California State Parks
Early Detection and Rapid Response (EDRR) Handbook for Invasive Species Management

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List of Abbreviations and Acronyms

Cal-IPC	California Invasive Plant Council
CDFA	California Department of Food and Agriculture
CNPS	California Native Plant Society
CSPF	California State Parks Foundation
EDRR	Early Detection Rapid Response
DPR	Department of Parks and Recreation
GIS	Geographic Information System
IPM	Integrated Pest Management
NR	Natural Resources
NRD	Natural Resources Division
WIMS	Weed Information Management System

INTRODUCTION

This Early Detection Rapid Response (EDRR) Handbook for Invasive Species Management is designed for California State Parks (Parks) district natural resource managers and those planning and conducting terrestrial early detection surveys, field crews collecting data and eradicating new weeds, and partners, volunteers, or other groups interested in assisting and following these methods.

California State Parks Natural Resources Division (NRD) embarked on an EDRR pilot project in 2012 with Santa Cruz and Orange Coast Districts volunteering to lead the effort. Their Natural Resources (NR) staff contributed hundreds of hours in development of the methods and tested them firsthand. In 2014, Sierra, North Coast Redwoods, and San Diego Coast Districts joined the training and data collection effort.

The original handbook was written in 2015 by Ramona Robison and Nita Barve (NRD) with Tim Hyland and Daniella Schweizer (Santa Cruz District). Technical assistance and review were provided by the Santa Cruz Resource Conservation District and the California Invasive Plant Council (Cal-IPC). Some of the contents of the original handbook have been preserved; we have updated and expanded on various components for greater clarity and utility. This version was reviewed by Tim Hyland (Santa Cruz), Lana Nguyen (Orange Coast), and Michelle Forys (North Coast Redwoods) who are all implementing successful EDRR programs in their respective districts.

THE IMPORTANCE OF EARLY DETECTION - RAPID RESPONSE

Invasive plants threaten native species and natural habitats in our parks. Since the protection of biodiversity is central to our Mission, much time, effort, and expense goes towards managing weeds. They physically compete with and exclude native plants, which give our parks their unique characteristics and provide food and habitat for native wildlife. Invasive plants can also negatively alter ecosystem functions such as water availability or fire regimes. Additionally, controlling invasive plants is among the top recommended actions for enhancing ecosystem resiliency and climate change adaptation.

The Natural Resources section of our Department Operations Manual (DOM) clearly instructs us to manage invasive species:

> *DOM 0310.7 Exotic Plant Control*
>
> *Controlling damaging exotic plant species is one of the Department's greatest challenges in fulfilling its mission to help preserve the natural resource values of the State Park System. Invasive exotic (non-native) plants pose a serious threat to native ecosystems. These species can spread rapidly and out-compete California's native species, simultaneously changing the landscape, destroying habitat for other native species, and upsetting natural ecosystem processes.*

When an invasive plant is first introduced, the infestation often starts as a few plants brought in on equipment along roads or dispersed by wind or water. Over time the infestation spreads and the seed bank builds up, increasing management costs and potentially decreasing revenue by impacting aesthetics and restricting recreation. The most cost-effective way to approach this problem is to remove the new infestation when it is small. Again, the DOM instructs us in this way:

> *DOM 0310.7.2 Removal of Established Populations of Exotic Plants*
>
> *The immediate removal of new invasions is the most effective method of controlling highly invasive species. District Resource Ecologists will complete, or cause to be completed, annual inspections of each unit to determine whether infestations of any new exotic plants occur in their units.*

Thus, we are explicitly directed in our DOM to develop an EDRR program with annual monitoring to help control new invasions of exotic invasive species.

Additional guidance on the importance of practicing EDRR is provided by the California Invasive Plant Council (Cal-IPC):

> *Early detection and rapid response (EDRR) is a management approach that capitalizes on our ability to most effectively eradicate invasive plant populations when they are small. By detecting a new invasive plant 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. (California Invasive Species Council, cal-ipc.org)*

Many other natural resource conservation experts and public land management agencies recognize the importance of practicing EDRR as part of an integrated weed management effort and have developed EDRR programs over the last several decades. Visit the *References and Resources* section of the Appendices to see more of their documents.

The invasion curve on the next page demonstrates that as time passes the likelihood of successfully controlling an infestation decreases. The associated costs and labor effort increase when populations remain untreated. A small population can likely be eradicated but once widespread, eradication is no longer feasible. At this stage management goals shift to containment. Therefore, the most effective strategy is to place a high priority on controlling small populations of aggressive species before their impacts become apparent. If a new invasive plant is not detected and eradicated early, expensive long-term management will likely become necessary.

