

APPENDIX N:
STRATEGY FOR REDUCING NONNATIVE PLANTS IN
WILDERNESS

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CONTENTS

STRATEGY FOR REDUCING NONNATIVE PLANTS IN WILDERNESS	N-5
Purpose and Background	N-5
Need for Strategy	N-6
Best Practices for Preventing Introduction and Spread of Nonnative Plants into Wilderness.....	N-7
Soil-Disturbing Activities	N-7
Construction, Facilities Maintenance, and Disturbed Lands Restoration	N-8
Fire Management	N-9
Import of Stock and Feed.....	N-10
Travel To and Within Wilderness	N-11
Early Detection and Rapid Response.....	N-12
Background	N-12
History	N-12
Active and Passive Surveillance	N-13
Priority Species, Vectors, and Sites	N-13
Data Collection and Management.....	N-16
Field Protocols	N-16
Rapid Response.....	N-17
Monitoring	N-18
Attachment 1: Public Participation and Outreach.....	N-19
Attachment 2: Invasive Nonnative Plant Observation Card	N-23
Attachment 3: Data Collection and Management	N-27
Attachment 4: Early Detection Field Protocols	N-31

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STRATEGY FOR REDUCING NONNATIVE PLANTS IN WILDERNESS

This strategy is based on the parks' best practices established in 2004 (Management Directive 38, Preventing Introduction and Spread of Invasive Nonnative Plants). These practices continue to be improved as additional knowledge is gained from implementation of prevention, early detection, and rapid response procedures.

PURPOSE AND BACKGROUND

This strategy establishes guidelines to (1) prevent the introduction and spread of nonnative plant species within the wilderness of Sequoia and Kings Canyon National Parks, and, (2) where new introductions do occur, to detect and control them early, before they spread. It covers activities performed by government employees, parks' concessioners, permittees, contractors, partners, and visitors.

National Park Service (NPS) policies on preventing the introduction and spread of nonnative plants include the following:

- The NPS is directed by its founding document, the NPS Organic Act (16 USC 1) to "conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."
- Sections 2 (a) and (c) of the Wilderness Act (1964) direct managers to protect and preserve various qualities of wilderness character. Nonnative invasive plants threaten the natural quality of wilderness, opportunities for primitive recreation, and features of ecological value.
- Nonnative species will not be allowed to displace native species if displacement can be prevented (NPS Management Policies 2006, 4.4.4).
- New nonnative species will not be introduced into parks, except in specific rare situations (NPS Management Policies 2006, 4.4.4.1).
- Livestock grazing will use best management practices to protect the parks' resources, with particular attention being given to protecting wetland and riparian areas, sensitive species and their habitats . . . Managers must regulate livestock so that ecosystem dynamics and the composition, condition, and distribution of native plants and animal communities are not significantly altered (NPS Management Policies 2006, 8.6.8.2). Note that in these parks grazing is limited to recreational and administrative saddle and packstock, so this policy is applied for stock, not livestock.
- Activities may not be categorically excluded from NEPA if they contribute to the introduction, continued existence, or spread of federally listed noxious weeds (DO-12 Handbook 3.5N, Federal Noxious Weed Control Act).
- Activities may not be categorically excluded from NEPA if they contribute to the introduction, continued existence, or spread of nonnative invasive species or actions that may promote the introduction, growth, or expansion of the range of nonnative invasive species (DO-12 Handbook 3.5O, Executive Order 13112).

By far the most efficient and cost-effective actions that can be taken to keep invasive nonnative plants from displacing native species are to (1) prevent the entry of nonnative plants into the parks, (2) prevent the spread of existing nonnative plant populations within the parks, and (3) detect and control newly

introduced nonnative plants early, before they establish and spread. Preventing the entry of nonnative plants into the parks' frontcountry is the essential first step for preventing their movement into wilderness. This is because many nonnative plants that become established in wilderness first become established in the parks' frontcountry. Once new populations of nonnative plants establish they may multiply rapidly. As a consequence, removal can be extremely difficult and costly, especially in remote wilderness. Sometimes treatment is not even possible. The importance of a strong prevention, early detection, and rapid response program as a vital component in protecting native ecosystems from the impacts of invasive nonnative plants cannot be overstated.

Seeds and other propagative parts (hereafter generalized as "seeds") of nonnative plants can travel wherever and whenever people, stock, vehicles, equipment, or earthen and plant materials are moved from one location to another. Seeds can lodge in the treads of car tires, bicycle tires, or shoes. Soil, sand, or gravel imported for construction or other activities can contain nonnative plant seeds. Hay, used to feed stock, or straw, used for soil stabilization, can contain nonnative plant seeds from the fields where the hay was grown. Some nonnatives, such as puncture vine (*Tribulus terrestris*), have spiny or hook-like seed coats and can arrive in the parks stuck to the fur of pets, wildlife, and stock or on people's clothing, shoelaces, and camping gear. Nonnative plants installed around the parks' residences for landscaping can spread to surrounding natural areas. Seeds can blow in from the gardens of neighboring private landowners or can wash down rivers and streams.

The objectives of this strategy are to:

1. Establish best practices to prevent introduction and spread of invasive plants to wilderness by the following mechanisms:
 - a. Soil-disturbing activities resulting from construction, facilities maintenance, disturbed lands restoration, and fire management;
 - b. Import of stock and their feed;
 - c. Travel to and within wilderness.
2. Establish a framework for planning and implementing an early detection and rapid response program in wilderness.

NEED FOR STRATEGY

Once introduced, invasive nonnative plants can spread across landscapes and quickly become difficult or impossible to control. Invasive plants can out-compete native vegetation, displacing native plants and animals from previously occupied habitat, diminishing native plant diversity, and endangering plant and animal species that are already rare. Invasive plants can reduce or degrade wildlife habitat and forage and cause illness, injury, and sometimes death in wildlife and stock. Invasive plants can alter soil nutrient and moisture levels, increase fire frequency, and change the burning season. These altered environmental conditions may favor further nonnative plant invasions. For example, areas previously dominated by woody vegetation may become dominated by annual nonnative grasses and forbs. Invasive plants can cause the deterioration of wetland meadows. Finally, many invasive plants are spiny and can turn a formerly pleasant recreational experience into a painful encounter for visitors.

