Grasses Among California Native Grass Species in the Sacramento Valley

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In the inland regions of northern California establishing stands of native grasses from seed in non-native annual grasslands requires intensive management. Less is known about how well established native grasses may resist invasion, especially among native grass species. The objective of this study was to compare the ability of native grass species and species combinations to compete with non-native grasses and record their resistance to invasion over a five-year period. Six species of native grasses were planted at three densities in monospecific and mixed species plots (two treatments of two species, one treatment of three species, and one treatment of six species). The soil at the site is well drained, Yolo silt loam. Percent cover was estimated year 2 and 3 and biomass was sampled year 5. Both species composition and native grass biomass were important in explaining variation in non-native grass biomass year 5. Overall, by year 5, non-native grass biomass was negatively correlated with native grass biomass. One species, *Leymus triticoides,* had significantly less non-native grass cover than all treatments but one, including the most diverse treatment. Although species ranged in height and growth rate, faster growing, taller species did not necessarily have the least non-native grass cover year 5. In addition, native grass species ranking higher in cover the first two years did not necessarily maintain their rank by year 5. This study demonstrates that established stands of native grasses have the ability to resist invasion by non-native annual grasses and that this ability varies among species and with time.

Volunteer Efforts to Educate and Influence Corporate America and Local Governments to Stop Selling and Using Pampas Grass (*Cortaderia selloana*) and Other Invasive Non-Native Plants

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For the past year, the San Diego Chapter of the California Native Plant Society has been taking matters into its own hands to educate the nursery industry and businesses about the perils of selling and using invasive non-native plant species. There are also citizens working in the cities of San Diego, Encinitas, and Carlsbad to educate their City Councils on the negative impacts of invasive non-native plants. The most problematic plant and highest seller in San Diego County appears to be pampas grass (*Cortaderia selloana*). We have worked successfully with Color Spot Nursery to stop growing it in California and with WalMart to stop selling it in California. We are working with several large businesses to remove pampas grass from their landscaping. REI in San Diego has removed it from their landscaping, and Fenton Marketplace, one of the premier shopping places in San Diego adjacent the environmentally sensitive San Diego River, has tentatively agreed to replace pampas grass with non-invasive plants. Negotiations are ongoing with Target (selling) and Legoland (landscape use). Techniques and tactics for how to turn corporate America and local governments into better environmental stewards and examples of successful outreach efforts will be presented.

Arundo Eradication and Coordination Program

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The purpose of this program is to coordinate and assist *Arundo donax* eradication projects throughout the Sacramento/San Joaquin River and Bay-Delta regions of California. The *Arundo donax* Eradication and Coordination Program is a regional effort inspired by the collaborative achievements of Team *Arundo* del Norte (TAdN), a coalition of property owners, and representatives from government agencies, academic institutions, and non-profit organizations that are working on *Arundo*-related issues. The goal of the program is to bring multiple eradication projects under one umbrella to increase efficiency, pool resources, and standardize methodologies. The *Arundo* program was initiated in April, 2001 and is funded for three years. It is administered for TAdN by the Sonoma Ecology Center.

All *Arundo* data will be integrated on the Program's mapserver, graphically displaying *Arundo* locations on watershed maps and linking these sites with monitoring data and photo-documentation. An online *Arundo* information library, accessible from the TAdN website, is available to assist current and potential partners. It includes updated control methods, a list of regional experts, project contact information, research literature, archived TAdN listserv discussions, and educational outreach materials. Potential partners are invited to apply to the Program for inclusion in subsequent grant proposals. All weed enthusiasts and eradication groups are encouraged to join our listserv, use our survey protocols, and share data through our on-line database. *Arundo* eradication efforts throughout California will benefit from the networking and resource assistance of the *Arundo* Eradication and Coordination Program. For more information about the *Arundo donax* field data protocol or to browse the *Arundo* information library, visit the TAdN website (http://teamarundo.org).

Community Responses to Spotted Knapweed: A Sociological View

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Biological invasions represent significant ecological and economic threats in California. Biological invasions also raise a series of less visible social issues: what social groups are impacted by different invasive species? How are different social groups uniquely impacted? And the selection of management strategies raises questions of decision-making process: who gets to decide which invasives are to be managed and how? Who may benefit or be impacted by different management practices?