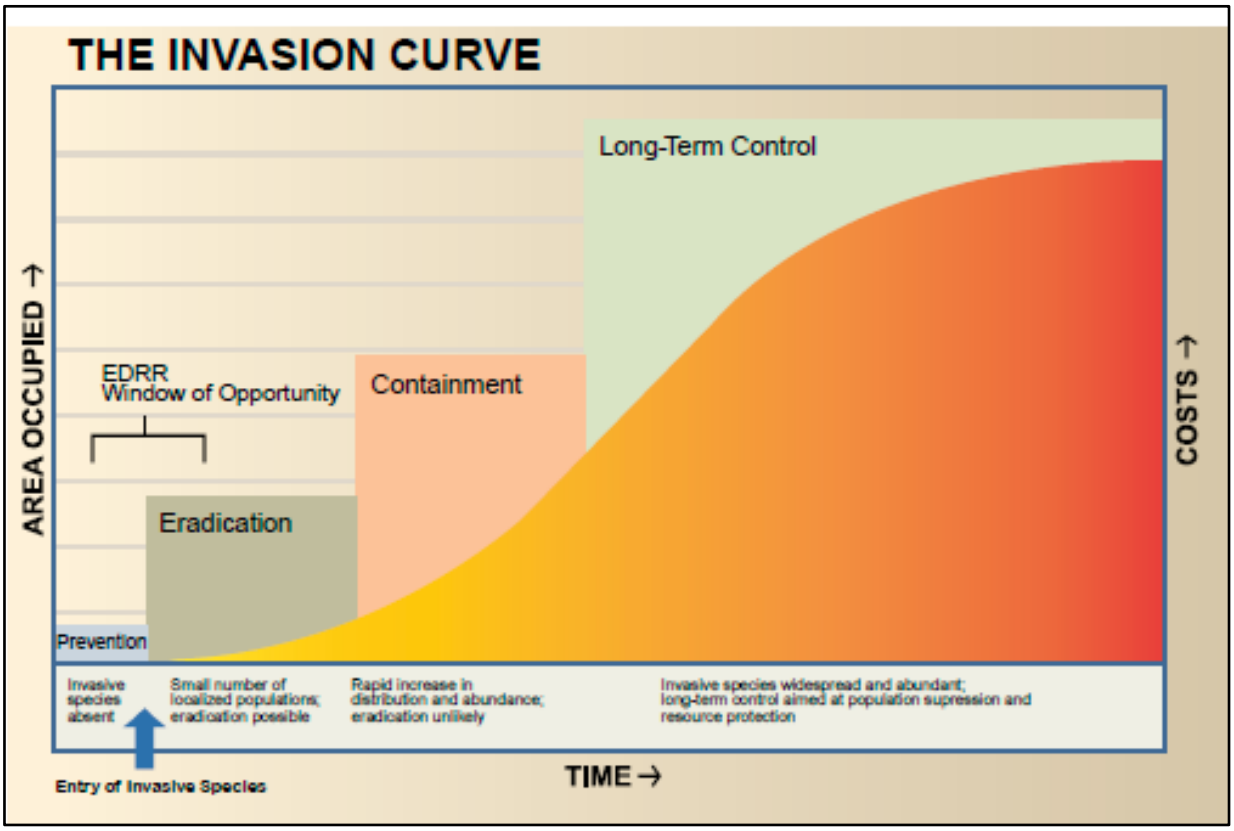


Figure 1. The stages of species invasion from Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response. U.S. Department of the Interior, 2016.

PREVENTION

The adage "an ounce of prevention is worth a pound of cure" also applies to managing invasive plants. Proper hygiene - including the cleaning of vehicles, tools, boots, and clothing - is integral to effective land management. Best management practices (BMPs) for preventing the spread of weed seeds and propagules are presented in the appendices. By definition, land managers engaging in early detection and rapid response will come into contact with invasive plant material new to their region. It is critical to implement rigorous prevention protocols with any EDRR program. Here are three basic prevention tips for staff:

- Work from clean sites to weedy sites each day
- Start clean and end clean, particularly as relates to tools.
- Carry and use brushes for equipment, boots, and clothing. Brush before you leave a site.

