Appendix A

Tejon Ranch
Weed Management Strategy

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Caveat

This weed management Strategy should be considered a living document. It represents the current knowledge and understanding of non-native invasive plants on a portion of the Tejon Ranch, and should be continually updated as information becomes available to guide weed management on the Ranch. Not included in this Strategy are site specific recommendations, which would require an ecosystem and economic based analysis of conservation priorities.

Recommended citation

When citing this report, please use the following format:

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TABLE OF CONTENTS

Executive Summary

Invasive species are considered the second greatest threat to biodiversity worldwide. Tejon Ranch, one of the most biologically diverse regions in the state, is no exception. Invasive plants are now considered one of the leading conservation challenges facing the two land managers of Tejon Ranch, The Tejon Ranch Conservancy (Conservancy) and the Tejon Ranch Company (TRC).

Over time, weeds have spread to varying degrees on the Ranch, affecting flora, fauna, and ecosystem processes. Weed management programs require a full understanding of the invading species' impacts, invasiveness, abundance, and distribution in order to make the best management decisions possible and to utilize limited resources effectively, especially over such a large area as the Ranch. The results from two weed surveys conducted in the spring and summer of 2010, of 72,000 of the 240,000 acres of the Ranch, have provided the Tejon Ranch land managers with systematically collected information needed to collaborate and develop a comprehensive and coordinated weed management strategy. This Strategy includes a overview of the threat posed by invasive plants, best management practices, and invasive plant distribution and abundance analysis over a portion of the Ranch, and short and long-term objectives, which include preliminary recommendations on which species could be targeted for which management objective.

From a list of nearly 200 non-native plant taxa occurring on or near Tejon Ranch, John Knapp and Mike White identified 32 weed species that are known to negatively affect wildlands or pose indirect impacts to the Ranch. Landscape-level mapping methods developed by Native Range, Inc, utilizing full-time helicopter support were used to survey weed species on the Ranch and assess each population's location, size, density, and age class. Three thousand and seven transect miles were flown over 72,000 acres. Abundance and distribution data collected during aerial surveys were used in a ranking index to prioritize each species for management feasibility (Appendix 1). It should be noted that once the remaining portions of the Ranch are surveyed, the overall management feasibility of each species may change. It is expected that population trends will be similar across the Ranch, however.

Each species was ranked for priority of control using two prioritization systems 1) the California Invasive Plant Council's (Cal-IPC) Plant Assessment Form, and 2) a management feasibility index. Cal-IPC's prioritization system includes ranks of High, Moderate, or Limited. A rank of High was assigned to 34.8% of the surveyed weeds, Moderate to 39.1, and Limited to 21.7%. 4.4% of the 23 species were evaluated by Cal-IPC but Not Listed due to their minor impact to wildlands or because there was insufficient documentation available to rank them. All species were then subjected to a management feasibility index developed from the spatial data collected during the 2010 weed surveys. A management feasibility index of A, B, or C was assigned to each species to indicate eradication difficulty, with A being the easiest to eradicate, and C being the most difficult (Appendix 2). A rank of A was assigned to 34.8%, B to 30.4%, and C to 34.8% of the 23 species. The combined ranking score for each species enables land managers to efficiently utilize limited resources by focusing efforts on species that cause the greatest threat and, most importantly, are manageable on Tejon Ranch lands. As top tier species are eradicated over time, the next tier of weeds can be targeted for management, allowing ecosystem processes to rebound and native flora and fauna to respond.

Since invasive plant management generally requires a long-term commitment, this Strategy was developed to establish accepted operation goals, procedures, and methodologies for managing weeds as the landscape-scale. Over time, multi-year work plans will be developed and revised based on available resources, however, the overall Strategy will remain the same regardless of staff turnover.

In addition to this Strategy, an extensive and current database of weed distributions and abundance, and coordinated implementation programs will enable the Tejon Ranch land managers to effectively tackle the invasive weed crisis ranch-wide.

The Purpose and Scope of this Strategy

Weeds defined

The word "weed" (used here interchangeably with "invasive plant") has many definitions; however, the most common and accepted definition used in California is, any plant introduced knowingly or unknowingly to [or spread throughout] North America after European contact, and has the ability to invade and adversely impact and degrade wildlands (Randall et al. 2002).

Purpose

Weeds know no boundaries, and one land manager's weed can easily become his or her neighbor's weed. The Weed Management Strategy (hereafter, simply Strategy) outlined here is intended to enable the Conservancy and TRC to coordinate the systematic eradication, reduction, containment, and control of priority weeds throughout the Ranch. Working together from a shared foundation will enable both land managers to work more efficiently by sharing information and pooling limited resources to reach common weed management goals. Housing all pertinent weed management information in a centralized location, managed by specialists from both the Conservancy and TRC, will empower both land managers, and their potential cooperators and contractors to take timely and organized weed control action by quickly providing them the data crucial to making informed weed management decisions.

Why is this Strategy necessary?

Management of weeds usually requires a long-term commitment both to remove all living plants and to exhaust the associated soil seed bank. A strategy that clearly outlines the scope of the problem, the management objectives, and a suite of recommended control actions will provide a road map for current and future land managers to follow and learn from.

If such a systematic strategy were not developed, staff turnover and potential future changes in management philosophy could redirect weed management resources to other weed species, populations, or other conservation challenges, resulting in years of work wasted by forgetting about or abandoning valuable and intensive projects that require consistent long-term attention for successful completion. Those populations would then rebound and replenish their soil seed banks, setting the 'weed management clock' for that population or species back to zero. Successfully controlling weeds requires both consistent treatment and thorough and regular monitoring (Mack and Lonsdale 2002). This Strategy will serve as a roadmap to follow in order to achieve these long-term goals. As the old adage goes, "When you fail to plan, you are planning to fail."

By creating a computer database and associated management strategy of weed populations, key information will be readily available to all future weed managers who will be able to use it to analyze changes in populations, develop monitoring schedules, evaluate control efficacy, and record the appearance of new populations in the long term. Weed infestations are never static, and multiple species and populations often are difficult to keep track of with the human brain alone. If key species and population information are not recorded in a database and outlined in a management strategy, then that organizational knowledge can easily be lost when the land manager relocates or dies. The epitaph of a land manager's tombstone could read, "Here lies all the institutional weed knowledge of the preserve (Schoenig et al. 2002)."

Managing the Ranch weed control data in this way also allows for regional, state and national entities involved in managing weeds to share data, thus contributing to larger weed awareness campaigns. Distribution maps generated from the dataset are an effective tool for educating others about weed prevention and impacts (Schoenig et al. 2002), and when seeking funding for projects and programs.

Basing management decisions on systematically gathered data allows Ranch managers to defend management positions, rather than entering a discussion based on anecdotal evidence or beliefs. Management of weedy tree species or attractive ornamentals, in particular, often requires strong evidence to convince skeptics. The importance of weed control, and necessity of the control methods employed, such as herbicide applications or biological control are not always readily accepted or understood. Weed management can present issues that may run counter to the values and beliefs of some members of the public. Education and outreach are essential tools for promoting the understanding of the issues, and provide the foundation for invasive species prevention programs.

Weeds have a devastating effect on wildlands around the world (D'Antonio and Vitousek 1992), and their management for the preservation of native biodiversity is one of the major challenges of this century (D'Antonio and Meyerson 2002). Land managers entrusted with protecting natural resources often attempt to control weeds through a form of triage, where they hastily and unsystematically identify which species will be targeted for control and which ones will be left to possibly spread. These decisions are often based on anecdotal and unverified data (Pete Holloran 2006, personal communication). Diverting limited resources to survey and inventory weed populations might appear to be a waste of time and money when the impacts caused by weeds are readily apparent. Yet land managers often function as physicians who are entrusted with healing their patient (the land), and a good doctor should give his or her patient a proper examination before prescribing a remedy to cure an illness (Knapp and Knapp 2005). A proper physical will also provide a sound scientific foundation for future management actions.

Funding is often very limited for weed management, and it is critical to prioritize both species and populations for control in order to utilize resources effectively (D'Antonio and Meyerson 2002). Managing weeds without the knowledge of their impacts, abundance, distribution and rates of spread has been compared to fighting a wildfire without knowing the location, size, direction and rate of spread of that fire; this can negate the effectiveness of fire fighters and potentially jeopardize their lives (Schoenig et al. 2002). Likewise, managing weeds without the relevant data often limits the effectiveness of management efforts while potentially wasting time and money and jeopardizing the health of the ecosystem.

There are two general weed management strategies: site-led and species-led (Department of Conservation 1998). A species-led strategy focuses work on individual weed species wherever they may occur across the landscape. A site-led strategy focuses work on multiple species within a designated site. In order for a site-led strategy to be effective, an exhaustive dataset of natural resources is needed to prioritize sites for protection (Knapp and Knapp 2005). The Strategy presented here for Tejon Ranch is primarily a species-led approach, where the focus is the weed, not the site invaded.

Issues not addressed in this Strategy

This Strategy focuses on weeds of wildlands. Weeds known to be closely tied to chronic human disturbance, agriculture, or cultivation, which on the Ranch typically have large and widespread distributions, were not surveyed or evaluated due to their limited ability to successfully invade and degrade intact or recovering wildland ecosystems (Scott Steinmaus, California Polytechnic State University San Luis Obispo, personal communication). These species may be suitable targets for control in areas where native vegetation has been severely disturbed by previous land uses, depending on site values and circumstances.

The effect of different weed species on ecosystem processes, and biological resources was a major focus of the Strategy employed here. Threats posed to the recreational and grazing value of wildlands by these species were not considered, although they can be important. If a species is known to obstruct the movement of wildlife or form monotypic stands, it may be inferred that it can impede recreationalists as well. In addition, species known to be toxic to livestock or other mammals are also likely toxic to humans. Recreational impacts can in some cases be inferred from the literature cited in the Plant Assessment Forms (PAFs) used to rank each species. Quantifying the degradation of the recreational values of wildlands is very subjective, however (Eiswerth 2005).

Techniques such as biological control and prescribed burning were not included in the recommended management methods for each species, as they require considerable planning and political buy-in. However, these techniques can be effective and should be considered. Management of non-native vertebrates or invertebrates was also beyond the scope of this plan. However, such taxa should be considered when addressing large-scale weed control, as the management of each can affect the other and the order in which they are approached can be crucial (Zavaleta et al. 2001).

A complementary, and often necessary, component of large population weed removal is revegetation and/or restoration by outplanting native stock or by direct seeding. Large bare areas where weeds have been removed are often filled by other nearby or easily dispersed weed species. Outplanting or seeding native plants expedites site recovery and increases resistance to invasion (D'Antonio and Meyerson 2002). The plan presented here does not address revegetation or restoration of treated weed sites because the majority of infestations targeted are incipient populations (those with small numbers of individuals, occupying small areas, or not yet well-established), surrounded by native vegetation that can easily recolonize the treated site. A restoration initiative would also merit its own comprehensive strategy to adequately address outplanting objectives and programmatic implementation.

Background

Tejon Ranch Overview

Tejon Ranch is located along Interstate 5, approximately 60 miles north of Los Angeles and 30 miles south of Bakersfield. At nearly 270,000 acres, Tejon Ranch is the largest continuous expanse of private land in California. Its 422 square miles make it almost as large as the City of Los Angeles and about 40% the size of Rhode Island.

Tejon Ranch is located at the intersection of four major ecological regions: the Great Central Valley, the Sierra Nevada, the Mojave Desert, and Southwestern California. Thus, the diversity of plants and animals found on Tejon Ranch reflects its position at what has been termed a

biogeographic crossroads, where species unique to each of these regions can be found together on the Ranch.

Tejon Ranch appears to be a hotspot of evolution, where a large number of different species and subspecies have evolved over time. Tejon Ranch is a largely roadless, biological core area with high habitat integrity and intact, functioning watersheds. The Ranch is also characterized by high topographic complexity – over 6,000 feet of elevation change, major north-south and east-west trending canyons, and a well-distributed diversity of slopes and aspects – thereby providing landscape resilience and a potential refuge for species in the face of climate change.

The east-west trending Tehachapi Mountain Range is the spine of the regional landscape linkage between the Coast/Transverse Ranges to the west and the Sierra Nevada to the east. Tejon Ranch's location at the center of this continentally significant linkage is important to its conservation significance. This linkage includes the last native grassland corridor surrounding agricultural lands in the southern San Joaquin Valley, oak and pinyon-juniper woodlands that connect to the west and east slopes of the Sierra Nevada respectively, and "sky islands" of conifer habitat connecting the more extensive conifer forests in the adjacent Transverse Range and Sierra Nevada.

The elevational gradients found in this region combined with the ecoregional convergence described above contribute to its outstanding evolutionary connectivity. The region is known by taxonomists as a notably dynamic area for contact between sub-specific forms, races and morphs of numerous taxa. Intraspecific diversity is thought to contribute to the resiliency of species in the face of environmental stochasticity and climate change. The evolutionary processes that create this diversity are worthy of conservation in their own right.

Significant public and private conservation investments have been made in this Tehachapi linkage, including the Los Padres and Sequoia National Forests, the Wildlands Conservancy's Windwolves Preserve, Bittercreek National Wildlife Refuge, Carrizo Plains National Monument and other Bureau of Land Management administered lands, as well as private lands protected from development via current use tax incentives (Williamson Act) and conservation easements. The conserved lands on Tejon Ranch represent a major contribution towards securing this continental-scale linkage, and create leverage for additional conservation to complete this statewide conservation priority.

Tejon Ranch supports over two dozen different major vegetation communities, representing over 60% of the vegetation communities in the Tehachapi region. Given its unique biogeographic position, variable topography and diverse geologic origins, many distinct associations of plant species are likely to be discovered with further investigation. Tejon Ranch lands conserve a nice representation of the biodiversity of the region, and provide a unique opportunity to conserve habitats that are under-protected in the region, as described below.

• Within the 240,000-acre potential conservation area of the Ranch, over 84,000 acres of oak woodlands exist, which would represent a substantial increase in the conservation of these habitats in the region.

• Likewise, nearly 100,000 acres of grasslands are present in the potential conservation area, including over 10,000 acres of native grasslands and tens of thousands more which support substantial populations of native forbs.

• "Sky islands" of conifer forest, primarily white fir, in the conserved lands on the Ranch are a regionally significant community serving to connect high elevation conifer forests in the adjacent Sierra Madre, San Emigdio Mountains and Sierra Nevada.

• Numerous special status plant species are found in the conserved lands on Tejon Ranch, including striped adobe lily (State Threatened), Bakersfield cactus (Federally Endangered), Tehachapi buckwheat (CNPS List 1B.1), Vasek's clarkia (CNPS List 1B.1), Tejon poppy (CNPS List 1B.1), Comanche Point layia (CNPS List 1B.1), Piute Mountain's navarretia (CNPS List 1B.1), Fort Tejon woolly sunflower (CNPS List 1B.1), alkali mariposa lily (CNPS List 1B.2), calico monkeyflower (CNPS List 1B.2), Palmer's mariposa lily (CNPS List 1B.2), red rock tarplant (CNPS List 1B.2), San Bernardino aster (CNPS List 1B.2), and flax-like monardella (CNPS List 1B.3). Many of these special status plants are known only from Tejon Ranch; for others, the center of their distributions are on the Ranch.

The conserved lands of Tejon Ranch also provide high quality habitat for diverse wildlife, as outlined below:

• Perhaps the Ranch's most iconic species is the endangered California condor. The high country of the Ranch provides important condor foraging and roosting habitat. Condors recently tracked with satellite tags have exhibited very high utilization of the conserved lands.

• The extensive oak woodlands on Tejon Ranch also support extensive high quality habitat for cavity nesting birds, such as the acorn woodpecker, purple martin (California Species of Special Concern) and California spotted owl (California Species of Special Concern), as well as many raptor species such as the golden eagle (California Fully Protected Species and California Species of Special Concern), red-tailed hawk and Cooper's hawk (California Species of Special Concern). In fact, the conservation value of the oak woodlands on the north slope of Tejon Ranch is recognized by their inclusion within Audubon California's Tehachapi Mountains Important Bird Area, and the Conservancy's first Christmas Bird Count produced the highest count of golden eagles in the U.S.

• The San Joaquin Valley grasslands on the Ranch are known to support blunt-nosed leopard lizards (Federally and State-Endangered), San Joaquin kit foxes (Federally Endangered and State Threatened), San Joaquin whipsnakes (California Species of Special Concern), burrowing owls (California Species of Special Concern), California horned larks (California Species of Special Concern), and loggerhead shrikes (California Species of Special Concern), as well as wintering populations of mountain plovers (California Species of Special Concern), long-billed curlews, ferruginous hawks, and prairie falcons.