One of the primary purposes of Sequoia and Kings Canyon National Parks is to protect, restore and maintain the parks' diverse natural resources against external threats. The parks are committed to preserving the diverse native flora against the threat of invasive plants by using Integrated Pest Management (IPM). Integrated Pest Management provides a framework for planning a comprehensive invasive plant management program and for combining tools (physical/ mechanical, chemical,

cultural/fire, and biological) for controlling existing infestations. Integrated Pest Management strongly emphasizes preventing the introduction and spread of new nonnative plants and the early detection and control of new infestations. Prevention of new introductions requires the cooperative efforts of the parks' staff in all divisions, as well as concessioners, contractors, frontcountry visitors, wilderness users, residents, owners of private inholdings, permittees, and neighboring communities.

One of the outstanding qualities of Sequoia and Kings Canyon National Parks is their large expanse of continuous, intact ecosystems, spanning over 13,000 feet of elevation and diverse vegetation types, and largely unfragmented by roads, dams, or other development. As a result, these parks' middle and high elevations retain diverse habitats that are relatively uninvaded by nonnative plants. In comparison to other areas of California, where native plants can be hard to pick out among the tangle of invaders even in natural preserves, this makes protecting the parks' intact ecosystems through prevention all the more important. Large areas of relatively uninvaded, unfragmented, undeveloped habitat are increasingly rare in the world, and therefore of immense ecological, cultural and other value. Finally, climate change is expected to make some habitats more suitable for some nonnative plants, so invasion rates may increase. Preventing these invasions is one of the few things that can be done to increase ecosystem resistance and resilience in the face of unprecedented human-caused climatic change.

BEST PRACTICES FOR PREVENTING INTRODUCTION AND SPREAD OF NONNATIVE PLANTS INTO WILDERNESS

While this strategy focuses on the protection of wilderness ecosystems, the following best practices include those frontcountry activities and locations that have a strong connection to wilderness. Other activities that have a weaker connection to wilderness nonnative plant introductions, such as landscaping, planting of vegetation, and maintenance of cultural landscapes, are addressed in other documents but excluded here.

These best practices are a menu from which necessary mitigations can be chosen when invasive plant staff are reviewing proposed projects and routine operational activities during planning and compliance. For each project or operational activity, the risk of introducing or spreading nonnative plants will be assessed and best practices prescribed accordingly. For example, a trail construction project at high elevation, with no nearby nonnative plant populations, no use of imported earthen materials, and use of hand tools only, is at low risk of introducing nonnative plants and would not require post-project surveys for invasive plants to be funded by the project. By contrast, a frontcountry road construction project adjacent to invasive plant populations, using imported gravel, and requiring earthmoving equipment is at high risk of introducing nonnative plants and would require pre-project surveys, post-project surveys, and post-project treatment to be funded by the project. The highest-risk situations, for which the practice is most necessary, are described in the descriptions below as applicable. To be most effective, all these practices will require invasive plant staff to provide active outreach to project and operations staff, partners, and the public to explain their importance, describe the high-risk situations where the practice is most necessary, and work together to adjust the practices when they are not feasible.

SOIL-DISTURBING ACTIVITIES

The soil disturbance inherent in construction, coupled with the import of equipment and materials that may harbor nonnative plant seeds, make many construction sites high-risk areas for invasion by nonnative plants. Construction projects affecting the spread of invasive plants into wilderness include projects occurring both in frontcountry and wilderness because invasive nonnative plants can spread rapidly from disturbed frontcountry construction sites into adjacent wilderness ecosystems. Recent disturbed lands restoration sites, areas that have sustained high-intensity fire, fire lines, fuel breaks, and trails are also

vulnerable to import and spread of nonnative plants. Soils are disturbed to restore natural topography, to build fire line, or by repeated foot traffic. Vehicles, equipment, clothing, and boots brought to a work site can harbor nonnative plant seeds from the previous work site. Materials that are imported to help mitigate soil erosion, such as straw, can contain nonnative plant seeds.

CONSTRUCTION, FACILITIES MAINTENANCE, AND DISTURBED LANDS RESTORATION

The following practices will be followed in construction, facilities maintenance and disturbed lands restoration activities:

1. Before any equipment is brought into the parks or moved to new areas within the parks after being used off pavement, it will be pressure or steam washed in order to remove seed-containing soil and plant parts. Examples of equipment are backhoes, tractors, loaders, excavators, dozers, bobcats, wheeled compressors, street sweepers, or trucks and trailers that have traveled off-road. Trained staff of the parks will inspect equipment to verify cleanliness before it enters the parks.
2. Topsoil will not be imported into the parks.
3. Before moving vehicles or equipment that have been used off paved surfaces to a new job site within the parks, visually inspect and clean the vehicles or equipment (including the undercarriage) thoroughly to remove all mud, dirt, and plant parts, particularly when moving from lower to higher elevations, from areas of known weed infestations, or into meadows, riparian areas, or other wetlands.
4. Do not use straw- or hay-based erosion control materials, even those certified as weed-free. Other fibrous materials, such as shaved aspen (excelsior) and coconut fiber (coir) are available at much lower risk. Because wood and coconut fibers are innately free of plant seeds, weed-free certification is not required for these products.
5. Use weed-free, locally-staged fill or on-site fill (mineral) materials when it can be extracted from the project site without causing adverse impacts to the native vegetation, soils, or hydrology.
6. Imported mineral materials will come from an approved source. Such materials include boulders, gravel, sand, road base, fill dirt, and all other earthen materials. Consult with the invasive plant ecologist at least a month in advance of project work. Quarries are rarely, if ever, free of invasive plants. Invasive plant staff will work with project managers to minimize the risk of importing invasive plants with mineral materials by inspecting proposed materials at the quarry or other source sites for presence of invasive plants. Mitigations to lower the risk may include washing coarse materials (boulders, rock, and coarse gravel), stripping the top 12 inches of material in a stockpile, requiring freshly-produced material stored less than one month, or other prescriptions specific to the situation. Some high-risk materials may be rejected. Material from quarries participating in the Sierra Nevada Region Weed Free Aggregate Program, managed by Yosemite National Park, may be used if the quarry receives a certification of "Full Compliance." Material from quarries receiving a "Conditional" certification will need to be inspected by the parks' invasive plant staff. Use of material from participating quarries is encouraged in order to provide incentive and recognition to quarry operators that implement good weed management practices. Consult with the invasive plant ecologist about participating quarries.
7. Do not move low-elevation (foothills) road materials to higher elevations.
8. Minimize the area of soil disturbance. Consider realigning trails or reducing the trail width to minimize disturbance. Scrape road shoulders only where steep, material-shedding slopes make this action necessary. When removing invasive plants, consider using herbicides rather than digging out roots, where appropriate.