EDRR PROGRAM GOALS

<u>NRD Goals:</u>

- Spread the message of the importance of practicing prevention and EDRR and engaging in regional partnerships for effective landscape-scale weed management
- Deliver training on EDRR - including survey protocols, species identification, and mapping techniques - for staff at each district

- Compile a dataset of early detection occurrences statewide and summarize in annual reports

District Goals:

- Integrate prevention and early detection as fundamental components of each district's weed management program
- Develop an EDRR program over time to fit the needs and resources of each district
- Survey and document high priority areas each year for target EDRR species using GPS and GIS technologies
- Treat new weed species and populations promptly
- Transfer data collected back to NRD annually

CUSTOMIZING AN EDRR PROGRAM IN A DISTRICT

The remainder of the workbook provides guidance on the development of a district EDRR program from species and geography selection to training and implementation. NRD recognizes that districts are challenged and resources vary across the state. Staff within the districts understand these constraints and opportunities best, as well as which resources to protect and which invasive plant threats are most likely to occur. The frameworks presented here offer flexible guidance intended to allow staff, most often Environmental Scientists, to apply their detailed knowledge in the implementation of EDRR at a district and park unit scale. The program may evolve over time to best fit the needs, resources, and workflow of each district.

An EDRR program has at least six primary components: survey geography, surveyor selection and training, a target species list, field methods, a treatment strategy, and a data management strategy. This section offers guidance on and consideration for establishing each of these components within your district. Several of these factors influence each other, requiring the team to loop back to topics as the program is developed. A pilot season is often the best way to try out and then revisit these components. Budget that into your timeline for launching an EDRR program and remain flexible on the direction of each component until you have the chance to field test them. A season of field work will give you valuable information on how much surveying and treatment you can accomplish given your resources.

Early detection surveys typically occur on foot, though some organizations integrate driving, boating, and aerials surveys as well. This protocol offers guidance on foot surveys along road and trail corridors. It works well for surveys of riparian areas, which are also linear, as well as infrastructure areas including campgrounds, maintenance yards, parking lots, pullouts, dam faces, and sites with recent disturbance such as construction areas.

The guidance here has some limitations when surveying for a single species across a wide area, like the *Volutaria* project in the Colorado Desert District. When you encounter a wide area search scenario, you can modify some of the steps- like the monitoring methods - and retain others - like the data management strategy.

INITIAL CONSIDERATIONS

Staff should gather to discuss the needs and resources for EDRR. First, explore the needs within the district. Which park units should be prioritized for surveys? Is there a particular timing associated with access to perform surveys based on factors like heat or water levels? What are the best months to see the target plants? How long can you spend performing surveys each year?

When you have an idea of *what* you want to survey, turn to *who* can perform surveys. Do you have the staff available for surveys when you need them? Do you need to supplement with contractors? Or do you need to rely on volunteers? What level of training will surveyors need and at what frequency? There will be decisions to make on every aspect of the program. Exploring these questions early will position you to create a customized program for your district. A list of guiding questions for these initial conversations is available in Appendix A.

COMPONENTS OF AN EDRR PROGRAM

Survey Geography

The search areas for early detection surveys can be thought of as survey geography. In many ways, geography is the first factor in establishing an EDRR program. What areas are at risk of invasion? What areas need the highest protection? Where you search for new weeds will inform costs, time required for the program, target species, surveyor selection, timing, and treatment feasibility. This section will provide over-arching themes and approaches to defining survey geography for your district.

Hopefully the exercise on initial considerations will provide some idea of how much time you can dedicate to early detection surveys for your pilot season. As you work through the following concepts and potential tools for identifying survey routes, keep in mind that you can revise after you have more information from the pilot season.

<u>Overview</u>
We know that disturbance facilitates invasion. Roads and trails, as well as infrastructure areas like campgrounds, parking lots, and maintenance yards, are locations where disturbance occurs repeatedly. Weed seeds spread via tools, vehicles, people, and pets among other vectors. Focusing on areas with repeated disturbance and vectors increases the likelihood of intercepting a population of new invasive plants. While these areas often have compromised habitat, rapid response can prevent future spread into high value natural areas, which is an important goal.

<u>Features to Survey</u>
Many successful EDRR programs focus on road and trail networks. This is an excellent approach given that these features have both disturbance and vectors, which facilitate plant invasions. Most EDRR programs will spend the bulk of their time on road and trail networks, though not all. Other important features to survey include facilities and visitor use areas like campgrounds and parking lots. Staff use areas like maintenance yards and material depots are also hotspots for new weeds. Staff equipment is often used across large landscapes, making detections in staff use areas

incredibly valuable. Other features - like roadside pullouts, dam faces, water tanks, and other utility areas - are common locations for detecting new weeds. Riparian corridors are natural pathways for the movement of plant propagules, including new weeds. The approaches presented below largely focus on road and trail surveys. A successful EDRR program will find ways to integrate these additional features over time.