• The Tehachapi pocket mouse (California Species of Special Concern), burrowing owl, wintering populations of mountain plover and long-billed curlew, and a reintroduced population of pronghorn antelope are found in the Antelope Valley portion of Tejon Ranch.

The richness of the flora and fauna described above have been recognized by a variety of California agencies and organizations, as outlined below:

• Tejon Ranch meets nearly all of the *Priority Criteria for Conservation* established by the California Resources Agency.

• The California Wilderness Coalition named Tejon Ranch as one of *California's Ten Most Threatened Wild Places*.

• Audubon California has identified the Tehachapi Mountains around Tejon Ranch as an *Important Bird Area*. • Los Angeles County has designated *Significant Ecological Areas* (SEA) on Tejon Ranch and is considering expanding the area of the Ranch under this designation.

• The U.S. Fish and Wildlife Service designated a very large part of Tejon Ranch as *Critical Habitat* for the endangered California condor and as important for recovery of many other endangered San Joaquin Valley species.

A Brief History of the Tejon Ranch Conservancy

The mission of the Tejon Ranch Conservancy (Conservancy) is to preserve, enhance, and restore the native biodiversity and ecosystem values of the Ranch and Tehachapi Range for the benefit of California's future generations. The Conservancy will work collaboratively with the Tejon Ranch Company (TRC) and others to promote the long-term science-based stewardship of the Ranch and to provide for public benefits through educational and public access programs.

The Conservancy was created as part of the Tejon Ranch Conservation and Land Use Agreement, executed on June 17, 2008 by TRC, Audubon California, Endangered Habitats League, Natural Resources Defense Council, Planning and Conservation League, and Sierra Club. It is overseen by an independent Board of Directors that includes leaders from the environmental community, TRC and their development partners, academia, business, and government.

The Conservancy's short-term goals include:

- Systematically exploring Tejon Ranch to document and better understand its unique natural resources
- Using this knowledge and scientific principles to develop sound stewardship practices that maintain, enhance and restore the Ranch's conservation values
- Pursuing partnerships that advance the Conservancy's mission and conservation goals for Tejon Ranch and Tehachapi Range
- Providing public opportunities to learn about, explore and experience first-hand the beauty and diversity of the Ranch

The Conservancy's Science Program have established the following as their core values:

> "Understanding and applying the best available conservation science is our foundation for stewardship, restoration and protection of native biodiversity and ecosystem values. The Tejon Ranch Conservancy is committed to maintaining our independence to help to ensure the integrity of our actions. The Tejon Ranch Conservancy was born out of an extraordinary collaboration. We seek to continue in that spirit by proactively seeking partnerships on key elements of our work.
>
> The Tejon Ranch Conservancy is committed to a culture of openness in our activities and our decisions. All of our activities are considered in light of our mission to preserve, enhance, and restore the native biodiversity and ecosystem values of Tejon Ranch and the Tehachapi Range

for the benefit of California's future generations. Conservation of Tejon Ranch is forever, so we consider ourselves the temporary custodians of this mission. We strive to implement rigorous research and management projects to inform our current stewardship of Tejon Ranch and to develop a baseline understanding of the Ranch's natural resources for future generations of Conservancy stewards. The scale and complexity of the conserved lands compels collaboration with strong partners from academia, non-governmental organizations, government agencies, and the general public.

We make a concerted attempt to provide meaningful research and public access, but we know that not everyone will be able to explore Tejon Ranch, as we have had the good fortune to. Thus, the interactive map below provides glimpses into some of the resources found on the Ranch, and the links on this page to research, citizen science, and other resources will provide a variety of additional information about Tejon Ranch."

A Brief History of the Tejon Ranch Company

The history of the Tejon Ranch started in 1843 with the establishment of the first of four Mexican land grants that would be purchased by Tejon's founder, General Edward Fitzgerald Beale, a historic figure in early California. The 270,000–acre Ranch is now the principal asset of the Tejon Ranch Company, which was incorporated in 1936.

In May, 2008, the Tejon Ranch Company reached an agreement with five of the nation's largest and most powerful environmental resource organizations on a comprehensive, ranch–wide conservation and land use plan. The agreement with the Sierra Club, Natural Resources Defense Council, Audubon California, the Planning and Conservation League and Endangered Habitats League, calls for the permanent conservation of up to 240,000 acres of the Ranch. It also establishes and provides the mechanism for funding a private conservancy that will work with the Tejon Ranch Company to manage the conserved lands. The agreement also opens the door to significant public access to the Ranch and all parties have pledged to work with the State toward the development of a new State Park. The environmental organizations have agreed not to challenge the Ranch's development projects on the remaining ten percent of its land.

Farming and ranching have been the primary activities at the Ranch over the years and will continue under the agreement, as will hunting, filming, mining and oil production.

Partnerships

Tejon Ranch land managers understand the need to manage the Ranch holistically and collaboratively. An increase in ecosystem health on one side of the Ranch ultimately benefits the other side, and conversely, threats to one entity's property are threats to the other's. Ranch personnel, recreationalists, researchers, volunteers, and visitors cross property lines, and weeds can easily be dispersed by them. Developing a strong partnership for weed management will enable both organizations to eliminate or reduce weed threats to their conservation objectives. Each land manager brings to the table unique and specific knowledge and resources, which can be drawn upon to effectively tackle the difficult challenge of Ranch-wide weed management.

The threats posed by invasive species are often too large for one or even two organizations to tackle. Both land managers have developed partnerships with other entities such as the Bren School of Environmental Science and Management, other academic institutions, JiJi Foundation, Packard Foundation, and Resources Legacy Foundatation, Los Angles Conservation Corps, Farmworker Institute for Environmental Leadership and Development, and Native Range, Inc. to address this critical conservation issue. Over time, more partnerships will be fostered to bring even more resources and expertise to the table.

Weed Impacts and Trends

Homogenizing Biodiversity

The invasion of native plant communities by weed species threatens native biodiversity not only locally, but also worldwide (Coblentz 1990; LaRoche 1994; Williamson 1996). The current geologic epoch (Holocene) is sometimes referred to as the Homogecene by ecologists (Purvis 2003), due to the unprecedented rate of human-assisted organism dispersal and successful establishment of taxa to new locations throughout the globe (Hobbs and Humphries 1995). The effect is like an anthropogenic blender mixing the world's biota (Olden et al. 2004). Rare taxa may be at a greater risk of extinction as weeds degrade habitat and reduce their population sizes. When weeds cause the local extinction of an organism, a collapse of the trophic structure can sometimes result. This is based on the concept of a trophic cascade, where a native keystone species is removed, and the other dependent species perish after its absence (Vitousek 1990).

Invasion by plants is not as dramatic as the occurrence of wildfire, oil spills or clear-cutting, but weeds are spreading at an alarming rate (D'Antonio and Vitousek 1992). Before the arrival of humans to the Hawaiian Islands, one non-native species would become naturalized every 70,000 years, but today a non-native species arrives every 18 days (D'Antonio and Vitousek 1992). In the U.S. National Parks alone, weed species are expanding their range by 8-12% per year (Hiebert and Stubbendiek 1993). This is currently equivalent to an area the size of Delaware becoming newly colonized by weeds each year (Carpenter and Murray 2000).

Although dispersal is a natural process, the enormous increase in global commerce and travel has rendered natural barriers such as mountain ranges, deserts and oceans ineffective as obstacles to plant dispersal (Levin et al. 2002). Weeds disperse and become naturalized 1,000 times faster by humans than they would under natural conditions. Boats, planes, automobiles and outdoor equipment are all effective vectors by which weeds can be dispersed (Babbit 1998). Humans also spread weed species deliberately for landscaping. The same characteristics that make a plant horticulturally desirable such as needing little care, being drought tolerant, being easy to propagate, and producing abundant flowers (and thus seeds) also make them invasive. The rate of weed dispersal by humans increases with an increase in human populations (Hodkinson and Thompson 1997), and with Tejon Ranch in close proximity to one of the largest urban areas in the world, future invasions are inevitable.

However, invasion of Tejon Ranch by weeds may not always be vectored by humans. Wind and wildlife aided dispersal also present challenges to detecting weeds in remote and less visited areas.

Eternal vigilance is therefore needed, and illustrates the need for a regional weed management strategy.

Hybridization

Weeds can hybridize with closely-related native plants, potentially causing a decrease in native species populations in two ways. When a weed hybridizes with a native taxon, the hybrid offspring can become more invasive than the parent plant if a doubling of chromosomes occurs (creating a fertile individual). The new invasive offspring which usually have greater vigor than their parents, can then outcompete the native parent population, resulting in a decrease in the native taxon's range (Randall and Hoshovsky 2000). If the hybrid offspring remain sterile, the native population can still be affected by the reduction of its fertile offspring through crossbreeding with the non-native sterile species (Randall and Hoshovsky 2000).

Closely related species within the same genus (congeners) hybridize more readily than those species that are more distantly related. Of the 23 weed species surveyed and ranked in this Strategy, four are congeners (*Brassica spp., Cirsium vulgare ,Rubus armeniacus,* and *Vitis vinefera*)with native Tejon Ranch species. Unfortunately, several cases of weed species hybridizing with native flora do exist. Management issues relating to the control of hybrids are more complicated than those involving control of easily recognizable weed species. Hybridization between native and non-native species is considered one of the greatest unrecognized threats to biodiversity (Vila et al. 2000; Perry et al. 2002).

Alteration of Ecosystem Processes

Due to the high rate with which weed species can spread and the absence of herbivores from the weeds' home range, weed populations can increase rapidly, to the point where they can alter the functioning of native ecosystems that they invade (D'Antonio and Vitousek 1992; Carpenter and Murray 2000). Ecosystem processes such as nutrient cycling can be altered by weeds, which can lead to less desirable soil conditions for native taxa. For example, the invasion of the nitrogen-fixer *Myrica faya* (fire tree) on the Hawaiian Islands has increased the level of nitrogen in the soil of formerly nitrogen-deficient sites, making these soils more susceptible to further invasion and promoting the persistence of fire tree in the ecosystem. Native Hawaiian plants are adapted to the nitrogen poor soils and do not fare well when competing under the altered soil conditions. This type of change in nutrient cycling can lead to the alteration of primary successional ecosystems (Vitousek 1990). *Robinia pseudoacacia* (black locust) found on the Ranch is a known nitrogen fixer.

Weeds can have a negative effect both through promoting soil erosion, and in unnaturally stabilizing a shifting substrate. Weed species can increase the rate of soil erosion by diverting stream flow in watercourses, and by replacing a deeply tap-rooted native species with a shallowly rooted weed. The resulting erosion strips away valuable plant litter and topsoil, and releases sediments that flow downhill into streams, rivers and water bodies, resulting in the alteration of flood channels and degradation of water quality (Lacey et al. 1989). One experiment simulating rainfall onto high elevation areas of Montana infested by spotted knapweed found 56% to 192% higher sediment runoff in plants dominated by the invasive than plots dominated by native bunch grasses (Lacey et al. 1994). In an opposite negative effect, infestations of coastal dunes by *Carpobrotus edulis* (Hottentot fig) promote the stabilization of naturally migrating sand, which results in an unnatural parallel orientation of dunes to the shoreline (Randall and Hoshovsky 2000).

Fire regimes can also be dramatically altered by weeds. Some examples are *Arundo donax* (giant reed), which remains flammable throughout the year in riparian habitats, and *Eucalyptus globulus* (blue gum), which can create intense fires due to its extreme flammability, massive size, and proclivity for growing in dense groves. Increased fire frequency, such as that caused by the invasion of native desert landscapes by Mediterranean annual grasses, not only drastically affects the species composition, but also result in atmospheric change on a global scale (Randall and Hoshovsky 2000).

Allelopathic chemicals found in the tissue of some weed species may affect the growth or germination of native plant species. Not only are individual plants affected by allelochemicals, but plant succession, vegetation patterns, seed preservation, germination of fungal spores, nitrogen cycling and mutualistic associations are also affected (Einhellig 1995). It has long been observed that areas with thick plant litter under dense stands of *Eucalyptus globulus* and *E. camaldulensis* (Eucalyptus trees) are devoid of understory vegetation. Other weed species such as *Mesembryanthemum crystallinum* (crystalline ice plant) accumulate salt in their tissues, which is deposited on the soil when they die (Randall and Hoshovsky 2000), inhibiting the germination of native species.

Threats to Native Flora and Fauna

When a plant naturalizes (becomes self-sustaining in the landscape), it can compete with native plant species for resources such as light, water, space and nutrients (Brown et al. 2002). A decrease in any of these resources could lead to a decrease in the abundance of native plants (Foster-Huenneke and Thomson 1994), and the fauna that depend on them. Competition for resources has caused a decline in 18% of endangered species (Wilson 1999). Research in riparian habitats of the American Southwest desert regions have shown lower bird diversity and density in areas dominated by *Tamarix ramosissima* (salt cedar), versus areas of native cottonwood-willow dominated vegetation (Hass 2002).

Weeds outcompete native vegetation for space. Simply put, every location that a weed occupies is one less niche for the native flora and the food and pollination webs that they are a part of. *Acroptilon repens* (Russian knapweed) has been documented to outcompete native species on over one million acres within the United States (Whitson 1999). This represents a substantial loss of biodiversity.

Without light, plants cannot photosynthesize the vital carbohydrates that are needed for growth. If one plant can outcompete another for light, it will have the advantage of utilizing its newly acquired energy to compete for other important resources such as nutrients and water. On the island of Hawaii, the globally invasive *Pennisetum setaceum* (fountain grass) has altered the structure of the rare tropical dry forest ecosystem understory. Fountain grass can outcompete native seedlings for light (Cabin et al. 2002), thus preventing them from accessing other resources and further limiting their growth.

Accessible water, a limited resource in southern California and on Tejon Ranch, is a requirement for the survival of both plants and animals. Many weed species such as *Tamarix ramosissima* (salt cedar) require larger amounts of water for survival than do many native plants (Hass 2002). These weeds lower surface and ground water levels to a point where native flora and fauna can not access it, forcing them to either migrate or die. This subsequently alters the local microclimate and trophic structure (Randall and Hoshovsky 2000). Areas where large stands of *T. ramosissima* are present

lack the expected native components of willows, cottonwoods, and surface water, but once *T. ramosissima* has been removed, land managers have witnessed the rapid return of both native vegetation and surface waters (Hass 2002).

Competition for pollinators can lead to the decline of native plants as well as the proliferation of weeds (Brown et al. 2002). Weeds with showy flowers or large quantities of nectar, such as *Nicotiana glauca* (tree tobacco), are heavily visited by native hummingbirds that would otherwise pollinate native plants like *Epilobium canum* (California fuchsia). Therefore, hummingbird populations could be unnaturally high (Schueller 2004), altering ecosystems in ways not yet determined.

Fourteen percent of the species which were federally listed as endangered in 1996 have become increasingly threatened as a result of plant invasions (Chen 2001). Weeds on Tejon Ranch may play an important role in impacting the numerous special-status species found there.

Decrease in Recreational Value of Wildlands

Although difficult to quantify, weeds degrade the recreational quality of wildlands (Richardson and van Wilgen 2004; Eiswerth 2005). When weeds such as *Hirschfeldia incana* (mustard) or *Tamarix ramosissima* (saltcedar) infest broad areas, the diversity and range of native species dwindles. Birders and amateur naturalists may be disappointed with their viewing experience. Large spiny infestations of *Centaurea solstitialis* (yellow star thistle) or acres of spiny *Silybum marianum* (milk thistle) can make trails and recreation areas difficult to access and maintain. Even ubiquitous Mediterranean annual grasses can make hiking and camping unpleasant when barbed seed heads penetrate socks and camping gear. When weeds alter the quality of landscapes and diminish the recreational experience, recreationalists such as sport hunters may choose to go elsewhere.

Weed Species Benefits

Ecological interactions are complex, and although deleterious impacts from weeds have been well documented, it is wise to fully understand the relationships among native and non-native species before proceeding with control of widespread species (D'Antonio and Meyerson 2002). Native wildlife have been known to utilize weed species; for example, hummingbirds sip nectar from non-native tree tobacco and eucalyptus flowers, and ravens eat European olives and fig tree fruits. Unintended consequences could result from the failure to adequately anticipate the possible ecological effects of a large-scale weed management activity (Brenton and Klinger 1994; D'Antonio and Meyerson 2002). This will be important in the future as the Conservancy shifts from eradication of incipient populations to control of more widespread ones.

Strategy: Goals, Objectives and Tactics or Tools

Vision and Goals

The Conservancy and TRC are working to develop a weed management program to strategically and cooperatively address the weed problem on Tejon Ranch. Although TRC has been controlling weeds for decades, this is the first comprehensive Weed Management Strategy for the Ranch. It will be the foundation for coordinated Ranch-wide weed management.