The Salmon River of Northern California is remote, pristine and biologically significant. Residents of this relatively isolated watershed include the Karuk tribe, white loggers, "back to the land hippies," and small-scale farmers, loggers and miners. Members of the Salmon River Restoration Council, the Karuk Tribe of California and the U.S. Forest Service are each differently affected by, and have different notions of the best way to respond to the presence of Spotted Knapweed. As a Class A invasive species, Spotted Knapweed requires treatment, yet 90% of community members oppose the Forest Service's plan to apply pesticides to plant populations. Members of the Karuk tribe oppose spraying due to concerns over impacts on traditional basket makers who chew native plant roots as part of the preparation process. Other community members oppose spraying due to concern over general human impacts, damage to fisheries habitat, water quality and riverside ecosystems. Community opposition to spraying has led to an alternative program of intensive hand eradication that is now in its seventh year. While less cost-effective in

traditional economic terms, this approach appears to have significant social, political and ecological benefits including community education and empowerment, support of cultural tradition, and maintenance of pristine and significant fisheries. For people living along the Salmon River of Northern California digging knapweed appears to be about more than how to eradicate a Class A invasive species, it is also about community building, local autonomy, local land management and connection to place. This case study suggests that management processes that incorporate social as well as ecological and economic factors may have the best chance of success.

Diffuse Knapweed (*Centaurea diffusa*) Control on South Fork Mountain, Trinity County, California

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The population of diffuse knapweed on the top of the South Fork Mountain is considered to be the largest in the State of California, and occupies approximately 800 acres of public and private lands in Trinity County. It is spreading into Humboldt County and has been identified on Eight-mile Ridge and Pilot Creek, west of South Fork Mountain. The Trinity County Weed Management Cooperative (Cooperative) has focused its control efforts in the county on three noxious weeds, with diffuse knapweed its number one priority. The Cooperative received funding from the California Department of Food and Agriculture (CDFA) to conduct an inventory of the total geographic occupation of diffuse knapweed during the summer of 2001 in the South Fork Mountain area. Plants were manually removed during July of 2001, 2002, and 2003 from the edges of the population toward the center with emphasis on outer satellite populations to contain the extent of the infestation. Manual control of diffuse knapweed on South Fork Mountain has contained the population within the 2001 boundaries, reduced the density of plants where manual control has been implemented, and raised the awareness of private landowners. In 2004, manual control will continue and contiguous patches of knapweed will be seeded with native grasses and mulched with native grass straw to accelerate occupation of disturbed habitat with native species.

Ecological and Hydraulic Effects of Red Sesbania (*Sesbania punicea*) Invasion of Riparian Areas in California

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Red sesbania (rattlebox, Chinese wisteria, scarlet wisteria, *Sesbania punicea*) is an invasive shrub or small tree reported recently from riparian areas in the Sacramento-San Joaquin Delta, Lower American River, San Joaquin River, and other Central Valley locations. It is native to South America and is a major weed in southern Africa. It is also well established in the southeastern United States. The most extensive stands in California are along 11 river miles of the Lower American River in Sacramento, and along 15 river miles of the San Joaquin River near Fresno. We used geographic information system (GIS) and vegetation transect data to analyze the hydraulic conditions and plant species composition of red sesbania stands at these two locations. Red sesbania is mostly found in areas close to the low-flow channel that were previously sparsely vegetated or dominated by herbaceous vegetation. Its effect on hydraulic roughness may therefore be substantial. Red sesbania is expected to further reduce flood conveyance capacity if not controlled, because it has the potential to spread rapidly. The biology of the plant and research from South Africa and the

southeastern United States suggest several control methods that could be applied in California.