When prioritizing which features to survey, you can approach some of these logically in the field. If you come upon a water tank, for example, survey around it before returning to the road or trail. For features less easy to integrate during routine road and trail surveys, examine the resource or infrastructure value of the site to determine where it sits within your survey priorities. Rank high value habitat or infrastructure higher than sites of low or moderate value. An example might be that you survey trailheads and parking lots leading to sensitive habitats over trailheads in lower value areas. Consider surveying areas adjacent to known populations of your highest priority invasive plants to ensure early detection.

Treatment limitations may also factor into your prioritization. If you know that your treatments would be limited for reasons including sensitive species or structures, you will need to detect target species early in the invasion cycle to have any success. On the other hand, if you have areas where treatments would be unfeasible, like busy roadways, eroding cliffs, or waste areas, you may rank those sites lower as rapid response is less likely to occur. This is a challenging balance because these highly disturbed sites often facilitate invasion.

Timing

Surveys should occur when target species are most detectable. While this is challenging to perfect for a list of species, you can base your timing on the habitats of your district. Survey grassland when those systems are at peak phenology to optimize species detection Forests can often be surveyed a bit earlier, and wetlands and riparian areas a bit later. Keep the phenological patterns of your most important species in mind when you decide what geography to address each month or season, as well as the overall habitat.

Efficiency

Once you have surveyed a route once, it may become more efficient to re-survey as you only need to map changes to known populations. Many data collection applications allow staff to update or add a new record for a population, carrying over attributes from previous mapping efforts. Furthermore, returning to the field with data in hand may speed up detection. Highly disturbed areas with several patches of target species will become easier to survey in subsequent years. Areas with successful treatments may also be easier to survey in subsequent years as there should be fewer plants or patches of plants to detect. On the other hand, subsequent surveys of fairly clean areas will take the same amount of time in most cases. There are few ways to mitigate drive time and logistics, other than creating efficient survey routes that maximize those variables. Thus, the time it takes to survey areas with few or no target species tends to be fairly stable each survey cycle.

Regardless of which approach you adopt for designing your survey geography, you should consider efficiency. The approaches below have merit, but you should consider efficiency when making final

selections. For example, if you do a GIS prioritization and find that segments of a far-flung trail are high priority, consider bundling a day of work in the same general area. A pilot season will help you refine your approach.

Approach 1. State Parks Survey Routes

In the process of creating the 2015 handbook, the authors developed survey routes for all districts using a GIS prioritization exercise. While some jurisdictions have changed, these survey routes are available to you. Please consider these as a starting point for your EDRR program. Fold in the themes above and models below as needed to revise these routes. For a more complete explanation of the methods used to design these routes, see Appendix F.

Approach 2: Mix of Disturbed and High Value Areas

Given that we know disturbed areas are prone to invasion, it is important to focus on these areas. You can balance surveys of disturbed areas by incorporating high value natural areas into your survey geography. You might focus 60-70% of your program time on highly disturbed areas but spend the balance in high value natural areas where the introduction of a new weed would cause great harm to natural resources. Some examples of high value natural areas are known localities containing sensitive species, groves of special trees such as giant Sequoias or California fan palms, watersheds for salmon-bearing streams, trails leading into a wilderness area, restoration areas with high levels of investment, etc.

In most situations, roads and trails are not limited to either highly disturbed areas or high value natural areas. They often move from highly disturbed parking lots into a middle zone or two and then may continue to high value natural areas. It is recommended that you follow trail routes in logical ways to reduce surveyor error and maximize efficiency.

Approach 3. Comprehensive Road and Trail Surveys on a Cycle

It may be feasible to comprehensively survey your entire road and trail network if you rotate survey geography annually on a cycle. Survey cycles may range from three to five years. If five years feels too long to wait to revisit important areas, you can repeat a subset annually.

For example, a program on Mount Tamalpais cycles through the 338-mile road and trail network every three years. Eight miles are repeated each year to facilitate rapid response projects in a high value grassland habitat. The team also surveys eight to ten miles of riparian areas each year. All other segments are rotated in a three-year cycle. Miscellaneous features, like water tanks, parking lots, trail heads, and maintenance yards, are surveyed as they are encountered on road and trail surveys. The team covers several high traffic roads by using pullouts as a proxy for the road as a whole. Each year the team ensures that all quadrants of the total survey area are covered as well as a mix of feature types and habitats. Roads and trails remain the core of the program.

Special Consideration: Survey Geography for EDRR following Wildfires

Wildfires are large-scale disturbances that can facilitate rapid spread of invasive species. Though native species may resprout and return over time, near-term conditions of increased sunlight, bare soil, and nutrients favor early colonizers. Indirect operational impacts can cause even greater

problems. Activities associated with fire suppression and mop-up can cause soil disturbance or compaction and equipment brought in may be contaminated with weed propagules, while fire retardant can act as a fertilizer.