The following four weed management goals are shared by both Tejon Ranch land managers:

1. Prevent the introduction of new species to or throughout the Ranch. This is the highest priority action in this Strategy. Incorporating best management practices in all Ranch operations will reduce the number of new weeds, and other organisms, reaching the Ranch and becoming established.
2. Eliminate or reduce the spread of priority weed species by controlling them along dispersal corridors such as roads and trails across the Ranch.
3. Eradicate incipient species to zero density and populations before they become widespread and too damaging and costly to manage.
4. Target select infestations of widespread species at key sites such as rare or listed plant populations, watersheds that contain small incipient weed populations, and human-inhabited areas that can be sites of new introductions or sources of broader dispersal.

Once incipient species and populations have been eradicated, roadsides are cleared of priority weeds, high value resources are protected, and sufficient support is secured, larger weed infestations can be addressed systematically.

Objectives:

Awareness

Until all entities operating on the Ranch are fully aware of the weed threats to ecosystem health and native biodiversity, new invasive species will continue to be dispersed to and throughout Tejon Ranch. Ranch land managers understand the need for increased awareness. Development and implementation of prevention measures is a high priority.

Prevention

The most cost-effective method to address weeds is to prevent them before they colonize or become established (Zavaleta 2000). Preventing species introduction or establishment will also completely avoid any impacts to the ecosystem. Implementing prevention measures may require a change in the operational culture of each entity. By instituting small prevention practices first, awareness of the weed crisis will increase among Ranch visitor communities, thus paving the way for implementing further strategies.

All staff and visitors to the Ranch must be educated in as many ways as possible to 1) become aware of routes of introduction, and the real threats presented by introduced organisms, 2) ensure that their own clothing and equipment are free of plants and animals, seeds and soil, 3) ensure that boats, aircraft, vehicles, and heavy equipment are maintained free of these contaminants, 4) ensure that the risk of introducing novel organisms is carefully considered before items are transported to the Ranch, and 5) ensure that measures have been taken to reduce this risk. Items potentially transported include dumpsters, building and fencing materials, erosion control materials, and used vehicles, trailers, and portable buildings, etc.

Management of non-native plants in cultural zones and administrative areas:

Local-source native plants from site-collected propagules will be the preferred materials for landscaping inhabited areas. Invasive species currently in Ranch landscaping should be replaced at the first opportunity with native plants that serve similar landscape functions such as appearance, shade, and color/texture. By landscaping with species native to the Tejon Ranch,

wildlife habitat can be extended to reclaim disturbed sites, and the sites can be used to teach about the Ranch's unique plant species.

Exclusion

The 2010 weed surveys identified areas of the Ranch that are relatively weed-free or at least free of specific weed species. One goal is to maintain the absence of weeds in these locations. Techniques to achieve this goal will include: 1) controlling roadside weeds; 2) ensuring that personnel clean vehicles before entering a weed-free zone, and check to make sure that their clothing, shoes and field equipment contain no seeds or soil; and 3) educating visitors about the importance of cleaning their clothing, shoes, and recreational gear before entering the Ranch, and 4) following other invasive species prevention protocols developed by the Conservancy and TRC.

Localized Control

When a weed species is ubiquitous it may be unrealistic to eliminate it completely from a site, watershed or the entire Ranch. Localized treatment may be necessary, however, when that weed invades a treated population of another invasive species or a rare plant population. The goal of control is to eliminate the plant at the immediate site; the overall abundance of that species does not change significantly, however. For example, widespread species such as *Hirschfeldia incana* (mustard) occurring along roadsides may be targeted for control, but its general abundance will most likely not be decreased significantly.

Reduction

The goal of reduction is to limit the abundance of a widespread species either throughout a specific watershed or the entire Ranch. Unlike control, reduction results in a decrease in species abundance. Over time as a species is consistently reduced, it may then be targeted for eradication. *Tamarix ramosissima* (saltcedar) and *Silybum marianum* (milk thistle), for example, are two species that are identified for reduction and could be targeted for eradication, at least in certain areas, at a later date.

Containment

The goal of containment is to restrict a species or population to a specific area. *Carduus pycnocephalus* (Italian thistle) infests the valley portion of the Ranch, and is targeted for containment by eradicating populations anywhere outside of the main infested area.

Eradication

Species that have recently colonized the Ranch or are still becoming established are a high priority for land managers, because these species are relatively easy and cost-effective to eradicate (Zavaleta et al. 2001), and their impacts are minor compared to widespread species (Zavaleta 2000). Species that have small populations are much easier to eradicate than larger ones, due to the limited seed bank present. While some land managers do not attempt to eradicate weed species because of the preconceived notion that it is impossible to do so, it is important to remember that humans are adept at causing species extinctions (Olson 1989)! Species such as *Robinia pseudoacacia* (black locust) or *Xanthium spinosum* (spiny cocklebur), for example, have so few and such small infestations that eradication at this time appears feasible.

A study conducted by Rejmanek and Pitcairn (2002) of the University of California: Davis analyzed weed eradication efforts conducted by the California Department of Food and Agriculture over a 30-year period. Results showed that weed eradication success decreased

exponentially and the effort required (time, money, etc.) increased exponentially as the size of the weed infestation increased. They also found that infestations less than 0.08 hectares had nearly 100% eradication success, while infestations one hectare and greater had nearly no eradication success. The median population size of the 28 weed species recorded in 2010 at Tejon Ranch was 0.004 hectares; however, this size will only increase as these highly invasive species continue to expand.

No matter what the management objective for a targeted weed species, all above-ground plants in each targeted population will be controlled to zero density. Once all plants have been removed or treated, the population seed bank should be monitored for seedlings or resprouts until each population is truly eradicated. Consistent monitoring and immediate treatment is important to maintain the benefits derived from the initial treatment. Some species necessitate multiple monitoring surveys throughout the growing season, while others require only one inspection due to their reproductive cycle. All species will require repeated visits for several to many years, to ensure that the seed bank has been exhausted.

Weed Management Principles

Know the Site

The ultimate goal of all weed management programs is not simply to eliminate the weed but to protect what the weed threatens. For that reason, it is important to ensure that management actions do not adversely affect the site which is being protected. It is crucial to take time to learn about the unique resources of Tejon Ranch and to inspect sites for cultural, historical, and biological resources prior to commencing work, in order to avoid damaging these resources.

Understanding Invasion

Invasion is often thought of as a static state; however, invasion is actually a process. Understanding the process of invasion enables land managers to focus treatment efforts on species and populations that can successfully be managed. There are four phases of invasion: colonization, establishment (incipient populations), spread, and apparent equilibrium (Williams 1997). It is most cost-effective to target species that are in the colonization phase since they have caused little or no impact, have little to no seed bank, and are therefore relatively easy to eradicate. Once a species colonizes a site, it will then become established. This is also an ideal phase to target a weed species, but now a soil seed bank is developing, which will require further monitoring and management. Once a weed is established, it will begin to spread at an exponential rate. Targeting it early in this expansion phase is optimal, but once the weed has spread too far, it will then reach a state of apparent equilibrium. This phase usually draws a lot of attention since infestations are apparent to even the layperson. However, resources should be directed to species that are in the beginning stages of invasion, not the final stages (Fig. 1) (Williams 1997).

Population Ecology

Since population edges are the sites of population expansion, small weed populations have higher rates of expansion than larger ones due to their greater ratio of population edge to population area (Steinmaus 2003, personal communication). Therefore small populations should be targeted first, and then larger populations can be addressed. Working from the outside edge inward on larger populations is considered the best method to tackle established populations,

because it is best to avoid creating many small populations that can readily re-expand (Steinmaus 2002, personal communication).

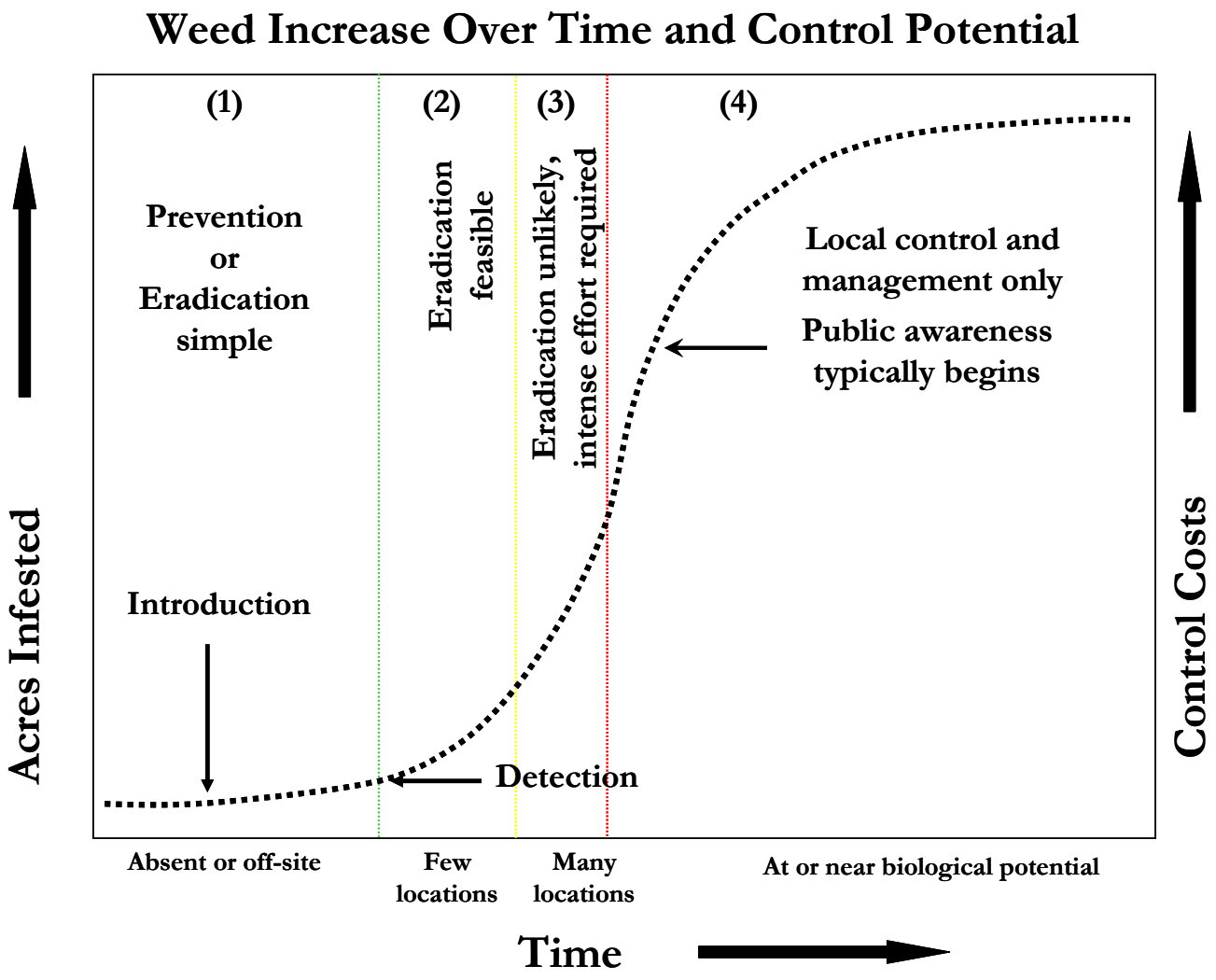

Figure 1. An illustration of the process of invasion, and the optimal time to initiate management activities. (Siemens and Tu 2007).

Working the Watershed

When managing weed populations, it is best to start at the top of a watershed or a population, or up-wind in areas with predominant wind patterns, to avoid re-infestation of the site. Exceptions may include: infestations along dispersal corridors such as roads and trails, or where rare biological resources are located at the bottom of a watershed threatened by a widespread weed species. Another exception would be a plant which produces seeds of limited dispersal capability, such as *Phalaris aquatica* (Harding grass). In this case it is best to eradicate outlier populations first, before they expand and spread further, and then tackle large dense infestations.

Best Management Practices for the Prevention of Weed Introduction, Dispersal and Expansion

Weed hygiene must be a routine practice when managing weed species (Coulston 2002). Clothes, equipment, and vehicles must be inspected and thoroughly cleaned of all plant parts and

visible soil prior to starting work or when moving from site to site (Appendix 3). It is also best avoid traveling through weed populations while en route to target infestations in order avoid spreading the populations further. If it is necessary to pass through a weed population, the access route should be cleared of weeds before passing through it. For example, it would be prudent to cut back seed-bearing mustard where it overhangs a road or path to avoid carrying seeds into a mustard free area.

Worker Safety

The work site must also be inspected for possible threats to weed worker safety. These may include: steep slopes or cliffs, loose substrate, poison oak, cactus, wildlife, and poisonous animals. Sharp and heavy tools and herbicide must be carried property, in wraps or over-packs as necessary to avoid injury to or contamination of the weed worker. Once at the site, edged or tined tools must be stored in a specific, "out of the way" location, sharp edges down, when not in use. While not in use, these tools must be placed where they will not present a hazard to workers while moving around a difficult site. Power tools must be placed in a similar safe area, with the cutting end away from the workers. Appropriate personal protective equipment (PPE) must be provided for all workers, and properly worn at all times while working. Vehicles should have a first-responder kit adequate for the number of workers on the project, and should include splints. Appendix 4 outlines how to prevent fire ignitions with regard to weed management work.

Herbicide Safety

It is important to make sure that each weed worker reads and understands the information on the herbicide label and Material Data Safety Sheet before using an herbicide, and reviews this information frequently.

In addition to PPE, all weed workers must have immediate access to sufficient eyewash to provide thorough irrigation of both eyes in case of emergency. Belt-kit or backpack bottles are recommended. A larger supply (sufficient for a 15-minute wash) should be in the vehicle.

Herbicide containers and application equipment must be placed securely on level ground, in a location convenient to the work area but isolated from areas where workers will rest, eat, or store clean equipment. Sufficient clean water (minimum 10 gallons per crew), soap and disposable towels must be readily available to weed workers at all times they are mixing or applying herbicides.

Herbicides and application equipment must not be carried inside a vehicle. Herbicide should be transported inside containers, and small application equipment inside over-packs such as sealable five gallon buckets. Clean PPE should be transported in sealed plastic boxes or "totes." Plastic or metal grid-side crates, or a similar pigeonhole system, should be placed in the truck or ATV bed to keep buckets and totes upright and in place during transport. All herbicides or application equipment must be kept isolated from personal gear, food and drinking/washing water at all times. Contamination of hand tools such as saws, axes, drills, etc. with herbicide can be avoided either by working with a partner on cut-stump and injection applications, or by meticulously removing and donning herbicide-protective gloves when changing from cutting to applying. Even with such preventative measures, it is best to assume that cutting and drilling tools have become herbicide-contaminated, and to clean them thoroughly at the end of each work day. It is particularly important not to contaminate field logbooks, data sheets, weather monitoring equipment, binoculars, etc. with herbicides.

Under most conditions, indicator dyes should be used when applying herbicide. Besides ensuring effective application, these dyes disclose contamination of weed workers and equipment. Appendix 5 covers appropriate first-aid response to herbicide contamination of workers. Appendices 6 and 7 serve as mixing cheat sheets to eliminate the risk of calculation error when needing to mix herbicide frequently.

Environmental Safety for Herbicide Applications

Weather and site conditions must be carefully taken into account prior to applying herbicides. In order to avoid drift to off-target plants, spray applications should not be made when wind speeds are 10 mph or greater (the herbicide label should be checked for specifics), during conditions when temperatures are over 80^{o} F, or when a temperature inversion may exist. However, microclimate conditions at a site may allow for spray applications in some areas of a site, even when external conditions would preclude it. It is best to carry a portable weather kit (USFS belt kit, or Kestrel© weather meter) and monitor wind speed and direction and temperature frequently. Wick, cut-stump, basal bark, and injection applications usually are not limited by weather conditions, so they often provide good alternatives to foliar spray applications in problematic weather conditions.

The site should be inspected for water sources, as some herbicides cannot be applied near open water such as streams, vernal pools, or the sea. Soil texture should be investigated, since some herbicides do not adsorb (bind) to clay colloids, and thus may leach readily through sandy soil.

Transport of herbicides and application equipment as described for worker safety, above, will protect the Ranch environment as well. A portable five-gallon spill kit must be carried with the herbicides at all times. Kits sealed in five-gallon plastic buckets are inexpensive, convenient, and adequate.