Controlling Weeds with Weeds: Disturbance, Succession, Yellow Lupines and Their Role in the Successful Restoration of a Native Dune Community

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At the 2000 Cal-EPPC Conference we reported that yellow lupine are an effective, non-toxic means for controlling re-growth and re-seeding of exotic weeds. Here we report on the present status of this experiment. In 1998, we planted ~20,000 12-inch tall yellow lupines on a secondary dune at the Moss Landing Marine Laboratory site. At the time ~90% of this 10 ha site was dominated by ripgut brome, wild radish, and mustard. We selected yellow lupine because it is native to coastal dunes of central California, fast growing, and short-lived. We did not have to be concerned with building up nitrogen in pristine dune sands because 8,000 years of human occupation had already enriched the soil nitrogen composition. By 1999, lupines achieved nearly 100% canopy cover in areas where they were planted and had deposited a thick duff layer, preventing the success of weeds that germinated within the patch. By 2000, most of the yellow lupine from the first plantings had died or were killed by ghost moths, leaving the patches open and virtually weed free. This enabled existing native stands to expand, it created conditions highly favorable to native annuals and perennials which volunteered at the site, possibly from long dormant seed stocks, and it provided an ideal setting to establish other native dune plants. All within a setting where weeds were controlled to the point that simple hand pulling is the only maintenance required. At present we have 100% native cover over the 10 ha site, of which less than 10% is yellow lupine, and only occasional and minor weedy incursions which are easily controlled. In addition we have populations of federally endangered and threatened sand gilia and Monterey spineflower that number in the hundreds of thousands, and we have dramatically improved the habitat value for California legless lizards.

Creeping Water Primrose (*Ludwigia hexapetala*) in the Laguna de Santa Rosa

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Creeping Water Primrose *(Ludwigia hexapetala)* is a perennial, aquatic, vascular plant that favors shallow, fresh water. It is identified by bright yellow flowers and alternate, narrowly elliptic-shaped leaves. *Ludwigia* forms dense mats of upright vegetation three to five feet tall, covering large areas of water with growth continuing into terrestrial areas. Creeping Water Primrose reproduces through seed and plant fragments. Currently, *Ludwigia* is on Cal-EPPC's "Need More Information" list. The main goal of the Laguna Vegetation Management Project is to assess the extent of the invasive plants in the Laguna de Santa Rosa, Sonoma County, and make recommendations for a management plan that includes an ecosystem-wide approach. We are currently assessing the presence and extent of invasive plant species in the Laguna, primarily *Ludwigia* due to its abundance in the study area, and mapping the extent, abundance and seasonal growth patterns. Correlations between sediment trapping, excess nutrient loads, and the relationship between mosquito populations and *Ludwigia* are also part of the research.

The poster includes a map of the infestation within the study area, facts about the species, an overview of the research project, and photos of the Laguna and *Ludwigia*.

Challenges of Restoring Native Habitat in a *Spartina alterniflora* Hybrid Invaded Ecosystem

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Spartina alterniflora (Atlantic smooth cordgrass) and its hybrids with the native *S. foliosa* (Pacific cordgrass) are rapidly spreading and threatening to cause fundamental changes in the structure, function, and value of the San Francisco Estuary's tidal lands. Invasion impacts include possible local extinction of *S. foliosa*, choking of tidal creeks, domination of restored tidal marshes, and displacement of thousands of acres of shorebird foraging habitat. In 2000, the State Coastal Conservancy initiated the Invasive *Spartina* Project to implement a long-term management program to arrest and reverse the spread of invasive non-native *Spartina* in the San Francisco Estuary.

The prevailing wisdom in weed control for habitat restoration suggests that one "manage for" the habitat that is desired – this is usually the "native" or "pre-invasion" state. In control of hybrid *Spartina*, this can pose a number of challenges, depending on the site-specific invasion scenario. For example, where hybrid *Spartina* invasion of mudflats has caused increased sedimentation and significantly raised ground surface elevations, restoration to a pre-invasion mudflat state may be infeasible; creation of native mid or high marsh, with species such as *Salicornia virginica* (pickleweed) and *Distichlis spicata* (salt grass), might be the only viable alternative. As another example, restoration of hybrid-invaded *S. foliosa* marsh to a "pure" *S. foliosa* state is complicated by the extreme difficulty in distinguishing some hybrids from natives, due to continual backcrossing of hybrids with both parent species. This complicates the determination of which plants to remove, and it makes it difficult to monitor new growth to protect against reinfestation. In some situations, depending on proximity of the "restored" site to other hybrid-invaded sites, it may not be feasible to preserve any native *S. foliosa* until neighboring sites are controlled. A conservative approach might be to remove all *Spartina* species, and "restore" only the high marsh areas, pending sufficient reduction in invasion pressure. Restoring native habitat in an ecosystem invaded by *S. alterniflora* hybrids will be challenging, requiring a flexible and adaptive program guided by the best available science to achieve its objective