For all of these reasons, conducting EDRR surveys the first 2-3 springs following a wildfire is very important. The table below shows a scheme for prioritizing areas to survey depending on the size of the fire. Checking a map of burn severity is also helpful as high severity areas tend to be the most heavily invaded. For more information, see the Fire and Weeds resources in the appendices.

Table 1. Prioritizing areas for EDRR surveys following wildfire

Fire size (acres)	Camps, helibase, drop pts	Known infestations burned	Dozer lines	Hand lines	Retardant	High severity	Sensitive habitat, rare spp.
100	x	x	x	x	x	x	x
1,000	x	x	x	x	x	x	x
10,000	x	x	x	x			
100,000	x	x	x				
1,000,000	x	x	x				

Table adapted from Garrett Dickman, Vegetation Ecologist, Yosemite National Park, 2020.

A heavy infestation of wild mustard follows the dozer line up the hill at Pt. Mugu State Park after the Woolsey Fire. Photo by Jim Suero

Surveyor Selection

Several factors may inform your surveyor selection process. Which surveyors or combination of surveyors you use will inform costs, time for program implementation, training needs, oversight needs, treatment feasibility on surveys, and your data management strategy. This discussion reviews several considerations to keep in mind during your selection.

Year-round staff

Year-round staff often have the greatest knowledge of park units and the highest degree of training for plant identification. Additionally, year-round staff often have a strong sense of what is new or out of place in a site if they have worked there for enough time to gain familiarity with both native and non-native species. They also have more access to State Parks data systems and more opportunity to ensure that data quality control and sharing is completed. These attributes make year-round staff ideal EDRR surveyors. Limitations with year-round staff include the fact that many are already at maximum capacity with their current job duties.

Seasonal staff

Seasonal staff often have some training in plant identification and because many will return for more than one season, they may have beneficial familiarity with the area in terms of logistics and common species. Seasonal staff require more and repeated training as they cycle in and out of the district, but they are an excellent supplement to year-round staff in an EDRR program. Because they are not long-term, it is critical to balance their field time with opportunities to quality control their data. Ideally a year-round staff person will review seasonal data before the latter conclude their seasons to clarify any confusion.

Other State Parks staff

You may be able to engage staff from divisions other than natural resources that work in your district for help with EDRR and other weed work. Consider reaching out to your supervising ranger, maintenance supervisor, and interpreters regarding early detection targets as well as your common weeds. They may report back with new detections. Here are a few other ideas:

- The vegetation ecologist for the Pacific West Region of the National Park Service recently implemented an annual all-staff workshop in each park called “Working Together Against Weeds” to develop early detection and prevention BMPs.
- North Coast Redwoods District (NCRD) sends “Weed of the Week” flyers through the district email and posts them at the park entrance kiosks along with a pack of laminated EDRR ID cards
- NCRD staff also give a 20-minute weed talk during the annual orientation for new park aides
- Santa Cruz District regularly trains their docents in EDRR and weed identification. The cadre that teaches new cadet rangers introduces them to EDRR and lets them know that they can play a role.

Contractors

Contractors can perform early detection surveys when the State Parks staff are not available to implement an EDRR program. Select a contractor with area familiarity, plant identification

experience, and a willingness to diligently implement your protocol including how data is to be collected and shared. An openness to communication and feedback are also highly desirable. Expect to provide some oversight to ensure data meet expectations and to review the pilot season with your contractor. Contractors must also be willing to share data frequently and in a timely fashion to ensure the rapid response can occur for target weeds.

Volunteers

Volunteers range from dedicated naturalists who know parks as well as staff to motivated individuals with no plant identification or GIS/GPS experience. When deciding whether to use volunteers, consider where your volunteers fall on that spectrum. Employing volunteers to collect protocol level data will require training and oversight by staff. While some volunteers might not be able to execute a full species list or protocol, many provide helpful supplementation to the overall program. Some organizations employ different tiers of involvement for different tasks depending on their volunteer's commitment and expertise.

Even when in a supplementary role, volunteers require oversight to ensure their contributions are acknowledged and utilized. If you're unable to provide that, you might consider having an outside partner - such as California State Parks Foundation *Parks Champions* program - manage a volunteer project for you. Or instead of an ongoing volunteer program, just hold a few events at particular times, such as during Invasive Species Action Week or for California Biodiversity Day.