All herbicide should be stored in containment equipment, such as large trays with risers. These should be on secure and level ground or flooring, and away from heavy items which could break or tip containers in the event of an earthquake. Spill equipment sufficient for the size of a worst-case anticipated spill must be available and stored where it is readily accessible to the herbicide storage area.

Herbicide Resistance

It is the responsibility of the weed worker to take measures to avoid herbicide resistance (Cousens and Mortimer 1995). Herbicide resistance can develop when a weed species population is frequently and repeatedly treated with an herbicide that has the same mode of action. Over time, only those plants that are unaffected remain and are able to reproduce and pass on their resistance traits to offspring. Switching between herbicides with different modes of action, e.g. enzyme inhibitors or hormone mimics, will help to reduce the risk of developing herbicide resistance.

Herbicide Effectiveness

Several factors contribute to the effectiveness of systemic herbicides, and their application should only occur under the optimal conditions. Applicators must consider the pH of the water mixed with the herbicide and its mineral content, particularly calcium and magnesium (water 'hardness'). Ranch water sources that may be used for mixing herbicides should be tested for these elements. Since these conditions can be expected to vary with water flow and water table height, testing should be done periodically. Field water testing kits are available and inexpensive,

and should be part of the weed worker tool kit. Acidifiers can be used according to manufacturers' recommendations, and/or herbicide amounts can be adjusted to correct for water hardness. Presence of algae and other microorganisms in water used for mixing will greatly affect herbicide activity, sometimes even defeating it, since herbicides are so readily bound to organic matter. Therefore, field water sources such as ponds and streams (or ocean water) should not be used for mixing herbicides, and water in containers should not be stored long, and should be inspected for algae after long-term use. Plant phenology and vigor, and the presence of dust on the leaves of the target species also greatly affect herbicide effectiveness. The herbicide label should always be consulted for advice on these matters (Appendix 8).

Specimen Collection

When an unknown plant sample is collected in the field for identification back in the office, it should be handled as a highly invasive weed species until it can be determined that it is not. Ziploc-style bags (without holes) should be brought in the field to safely transport a specimen (Appendix 9). If a proper container is not available that can ensure that propagules are not dispersed in transit, a photograph of the specimen should be taken and the population location recorded with a global positioning system (GPS unit) using mapping protocols (Appendix 10).

Integrated Toolbox

Managing multiple weed species requires having multiple tools and techniques (Appendix 11) in a manager's "toolbox." No weed, site, or weather condition is ever the same, and having a range of options enables land managers to adapt to constantly changing conditions. It is vital to record and track management techniques in order to determine the most effective control method, and in some cases adapt existing ones, or develop new ones. The slow winter season is a good time to assess the past year's control efficacy using databased treatment records and field notes in order to learn from mistakes and capitalize on successes. Drawing upon tools not currently used in the weed management trade, including techniques and methods from other disciplines, will help to further conservation goals.

Cultural controls:

Many troublesome weeds are very highly dependent on ongoing disturbance, whether natural (fire, flood, landslide, etc.) or artificial (grazing, mowing, disturbance by foot or vehicle traffic, construction, etc.). Where appropriate, measures should be taken to protect vulnerable areas from further disturbance, and to facilitate or directly aid native plant recovery by mulching, seeding, or other similar techniques.

Mechanical and Physical Control

Mechanical and physical control methods such as pulling, grubbing, cutting, girdling, or mowing, can be used on species that do not resprout e.g. on stands of annual grasses or along roadsides. These methods utilize a wide array of hand and power tools, including: weed wrenches, loppers, hand cultivators, handsaws, brush cutters, chain saws, power hedgers, and tractors. Mechanical and physical control is often most appropriate for supervised, but untrained volunteers.

Chemical **C**ontrol

Herbicide application is another tool that is utilized when mechanical or physical techniques are not effective alone, or are not the best treatment option due to possible collateral damage,

relatively high time requirement, or weather conditions. When employing herbicides, techniques such as cut-stump, drill-and-squirt, hack-and-squirt, glove-of-death, and basal bark application should be used whenever feasible to reduce both drift and the amount of herbicide used in the environment. Herbicides (Appendix 12) with the lowest EPA rating ("caution"), such as glyphosate, are preferred in order to minimize risks to the applicator and environment. Herbicides with a higher EPA rating such as "danger", for example Garlon 3A, may sometimes be used when they are deemed to be the most efficacious method of treatment. All recommended use and safety regulations and California state guidelines must be scrupulously followed. Only well-experienced licensed applicators should mix or apply these materials. Selective herbicides will be used to treat populations of invasive dicots where native monocots are present. Similarly, herbicides selective for monocots only, will be used as appropriate where an invasive grass grows amongst desirable dicot plants. Selective herbicides, such as those effective only on thistles (*Asteraceae*) or herbaceous taxa in the pea family *(Fabaceae)* will be used when appropriate, such as for *Centaurea solstitialis* (yellow star thistle) or sweet pea (*Lathyrus* spp.) When a weed species is found invading robust perennial native vegetation, very low rates of a non-selective herbicide (Appendices 12 and 13) such as glyphosate should be carefully applied. This "surgical" application method will cause minimal harm to surrounding native plants. Herbicide applications near or among rare or listed plant populations will be carefully designed, reviewed, implemented, and monitored. Actions involving listed species will only be undertaken in consultation with and after approval by the appropriate regulatory agency.

The three main herbicide delivery systems used are: 1) truck- or all-terrain vehicle (ATV)-mounted spray rig, 2) backpack sprayer, and 3) spray or squeeze bottles. A truck-mounted sprayer (150-200 gallons), ATV rack-mounted sprayer (14 gallons), or trailer-mounted sprayer (25 gallons) can be used when treating roadsides and other areas accessible to these vehicles. A truck mounted spray rig can hold large amounts of herbicide to treat large infestations. The truck mounted spray rig hose is not as heavy as a backpack sprayer, but has a limited range and is some times unwieldy. Small populations or those found further than the length of the spray rig hose are usually treated with herbicide contained in a backpack sprayer (three to five gallon capacity), handheld sprayers of one to two gallon capacity, lab-style squeeze bottles, or hand spray bottles, ranging in capacity from one-half ounce to one quart. Backpack sprayers can carry considerably more herbicide than a spray bottle, but are heavy and cumbersome when hiking over rough terrain and thick vegetation. Handheld bottles are easy to carry and maneuver, especially in dense vegetation and on steep slopes, but they contain a very limited amount of herbicide. The best container will be selected based on a combination of terrain, vegetation, and population size to ensure safety and efficiency.

Aerial Transport

Advanced techniques and methods to remove non-native feral ungulates have recently been developed and successfully implemented, and similar techniques need to be developed for successful plant eradications (Dolan et al. 2003). Helicopters can be instrumental when working in remote terrain that is difficult or dangerous to access on the ground, in areas where vegetation impedes ground transportation, or where weed seeds might readily be dispersed by ground access. A helicopter is also probably the most effective tool to use for early detection of and rapid response to new weed invasions. A small, light helicopter, which can hover within five feet of the ground, can provide a perfect vantage point from which to locate an infestation as well as the means by which to respond quickly to eliminate it. Hiking into remote weed infestations can expend a great deal of time and effort, disperse weed seed along the access route, and damage recovering or intact vegetation, resulting in erosion (which further facilitates weed

establishment). Aerial transport can eliminate these impacts by taking the weed worker directly to the site. When helicopters are utilized, however, contractors must observe established no-fly zones around resources sensitive to disturbance (such as active bald eagle nests) and developed areas. Coordination with each landowner must occur prior to flights.

Mapping and Monitoring

It is important to map all new weed populations using the mapping protocol (Appendix 10), and regularly monitor treated populations based on the reproductive life cycle of each species listed in the treatment and survey schedule (Appendix 13). Failing to monitor treated populations consistently could result in wasted work if treated plants resprout or seedlings that have germinated from the soil seed bank are allowed to reach reproductive age (Grundy and Jones 2002, Coulston 2002; Fig. 2). Soil seed banks for some species such as *Genista monspessulana* (French broom) can remain viable for over 50 years, while many others, such as grasses, are viable for a much shorter period. It is important to know how long each species' seed bank can last, and to monitor all treated populations for that duration of time or longer.

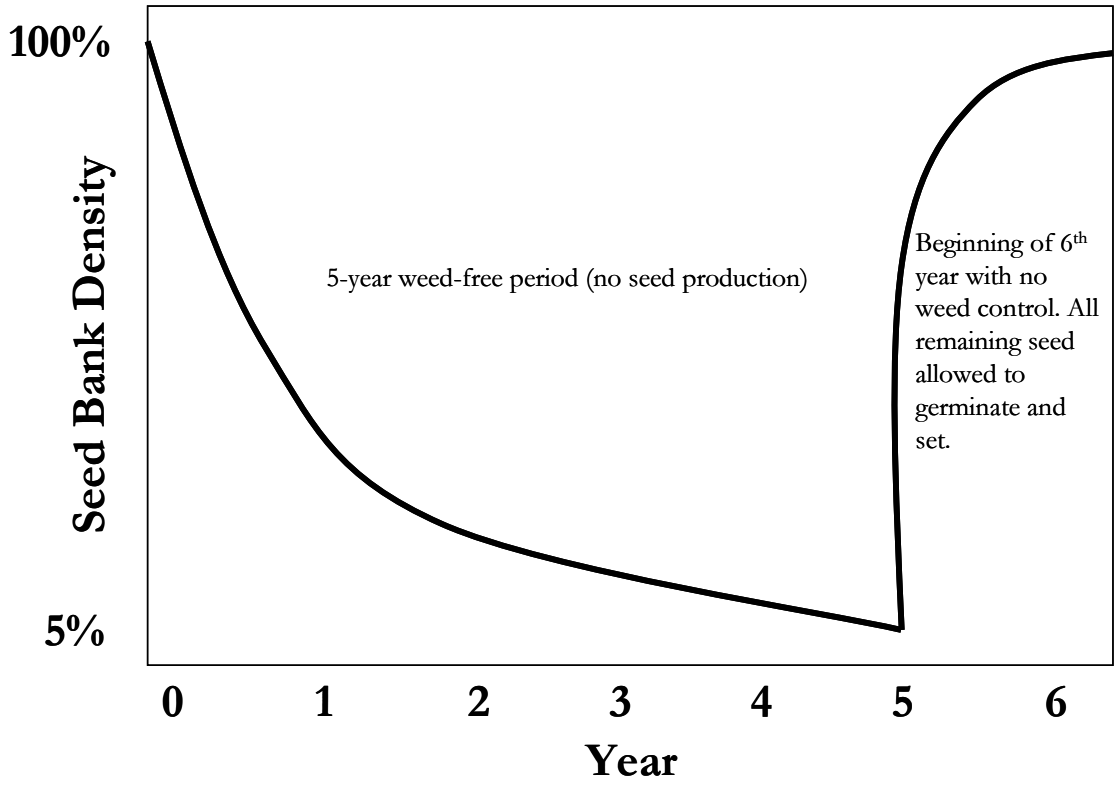

Figure 2. The following illustration demonstrates the need for consistent seed bank monitoring following the removal of all above ground plants (Burnside et al. 1996).

Once all above-ground plants of a population have been completely removed, and the site is yielding no new seedlings, the monitoring schedule can be modified for each species based on the time it would take a plant to reach reproductive maturity. For example, if it takes *Foeniculum vulgare* (fennel) only six months to produce seed following germination, then a six-month monitoring schedule should be developed for all treated *F. vulgare* populations. An annual

monitoring schedule will be implemented for all treated populations of *G. monspessulana* or *Spartium junceum* (Spanish broom) since it would take one year for seedlings to reach reproductive maturity. The shortest expected time to maturity should be used when developing such a schedule.

With each successive season, as soil seed banks are depleted, monitoring of treated populations can be achieved in a shorter amount of time. Once all originally targeted sites have been monitored, new populations can be addressed within the same treatment time. It is important to note that consistently monitoring treated populations is a key component of a weed management program. Unfortunately, it is often viewed as unnecessary or superfluous, especially when funding is tight, and as such is usually the first program element to be eliminated. Without monitoring and follow-up treatment, all previous work can be wasted if propagules are allowed to grow and produce more seeds. This resets the "seed bank viability clock" back to zero.

Priority Weed Species

Setting Priorities

There are two general accepted approaches to managing weed species: species-led and site-led approaches ([New Zealand] Department of Conservation 1998). Although is it optimal to utilize both approaches, it is essential to start with a species-led approach in order to understand the threats to the resources at risk.

The species-led approach

The first priority is to prevent new weed introductions. This is accomplished by 1) closing channels for weeds vectored to the Ranch by humans, 2) regularly monitoring all the related "points of entry," and 3) regularly and systematically monitoring the entire Ranch for new weeds vectored in by wind, ocean currents, or birds.

The second priority involves a weed species-led approach, where weed species with limited distributions are eradicated from the Ranch or large sections of the Ranch. Many of the species outlined as a high priority in this Strategy are known to be highly invasive and damaging elsewhere, and are poised to spread in similar ecosystems on the Ranch. Since their population size and range are relatively limited on the Ranch, their impacts may not yet be readily evident. However, if left unmanaged they will continue to expand as they have done elsewhere, causing difficult and more costly problems later. Orr's Law states that, "each increment [incipient weed species or population] seems reasonable in its context, but constitutes a huge problem in aggregation." Eradicating an aggregation of weed species with limited abundance will have a beneficial cumulative effect beyond what might be expected when these populations are viewed individually. Eradicating weeds before they become widespread is a high priority for Ranch land managers. The cost to eradicate a few localized populations is comparatively minimal and impacts caused are relatively low compared to allowing them to become widespread species. Eradicating these species now will ensure they do not negatively affect listed native species or unique ecosystems in the future.

The site-led approach

Although the weed Strategy outlined here takes a primarily species-led approach, it does have elements of a site-led strategy. Sites of high resource value, such as those supporting rare or listed plant populations, areas presently uninfested by weeds, and riparian corridors and wetlands, will be considered for weed control actions even if the weed species threatening these sites may be rated as relatively lower priorities for control based on species considerations alone.

Dispersal corridors such as roads and trails, entry areas such as boat landings and airstrips, and inhabited areas such as staff housing and campgrounds will be treated for a range of priority species, and carefully monitored for new introductions, since these are the areas where new weeds often appear first, and from where both new and existing weeds are readily dispersed.

In these cases, the driving force behind management efforts is not a particular weed species, but rather the site itself or the resources that are threatened. The Ranch land managers do not have the resources to tackle every weed species or population across the entire Ranch, and therefore it is important to focus on key sites for those species that are unrealistic to eradicate Ranch wide.

Weed Ranking Criteria

Invasive Species Identification

The first objective of this Strategy was to identify which of the naturalized non-native species on Tejon Ranch are known to be invasive and which are likely to adversely affect wildlands. Naturalized species are non-native species that maintain self-sustaining populations without human assistance; this includes both invasive and non-invasive species. An unofficial flora of Tejon Ranch was used to identify nearly 200 naturalized plants. The list of naturalized species was then compared with the California Invasive Plant Council's (Cal-IPC) 2006 Invasive Plant Inventory of weeds in California in order to derive a preliminary list of ~30 invasive weed species found on the Ranch. Cal-IPC is a private non-profit organization whose mission is to protect California wildlands from invasive plants through restoration, research and education. It is the leading authority on weeds for the State of California.

Cal-IPC's Threat Ranking

Like many wildland areas, Tejon Ranch has too many weed species to manage at once. Ranking weeds provides a uniform methodology for control prioritization which allows for 1) the highest ranked and manageable species to be controlled first, 2) limited resources to be used efficiently, and 3) management decisions to be based on systematic investigation, and to therefore be defensible.

Cal-IPC's ranking system (Plant Assessment Form or PAF) was used to determine the threat posed by each species. A PAF is separated into three sections, each of which is composed of several sub-sections. The first section is designed to assess the species' ecological impacts, the second section is designed to determine the ability to invade native habitats, and the third section evaluates the current ecological amplitude and distribution of the invasion in native habitats. Within each sub-section the level of documentation used in the assessment (as described in the literature review summary) is assessed, thus providing a confidence level for the overall ranking. Sub-sections documented with lower tiers of documentation such as gray literature, observations, or anecdotes highlight information gaps that should be updated as future research is available.