9. Consider the location of soil disturbance. To avoid patches of invasive plants when aligning new trails, consult invasive plant staff when planning projects.
10. Minimize the frequency of soil disturbance. For example, disturbing an area once every five years creates less risk than disturbing it every year. If a site has to be cleared of vegetation yearly (such as road ditches) and the site is outside wilderness, consider paving as an alternative.
11. After completing construction or when otherwise stabilizing disturbed soils, revegetate the area or cover bare soil with local litter and duff mulch prior to fall rains in October-November. This mulch will provide a source of seeds to reestablish native vegetation and reduce the risk of nonnative seeds germinating. Ideally, the litter and duff should be collected from surrounding areas, but do not denude the collection area. Leave at least 50 percent of the material in place and do not disturb vegetation.
12. As a desired practice for planned construction sites, survey for and remove invasive plants at least one year before the start of construction. For sites where priority invasive plants are likely to be present, include funding for one year's pre-project survey when planning projects. Contact invasive plant staff to conduct surveys.
13. As a desired practice after construction and until sites are fully revegetated, schedule annual invasive plant surveys by qualified botanical technicians so that new introductions are detected early and prevented from becoming problems. For sites where there is substantial risk of introducing or spreading non-native plants through construction activities, include funding for one to three years of follow-up surveys when planning projects.
14. Consider the risk of nonnative plant invasion when locating perpetually disturbed facilities, such as campgrounds, corrals, and trails. For example, campsites adjacent to meadows and trails through meadows create a high risk for nonnative plants to become established in meadows. Future planning should consider closure of such high-risk campsites and rerouting of such trails.

FIRE MANAGEMENT

The following practices will be followed when disturbing soils in the fire management program:

1. Before any equipment is brought into the parks or moved to new areas within the parks after being used off pavement, it will be pressure or steam washed in order to remove seed-containing soil and plant parts. Examples of equipment are fire engines, crew buggies, dozers, water tenders, or trucks and trailers that have traveled off-road. This restriction will not apply to equipment responding to initial attack of wildland fire where fire spread is threatening life or property. For equipment responding to extended attack of wildland fire where fire spread is threatening life or property, the Fire Management Officer will request exceptions with the Chief of Resources Management and Science.
2. Minimize the area of soil disturbance. In frontcountry fire units, use hand line rather than dozer line where possible. Construct fire lines to minimum width required relative to fire behavior and terrain.
3. Consider the location of soil disturbance. Fire planners, resource advisors, and incident staff should consult the parks' invasive plant staff when locating hand line and dozer line in areas known to have populations of invasive plants. Dozer line and hand line should be located well away from invasive plant populations whenever possible.
4. When rehabilitating fire line, return windrowed soils to original position and cover bare soil with local litter and duff mulch prior to fall rains in October-November. This mulch will provide a source of seeds to reestablish native vegetation and reduce the risk of nonnative seeds

germinating. Ideally, the litter and duff should be collected from surrounding areas, but do not denude the collection area. Leave at least 50 percent of the material in place and do not disturb vegetation.

5. On fires, invasive plant staff should be consulted by the resource advisor, or when appropriate for large fires, assigned as an additional resource advisor to the incident management team whenever the spread of invasive plants is probable. Invasive plant staff should be consulted in the development of fire line and burned area rehabilitation plans.
6. As a desired practice in planned burn units at high risk for spreading known invasive plant populations, survey for and remove invasive plants at least one year before a planned ignition, if funding and staff are available.
7. As a desired practice in post-burn units, schedule annual invasive plant surveys by qualified botanical technicians so that new introductions are detected early and prevented from becoming problems. One to three years of follow-up surveys should be funded by projects. In recognition that current funding structures may not allow for dedicated surveys, post-fire invasive plant detection may need to rely on limited searches conducted by fire effects monitoring crews while traveling to and from plots.

IMPORT OF STOCK AND FEED

Hay, unprocessed feed, and straw may contain nonnative plant seeds. Invasive plants can be introduced into previously unoccupied areas during transport of feed materials, by laying out hay at pack stations or trail heads, and in manure deposited by stock throughout the parks. A portion of plant seeds remain live and viable as they pass through the digestive systems of horses and mules, and their manure can act as fertilizer. Use of straw as mulch is covered in the preceding section.

No stock feed is truly “weed free,” but the types of stock feed vary in their risk of containing undesirable plants. California certified weed-free forage is produced from hay, feed, or straw products grown in a field that has received reasonable and prudent visual inspection and where no propagative parts or seeds of state- or federal-listed noxious weeds were detected. Unfortunately, many of the plants that cause problems in the parks’ wilderness areas, such as reed canarygrass, orchard grass, timothy grass, and velvet grass, are not on the California or federal noxious weed lists, are desirable for hay production, and therefore may be present in certified weed-free forage. Even processed pellets can contain trace amounts of viable seed. However, the risk of importing viable seeds decreases with the level of processing: highly milled, heat-treated pellets have many fewer viable seeds than raw hay. More risk can be tolerated in frontcountry sites, where the probability of detection is higher and there are fewer barriers to effective treatment of established plants, than in wilderness sites, where probability of detection is low and there are more barriers to effective treatment of established plants.