Volunteers working with the California State Parks Foundation's Parks Champion program removing French broom at the Confluence of the American River in the Auburn State Recreation Area.

Partners

Many districts work in partnership with neighboring landowners, other agencies, NGOs, cooperating associations, "friends" groups, local tribes, Weed Management Areas (WMAs), students, and other interested parties. Working collaboratively on a landscape-scale across jurisdictions can greatly increase the effectiveness of invasive species management and other stewardship projects. Not only do you increase your capacity and labor force; you also have greater chances of eradicating species at the scale of watersheds or other larger ecological units.

When working with partners, regular meetings may be needed for training and coordinating on priorities, methods, goals, and progress reporting. Partners may also impact your protocol decisions, including what platforms (hardware and software) to use in order to easily share data.

*Note - For additional examples of successfully engaging with local partners, see the Orange Coast District Case Studies in Appendix G.

Target Species Lists

While there are hundreds of invasive plants in California, early detection focuses on species new to a region or present only in small populations. The creation of a species list should consider your survey geography and surveyor selection as well as feasibility of treatment if detected. The target species list will factor into timing of surveys.

There are several ways to craft a target species list. The focus should be on fast moving, highly damaging species - preferably with known control strategies - that are either absent or of very limited distribution. Whenever possible align your list with other organizations in your region. If a regional early detection list already exists, use it – at least as a starting point to further refine.

- Areas with existing Regional Priority lists of Eradication and Surveillance targets created by Cal-IPC are Bay Area, Central Coast, Central Sierra, North Central, North Sierra, Northwest region, South Central Coast, and South Coast. (https://www.calflora.org/entry/onegroup.html?gid=3)
- See the CalWeedMapper Regions link here (http://calweedmapper.cal-ipc.org/regions/). See directions for generating a CalWeedMapper Report in Appendix B.
- Consult the Regional Prioritization tool on the Cal-IPC website.
- Also check with WMAs and other agencies nearby for existing regional lists.
- Have local experts review your list.

When reviewing potential species to add to the list, review the potential impact of the species. Is there suitable habitat? Is that habitat valuable? Distribution of the species is also of interest. What are current levels of the species? Is the distribution well known on district lands? How about on adjacent lands? Finally, is the species easily identifiable or does it have similar congener that will compromise detections? Some of this information can be garnered from reading plant profiles in the Cal-IPC Inventory and other sources while some will be based on local knowledge.

There is no magic number in the creation of an early detection target list. One driver should be the feasibility of surveyors recalling the list and reliably detecting that number of species. Generally, the more experienced your surveyors are with plant identification and your park units, the more species you can integrate. Remember – good early detection targets are not abundant locally. A lack of reference sites and direct experience will create identification challenges as staff may not have encountered the species prior to learning them in training. For large districts with varied geography, potential new weeds may vary considerably from park to park. It will usually be easier to create a composite target species list than to have separate lists for each park.

Target species lists should be considered living lists. Review the list after the pilot season and remain flexible. Were some species thought to be absent or in low numbers detected more than expected? If so, consider whether to continue monitoring for the species. Were there detections of novel species not included on the list? Should they be added for further monitoring? Review the list annually or at least every three to five years make additions or deletions as needed.

Document your list in a shared file space. Include it in your data collection forms. For data taken with Calflora or Collector, this is possible with a Plant List or domain value list. By making this part of your data collection form, you can prevent spelling errors while providing staff with a handy reference in the field. Calflora will also manage scientific name changes within your dataset over time.

Consider illustrating your target species list with photos and identification tips. Include non-target or native lookalike species found in your area to help differentiate them. There are several ways to make these resources. Adapt the Cal-IPC plant identification cards as shown in the following graphic from North Coast Redwoods District. Powerpoint slides can be created with similar information and easily exported to PDF. You can also paste your plant list into a Word doc table where you can import photos, add tips on lookalikes, add key diagnostic features, and save it as a PDF. Put any of these PDF resources onto survey devices so that staff have them on hand in the field. For more discussion of plant identification, see page 21.