2003 Cal-IPC Red Alert!
New Invasions, Recent Expansions, and a Few Others to be on the Look-Out For....

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The overall purpose of the annual Cal-IPC Red Alert! is to become more proactive in our invasive species prevention, early detection and rapid response efforts in California. Specifically, the annual Red Alert! works to inform land managers of invasive species that have just recently been detected in

California (and are not yet listed in the Jepson Manual or in CalFlora) and have the potential to become widely invasive in the state, and to also provide updates on already-established non-native plants that have recently been reported as expanding their range(s) within the state.

This 2003 edition of the Cal-IPC Red Alert! does not report any new invasive species into California, although it is unclear if we are truly doing a better job or if any new species have simply not been reported (to CDFA). This 2003 edition also includes updates on the range expansion of two species in Northern California, as well as a heads-up on three species that are rapidly expanding their range and extent just north of California in the Pacific Northwest states (Oregon and Washington). These three species have the potential to become largely problematic in California, and we urge all land managers to be vigilant for the first signs of these species in California, and to eradicate those small patches where they already exist.

Additional reports of new non-native species can also be seen in Cal-IPC News, the Noteworthy Collections section of the journal Madroño and on The Nature Conservany's Invasives-on-the-Web homepage (http://tncweeds.ucdavis.edu). If you know of any new invasives or new range expansions within California, please contact Joe DiTomaso at UC Davis and Steve Schoenig at CDFA for inclusion into next year's Cal-IPC Red Alert!

Recent Range Expansions of Non-Native Species Previously Reported in Other Publications as Established in California:

Elytrigia pontica **(rush wheatgrass, tall wheatgrass)** – *Elytrigia pontica*, a European perennial grass, has been previously documented from Contra Costa, Inyo, Kern, Lassen, Plumas, San Bernardino, Santa Clara and San Diego Counties (Jepson Manual & CalFlora database). Dan Glusenkamp of Audubon Canyon Ranch now reports that it is rapidly expanding its range in Mendocino, Marin and Sonoma Counties. He reports that it is present at Bouverie Preserve in Sonoma Valley, and that it was first introduced as forage. Dan also reports seeing patches of it in Mendocino County (at Goat Mountain), and that it appears to invade grasslands that are relatively wet in winter and dry in summer (such as vernal pool habitats), and may be working to exclude all other species.

Centaurea x pratensis (**meadow knapweed*****; *****C. jacea x C. nigra*****)** – This species is a repeat from last year's (2002) Red Alert, but Carri Pirosko (CDFA) reports that she is continuing to see expansions in the range of this species in Northern California, especially in Del Norte and Siskiyou Counties. Carri reports that she has seen it creeping along several highways from southern Oregon into California.

Warnings from the North...Problematic Invasive Species in the Pacific Northwest, Which are not (yet) Problematic in California:

Brachypodium sylvaticum **(false-brome)** – *Brachypodium sylvaticum* was first identified and vouchered in Oregon near Corvallis in the 1930s. It has not been reported as being problematic or an invader anywhere else in the world, nor has it been documented anywhere in California. In the late 1990s however, people finally started to think of this species as an invader in Oregon, began mapping its distribution and discovered that *B. sylvaticum* is apparently now widespread across much of the

Willamette Valley, and parts of the Coast Range and western Cascades. Populations extend as far south as Josephine County, making it a likely candidate to expand its range into California. *B. sylvaticum* can come to dominate in full sun or open grassland habitats, as well as in dense shaded coniferous understories, and is now common along logging roads and fire lines in coniferous forests.