Within sections 1 and 3, an alphabetical abbreviation sums up the invasive attributes of the species. A scoring matrix is then utilized, where all possible abbreviation combinations are listed to determine each section score. A point system then produces an overall score for section 2. Lastly, a matrix is used to combine all section scores to determine the species' overall score and rank. The following is a list of each sub-section by main section title:

Section 1- Ecological Impact
- 1.1- Impact on abiotic ecosystem processes
- 1.2- Impact on plant community composition, structure, and interactions
- 1.3- Impact on higher trophic levels
- 1.4- Impact on genetic integrity

Section 2- Invasive Potential
- 2.1- Role of anthropogenic and natural disturbance in establishment
- 2.2- Local rate of spread with no management
- 2.3- Recent trend in total area infested within California
- 2.4- Innate reproductive potential
- 2.5- Potential for human-caused dispersal
- 2.6- Potential for natural long-distance dispersal (>1 km)
- 2.7- Other regions invaded

Section 3- Ecological Amplitude and Distribution
- 3.1- Ecological amplitude
- 3.2- Distribution

The overall rank falls into three main impact categories- high, moderate, and limited. Species designated as high or moderate may also be assigned an additional status of "alert," which indicates species with a limited amplitude and distribution, but which have the potential to invade existing habitats in California. Ranking categories are as follows:

High: These species have severe ecological impacts on ecosystems, plant and animal communities, and vegetation structure. Their reproductive biology and other attributes are conducive to moderate to high rates of dispersal and establishment. These species are usually widely distributed ecologically, both among and within ecosystems.

Moderate: These species have substantial and apparent but generally not severe ecological impacts on ecosystems, plant and animal communities, and vegetation structure. Their reproductive biology is conducive to moderate to high rates of dispersal, though establishment is generally dependent on ecological disturbance. Ecological amplitude and distribution may range from limited to widespread.

Limited: The ecological impacts of these species are minor. Their reproductive biology and other invasiveness attributes result in low to moderate rates of invasion. Ecological amplitude and distribution tend to be generally limited (however, they may be locally persistent and problematic). These species may be more problematic than their rank reveals if there is a lack of published literature.

Alert: This is an additional designation for some species in either the high or medium category, but whose current ecological amplitude and distribution are limited. This designation alerts managers to species that are capable of rapidly invading unexploited ecosystems based on initial, localized observations, and on observed ecological behavior in similar ecosystems elsewhere. Of all the species surveyed on Tejon Ranch, only *Washingtonia robusta* (Mexican fan palm) was assigned this designation.

Not Listed (NL): These are species that have been evaluated, but for which information is currently inadequate to respond with certainty to the minimum number of criteria questions (i.e., too many "U" responses) or for which the sum effects of ecological impacts, invasiveness, and ecological amplitude and distribution fall below the threshold for listing (i.e., the overall rank falls below Low). Many such species are widespread but are not known to have documented substantial ecological impacts (though such evidence may appear in the future). All species receiving a "D" score for ecological impact (Section 1), regardless of what other section scores they receive, are by default placed into this category (California Invasive Plant Council 2003). All species ranked as Not Listed lacked sufficient documentation regarding their impacts. Although a species has been assigned a rank of Not Listed, it does not mean that it does not have impacts.

Management Feasibility

An additional ranking system or index was developed to determine the ease of control, and the abundance and distribution on Tejon Ranch. This ranking utilizes the number of populations, the median population size, and the gross area by species recorded during the 2010 weed surveys. The number of populations a species has is an indicator of the access time needed to eradicate that species. Traveling to many populations is much more time consuming and difficult than accessing one or few populations. The number of populations is also an effective way to determine which phase of invasion a species is in or how invasive it is. For example, many small populations could mean the species is in the expansion phase of invasion. The median population size indicates how successful control efforts may be for a given species based on the size of the infestation. Typically, smaller populations have less seed in the soil, and are thus easier to eradicate. The gross area combines both the number of populations and their size, and provides a clear picture of how manageable the species really is.

The number of populations, median population size, and gross area infested for each species were each assigned a numeric value ranging from one to three. Each of the three values were then added together for each species. The final values were then assigned a qualitative rank ranging from A, B, or C. The lowest numeric value corresponded to a rank of A, which indicates a high probability that the species can be eradicated, whereas a rank of C indicates an extremely low probability of eradication success, as outlined below.

A: high probability that a species can be eradicated.

B: depending on the level of resources invested, a species may or may not be eradicated, but can be significantly reduced.

C: highly unlikely that a species can be eradicated.

Results

Cal-IPC's Threat Ranking

The primary ranking system (Cal-IPC's PAF) was based on each species' impacts, invasiveness, and range and frequency of habitat types invaded. On Tejon Ranch, a rank of High was assigned to eight species (34.8%), Moderate to nine species (39.1%), Limited to five species (21.7%), and Not Listed to one species (4.4%) (Fig. 3).

The Cal-IPC threat ranking for all 23 species considered on Tejon Ranch is summarized below in Figure 3, below.

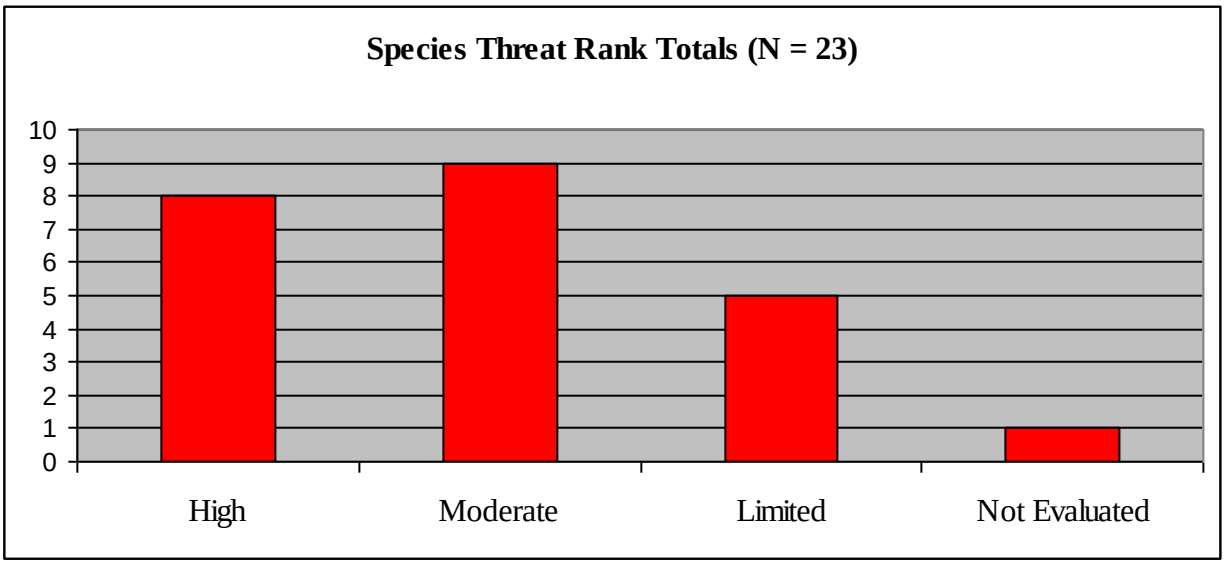

Figure 3. Number of 23ranked species on the Ranch by threat rank.

Management Feasibility Ranking

All species were then subjected to a secondary ranking system which was based on the number of populations, median population size, and ease of control. This resulted in eight species receiving a rank of A (34.8%, not including those species for which no populations were located, e.g. *Spartium junceum*), seven species receiving a rank of B (30.4%), and eight species receiving a rank of C (34.8%) (Fig. 4).

Management feasibility rankings are summarized for Tejon Ranch in Figure 4. It should be noted that the management feasibility rank is for the entire Ranch. Some weed species with limited abundance may be eradicable from a specific watershed, however the chances of reinfestation are higher when source populations are located nearby.

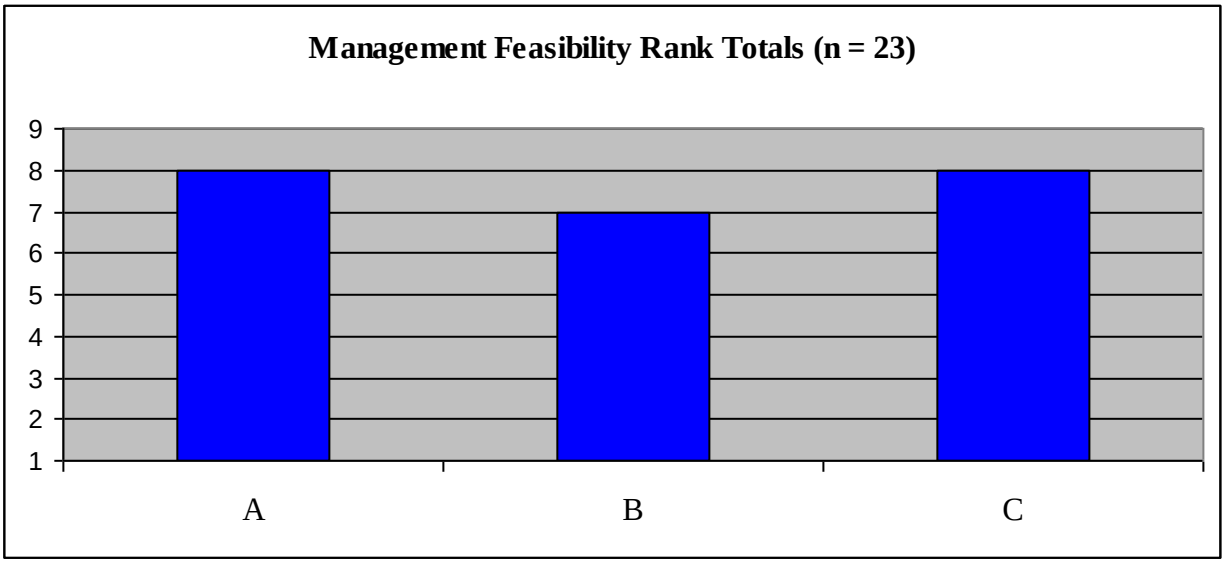

Figure 4. Number of weed species on the Ranch assigned to each of three management ranks (out of a total of 23). Note that 8 species have a rank of A, which indicates that a substantial number of species are eradicable.

Managing multiple weed species at the landscape level requires a systematic and transparent approach to effectively reach management objectives. Subjecting each species to a ranking scheme allows for consistent prioritization of key elements to be compared across all species. Developing such a ranking scheme to fit all scenarios is difficult, and some species, those that are outliers in analysis, may prove to be exceptions to the rule.

When prioritizing the management of weeds based on the threats they pose, land managers should target species ranked High initially, then Moderate, and so on, addressing highly invasive species first. Unfortunately, in many situations, it is usually the High ranked species that have already reached un-eradicatable proportions. This is the case for *Hirschfeldia incana* (mustard) on Tejon Ranch. The management feasibility rank (A-C) should strongly be weighed in tandem with the threat rank. A species ranked as an A indicates, regardless of its invasiveness, that it can easily be eradicated. Focusing on species that can be eradicated (rank of A) should be a priority since potential future problems can be eliminated before they become unmanageable. Incipient species expand faster than well-established species.

Combined Ranking

The combined threat and management feasibility rankings are list in figure 5 below.

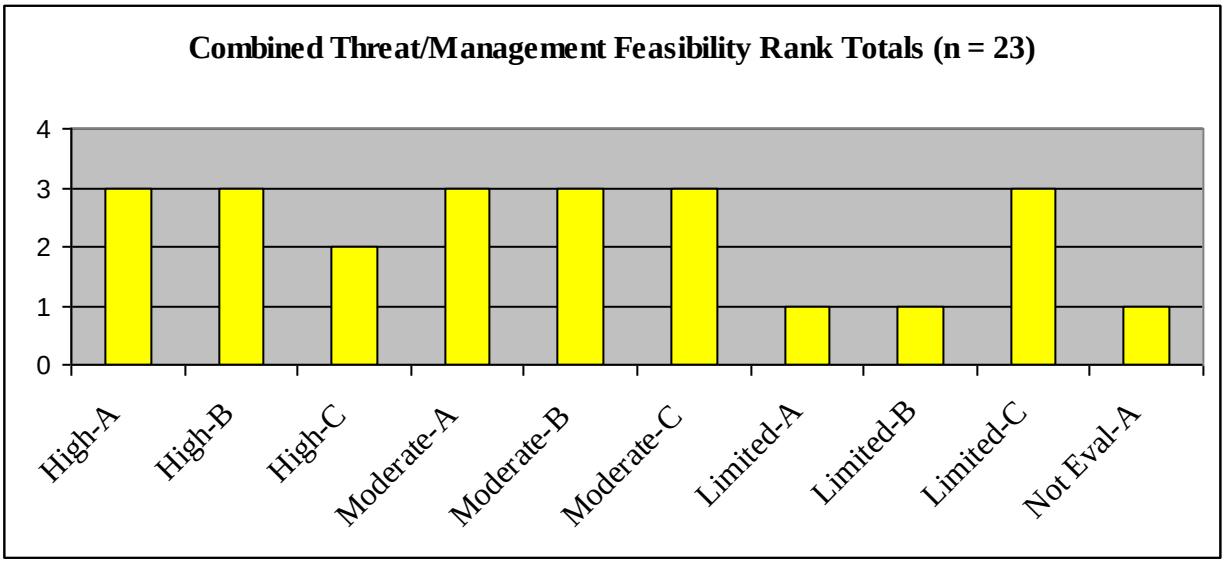

Figure 5. The combination of threat and management ranks. Fortunately there are very few species that are ranked High-C (highly invasive, difficult to control widespread species), and many species that are ranked A (eradicable).

Once A-ranked species have been eradicated, B-ranked, and then C-ranked species should be targeted in that order. It is difficult to differentiate, based solely on rank, between species that have average ranks, i.e. a Moderate-B vs. a Limited-A. Other factors may influence management decisions in these cases, such as the level of available resources. In the example above, when resources are scarce, it is feasible to manage the Limited-A over the more widespread and difficult to control Moderate-B species. Each weed species and its ranking is listed in 1 and 2.

Synopsis of the Ranch Weed Survey and Ranking

The following is a synopsis of the impacts (Cal-IPC Plant Assessment Form [PAF]), author observations, and population data (2010 Ranch surveys; Appendix 14) of the 23 priority weed species identified for weed control action. All population size data listed below are in units of square feet. The total number of populations recorded for each species is tallied as "#Pops." The median population size for each species was calculated "Median Pop." The most frequent population size recorded is represented as "Pop Mode." Both the minimum population size ("Min Pop") and maximum population size ("Max Pop") are listed below. The gross area ("Gross Area") was calculated by adding all area estimates for each species. The net area for each species "Net Area" was calculated by multiplying the area by the mean density range recorded for each population. Two types of species were not ranked for management feasibility: those that were not detected during the 2010 survey, and those which were detected but whose identification were in question. Of the species not detected, most were known to have invaded the region, but not the Ranch, and thus may not occur on the Ranch.

***Aegilops triuncialis* (barbed goatgrass): High**
This species forms dense stands and is known to alter fire frequency and reduce soil moisture, while also reducing forage material. Once present, this species has been known to dominate entire landscapes over two decades. It has been documented to be injurious to livestock and possibly wildlife. We suspect that this species is difficult to detect from helicopter survey platforms when it occurs at a low density.

Species not detected during 2010 surveys.