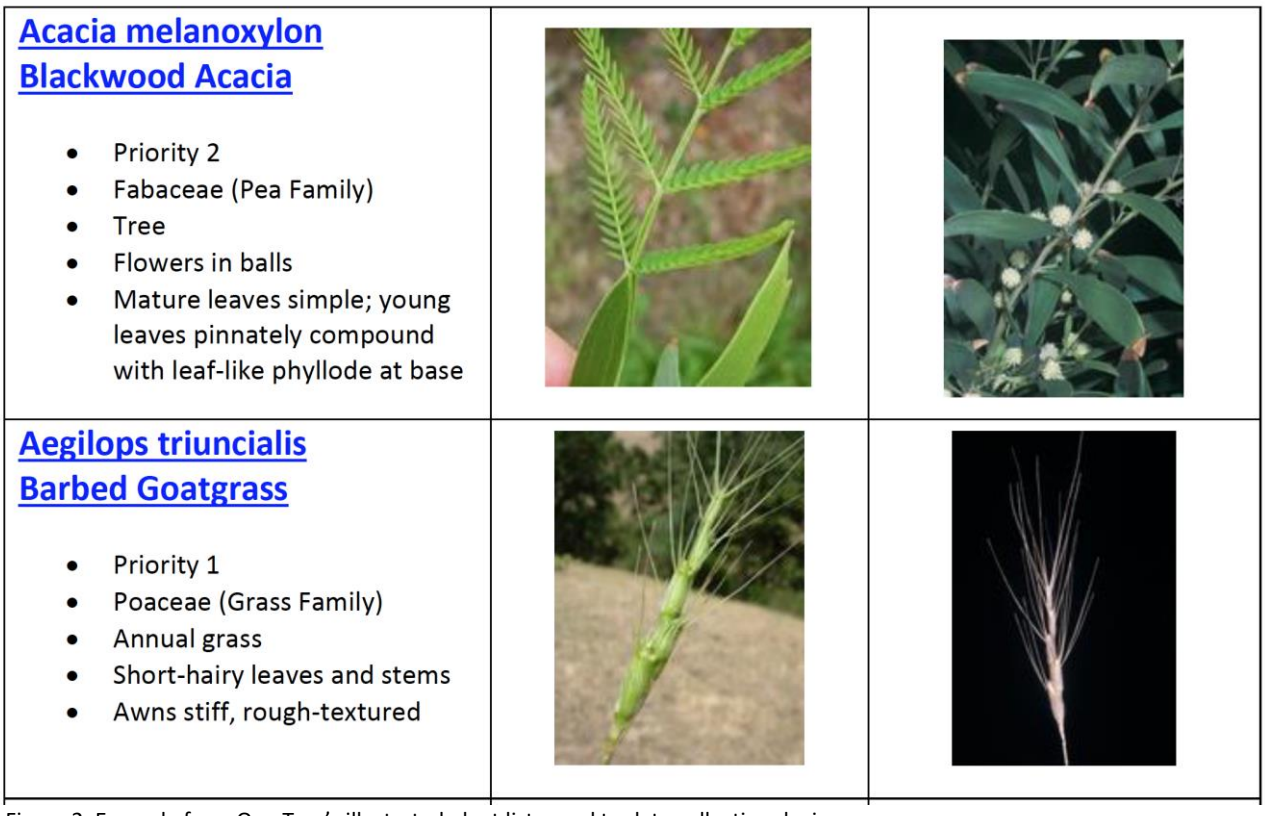


Figure 2. Example from One Tam's illustrated plant list saved to data collection devices.