The following practices will be followed when importing stock and feed into the park:

1. California, Nevada, or other state-certified weed free forage (baled or loose hay, hay cubes, or straw bedding) is required when hay products are used as supplemental forage or bedding in the parks’ frontcountry zones. This requirement will be included in pack station concessions contracts and commercial use authorizations.
2. Feed carried into the wilderness will be commercially-processed pellets, rolled grains, or fermented hay (e.g., ChaffhayTM). These products have a high level of mechanical milling, heat treatment, and/or anaerobic fermentation that destroys seeds. Other feed products that have similar levels of processing that destroy nearly all seeds may be permitted. Baled or loose hay and

compressed hay cubes, which have little to no processing, will not be used in wilderness. This applies to all users: administrative, commercial, and private.

3. Stock users are encouraged to purge their animals for three days on pellets, rolled grains, fermented hay, or certified weed free forage prior to entering the park.
4. As a desired practice, stock should be inspected and cleaned by handlers prior to entering the parks, or prior to moving from frontcountry to wilderness within the parks. Inspect for and remove any plant parts, seeds, or soil that may have adhered to animals, tack, or equipment, and handle loads and tack in such a way as to avoid picking up plant parts, soil, or mud. This desired practice will be included in pack station concessions contracts and commercial use authorizations. Private stock users will be informed of this practice through outreach and education. Because this desired practice is difficult to achieve operationally, it will be a topic for ongoing discussion and improvement between invasive plant staff and animal handlers.
5. Manure that accumulates in corrals will be removed from the parks and not stockpiled or burned within the parks. This requirement will be included in pack station concessions contracts.
6. As a desired practice, NPS administrative corrals and concessioner pack stations will be kept free of invasive plants within a 50-foot buffer of the facility. This will be the responsibility of the NPS corrals and concessioner pack station staff. Invasive plant staff will monitor sites for invasive plants and consult on appropriate management strategies. Because there is limited time and funding to accomplish this practice, invasive plant staff will continue to work with corrals and concessioner staff to control invasive plants in the highest-risk facilities.

TRAVEL TO AND WITHIN WILDERNESS

The wilderness of Sequoia and Kings Canyon National Parks remains relatively uninvaded by nonnative plants. Even those species, such as cheatgrass and bull thistle, that have managed to colonize wilderness sites have left many wilderness drainages untouched. Protection of the wilderness, which is nearly 97% of the parks' acreage, from invasion by nonnative plants is among the highest priorities of the invasive plant management program.

The following practices will be followed to protect wilderness vegetation:

1. Frontcountry helibases and helispots are focal points for the movement of nonnative plant seeds from the frontcountry to the wilderness. As a desired practice, the Ash Mountain helibase and frontcountry helispots will be kept free of invasive plants within a 50-foot buffer of the facility to reduce the risk of contaminating clothing, shoes, gear, and external loads. Cargo nets will be inspected and cleaned after use, particularly after use outside the parks or in low elevations. This will be the responsibility of heliport staff. Invasive plant staff are available to consult.
2. Helicopter users will be responsible for inspecting and cleaning their gear, clothing, boots, and external load items for plant seeds, plant parts, and caked dirt and mud before loading. Helitack staff will inspect and clean helicopter skids.
3. Heliport staff will track helicopter landing sites and cargo net drops and provide locations to a designated contact annually. Invasive plant, heliport, and wilderness ranger staff will work together to survey for new introductions and control invasive plants in wilderness helispots.
4. Trailheads will be inspected for invasive plants and kept weed-free. Invasive plant staff will work with trailhead rangers and trail crews to inspect for and remove invasive plants.
5. When travelling from frontcountry to wilderness, from areas of known weed infestations (communicated in training), or from foothills to higher elevations, wilderness users will inspect,

remove, and properly dispose of plant seeds, plant parts, and caked dirt and mud found on clothing, boots, tools, and camping equipment. Disposal consists of removing the seed, plant parts, and dirt from clothing and equipment at the origin of the material, or bagging the seeds, plant parts, and dirt and disposing in bagged garbage. Public users will be informed of this practice through outreach efforts.

6. Wilderness rangers, trailhead rangers, and trail crews will be trained in invasive plant identification and will be key personnel in early detection of new invasions.
7. As a desired practice, invasive plant staff will train all parks personnel in invasive plant identification, early detection, and reporting. The parks' newsletters, pamphlets, reference books in the parks' libraries, herbaria, and invasive plant observation cards are available for this purpose.
8. The parks' visitors will be informed of the threat of nonnative plant species and how they can help prevent nonnative plants from entering the parks. See attachment 1 for details of the public participation and outreach components of this strategy.

EARLY DETECTION AND RAPID RESPONSE

BACKGROUND

Early detection and rapid response (EDRR) is a management approach that capitalizes on managers' ability to most effectively eradicate invasive plant populations when they are small. By detecting a new invasive plant introduction before it has a chance to spread or build a large seed bank, managers can respond early enough in the invasion process to fully eradicate the species from a given area. Through EDRR, well-informed surveillance can prevent costly long-term control efforts, for which success is not ensured. After prevention, EDRR is the most effective and cost-efficient set of actions that can be taken to protect the parks' resources from the impacts of invasive plants. EDRR is recurring and cyclic in nature, so is best provided by an operational program.

Fortunately, the invasion of nonnative plants into the parks' montane, subalpine and alpine habitats is still in its early stages. While there are some established wilderness populations requiring expensive and intensive control, such as velvetgrass in the Kern Canyon, the relatively uninvaded condition of the parks' mid to upper elevation wilderness points to the importance of EDRR as the primary strategy to be employed to protect these intact ecosystems. The threat to these mid and upper elevation ecosystems does exist: cheatgrass has been found as high as 9,819 feet elevation, several pasture species introduced to Rock Creek have reproduced at 10,600 feet elevation, and several highly-invasive perennial grasses, including reed canarygrass, have been detected in scattered mid-elevation wilderness meadows.