***Ailanthus altisisima* (tree of heaven): Moderate- B**
This species has a high rate of spread, and displaces native species, and also alters soil chemistry through allelopathy.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
93,850	61,916	18	2,050	50	25,000	5,000

***Arundo donax* (giant cane): High-A**
Arundo donax alters ecosystem processes by consuming large quantities of water, increasing water temperature, and intercepting light available to native species, in particular understory vegetation. It displaces native vegetation, thus resulting in a decrease in the habitat value for nesting birds and fish.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
12,779	12,524	2	N/A	2,500	10,279	N/A

***Brassica nigra* (black mustard): Moderate-A**
The impacts of this species are not well documented, however, it is suspected to slightly alter fire regimes, and reduce the fecundity of native species.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
100	15	1	N/A	100	100	100

***Brassica tournefortii* (Sahara mustard): High-B**
This species is suspected of increasing fire frequency and altering fire regimes in desert ecosystems such as Antelope Valley, as well as reducing the diversity of annual plants and perennial seedlings. The abundance of observational data by Conservancy personnel across the Ranch indicates that the distribution and abundance of this species may have been underestimated during the time of the 2010 surveys due to the lack of basal leaves.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
168,200	16,251	5	18,869	3,137	70,657	N/A

***Cannabis sativa* (marijuana): Not Evaluated**

Although not considered a naturalized or invasive species, *Cannabis sativa* was surveyed due to the threats posed to wildlands by cultivation of illegal plantations. Those threats include non-registered herbicide use and illegal camp fires.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
0	0	2	N/A	N/A	N/A	N/A

***Carduus pycnocephalus* (Italian thistle): Moderate-C**

Carduus pycnocephalus has the ability to increase fire frequency and act as a ladder fuel by carrying flames to the overstory of trees. Dense infestations at the rosette stage inhibit light penetration to the soil surface, and mature plants can reach nearly 100% cover over large areas, thus inhibiting seedling recruitment and survivorship and altering community structure in grasslands. Although 85% of *C. pycnocephalus* seeds have germination inhibitors, these chemicals are readily leached away. *C. pycnocephalus* is also known to compete with native plant species for pollinator visitation, and it can harbor insect pests. National Park resource managers have observed that with the recovery of native vegetation (primarily native perennial grasses and ruderal native shrubs) on Santa Rosa Island after the removal of cattle, monitored population *C. pycnocephalus* have been significantly or entirely suppressed simply by natural increases in native plant and litter cover.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
508,866	91,313	141	400	1	90,000	100

***Centaurea solstitialis* (yellow star thistle): High-C**

Centaurea solstitialis significantly depletes soil moisture reserves in California grasslands. It can also reduce wildlife habitat, forage, and native species diversity. It outcompete native plants, and large infestations can fragment habitat. It is extremely spiny and affects the quality of recreational activities. It is also toxic to horses.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
656,543	41,629	26	1,500	1	20,000	3,000

***Cirsium vulgare* (bull thistle): Moderate-B**

Cirsium vulgare rosettes are known to interfere with pine growth, and can form large dense monotypic stands, which reduce habitat for forage species. It is often observed in conjunction with consistent soil disturbance such as ground squirrel activity (John Knapp, personal observation). There is the potential for hybridization with native *Cirsium* spp., but none are known to exist on Tejon Ranch property.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
35,494	4,873	35	100	1	5,625	100

***Conium maculatum* (poison hemlock): Moderate-A**
Conium maculatum forms dense monotypic stands that can displace native vegetation and decrease light availability. It also interferes with early successional processes. It is highly toxic to humans and wildlife.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
5,259	277	9	400	9	2,000	600

***Cortaderia selloana* (Pampas grass): High**
Cortaderia selloana alters fire intensity and frequency as well as vegetation community composition and structure. It can decrease wildlife forage and nesting habitat.

This species was not detected during 2010 surveys. Because it is easily seen from a helicopter survey platform, we believe that this is not an error.

***Cynara cardunculus* (artichoke thistle): Moderate**
Cynara cardunculus outcompetes native vegetation for light, water, and nutrients. It forms large monotypic stands that displace native plant and animal species, and severely alters grassland structure. It reduces the forage value for wildlife and livestock.

This species was not detected during 2010 surveys. Because it is easily seen from a helicopter survey platform, we believe that this is not an error.

***Dactylis glomerata* (orchard grass): Limited**
Dactylis glomerata has been documented to invade oak woodlands, coastal prairie, and serpentine habitats, but does not often displace native perennial grasses. It is promoted widely for livestock forage.

This species was not detected during 2010 surveys. It is suspected that cattle grazing may have decreased the detectability of this species during the time of the 2010 surveys.

***Eucalyptus sp.* (gum tree): Moderate* -C**
**Eucalyptus* species impacts range from limited to moderate. *Eucalyptus* species are allelopathic, and utilize large amounts of water, which has led to the drying up of streams in South Africa. A related species (*E. globulus*) has been reported as poor wildlife habitat. Thick leaf and bark litter alter understory vegetation, and decrease the germination and survivorship of native plants. *Eucalyptus* species are referred to as "widow makers," for their propensity to drop branches and limbs unexpectedly. Piles of large downed limbs, branches, and litter can impede wildlife movement and burn intensely during fires. *Eucalyptus* spp. increase fire intensity when burning within stands of native tree species, decrease soil moisture and light availability, and produce large amounts of leaf litter that reduce nitrogen mineralization rates in the soil. They alter the canopy structure and can lead to the elimination of shrub and herbaceous layers, resulting in native species displacement and elimination of

native forage for wildlife. Various *Eucalyptus* species were encountered during the 2010 surveys, but they were not identified to the species level.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
920,981	250,205	34	900	100	22,500	900

***Festuca arundinacea* (tall fescue): Moderate**

Festuca arundinacea displaces native species by forming dense stands and producing copious amounts of thatch that hinder germination of native seed and subsequent seedling survival. It is considered a threat to native California grasslands, because it alters the open grassland structure and decreases the diversity of native species over time. *F. arundinacea* can invade open, natural communities and displace native species. This is most likely when *F. arundinacea* already grows in the area, (i.e. along nearby roadsides or other disturbed areas) and when the natural community has either been subjected to disturbance or where the natural fire regime has been suppressed (Eidson 1997).

Tall fescue was introduced to the U.S. as a potential forage grass, and supplied to many farmers by the USDA-NRCS. This agency now recommends its eradication, having found that upland game birds and other small animals cannot utilize tall fescue-dominated habitat. (Sarah Chaney, personal communication). When affected with an endophytic fungus, it can be toxic to livestock and native mammalian herbivores.

This species was not detected during the 2010 surveys. It is suspected that cattle grazing may have decreased the detectability of this species during that time.

***Ficus carica* (fig tree): Moderate-A**

Ficus carica leaf litter is so different from that of native tree species, that it may alter soil chemistry and nutrient cycling. It forms dense stands in riparian forests and woodlands, but has also been documented invading dry rocky slopes on Catalina Island. It has an indirect effect on wildlife by producing fruits that are attractive to rats, which then prey upon nestling birds. Weed workers that come into contact with the resin from fruits, leaves, and sap often experience an uncomfortable skin reaction. It is considered a significant threat in California's Central Valley.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
8,951	8,775	20	263	100	2,500	400

***Foeniculum vulgare* (fennel): High-A**

Foeniculum vulgare alters fire frequency, intensity, and behavior when it is dry. It has a higher ignition temperature, but promotes greater intensity and duration of a fire once it does start. Once established it excludes nearly all other vegetation by forming dense monotypic stands on disturbed sites which shade the herbaceous understory layer, delaying or preventing recolonization by native vegetation. It alters grassland community structure, which can decrease the habitat value for predatory birds; however, it provides abundant foods for songbirds. *F. vulgare* readily becomes established in areas of disturbed soil and vegetation.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
50,299	15,592	8	349	1	35,561	1

***Hirschfeldia incana* (summer mustard): Moderate-C**

The impacts of this species are not well documented, however, it is suspected of slightly altering fire regimes, and reducing fecundity of native species. There is some indication that the Oxalic acids in mustard eaten by the desert tortoise may have negative physiological effects.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
62,302,186	2,401,086	583	400	1	60,000	1

***Juglans sp.* (walnut): Not Listed**

No documented impacts could be found for *Juglans sp.* after conducting a literature and Internet search. *Juglans* sp. encountered were not positively identified to species, but suspected of being *J. regia* (English walnut).

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
3,800	3,724	3	900	400	2,500	N/A

***Lepidium latifolium* (perennial pepperweed): High-B**

This species forms dense monotypic stands that alter soil salinity by acting as a "salt pump" which moves salts from deep within the ground to the soil surface. It alters the carbon/nitrogen ratio of the soil surface through addition of abundant leaf litter, and lessens food availability for nesting waterfowl.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
108,780	7,035	19	225	4	5,000	25

***Marrubium vulgare* (horehound): Limited-C**

This species competes with native vegetation, and is known to alter grassland structure. It decreases forage material for livestock and possibly wildlife.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
4,682,678	509,043	219	200	1	90,000	200

***Nicotiana glauca* (tree tobacco): Moderate-B**

Nicotiana glauca displaces native plants and competes with native tube flowered plants for pollinator visitation by hummingbirds. There is no known evidence of hybridization with other native *Nicotiana* species, but there is this potential.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
221,492	14,220	50	125	25	80,000	25

***Olea europaea* (European olive): Limited-B**
Olea europaea displaces native plants and reduces light availability, but seldom occurs in large stands. The fruits are attractive to birds, and are dispersed very widely.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
229,209	115,780	13	400	9	30,000	900

***Pennisetum setaceum* (fountain grass): Moderate**
This species increases fuel load and frequency, intensity and spread of fire. It has high growth rates and can outcompete native species for resources, and converts desert shrub communities to grassland. *P. setaceum* can alter habitat structure for ground nesting birds.

This species was not detected during the 2010 surveys.

***Phalaris aquatica* (Harding grass): Moderate**
Phalaris aquatica reduces water availability for native vegetation, and quickly forms large monotypic stands, which block passage of animals and establishment of native plants. It can be toxic to wildlife and livestock when consumed in large quantities. It is suspected of altering the fire regime of riparian areas.

This species was not detected during 2010 surveys. It is suspected that cattle grazing may have decreased the detectability of this species during the time of the 2010 surveys.

***Platanus sp.* (plane tree): Not Listed**
Two populations of *Platanus* sp. were detected that appeared to resemble *P. x acerfolia* (London plane tree), but this identification was not confirmed. This species was not included in the management feasibility ranking.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
2,600	2,548	2	N/A	100	2,500	N/A

***Robinia pseudoacacia* (black locust): Limited-A**

Robinia pseudoacacia alters nitrogen cycling and light availability. It displaces native vegetation, but only in small stands, and is poisonous to livestock when eaten. This species was not known to occur on Tejon Ranch property until the 2010 survey.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
3,840	3,764	8	337	4	1,078	N/A

***Rubus armeniacus* (Himalayan blackberry): High**

Rubus armeniacus reduces soil moisture, impedes light penetration to the sub-canopy and ground, and is very flammable. It infrequently hybridizes with the native *Rubus californica* (California blackberry), which it also may displace by pre-emptive competition.

This species was not detected during the 2010 surveys.

***Salsola tragus* (Russian thistle): Limited-C**

Salsola tragus alters soil chemistry by adding oxalate leachate to the soil, making phosphorous more available. It can be a fire hazard when dead plants build up in stream channels, along fence lines or forest edges. Although it can compete with native species for water and nutrients, it is not believed to be able to dominate native vegetation. It is an alternate host for the insect *Circulifer tenellus*, which can carry the virus curly-top that affects some native plant species.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
7,854,371	238,602	76	213	1	15,000	100

***Silybum marianum* (milk thistle): Limited-C**

Silybum marianum can act as a ladder fuel when its dead stalks carry fire into the canopy of trees. It may also increase fire frequency in grasslands. Rosettes and mature plants can inhibit light penetration to the sub-canopy vegetation and the ground, suppressing the germination and growth of native plants. It forms dense monotypic stands in enriched disturbed sites, and in these areas lowers plant diversity. It can be toxic to livestock; however, it is utilized widely by birds and rodents who prize the large seeds as a food source. This species is apparently disturbance-dependent, and when other vegetation and litter are allowed to develop, milk thistle seeds do not germinate (Sarah Chaney, personal communication).

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
5,231,546	609,898	679	150	1	250,000	100

***Solanum elaeagnifolium* (silver-leaf horse nettle): Evaluated Not Listed**

Solanum elaeagnifolium is allelopathic, suppressing the germination and growth of native plants. Although it is a well known pest in agricultural systems, where it can outcompete other species for water, it is also now invading non-agricultural systems in California (Sarah Chaney, personal

communication). All plant parts of *S. elaeagnifolium* are toxic to most livestock, and are expected to affect wildlife in the same manner (affecting the gastrointestinal and nervous systems). There are no known cases of *S. elaeagnifolium* hybridizing with the six native *Solanum* spp. in California, although this potential exists.

This species was not detected during the 2010 surveys, but was found infesting nearby sites.

***Spartium junceum* (Spanish broom): High**
Spartium junceum alters soil chemistry and fire intensity, and may reduce the biomass and diversity of native species, altering scrub and grassland vegetation communities.

This species was not detected during the 2010 surveys, but was found infesting nearby areas.

***Taeniatherum caputmedusae* (Medusahead): High-B**
This species increases litter density, suppresses native species, and increases fire frequency. *Taeniantherum caputmedusae* forms thick monotypic stands and is considered the most invasive and threatening annual grass species in California. It provides poor forage material for wildlife. This species was not easily detectable during the spring surveys, but was found during the summer survey. We suspect that the distribution and abundance of this species was underestimated during the surveys.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
253,438	17,439	3	85,404	25,603	142,431	N/A

***Tamarix parviflora* (smallflower tamarisk): High-A**
Tamarix parviflora has very high water use and can reduce sub-surface water sources, while increasing the deposition of salts on the soil surface. Over time, it converts the understory to more xeric species, and changes the structure of riparian areas to more dense vegetation. Increased flooding and fire frequency have also been attributed to *T. parviflora*.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
19,181	16,450	2	N/A	400	400	N/A

***Tamarix ramosissima* (salt cedar): High-C**
Tamarix ramosissima decreases available water and increases soil salinity (at the surface). Well-established populations facilitate a change from mesic to xeric vegetation. It forms a thick saline soil crust, creating a barrier that can exacerbate flooding and inhibit native seed germination. It also alters fire frequency in riparian ecosystems, and forms dense thickets. *T. ramosissima* outcompetes native vegetation, and although used by some native species, generally provides poor wildlife habitat.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
597,627	80,503	119	225	9	140,000	100

***Vinca major* (periwinkle): Moderate**
Vinca major alters natural erosional processes along drainages, and thus affects hydrologic regimes. It forms dense monotypic stands that exclude native vegetation, and change understory species composition. *V. major* outcompetes native vegetation (especially in riparian areas), and provides no forage for wildlife.

This species was not detected during the 2010 surveys.

***Xanthium spinosum* (spiny cocklebur): Evaluated, Not Listed-A**
Xanthium spinosum is considered a weed of rangeland and agricultural systems, and poses little risk to wildlands.

Gross Area	Net Area	# of Pops	Median Pop	Min. Pop.	Max Pop.	Pop Mode
26	5	2	N/A	1	25	N/A

***Vitis vinefera* (cultivated grape): Not Evaluated**
This species is not known to be invasive, however, some naturalized populations have previously been documented for the Ranch. None were detected during the 2010 surveys. Although this species does not show any invasive tendencies, it has the potential to hybridize with the native congener.

This species was not detected during the 2010 surveys.

Washingtonia robusta* (Mexican fan palm): Limited Alert
Washingtonia robusta can form dense stands, and increases fire danger, especially in riparian ecosystems. It can also harbor rodent pests. *This species is designated with an alert due to increasing observation data on the expansion of this species into new vegetation types.

This species was not detected during 2010 surveys, but was found used as landscaping in nearby areas.

Conclusion

Tejon Ranch is one of the most biologically diverse regions of California, and is home to a suite of unique and listed species, as well as rare vegetation communities. Non-native invasive plant species, or weeds, pose a significant threat to the health and integrity of the Ranch ecosystems and the species that inhabit them. Although the TRC has worked diligently over many years to tackle these threats, the the Conservancy and the TRC have now established a strong foundation of communication, coordination, and resource sharing to collectively and systematically manage the threats posed and the impacts caused by weeds on the Ranch.

Invasion by non-native plants is not a state but a process. Invasive species will continue to invade the Ranch as long as invasive species occur within California, and those invaders already present will continue to change within a spatial and temporal context. Management of natural ecosystems can and

should be considered as on-going maintenance. The Ranch, although relatively "weed-free" compared to many parts of the state, still faces a task list of deferred maintenance. The goal of this Strategy is to provide a clear rationale for setting management objectives in a systematic way that allows current and future land managers to follow and improve upon maintenance methods and procedures. It should be considered a "living" document, that is continually updated with the most current data and lessons learned regarding invasive plant management.

As this is the first systematic Weed Management Strategy for the Ranch, there is currently no work plan. However, with the formation of the Conservancy, and the collaborative efforts with the TRC and partners, work plans will be developed over the coming year as the next step in Ranch-wide weed management. This Strategy will serve as the initial roadmap to holistically manage weed species for decades to come.

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Appendices

Fourteen appendices are provided on the following pages.

Appendix 1 - Ranks- Listed by Species

The table below lists each species threat and management feasibility ranks in alphabetical order by scientific name.