For more information on this species, see
http://tncweeds.ucdavis.edu/esadocs/bracsylv.html

There is also a false-brome working group in Oregon, which has just completed a general survey of where it is located. They also have a good fact sheet on it: http://www.appliedeco.org/FBWG.htm

!!!Red Alert!!! Update from December 2003 - *Brachypodium sylvaticum* has been positively identified in San Mateo County, California! This species may be more widespread. It is not listed in the Jepson Manual, so those attempting to key to it may actually be misidentifying it! If you key to the genus *Brachypodium*, seriously consider sending a specimen to Dr. Fred Hrusa, Senior Systematist of the CDFA Herbarium or to your local herbarium for verification!!!

Ventenata dubia **(wiregrass, North Africa grass)** – *Ventenata dubia* has already been documented from Lassen, Plumas and Siskiyou Counties, but has not yet been identified as spreading or as being problematic in California. *V. dubia* is becoming more widespread across the west (Utah, Idaho, etc.), and recent expansions of this species in different parts of Oregon indicate that it may soon become a pest in California. *V. dubia* is of low palatability to grazing animals and it has also already demonstrated resistance to glyphosate and sethoxydim. It is likely spread as a contaminant in grass seed.

Dr. Beecher Crampton first identified *V. dubia* in California in 1983, when he was brought a specimen from Bear Valley (near Emigrant Gap) in Placer County. He then identified *V. dubia* as native to Eurasia, and speculated that it was likely a relatively recent introduction, since 1962, to California. Dr. Joe DiTomaso of UC Davis recently (in 2001) collected a specimen of *V. dubia* near Glenburn in Shasta County.

Polygonum cuspidatum **(Japanese knotweed, fleeceflower),** ***Polygonum polystachum*** **(Himalayan knotweed) and** ***Polygonum sachelinense*** **(giant knotweed) -**
All three species of knotweed are already present in several counties in California, but have not yet been reported as problematic in the state.

Polygonum cuspidatum **–** Documented from Modoc, Siskiyou, Humboldt, Mendocino, Sonoma, Marin, Contra Costa, San Francisco, Santa Cruz, Santa Clara, Monterey, Nevada, and Placer Counties.
P. polystachum **–** Documented in Del Norte, Humboldt, Mendocino, San Francisco, and Santa Cruz Counties.
P. sachelinense **–** Documented in Siskiyou, Del Norte, Humboldt, Mendocino, Sonoma, Santa Cruz, San Luis Obispo, Nevada, Yuba, Butte, El Dorado, and Sacramento Counties.

The knotweeds have a huge potential of becoming widely invasive in riparian areas across much of California, especially in the northern Coast Range. In the Pacific Northwest, all three knotweed species have only become a problematic invader since the 1990s, and knotweeds are already pestiferous in the Northeastern U.S. and in the Northern Midwest states, as well as in England. All three knotweed species can also hybridize with one another. The knotweeds are likely escaped ornamentals, and can be controlled relatively easily if infestations are small. Since these knotweeds already exist in scattered populations in California, we urge rapid action to eradicate these populations.

Compilation of Past Red Alerts:
2002 **(detailed report available in the 2002 CalEPPC Proceedings – Volume 6)**
Undaria pinnatifida – New expansion; present in at least 6 sites off the California coast
Washingtonia robusta – Widely planted as an ornamental tree; escaping in riparian communities in southern California
Hypericum canariense – Escaped from cultivation? Spreading in San Mateo County.
Centaurea x pratensis – Spreading in several counties in northern California.
Cynoglossum officinale – Spreading in timber grounds in northern California.
Centaurea maculosa – Widely established in California, now in Los Angeles County.
Sesbania punicea – Escaped ornamental; spreading in riparian areas in Sacramento-San Joaquin Delta and in Placer County.