HISTORY

Past EDRR at the parks has been both active and passive. Active EDRR has been conducted in wilderness by the parks' meadow monitoring program since 1995, when the establishment of a professional plant ecologist in charge of the program coincided with heightened awareness and understanding of invasion biology, which led to increased focus on EDRR as a part of meadow monitoring. The USGS Sequoia-Kings Canyon and Yosemite field stations conducted a nonnative plant inventory throughout the parks from 1996 through 1998, including in wilderness. The parks' invasive plant management program was established in 2002, when project-focused survey and control efforts in wilderness also began. Program staff conducted widespread early detections surveys along wilderness trails and in wilderness meadows in 2012 and 2013. Active surveys are also conducted by the parks' disturbed lands restoration program during the course of restoring disturbed lands, and by the plant ecology program during the course of

surveying for and monitoring rare plants. Passive detections have been reported by other staff of the parks, partners, volunteers, and visitors while engaged in other work or recreational activities.

ACTIVE AND PASSIVE SURVEILLANCE

Early detection surveillance is either active (ongoing and systematic) or passive (occurring as other activities are being conducted). Because the area within Sequoia and Kings Canyon National Parks that is designated or managed as wilderness is vast—838,000 acres—and newly introduced nonnative plant populations are small, finding them can be analogous to finding a needle in a haystack. The addition of large numbers of passive surveyors—the parks’ staff, volunteers, partners, and visitors—to the relatively few active surveyors has the potential to contribute significantly to the overall success of EDRR efforts in wilderness.

Active early detection is performed by staff and volunteers who have botanical expertise, who regularly work in wilderness, whose dedicated tasks include surveying for and mapping invasive plants, and who participate in a planned EDRR program that includes training, implementation of monitoring protocols, and detailed data collection and management. Active ED staff are expected to identify and detect a target list of nonnative plants, plus unknown plants that appear “out of place” and could potentially be nonnative. Active early detection is expected to have a significantly higher probability of detection per observer than passive early detection. Observation data recorded by active ED staff are more detailed than those recorded by passive observers. Currently, the invasive plant management program conducts active, dedicated nonnative plant survey and control actions with staff and volunteers when project funding is available for such surveys. Other parks programs such as the disturbed lands, plant ecology, and meadow monitoring programs also perform active EDRR annually as they carry out restoration, rare plant, meadow monitoring, and other tasks.

Passive early detection is performed by non-resource staff (interpreters, wilderness rangers, trail crews, etc.), partners, researchers, volunteers, and visitors who usually do not have botanical expertise, but through outreach and training, are asked to look for a short target list of invasive plants as they conduct other activities. Staff participating in passive early detection are asked **not** to remove plants, since many non-native plant species are difficult to distinguish from closely related natives, and observations must be confirmed by a qualified botanist prior to removal. Passive early detection is expected to have a significantly lower probability of detection per observer than active early detection, but the much greater number of passive observers increases the area of the parks that is searched annually. Observation data recorded by passive ED staff are less detailed than those collected by active observers. For passive ED to be effective, a substantial, sustained investment in developing training materials and conducting outreach by both invasive plant and interpretive program staff is necessary.

PRIORITY SPECIES, VECTORS, AND SITES

Early detection is especially challenging in the parks’ wilderness because the area that needs to be surveyed is large, nonnative plant occurrences are scattered and infrequent, and resources for surveillance are limited. To focus EDRR efforts where they are most needed, nonnative species, vectors, and areas (locations) have been prioritized. Some species are more likely to invade and cause problems than others, some of the parks’ management actions and recreational activities contribute more to invasion than others, and some areas are more likely to be invaded. Prioritization ensures that surveyors maximize resource protection by searching for the species that are most likely to damage the most important resources in the locations where those species are most likely to be found.

Priority Species: A shortlist has been developed for species that have been assessed as having high priority for prevention and EDRR in wilderness (table N-1) based on their likelihood of being present in wilderness and their potential ecological impacts. This is a short list of species used for training passive observers with limited expertise. A larger watch list is also maintained and is shared with ecologists in the USGS Sequoia-Kings Canyon Field Station, the Sierra Nevada Network Inventory & Monitoring Program, and the forestry, plant ecology, and disturbed lands restoration programs. When new populations of transformer species such as reed canarygrass and Himalayan blackberry are found, observers are asked to: 1) notify invasive plant management program staff immediately, and 2) provide detailed information about where the species was discovered, and additional information about patch size, abundance, habitat, and feasibility of control.

Table: N-1 List of Priority Nonnative Plants for Wilderness Early Detection and Rapid Response Activities

Grasses	Other Species
Cheatgrass (<i>Bromus tectorum</i>)	Italian thistle (<i>Carduus pycnocephalis</i>)
Smooth brome (<i>Bromus inermis</i>)	Yellow star thistle (<i>Centaurea solstitialis</i>)
Orchard grass (<i>Dactylis glomerata</i>)	Bull thistle (<i>Cirsium vulgare</i>)
Velvet grass (<i>Holcus lanatus</i>)	Prickly lettuce (<i>Lactuca serriola</i>)
Reed canarygrass (<i>Phalaris arundinacea</i>)	Oxeye daisy (<i>Leucanthemum vulgare</i>)
Kentucky bluegrass (<i>Poa pratensis</i>)	Himalayan blackberry (<i>Rubus armeniacus</i>)
	Dandelion (<i>Taraxacum officinale</i>)
	Woolly Mullein (<i>Verbascum thapsus</i>)

This is a dynamic list and will be modified through future planning.