Scientific Name	Gross Area Rank	Pop Rank	Median Rank	Rank Score	Feasibility Rank	Cal-IPC Rank	Combined Rank
Ailanthus altissima	1	1	2	4	B	Moderate	Moderate-B
Arundo donax	1	1	0	2	A	High	High-A
Brassica nigra	1	1	0	2	A	Moderate	Modarate-A
Brassica tournefortii	2	1	3		B	High	High-B
Carduus pycnocephalus	3	3	1	7	C	Moderate	Moderate-C
Centaurea solstitialis	3	2	2	7	C	High	High-C
Cirsium vulgare	1	2	1	4	B	Moderate	Moderate-B
Conium maculatum	1	1	1	3	A	Moderate	Moderate-A
Eucalyptus sp.	3	2	2	7	C	Limited-Moderate	Limited-Moderate-C
Ficus carica	1	1	1	3	A	Moderate	Moderate-A
Foeniculum vulgare	1	1	1	3	A	High	High-A
Hirschfeldia incana	3	3	1	7	C	Moderate	Moderate-C
Lepidium latifolium	2	1	1	4	B	High	High-B
Marrubium vulgare	3	3	1	7	C	Limited	Limited-C
Nicotiana glauca	2	3	1	6	B	Moderate	Moderate-B
Olea europea	2	1	1	4	B	Limited	Limited-B
Robinia pseudoacacia	1	1	1	3	A	Limited	Limited-A
Salsola tragus	3	3	1	7	C	Limited	Limited-C
Silybum marianum	3	3	1	7	C	Limited	Limited-C
Taeniatherum caputmedusae	2	1	3	6	B	High	High-B
Tamarix parviflora	1	1	0	2	A	High	High-A
Tamarix ramosissima	3	3	1	7	C	High	High-C
Xanthium spinosum	1	1	0	2	A	Not Evaluated	Not Evaluated-A

Appendix 2 - Species- Listed and Combined Ranks

The table below lists each species management feasibility and threat ranks in order of rank from High to Limited, and from A to C.

Scientific Name	Gross Area Rank	Pop Rank	Median Rank	Rank Score	Feasibility Rank	Cal-IPC Rank	Combined Rank
Arundo donax	1	1	0	2	A	High	High-A
Foeniculum vulgare	1	1	1	3	A	High	High-A
Tamarix parviflora	1	1	0	2	A	High	High-A
Brassica tournefortii	2	1	3	6	B	High	High-B
Lepidium latifolium	2	1	1	4	B	High	High-B
Taeniatherum caputmedusae	2	1	3	6	B	High	High-B
Centaurea solstitialis	3	2	2	7	C	High	High-C
Tamarix ramosissima	3	3	1	7	C	High	High-C
Robinia pseudoacacia	1	1	1	3	A	Limited	Limited-A
Olea europea	2	1	1	4	B	Limited	Limited-B
Marrubium vulgare	3	3	1	7	C	Limited	Limited-C
Salsola tragus	3	3	1	7	C	Limited	Limited-C
Silybum marianum	3	3	1	7	C	Limited	Limited-C
Eucalyptus sp.	3	2	2	7	C	Limited-Moderate	Limited-Moderate-C
Brassica nigra	1	1	0	2	A	Moderate	Modarate-A
Conium maculatum	1	1	1	3	A	Moderate	Moderate-A
Ficus carica	1	1	1	3	A	Moderate	Moderate-A
Ailanthus altissima	1	1	2	4	B	Moderate	Moderate-B
Cirsium vulgare	1	2	1	4	B	Moderate	Moderate-B
Nicotiana glauca	2	3	1	6	B	Moderate	Moderate-B
Carduus pycnocephalus	3	3	1	7	C	Moderate	Moderate-C
Hirschfeldia incana	3	3	1	7	C	Moderate	Moderate-C
Xanthium spinosum	1	1	0	2	A	Not Evaluated	Not Evaluated-A

Appendix 3 - Plant Transport and Disposal Procedures

1. Weeds that have been cut or removed from the ground should ideally be left in place to avoid dispersal of seed or plant parts with few exceptions. Piles of decaying weed biomass can also aid in re-finding a treated weed infestation in the future.

2. When biomass is mixed in with thick native vegetation, it can sometimes prove to be an impenetrable barrier when monitoring and retreating the site. In these cases, it may be wise to pile all biomass in an open site immediate adjacent to the treated site.

3. When possible, place the biomass out of sight in another infested area immediate nearby.

4. Weed biomass that is in fruit or seed, or a species that can reproduce from plant parts such as *Arundo donax* or *Vinca major* should not be moved from the immediate site unless: 1) the biomass will become a fire hazard to structures, or 2) the biomass is along trails or roads and is aesthetically unpleasing

5. If weed biomass must be removed from the site to a designated staging area, ensure that propagules are secured in a tarp (without holes or rips), and then carried to a vehicle. Always avoid dragging biomass across a trail or road. The biomass should be properly wrapped in a tarp from top to bottom to make sure that the biomass will not bounce out or blow away in transit. Before leaving the site, inspect the vehicle to see if any plant parts are resting on bumpers, tailgates, etc.

6. When biomass is unloaded, inspect the vehicle, tarp, person, and clothes for plant parts, and brush off in the designated staging area.

Appendix 4 - Fire Prevention Procedures

When conducting weed management activities, always be aware of the conditions of the environment and how your actions could potentially lead to an unintentional wildfire. The following "common sense" practices should always be followed:

1. Before driving a vehicle, inspect which side of the vehicle the tail pipe is on, so that if you pull off to the side for any reason, you are aware of where this potential fire ignition source is located.

2. If areas where heavy braking is needed, be aware that your brake pads/drums may be so hot that they could ignite dry vegetation fuels if you pull off the side of the road. Let them cool first if you must pull off the road.

3. If you need to pull off the side of a road, make sure no vegetation will be located close to the undercarriage of the vehicle. Once stopped, inspect and confirm that no vegetation is near the brakes, engine, or tailpipe.

4. Power tools such as mowers, brush cutters, power hedgers, and chain saws should not be operated when vegetation is dry and flammable. Avoid striking rocks with power tool blades and chains during all conditions. Sparks may occur and start a fire.

5. When operating power tools you should also have a Pulaski on site to help cut fire line if a fire is accidentally started.

6. Recently operated power tools should only be placed on bare soil, never on vegetated ground. If necessary create a bare area with a Pulaski.

7. Fuel cans should always be air tight, and stored at least 10 feet from the power tool when not in use or when starting. Fuel cans should be kept cool and in the shade.

8. Avoid dripping fuel on the power tool while fueling. If drips occur, wipe excess fuel with a towel and let residue evaporate for several minutes before starting.

Appendix 5 - Herbicide Health Hazards Label Cheat Sheet

- CHEMTREC (24hr) (800) 424-9300, EPA National Response Center (800) 424-8802
- If anything is swallowed or ingested, call CHEMTREC
- If skin irritation persists or if breathing is difficult, call CHEMTREC
- Have label with you when calling an Emergency number

Garlon 3A: EPA Reg #- 62719-37, Signal Word- **Danger**, Contact number- (800) 992-5994, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Do not induce vomiting. Sip glass of water.
2- Inhalation- No treatment necessary.
3- Ocular- Hold eye open and rinse slowly and gently with water for 30 minutes. Obtain prompt medical consultation from an eye doctor. Corrosive, and causes irreversible eye damage.
4- Dermal- Remove clothing and wash skin for 15-20 minutes. Do not come in contact with eyes or skin.

Garlon 4: EPA Reg #- 62719-40, Signal Word- **Caution**, Contact number- (800) 992-5994, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Do not induce vomiting.
2- Inhalation- Move to fresh air.
3- Ocular- Flush eyes thoroughly with water for 15-20 minutes. May cause slight temporary eye irritation. Corneal injury is unlikely.
4- Dermal- Wash with plenty of soap and water.

Glyphosate Pro II: EPA Reg #- 524-517-72112, Signal Word- **Caution**, Contact number- (314) 694-4000, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Immediately drink water. Do not induce vomiting.
2- Inhalation- Move to fresh air
3- Ocular- Immediately flush eyes with plenty of water holding eye open. May cause temporary eye irritation.
4- Dermal- Remove contaminated clothing, and wash with plenty of water.

Fusillade II: EPA Reg #- 100-1084, Signal Word- **Caution**, Contact number- (800) 888-8372, Hazards- standard PPEs for applying, use apron for mixing. Harmful if absorbed through skin, inhaled or swallowed.
1- Ingestion- Do not drink any liquids. Do not induce vomiting.
2- Inhalation- Move to fresh air.
3- Ocular- Immediately flush eyes with plenty of water, holding eye open and rinsing slowly and gently for 15 minutes. Get medical attention.
4- Dermal- Immediately wash with plenty of soap and water while for 15-20 minutes, remove contaminated clothing.

Habitat: EPA Reg #- 241-426, Signal Word- **Caution**, Contact number- (800) 832-HELP, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Do not induce vomiting. Sip a glass of water.
2- Inhalation- Move to fresh air. If not breathing, perform mouth-to-mouth.
3- Ocular- Flush with water for 15-20 minutes.

4- Dermal- Take off contaminated clothing, rinse skin with plenty of water for 15-20 minutes. Call poison control.

Milestone VM: EPA Reg #- 62719-519, Signal Word- **Caution**, Contact number- (800) 992-5994, Hazards- standard PPEs for mixing and applying.
1- Ingestion- No medical attention necessary.
2- Inhalation- Move to fresh air, if effects occur, consult a physician.
3- Ocular- Rinse eyes for several minutes.
4- Dermal- Wash skin with plenty of water.

Pathfinder II: EPA Reg #- 62719-176, Signal Word- **Caution**, Contact number- (800) 992-5994, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Do not induce vomiting.
2- Inhalation- Move to fresh air.
3- Ocular- Flush eyes thoroughly with water for 15-20 minutes.
4- Dermal- Wash with plenty of soap and water. Prolonged or frequently repeated skin contact may cause allergic reactions in some individuals.

Rodeo: EPA Reg #- 62719-324, Signal Word- **Caution**, Contact number- (800) 992-5994 or (314) 694-4000. Hazards- standard PPEs for mixing and applying.
1- Ingestion- No emergency medical treatment necessary.
2- Inhalation- Move to fresh air. Get medical attention. Avoid breathing spray mist.
3- Ocular- Rinse slowly and gently for 15-20 minutes.
4- Dermal- Remove contaminated clothing and immediately wash with plenty of soap and water for 15-20 minutes.

Round Up Pro: EPA Reg #- 524-475, Signal Word- **Caution**, Contact number- (800) 992-5994 or (314) 694-4000, Hazards- standard PPEs for mixing and applying.
1- Ingestion- Do not induce vomiting. Immediately drink water.
2- Inhalation- Move person to fresh air.
3- Ocular- Rinse eyes for 15-20 minutes.
4- Dermal- Remove contaminated clothing and immediately wash with plenty of soap and water for 15-20 minutes.

Transline: EPA Reg #- 62719-259, Signal Word- **Caution**, Contact number- (800) 992-5994, Hazards- standard PPEs for mixing and applying. Causes eye injury. Harmful if inhaled or absorbed through skin. Avoid contact with eyes, skin or clothing. Avoid breathing spray mist.
1- Ingestion- Drink 1 - 2 glasses of water if able to swallow. Do not induce vomiting.
2- Inhalation- Move to fresh air.
3- Ocular- Hold eyes open and rinse slowly and gently for 15-20 minutes. Call a poison control center or doctor for treatment advice.
4- Dermal- Immediately wash skin with plenty of soap and water, remove clothing. Call a poison control center or doctor for advice.

CanHance: EPA Reg #- 1050775, CA Reg #- 50024-AA, Signal Word- **Caution**, Contact number- day (559) 499-2100, evening (559) 994-9144, Hazards- standard PPE for mixing and applying. Avoid breathing spray mist. Mild irritant may cause redness in eyes or on skin.

1- Ingestion- Drink 1 or 2 glasses of water if able to swallow.
2- Inhalation- Move to fresh air.
3- Ocular- Immediately flush eyes with plenty of water and get medical attention.
4- Dermal- Immediately wash with soap and water, remove contaminated clothing.

Target Pro Spreader Activator: EPA Reg #- 1050775, CA Reg #-50022-AA, Signal Word- **Caution**, Contact number- (310) 773-8912, Hazards- standard PPE for mixing and applying. Irritation of eyes, nose, throat and skin. Avoid breathing spray mist.
1- Ingestion- Drink 1 or 2 glasses of water.
2- Inhalation- Remove victim to fresh air.
3- Ocular- Immediately flush with plenty of water get medical attention.
4- Dermal- Immediately wash skin with plenty of soap and remove clothing.

Mark-it-Red: Signal Word- **Caution**, Contact number- day (559) 499-2100, evening (559) 994-9144, Hazards- standard PPE for mixing and applying. Eye and skin irritant. Ingestion may cause stomach cramps and/or nausea. Mist may cause mild irritation of nasal membranes.
1- Ingestion- Drink water or milk to dilute, then induce vomiting.
2- Inhalation- Move to fresh air.
3- Ocular- Flush immediately with water for at least 15 minutes. Seek immediate medical attention.
4- Dermal- Wash thoroughly with soap and water. Remove clothing.

Appendix 6 - Herbicide Mixing Table

% Volume Spray Rig Mixing Table										
Mix % Rate	**Water**	**Round Up Pro**			**Rodeo**					
		Herbicide in qts	or	Herbicide in gal	Herbicide in qts	or	Herbicide in gal	CanHance	or	Target
2%	1 gallon	2.56 oz	or	0.02 gallons	2.56 oz	or	0.02 gallons	1 oz	or	0.66 oz
2%	25 gallons	2 qts	or	0.5 gallons	2 qts	or	0.5 gallons	25oz	or	16 oz
2%	50 gallons	4 qts	or	1 gallon	4 qts	or	1 gallon	50oz	or	32 oz
2%	75 gallons	6 qts	or	1.5 gallons	6 qts	or	1.5 gallons	75oz	or	1.5 qts
2%	100 gallons	8 qts	or	2 gallons	8 qts	or	2 gallons	100 oz	or	2.0 qts
2%	125 gallons	10 qts	or	2.5 gallons	10 qts	or	2.5 gallons	125 oz	or	2.5 qts
2%	150 gallons	12 qts	or	3 gallons	12 qts	or	3 gallons	150 oz	or	3.0 qts
5%	1 gallon	6.4 oz	or	0.05 gallons	6.4 oz	or	0.05 gallons	1 oz	or	0.66 oz
5%	25 gallons	5 qts	or	1.25 gallons	5 qts	or	1.25 gallons	25oz	or	16 oz
5%	50 gallons	10 qts	or	2.5 gallons	10 qts	or	2.5 gallons	50oz	or	32 oz
5%	75 gallons	15 qts	or	3.75 gallons	15 qts	or	3.75 gallons	75oz	or	1.5 qts
5%	100 gallons	20 qts	or	5 gallons	20 qts	or	5 gallons	100 oz	or	2.0 qts
5%	125 gallons	25 qts	or	6.25 gallons	25 qts	or	6.25 gallons	125 oz	or	2.5 qts
5%	150 gallons	30 qts	or	7.5 gallons	30 qts	or	7.5 gallons	150 oz	or	3.0 qts
10%	1 gallon	12.8 oz	or	0.1 gallons	12.8 oz	or	0.1 gallons	1 oz	or	0.66 oz
10%	25 gallons	10 qts	or	2.5 gallons	10 qts	or	2.5 gallons	25oz	or	16 oz
10%	50 gallons	20 qts	or	5 gallons	20 qts	or	5 gallons	50oz	or	32 oz
10%	75 gallons	30 qts	or	7.5 gallons	30 qts	or	7.5 gallons	75oz	or	1.5 qts
10%	100 gallons	40 qts	or	10 gallons	40 qts	or	10 gallons	100 oz	or	2.0 qts
10%	125 gallons	50 qts	or	12.5 gallons	50 qts	or	12.5 gallons	125 oz	or	2.5 qts
25%	1 gallon	1 qt	or	0.25 gallons	1 qt	or	0.25 gallons	1 oz	or	0.66 oz
25%	25 gallons	25 qts	or	6.25 gallons	25 qts	or	6.25 gallons	25oz	or	16 oz
25%	50 gallons	50 qts	or	12.5 gallons	50 qts	or	12.5 gallons	50oz	or	32 oz
25%	75 gallons	75 qts	or	18.5 gallons	75 qts	or	18.5 gallons	75oz	or	1.5 qts
25%	100 gallons	100 qts	or	25 gallons	100 qts	or	25 gallons	100 oz	or	2.0 qts
50%	1 gallon	2 qts	or	0.5 gallons	2 qts	or	0.5 gallons	1 oz	or	0.66 oz
50%	25 gallons	50 qts	or	12.5 gallons	50 qts	or	12.5 gallons	25oz	or	16 oz
50%	50 gallons	100 qts	or	25 gallons	100 qts	or	25 gallons	50oz	or	32 oz
50%	75 gallons	150 qts	or	37.5 gallons	150 qts	or	37.5 gallons	75oz	or	1.5 qts

Appendix 7 - Herbicide Mixing Cheat Sheet

Herbicide Mixing Table

Mixing procedure: Fill half of container with water, add CanHance or Target Pro Spreader, dye if needed, then add herbicide, and then remainder of water.