2001 (detailed report available in the 2001 Fall/Winter Vol. 9 (3/4) of CalEPPC News)
Cabomba caroliniana – Popular aquarium plant; spreading in several Sacramento River Delta sites.
Euphorbia oblongata – Becoming more common in the Berkeley Hills area.
Lavatera cretica – Spreading in southern California along Malibu, west to Zuma Canyon.
Hedera canariensis – Occurs throughout the Bay Area, and is probably more common than *H. helix.*
Saccharum ravennae – Ornamental grass, invasive in Imperial County in ditchbanks and marshes. Also spreading in Sutter and Yolo Counties.
Achnatherum brachychaetum – New infestation near Tracy.
Salvinia molesta – Becoming well-established in some aquatic habitats in Imperial, Riverside, and San Diego Counties.
Hydrilla verticillata – Ongoing eradication effort in Clear Lake (Lake County); has been identified in Yuba and Calaveras Counties, and in the Redding area.

2000 (details for this 2000 CalEPPC Red Alert is provided below, since it has not previously been printed by CalEPPC)
Caulerpa taxifolia – Eradication underway for two (three?) populations off the southern California coast.
Stipa capensis – Spreading in Palm Springs area.
Nassella tenuissima – Present in Contra Costa County; escaping from gardens from the Berkeley and El Cerrito area.
Cestrum nocturnum – Escaped ornamental in Orange and San Diego counties.

Nerium oleander – *Escaped ornamental in riparian zones in southern California and along the Sacramento River floodplain near Redding.*
Rhamnus alaternus – Naturalized in southern California in urban settings and disturbed arroyos, especially in Riverside and Los Angeles Counties.
Sisymbrium erysimoides – Spreading in the Riverside area and into Coachella Valley.
Rorippa sylvestris – Common weed from ornamental plantings; spreading in California.

1997 (detailed report available in the 1997 CalEPPC Proceedings)
Catalpa bignonoides – *Escaped ornamental in San Diego county and in the Sacramento-San Joaquin Delta area.*
Coincya monensis – Found in a pasture adjacent to the Manila Dunes in Humboldt County. Eradicated?
Cynanchum louiseae – Reported from the Riverside Botanic Garden in 1996.
Ehrharta longiflora – Reported from sites near Torrey Pines State Preserve in San Diego County.
Gleditsia triacanthos – Escaped ornamental in Orange and Sacramento Counties. May be more widespread in the Central Valley.
Helichrysum petiolare – *Escaped ornamental in Marin and Mendocino Counties, especially on the western slopes of Mount Tamalpais.*
Maytenus boaria – Escaped ornamental in Yolo County.
Retama monosperma – Escaped ornamental in San Diego County. Eradicated?
Sapium sebiferum – Escaped ornamental in the Sacramento-San Joaquin Delta region.
Pistacia atlantica – Escaped ornamental in the Sacramento Valley and in southern California.

Red Alert! New Weeds to Fear in California…

Accidently Ommitted from the 2000 CalEPPC Proceedings

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The goal of the CalEPPC Red Alert! is to provide an account of newly reported species in California that have the potential to become invasive and to comment on plant species which have been in California for some time, but are now spreading in extent or into new habitats. These species are typically known to be invasive in other areas and show potential to be highly invasive and troublesome in California. Be sure to look for updates on new non-native species in CalEPPC News, the Noteworthy Collections section of the journal Madroño, and on The Nature Conservancy's Weeds-on-the-Web Homepage (http://tncweeds.ucdavis.edu).

Newly detected species with high potential to become invasive in California:

Caulerpa taxifolia is a bright green alga with flat, leafy fronds that look like the branchlets of coast redwood trees or yews (*Taxus* sp.), (hence the *taxifolia* species epithet). The invasive *C. taxifolia* is thought to be derived from a single mutant clone, which was originally developed for aquarium use in Germany. Since its introduction in 1984 into the Mediterranean Sea via aquarium dumping near Monaco, this mutant strain has taken over more than 10,000 acres of Mediterranean seabed habitat. This species has since been introduced and begun to spread to near Sydney, Australia, and into southern California waters at two sites: off the coast of Carlsbad (near San Diego) and at Huntington Beach (near Los Angeles). *C. taxifolia* is capable of very high rates of growth, up to one inch per day, and small broken fragments have the potential to start new colonies, each of which could expand to cover more than 75 square feet within one year! This alga is sometimes called the "killer mutant alga" because it is able to form a dense smothering blanket of growth on just about any surface. *C. taxifolia* was first reported in California off the coast of San Diego in the summer of 2000, and that population has now been successfully eradicated using a chlorine bleach stock. Another population of *C. taxifolia* near Huntington Beach has been reported, and eradication efforts are currently underway to kill this population.