Regular early detection monitoring is especially important for species that form monotypic stands or alter ecosystem processes, such as reed canarygrass, velvet grass, Himalayan blackberry, and yellow star thistle. The larger watch list includes species such as medusa head (*Taeniatherum caput-medusae*), spotted knapweed (*Centaurea maculosa*), Canada thistle (*Cirsium arvensis*) and rush skeletonweed (*Chondrilla juncea*), which aren't yet in the parks but are problems in similar wilderness habitats. Other species, such as bur buttercup (*Ranunculus testiculatus*), lambsquarters (*Chenopodium album*) and bulbous bluegrass (*Poa bulbosa*), are common in corrals, burns, and other disturbed frontcountry areas. However, as it is not certain whether these species will spread or become problems in wilderness, they were not included. Although wilderness extends into lower elevation foothill woodlands, nonnative grasses and forbs have displaced foothills native plants to such an extent that common foothill invasives were not included unless, like Italian thistle, they are thought have the potential to expand into undisturbed middle and higher elevation habitats. Kentucky bluegrass, which has naturalized in many of the parks' meadows, is difficult even for trained botanists to distinguish from native bluegrasses, but is included because more information is needed about its distribution and expansion in the parks. Similarly, although dandelion and cheatgrass also have established populations in some parts of the wilderness and thus may not always be subject to rapid response efforts, they remain a priority for detection and documentation.

Note that the absence of a species from the wilderness priority nonnative plant list does not mean that it is not of concern in wilderness, or that it will not be controlled if detected. In addition to searching for particular species, ED staff will search priority sites where a great variety of non-native plants are likely to be introduced. In these relatively confined areas within the larger intact ecosystem, such as wilderness stock hitching rails, the goal is to detect and eradicate all newly-introduced non-native plants, if feasible. Prioritization of vectors and sites is discussed further below.

Priority Vectors: Known vectors for the introduction and spread of nonnative species are prioritized for prevention and EDRR based on their likelihood of resulting in the introduction or spread of these species into wilderness (table N-2). Equipment, materials, and stock brought into the parks, park operations and maintenance activities that result in soil or vegetation disturbance, and visitor activities can all result in the introduction and spread of nonnative plants. See the Prevention section above for a more detailed description of the activities that act as vectors. Ongoing outreach and education is necessary to keep staff, partners, and visitors aware of the risk of introducing nonnative plants via these vectors. Regular early detection surveys are necessary where these vectors are active.

Table N-2: Vectors for the Introduction and Spread of Nonnative Plants, Prioritized for Prevention and ED&RR Activities*

Priority Materials and Equipment	Priority Actions or Uses
<p>High Priority</p> <ul style="list-style-type: none"> • Fire vehicles, equipment, clothing and shoes • Helicopter cargo and helitack staff clothing and shoes • Imported earth-moving equipment • Imported earthen materials (gravel, etc.) • Imported landscaping and nursery plants • Imported erosion-control materials (straw, etc.) • Imported stock and stock feed <p>Lower Priority</p> <ul style="list-style-type: none"> • Staff, outside crews, and visitor equipment, clothing and shoes 	<p>High Priority</p> <ul style="list-style-type: none"> • Road and utility corridor construction and maintenance projects • Trail and wilderness facility construction and maintenance projects • Fire suppression and prescribed fire • Stock grazing, trail use and overnight stays <p>Lower Priority</p> <ul style="list-style-type: none"> • Routine park operations and maintenance activities • Wilderness hiking and camping

*This is a dynamic list and will be modified through future planning.

Priority Sites: Sites are prioritized for prevention and EDRR based on the likelihood of nonnative plant introduction, the presence of high-value resource or habitats, the difficulty of control, and other factors such as the existing distribution of nonnative plants. Both frontcountry and wilderness sites are discussed here. This is because activities that involve soil and vegetation disturbance, or the import of earthen or other materials into the parks, can result in the introduction or spread of invasive plants to frontcountry corrals, helispots, campgrounds, trailheads, and other areas that are known jumping-off points for the introduction of nonnative plants into wilderness. Priority sites also include threatened and endangered species habitats and sensitive habitats such as meadows and riparian areas. Riparian sites are also a priority because species introduced there can spread to areas downstream where they may not be detected before they become too large to control. Burned areas are considered high priority because some invasive plants such as cheatgrass are known to spread rapidly after fire. Note that because of the tremendous size of the parks, most of the parks' acreage will never be actively surveyed and will only rarely be passively surveyed.

Ideally, high priority sites would be actively surveyed annually, medium priority sites every 3 to 5 years, and low priority sites every 5 to 10 years. However, the parks may not have the capacity to implement this rotation schedule. With invasive plant staff putting sustained effort into outreach to passive surveyors, many sites can be passively surveyed annually. However, a significantly lower level of detection per passive surveyor vs. active surveyor would be expected. Active surveys would be conducted by the meadow monitoring program and invasive plant program when funds are available.

Table N-3: High, Medium, and Low Priority Sites for Early Detection and Rapid Response Actions¹

High Priority Sites	Medium Priority Sites	Low Priority Sites
<ul style="list-style-type: none"> • Frontcountry corrals • Wilderness stock camps and hitch rails • Grazed meadows • Riparian wetlands crossed by stock • Frontcountry helibase and helispots • Wilderness helispots • Trailheads • Recently burned areas • Construction sites • Utility corridors • T&E² species habitats, if threatened by invasive plants 	<ul style="list-style-type: none"> • Frontcountry campgrounds • Frontcountry visitor facilities • Maintenance facilities • High-use trails • Ungrazed meadows near invaded meadows • Riparian reaches downstream of trails and grazed meadows • Ranger stations • Trail crew camps • Trails entering wilderness from outside the parks • High-value, accessible giant sequoia groves • Other rare species habitats, if threatened by invasive plants 	<ul style="list-style-type: none"> • Roads near trailheads • Ungrazed meadows • Frequently-used off-trail routes and camps • Roads approaching the parks • Frontcountry trails • Other maintained trails

¹This is a dynamic list and will be modified through future planning.

²T&E=Threatened and Endangered

DATA COLLECTION AND MANAGEMENT

Systematic and repeated data collection and proper data management are essential for locating and tracking infestations over time, prioritizing threats, clarifying factors that contribute to the introduction and movement of invasive plants, and refining priorities and management actions. For most active surveys, spatial data are collected using Geographic Positioning System (GPS) units that contain a specialized data dictionary for collecting attributes. Data is maintained in the parks' ArcMap spatial geodatabase. Other staff and partners conducting passive surveys collect more limited data using paper Invasive Plant Observation Cards (attachment 2). A smart phone app, currently in development, will greatly expand the ability of non-resources staff, the parks' partners, volunteers and visitors to identify, map and assist in the control of nonnative plants.