Herbicide	Rate in %	650 ml=22oz Spray bottle				3 Gallon Backpack pump				1 Gallon			
Product	or prod/ac	Herbicide	CanHance	Target	Water	Herbicide	CanHance	Target	Water	Herbicide	CanHance	Target	Water
Round Up Pro	**2%**	**0.44 oz**	**None**	**None**	**650ml**	**7.68 oz**	**None**	**None**	**3 gal**	**2.56 oz**	**None**	**None**	**1 gal**
Round Up Pro	**5%**	**1.1 oz**	**None**	**None**	**650ml**	**19.2 oz**	**None**	**None**	**3 gal**	**6.4 oz**	**None**	**None**	**1 gal**
Round Up Pro	**10%**	**2.4 oz**	**None**	**None**	**650ml**	**38.4 oz**	**None**	**None**	**3 gal**	**12.8 oz**	**None**	**None**	**1 gal**
Round Up Pro	**25%**	**5.5 oz**	**None**	**None**	**650ml**	**3 qrts**	**None**	**None**	**3 gal**	**32 oz**	**None**	**None**	**1 gal**
Round Up Pro	**50%**	**11 oz**	**None**	**None**	**650ml**	**6 qrts**	**None**	**None**	**3 gal**	**64 oz**	**None**	**None**	**1 gal**
Rodeo	**2%**	**0.44 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**7.68 oz**	**3 oz**	**2 oz**	**3 gal**	**2.56 oz**	**1 oz**	**0.66 oz**	**1 gal**
Rodeo	**5%**	**1.1 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**19.2 oz**	**3 oz**	**2 oz**	**3 gal**	**6.4 oz**	**1 oz**	**0.66 oz**	**1 gal**
Rodeo	**10%**	**2.4 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**38.4 oz**	**3 oz**	**2 oz**	**3 gal**	**12.8 oz**	**1 oz**	**0.66 oz**	**1 gal**
Rodeo	**25%**	**5.5 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**3 qrts**	**3 oz**	**2 oz**	**3 gal**	**32 oz**	**1 oz**	**0.66 oz**	**1 gal**
Rodeo	**50%**	**11 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**6 qrts**	**3 oz**	**2 oz**	**3 gal**	**64 oz**	**1 oz**	**0.66 oz**	**1 gal**
Garlon 4	**36 oz p/a**	**0.067 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**1.18 oz**	**3 oz**	**2 oz**	**3 gal**	**0.39 oz**	**1 oz**	**0.66 oz**	**1 gal**
Transline	**8oz p/a**	**0.021 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**0.36 oz**	**3 oz**	**2 oz**	**3 gal**	**0.12 oz**	**1 oz**	**0.66 oz**	**1 gal**
Fusillade II	**20oz p/a**	**0.052 oz**	**1/4 oz**	**0.12 oz**	**650ml**	**0.91 oz**	**3 oz**	**2 oz**	**3 gal**	**0.3 oz**	**1 oz**	**0.66 oz**	**1 gal**

Appendix 8 - Herbicide Product Use Overview

Broad Spectrum/Non-selective/Systemic
Roundup Pro- glyphosate, will not penetrate the bark of woody species as a basal bark application. Utilized as a foliar, drill, or cut-stump application. NOT approved for aquatic use.

Rodeo-, glyphosate, a formulation of Roundup Pro that is approved for aquatic use. Contains no surfactant, and should be mixed with an aquatic approved surfactant such as CanHance for optimal control.

Habitat-, imazapyr, optimal control on woody species. Approved for aquatic use, but NOT to be used within ¼ mile upstream from a reservoir or well.

Broadleaf Selective/Systematic
Garlon 4- triclopyr, surfactant needed, and is NOT approved for aquatic use. Typically used as a foliar application, but can be mixed as a basal bark application. Volatilizes at 85-87 F^o. Can be used in place of Pathfinder II or mixed at a higher rate.

Pathfinder II- triclopyr, a premixed formulation of Garlon 4. Utilized as a basal bark application on thin barked shrub or tree species such as *Spartium junceum* and *Ficus carica*. NOT approved for aquatic use. Volatilizes at 87 F^o.

***Asteraceae - Fabaceae* Selective/Systemic/Pre-emergent**
Milestone VM- aminopyralid, Optimal control on all thistles in rosette stage, and herbaceous *Fabaceae*. Has a pre-emergent ability for an approximately three months, will kill the new seedlings as they germinate.

Transline- clopyralid, optimal control on all thistles in rosette stage, and herbaceous *Fabaceae*. Has a pre-emergent capability for an approximately one-month, killing new seedlings as they germinate.

Monocot Specific/Systemic
Fusillade II- fluazifop, control young grasses. NOT approve for aquatic use.
Dyes and Surfactants
Mark-It-Red- red dye added to tank mix for application identification. Approved for aquatic use. Red dye is easier to see than blue dye on green vegetation.

Target Pro-Spreader Activator- aquatic approved surfactant and de-foamer.

Can-Hance- a methylated seed oil, added to Rodeo or Garlon 4, Garlon 4 Ultra, to increase activity and penetration of the herbicide. Approved for aquatic use.

Appendix 9 - Plant Collection Procedures

When you encounter a plant population that you are unsure is a weed, follow the steps below to collect a plant specimen for identification in the office that afternoon.

Step 1. Find a plant that is representative of the population, e.g. find the one that looks like the majority of the other plants. Take a picture(s). Try to find a plant that has reproductive parts. The more leaves, flowers, fruits, and seeds the better. It is helpful diagnostically to have a stem with leaves attached.

Step 2. Place the plant parts in a Ziploc-style bag. Moisten a paper towel and insert it in the bag. This will help to keep the specimen fresh. Too wet will cause the specimen to become a pile of mush.

Step3. Fill out the Unknown Specimen Label completely (instructions below), and insert it in the bag.

Step 4. It is important to keep the specimen flat. Do not crush. Do not leave it out in the sun, and keep it in a cool location. Placing the specimen inside the backpack against the back of the pack, i.e. along your back, will help keep it flat. Do not disturb it when you remove or place any items inside the pack. Immediately place the specimen in a refrigerator or ice chest to keep fresh for identification.

Unknown Specimen Label (USL) Directions *(numbers should be entered as binomialsz)*

Plant Specimen ID: assign an ID for this specimen, starting with your initials and then a unique number. Label all other specimens consecutively.
GPS Number: print the number on the GPS unit. (enter number into the GPS or write the coordinate).
GPS Feature Number: print a number that corresponds to the feature (point) collected with the GPS.
Camera number: print the camera name and or identification number.
Photograph number: print number of the photograph(s) taken of the specimen. Take photographs of the entire plant, and flowers or fruits if present. Multiple photos may be needed.
Date: month, date, year
Time: print standard time, include AM or PM.
Mapper: print full name (no initials or handwriting.
Zone: enter number of the zone.
Plant community(s): enter dominant plant community(s) where found.
Plant description: record distinguishing characteristics such as: height and flower color.
Comments: add general comments that may assist in identification.
Plant IDer: to be filled out by person who identifies the plant in the office.

USL EXAMPLE:

Plant Specimen ID: MMM01
GPS Number:03
GPS Feature Number: 12
Camera Number: 04
Photograph number: 08, 09, 10, and 11
Date: 04-23-07
Time: 12:15 PM
Mapper: Mary M. Moore
Zone: 09
Plant community: grassland and coastal scrub
Plant description: thistle? 2 m tall, flower - purple, distinguishing characteristics- spines on leaves and flower heads.
Comments: 20-30 plants with seed all over the ground.
Plant IDer (once keyed in the office)

Appendix 10 - Mapping Procedures

A weed population is defined as any infestation with 100 feet between it and the next population
Example Trimble Geo XT Mapping Data Dictionary

Top 5 Species
List of the top 5 species most commonly encountered each day.

Species A through G
List of species using the scientific names beginning with A through G (including top 5).
Species H through P
List of species using the scientific **c names beginning with H through P (including top 5).**
Species Q through Z
List of species using the scientific names beginning with Q through Z (including top 5).

Date
Entered automatically by the GPS.

Mapped by
Enter three initials for mapper's name, e.g. Mary Mapping Moore = MMM. If two mappers are present, then enter three initials with a space between each set of initials, e.g. MMM XXX.

Area width (m)
Enter the average width of the population.

Area length (m)
Enter the average length of the population. Note: area width and length will be multiplied post processing and entered into the GIS.

Population Density
Select one of the following cover classes for the entire population using the cover diagrams on the attached sheet as a guide: 0-5%, 5-25%, 25-50%, 50-75%, 75-95%, 95-100%

Phenology
Select best stage the plant or population is in from the list below: bolting, leaves only, reproductive parts, dormant, dead.

Plant Height
Select the stage that best describes the height of the plant from the list below (most appropriate for shrubs and trees): Seedling (<10cm), Sapling (>10cm), Mature tree.

Where in Patch
Select your location where you are in relation to the population edge from the list below:
East edge, West edge, Center, North edge, South edge, Offset (select when using the "offset" function).

Number of Plants
Enter the number of plants if less than 10 (shrub and tree species only).

Comment
Enter any observations, discrepancies, or USL# and photograph #(s) (USL# and photograph # should always be paired).

This page is included for making photocopies on Rite in the Rain paper

Plant Specimen Number: _____
GPS Number: _____
GPS Feature Number: _____
Camera Number: _____
Photograph number: _____
Date: _____
Time: _____
Mapper: _____
Zone: _____
Plant community: _____
Plant description: _____
_____
Comments:
_____
Plant IDer: _____

Plant Specimen Number: _____
GPS Number: _____
GPS Feature Number: _____
Camera Number: _____
Photograph number: _____
Date: _____
Time: _____
Mapper: _____
Zone: _____
Plant community: _____
Plant description: _____
_____
Comments:
_____
Plant IDer: _____

Plant Specimen Number: _____
GPS Number: _____
GPS Feature Number: _____
Camera Number: _____
Photograph number: _____
Date: _____
Time: _____
Mapper: _____
Zone: _____
Plant community: _____
Plant description: _____
_____
Comments:
_____
Plant IDer: _____

Appendix 11 - Species Control Methods Table

The following treatments methods are based on species, not site specific recommendations. Treatment methods selected must consider site characteristics in choosing the appropriate treatment method.

Scientific Name	Treatment Method
Ailanthus altissima	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Arundo donax	Imazapyr 1% w/ CMR foliar, Glyphosate 50% cut-stump
Brassica nigra	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Brassica tournefortii	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Carduus pycnocephalus	Aminopyralid or Cloypyralid foliar
Centaurea solstitialis	Aminopyralid or Cloypyralid foliar
Cirsium vulgare	Aminopyralid or Cloypyralid foliar
Conium maculatum	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Eucalyptus sp.	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Ficus carica	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Foeniculum vulgare	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Hirschfeldia incana	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Lepidium latifolium	Garlon 4 Ultra 2% w/ CMR foliar
Marrubium vulgare	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Nicotiana glauca	Pathfinder II basal bark / cut-stump, or Garlon 4 Ultra 10% w/
Olea europea	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Robinia pseudoacacia	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Salsola tragus	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar
Silybum marianum	Aminopyralid or Cloypyralid foliar
Taeniatherum caputmedusae	Glyphosate 2% w/ CMR foliar
Tamarix parviflora	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Tamarix ramosissima	Pathfinder II basal bark or Garlon 4 1% w/ CMR foliar seedlings, Garlon 4 Ultra 100% drill-n-fill trees
Xanthium spinosum	Glyphosate 2% or Garlon 4 Ultra 1% w/ CMR foliar

Appendix 12 - Herbicide Use Guidelines & Safety Practices

The Standard Operating Procedure developed by The Nature Conservancy's Disney Wilderness Preserve is known to be comprehensive and applicable to wildlands situations, and thus adapted for Tejon Ranch. To ensure the appropriate and effective application of herbicides as a management tool, to minimize detrimental effects to the environment, to ensure the safety of all individuals at risk of exposure, and to minimize the Conservancy, TRC, and their contractor's exposure to liability, the following safety protocols have been adopted for the Ranch weed program.

1) Herbicides shall be used only in situations where benefits of controlling targeted weeds outweigh overall risks of using herbicides and other methods are prohibitively expensive, not effective, or more likely to cause unintended damage than the herbicide.

2) All herbicide and service containers (spray bottles/backpack sprayer, spray rig, etc) should be labeled properly as required by law, and should include the following minimum information:
   a) Product name, e.g. Roundup Pro
   b) Signal word, e.g. Caution
   c) Applicator contact information: Name, address, telephone number, e.g. John E. Nozzlehead, American Weed Company, 1234 Infestation Way, Somewhere Ville, CA 90000. (555) 555-5555.

3) An herbicide may be used only in a manner consistent with its labeling.

4) An herbicide may be used only in compliance with all federal, state and local regulations, including those related to licensing and/or certification of applicators, use of protective and safety gear, and posting requirements.

5) Standard safety practices, as specified by Federal, state, and county agencies, for storage, mixing, transportation, container and unused herbicide disposal, and spill containment will be followed.

6) Herbicide containers and related equipment will be stored in a locked location, away from people, animals, feed, and food.

7) Herbicide containers will be stored closed and inspected periodically for leakage.

8) All contractor certified applicators will maintain their certification when working on the Conservancy or TRC property, and will notify the appropriate land owner when applications are planned.

9) Receipt of employee, contractor, or volunteer suggestions or complaints relating to safety and health issues involving herbicides will be used to improve program safety.

10) All herbicide applicators shall wear the following protective gear when mixing or applying herbicides:
   a) Closed-toed footwear (preferably water repellant).
   b) Protective clothing (long-sleeve shirts [worn down], long pants, underwear, and socks not used for other activities). Coveralls can be worn in place of long shirt and pants.

c) Tyvek or nitrile gloves.
d) Safety glasses or goggles (which ever is specified in the label).
e) It is recommended to always wear an appropriate apron when mixing and loading herbicide.

11) Volunteers are required to fill out emergency contact information and sign consent and release forms.

12) Decontamination kits must be readily available in storage and mixing areas, and must include at least two one-gallon containers filled with potable water, eyewash bottles filled with eyewash or water, soap, and single use paper towels.

13) A binder containing all herbicide labels, Material Safety Data Sheets (MSDS), a map of Ranch roads, and directions to obtain medical attention, i.e. how to secure medical evacuation from the Ranch, will be available in all project vehicles and in herbicide storage areas.

14) Treated areas should be closed to public access (via signs, flagging, or applicator presence) until they are safe for re-entry (until the herbicide dries or for the minimum period required by the product label- whichever is longer).

15) All herbicide applications occurring must report all herbicide applications in accordance with State and County rules and regulations. An herbicide use report will still be made to either Kern or Los Angeles' County Agricultural Commisioner's Office each month, even if no herbicide has been applied.

16) Weather and site conditions should be taken into account prior to utilizing herbicide. Typically, spray applications should not be made when wind speeds are 10 mph or greater. The herbicide label should be checked 1) for specific conditions to avoid and 2) when a temperature inversion exists to avoid drift to off-target plants.

17) The site should be inspected for standing water, as some herbicide can not be applied near open water such as streams, vernal pools, or the sea. Inspect soil texture, since some herbicides do not absorb (bind) to clay colloids, and thus may leach readily through sandy soil. This is especially important when working around drinking water wells.

Appendix 13 – Population Monitoring Schedule by Species

The monitoring period is defined by the duration of time between when a population is controlled to zero density (no above ground plants) to the next infestation survey, or the time between two surveys. Monitoring events are implemented to detect plants that have germinated and before they become reproductive. The treatments period is the general season when herbicide applications will be most effective.

Scientific Name	Monitoring Period	Treatment Period
Ailanthus altissima	Annually	Fall
Arundo donax	Annually	Fall
Brassica nigra	Annually	Spring
Brassica tournefortii	Annually	Spring
Carduus pycnocephalus	Annually	Early Spring
Centaurea solstitialis	Annually	Late Spring
Cirsium vulgare	Annually	Spring
Conium maculatum	Annually	Spring
Eucalyptus sp.	5 Years	Fall
Ficus carica	5 Years	Fall
Foeniculum vulgare	Annually	Late Spring
Hirschfeldia incana	Annually	Spring
Lepidium latifolium	Annually	Spring
Marrubium vulgare	Annually	Spring
Nicotiana glauca	Annually	Late Spring
Olea europea	5 Years	Fall
Robinia pseudoacacia	5 Years	Fall
Salsola tragus	Annually	Early Summer
Silybum marianum	Annually	Spring
Taeniatherum caputmedusae	Annually	Spring
Tamarix parviflora	2 Years	Summer
Tamarix ramosissima	2 Years	Summer
Xanthium spinosum	Annually	Late Spring

Appendix 14 – 2010 Weed Distribution Map