Stipa capensis is a grass (Poaceae) native to the cape region of South Africa. In its native range, *S. capensis* is an important pasture grass in dry climates, and is also used for papermaking mats and cordage. Andrew Sanders of UC Riverside first discovered *S. capensis* in California several years ago (already on CalEPPC list), and reports that it has spread and has become common in the Palm Springs area. *S. capensis* has the potential to become a pest in California, as it is widely distributed as an ornamental grass, and is known to be a widespread invasive plant in dry areas of New Zealand.

Nassella tenuissima is a grass (family Poaceae) native to the southeastern and southcentral United States and northern Mexico. It is often sold as a desirable ornamental bunchgrass with the common names Texas needle-grass or fine-leaved nassella. *N. tenuissima* has the potential to become a natural area invader in California, since it is already highly invasive in similar Mediterranean habitats, such as in Australia and the eastern cape of South Africa. *N. tenuissima* has been reported as naturalizing in Contra Costa County, and Fred Hrusa of CDFA states that it readily establishes in sidewalk cracks adjacent to cultivated plants in gardens throughout the Berkeley/El Cerrito area.

Cestrum nocturnum is a shrub or small tree in the Solanaceae (nightshade family). Commonly called night jasmine, it is often planted as an ornamental and is an invasive weed in New Zealand. *C. nocturnum* has also been reported as an "Invader of Natural Areas in the U.S." namely, in Hawaii and in the southern U.S. Andrew Sanders of UC Riverside reports that *C. nocturnum* has begun invading riparian areas in southern California, and it is known from two locations in wet coastal willow thickets in Orange and San Diego counties.

Nerium oleander is a shrub in the Apocynaceae (dogbane family), and has been widely planted throughout California as a common ornamental along highways, streets, and in parking lots. Keely (1992) first reported that *N. oleander* had become invasive in northern California along the Sacramento River floodplain near Redding. This year, Andrew Sanders of UC Riverside reported that *N. oleander* is also invading riparian zones in southern California. Known localities of naturalized populations in southern California include the lower Waterman Canyon and the San Bernardino Mountains.

Rhamnus alaternus or Mediterranean buckthorn, is a shrub in the Rhamnaceae (buckthorn family). It is often planted as a drought-tolerant ornamental in southern California, Andrew Sanders of UC Riverside reports that *R. alaternus* has become naturalized in southern California in urban settings and along disturbed arroyos, especially in Riverside and in CSS/CHP LA Counties. It has the potential to become invasive here, as it is already a problem plant in the central coast, tablelands, and western slopes of New Zealand.

Sisymbrium erysimoides is an herbaceous plant in the Brassicaceae (mustard family). Commonly known as wallflower tumble-mustard, *S. erysimoides* is becoming a common urban weed in the Riverside area of southern California. Andrew Sanders of UC Riverside reported that it has now spread into desert habitats on the east-side of the Coachella Valley, which is a large expansion in both range and habitat for this species. *S. erysimoides* is already naturalized in similar habitats in Western Australia and has the potential to become a troublesome invader here too.

Rorippa sylvestris is another herbaceous plant in the Brassicaceae (mustard family), and is commonly known as yellow field-cress or creeping yellow cress. *R. sylvestris* is native to Eurasia, and has been listed as a noxious weed in North Carolina, Oregon, and California. Clyde Elmore, an Extension Weed Specialist at UC Davis, reports that *R. sylvestris* is common in ornamental plantings, and that *R. sylvestris* rhizomes are unintentionally being shipped interstate with vegetatively propagated herbaceous ornamentals. Joe DiTomaso of UC Davis reports that *R. sylvestris* has spread extensively in the years since its introduction to California, and is becoming a serious weed in greenhouse, container, and in field ornamentals. It also has the potential to be highly invasive in California wildlands, as it is often found along stream edges and in other wet areas.