Details of planned data collection and management are shown in attachment 3.

FIELD PROTOCOLS

The methods for conducting simple, rapid early detection are described in detail in attachment 4. Simple, repeated surveys are performed in likely locations to find the species most likely to invade. Surveys are guided by information about likely vectors for introduction. The goals are to work efficiently and safely, and to find and control the greatest number of invasive plant populations with relatively low effort and expense, before these populations can damage or displace native plants and other wilderness resources. When invasive plant populations are found, simple tools are used to describe and map these populations, and simple tools are used to control them. Data are collected and analyzed in order to learn more about where invasive plants are moving and why, to inform sound management, to improve EDRR over time, and to disseminate information and help other agencies and groups improve their own EDRR.

RAPID RESPONSE

The primary objectives of rapid response are to: (1) stop further seed production and dispersal to ensure that no further contributions are made to the seed bank, and (2) eradicate the infestation where possible, or contain the infestation so that no further resource damage is done while a long-term plan for control is developed.

In general, treatment of a non-native plant population is considered rapid response if treatment can be accomplished before the next reproductive cycle: at the time of detection, in the same growing season of detection, or in the first year after detection. Several years of follow-up treatment may be needed, but those efforts can generally be accomplished with existing staff and resources, and treatment is likely to lead to complete eradication. Control of larger, established populations that require additional project planning, funding, or compliance are not considered rapid response.

Immediate removal may be considered if:

- The work and treatment method is within the scope of an approved NEPA compliance document and an approved wilderness minimum requirements analysis.
- Staff are qualified to identify plants, are confident in the species identification, and a voucher specimen has been collected.
- Treatment can be accomplished safely with the staff present and within the time period available.
- The appropriate treatment tools are available.

Other factors influencing immediacy of removal include travel time to the location; the ecological threat, current distribution, and difficulty of control for the species; proximity to high-value habitats or sensitive species; the need to prevent imminent seed dispersal, and the priority of other work.

Thresholds and treatment methods for rapid response vs. longer-term planning and control will differ based on the species and situation. However, a typical rapid response effort will be by hand-pulling, cutting, or digging; by one to three people over one to three days; and will be scattered plants on less than one acre.

The types of control methods that would be considered in wilderness include the following:

- Manual (cutting, pulling, or digging out roots using hand tools),
- Flaming with propane torches,
- Tarping with black fabric for several years to deprive plants of light, or
- Application of herbicide with spray bottles or backpack sprayers. The herbicides clopyralid, glyphosate, and rimsulfuron have been approved by the superintendent to date.

Control methods will be chosen based on preservation of wilderness character and natural resources, expected effectiveness of the treatment, and operational efficiency and cost effectiveness. The specific choice of treatment method will depend on species characteristics (annual, biennial, rooting depth, presence of rhizomes, population density) and setting (proximity to water, visibility, avoiding damage to native plants and soils). If immediate control cannot be considered, is not desired, or is not feasible, staff will collect information needed for future assessments of long-term control need and feasibility.

MONITORING

Monitoring is the periodic repetition of systematic early detection surveys over time. Ideally, monitoring would occur following all management actions that could result in the introduction or spread of invasive plants. Data collected systematically over time will answer such questions as:

- Which species are being introduced, spreading and impacting resources in wilderness?
- What vectors contribute most to introduction and spread?
- Which habitats or species in wilderness are most threatened?
- Are ED&RR actions effective and sufficient for protecting the parks' resources from invasive nonnative species?

Ideally, repeated mapping and attribute data collection will result in a detailed picture of how managed and unmanaged invasive plant populations are changing in cover and spatial extent over time. Monitoring frequencies were described above for high, medium, and low priority areas. Suggested frequencies are based upon best professional judgment, as few models exist to inform monitoring frequency. Ongoing monitoring and other data collection will inform adaptive management so that monitoring frequency and the other methodologies described here can be improved over time.

**ATTACHMENT 1:
PUBLIC PARTICIPATION AND OUTREACH**

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Public participation in a prevention program is vital, for several reasons:

- Visitors need to be informed of appropriate practices to keep invaders from being introduced as a result of their actions;
- The power of an early detection program is increased immensely if even a fraction of the parks' 1.5 million annual visitors watch for and report suspected invasive plant locations; and
- Public understanding of the environmental challenges and costs posed by invasive species leads to support for and compliance with management efforts.

The following education and outreach efforts take place subject to adequate resources:

1. All staff, but particularly those in the division of interpretation, the wilderness office, and the Sequoia Natural History Association (SNHA), will share information about invasive plants and best practices to limit their spread with visitors heading into the wilderness.
2. Interpretive rangers offering walks, talks, slide shows, and informal programs and contacts may draw upon any of the following primary interpretive themes that could be used to expound on invasive species and provoke visitor responses to them:
 - a. The natural resources of the southern Sierra Nevada have undergone a series of human uses and impacts as values for those resources have evolved.
 - b. Because of the enormous topographic relief of the southern Sierra Nevada, the range creates a wide range of climates, shaping a diversity of interconnected habitats, each of which is occupied by carefully adapted, interdependent organisms.
 - c. The Sierra Nevada environment, which plays a critical role in defining the region's climate, geography, and economy, is greatly affected by human activities within the region.
 - d. Sequoia and Kings Canyon National Parks protect a large wilderness area where natural forces prevail and which provides significant social and scientific values to the world.
3. With the general public, staff will look for ways to share the following messages:
 - a. Plant invasions are biological pollutants with long-lasting effects. Invasive plant populations can grow to unmanageable levels over short time periods.
 - b. Prevention, followed by early detection and rapid response, is the first line of defense in protecting ecosystems from being degraded by nonnative plants.
 - c. Check before you go: Check carefully for mud or seeds in tires, shoes, clothing, camping gear, and pets before entering or traveling within the park. Remove and dispose of mud and seeds in bagged garbage.
 - d. Hikers, especially those traveling into wilderness, need to be vigilant about cleaning shoes, clothing, and equipment.
 - e. Do not pick flowers or plants. Those that are not protected as native wildflowers may be invasive weeds, and you may spread their seeds inadvertently.
 - f. At home, consider landscaping with plants that won't escape into wild surroundings. Contact your local extension office, county weed-control supervisor, land manager, garden club, and nature center to find out about attractive native or non-invasive alternatives.
 - g. Handouts and websites are available to help you identify weeds. Keep an eye out for any invasives around campsites and as you walk trails. Inform a ranger if you find any; call or stop in at a visitor center, where Invasive Plant Observation Cards are available.

4. These messages are currently communicated in one or more of the following ways. Additional efforts are under development:
 - a. **The parks' guide/newspaper:** Awareness and prevention message is included.
 - b. **Handouts:** are available at visitor centers
 - c. **Invasive Plant Observation Cards and Identification Cards:** available at visitor centers and campground kiosks, posted at trailhead permit offices
 - d. **The parks' website:** Information includes "What Can I Do?" actions and describes twelve important invaders.
 - e. **Interpretive wayside exhibits:** Emphasizes native plants and ecosystems.
 - f. **Trailhead orientation panels:** Information on how to avoid transporting invasives is included on panels at most of the parks' trailheads
 - g. **Indoor interpretive exhibits:** An exhibit for the greenhouse in the Giant Forest Museum is under development in 2014.
 - h. **Film permits:** Information packets for filming projects that will be working in the parks include guidelines for invasive "invasive plant prevention hygiene"
 - i. **Smart-phone app** to report invasive plant observations: Under development; to be added to the parks' website.
 - j. **Boot brushes:** Available at 12 trailheads as of 2013.
 - k. **In-person outreach:** This includes stock groups (e.g., Backcountry Horsemen) and other groups (e.g., presentations at sporting-goods stores).
 - l. **Training** for internal staff groups (e.g., annual training for fire staff, wilderness and trailhead rangers, trail crew, and natural resources staff; and wilderness operations meetings for packstock handlers).

**ATTACHMENT 2:
INVASIVE NONNATIVE PLANT OBSERVATION CARD**

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**ATTACHMENT 3:
DATA COLLECTION AND MANAGEMENT**

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GPS data and Invasive Plant Observation Reports are turned into the parks' invasive plant management program data manager and uploaded to the geodatabase daily, or backed up daily (to field computer, memory card, etc.) and turned in as frequently as possible. Contact the invasive plant management program staff through the program website at: <http://www.nps.gov/seki/naturescience/nnpmain.htm>.

When sufficient data have been collected, these data will show which species are most likely to be introduced into and spread in wilderness; which features (grazed v. ungrazed meadows, riparian areas, heavily used trails, helispots, etc.), which locations (ranger stations, trailheads, etc.), and which vectors (stock use, construction, recreation, fire management, etc.) are the best predictors for invasive plant introduction and establishment; and which ecological systems (wetlands v. uplands, etc.) are most sensitive to damage or displacement. These data will also help resource managers decide what frequency and intensity of monitoring are sufficient to protect the parks' resources from damage or displacement.

Data collected include:

- Spatial data, including points (for infestations less than 10 meters in diameter, or when time does not allow for mapping polygons), lines (along streams, trails and roads), and polygons;
- Attribute data (name of data collector, infestation number, patch radius, estimated cover, disturbance, phenology, control methods, etc.);
- Negative data (absence of nonnatives along surveyed trails or in camps and meadows);
- Voucher specimens for new species are documented and collected in a plant press for preservation; unknown specimens are collected for later identification;
- Photographs and associated documentation.

A sample Wilderness Invasive Plant Observation Card is available in attachment 2.

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**ATTACHMENT 4:
EARLY DETECTION FIELD PROTOCOLS**

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EARLY DETECTION

Basic early detection protocols include:

- Ideally, baseline surveys would be conducted for all designated trails in the parks, and other priority areas in wilderness, where they have not already been completed. These surveys would be repeated, as necessary, based upon priority.
- High priority areas, and areas near or downstream of existing priority species populations, are searched with more frequency and intensity than low priority areas.
- Active survey routes, whether trails, off-trail routes, or roads in the frontcountry, are mapped on GPS units (preferred) or paper maps so that both invasive plant presence and absence data are captured.
- For species such as cheatgrass, which are widely distributed along roads and trails, more coarse monitoring than points, lines, and polygons may be warranted. For example, populations mapped as lines generally include all plants within 100 feet of each other. The starting of new lines may be warranted where there is a significant change in patch density or line width.
- Search areas are divided into areas with well-defined boundaries such as trails and streams. Watersheds, valleys and habitat types can provide good boundaries for larger scale searches.
- In meadows and other wetlands, the perimeter, two longest axes, trail and stream crossings, grazing disturbances, and camping areas are generally surveyed. The methodology has not been further refined as wetlands vary in size, and because water, terrain, and dense vegetation can restrict access.
- Surveys of ranger stations, the Bearpaw High Sierra Camp, and other stock, trail crew, administrative camps, and high-use sites should focus on areas of high use, disturbance, and grazing; social trails; and points of water access.
- Where surveys are conducted in areas that contain abandoned and historic trails (especially those that cross meadows or riparian areas) and also historic cabins and mines, these historic features should get at least a preliminary survey.

In wilderness, active EDRR surveys are conducted using Trimble Juno GPS units by trained individuals and small teams, during day trips or extended backpacking trips. Data may also be recorded on Invasive Plant Observation Reports or in field notebooks. Multi-day trips are sometimes necessary because of the remoteness of many survey locations, and to maximize the area surveyed. Training, safety, and wilderness communication procedures are detailed in other documents. For identifying native and nonnative plants in the field, crews use the Jepson Manual (Baldwin et al. 2012), *Flora of the Yosemite Sierra* (Taylor 2010), and similar texts. Electronic versions of some texts are available for use with portable electronic readers. Crews should also carry hand lenses, gloves and hand trowels, cardboard presses, plastic bags for collecting seeds.

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