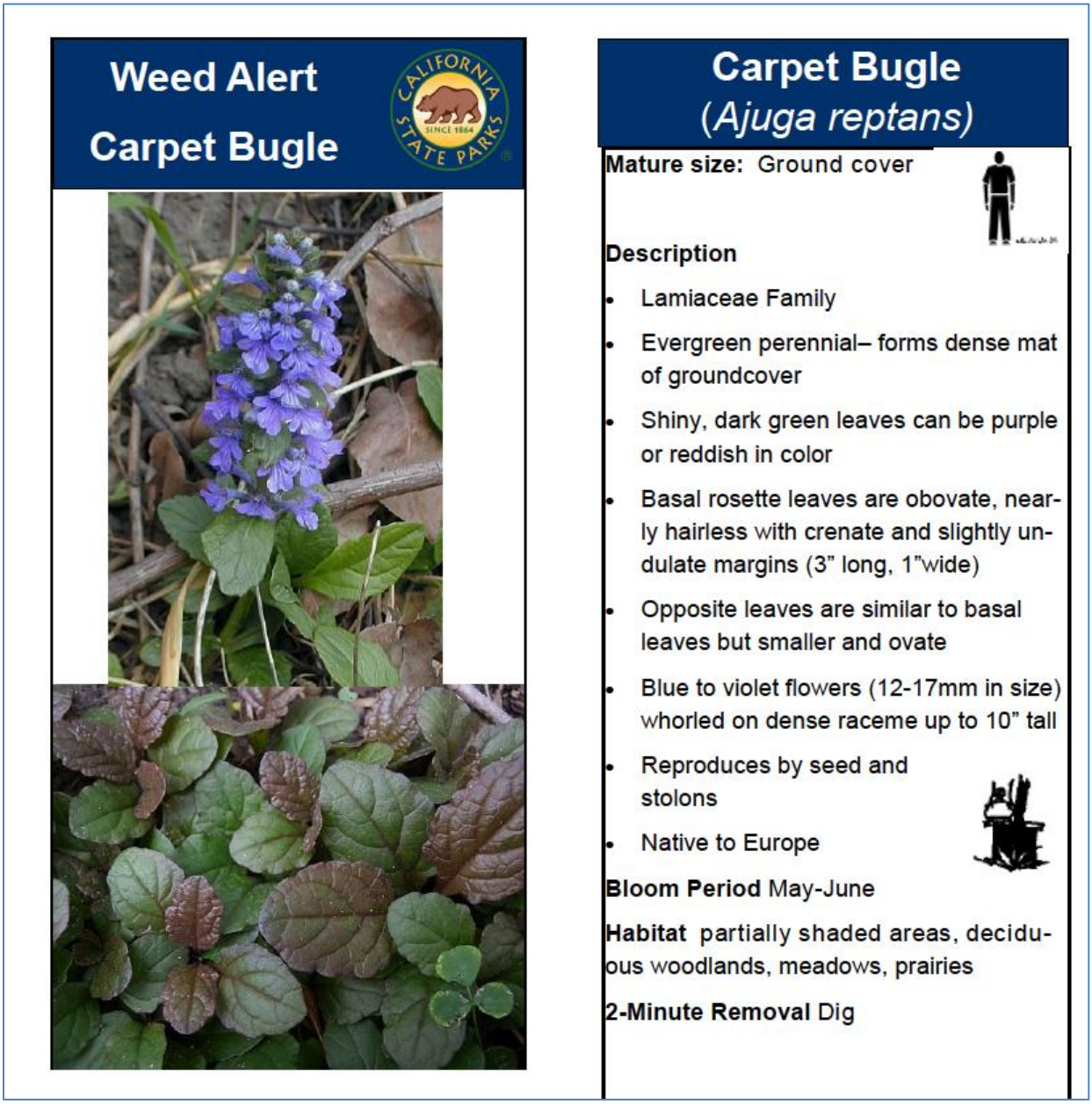


Figure 3. Example of North Coast Redwoods District's illustrated species list. They use these for training and download them onto survey devices to aid staff in plant identification.

Incorporating widespread weeds into an EDRR program

Having staff in the field focused on surveying invasive plants is a boon to your overall invasive plant management planning and implementation. In some cases, common weeds can be considered early detection targets when small outlier populations are encountered, especially if they are new to a particular area of your park.

Districts may map populations of their WIMS targets or other species of management interest concurrently as is feasible. You can think of these additional species as widespread weeds: weeds known to a district as problematic and therefore a management target. However, note that adding widespread weed species to get more information on their distribution will significantly lengthen

survey time. Many programs successfully implement this approach. This can also be added after a pilot season when you have a stronger understanding of how long early detection surveys take.

If you incorporate widespread weeds into your survey effort, distinguish those species from your early detection species by creating a ranked list. For example, you can have a list of priority one and priority two species. Priority one species are your early detection targets. Priority two plants may be your WIMS species or additional management targets. Staff will map all species on your list, but your treatment approach may vary. For example, you may decide not to treat widespread weeds on surveys.

Field Methods

With survey geography and a species list, it is time to train your selected surveyors with documented field methods including plant identification, the use of GPS technology, data form interpretation, how to define a patch of weeds for mapping, and treatment strategies. In order to train surveyors, you must consider and document a variety of decisions to ensure continuity across surveyors. The field methods will inform time and cost for surveys, the type of surveyors and how much oversight and training they will need, as well as the data management strategy for your program.

NRD staff are available to provide initial training and ongoing support. However, repeated or refresher trainings may also be necessary for new staff. This handbook will serve as a resource for these training purposes and updates will be provided periodically.

Data Collection Forms

While taking rich data is important, the data collection form needs to be trainable and realistic. Some values can be auto-populated or added in the office to speed data collection in the field. Important attributes to consider typically include:

- Park name and management unit number
- Date
- Surveyor name
- Latitude and longitude
- Species name – common and scientific
- Area (acres)
- Phenology
    - Rosette, vegetative, flowering, fruiting
- Percent cover
- Number of individuals
- Distribution
    - Scattered, patchy, continuous
- Treatment/Management status
    - verified, under management, searched for but not found, or extirpated
- Additional notes/comments/treatment information

Whenever possible, use a domain list to control the entry of values to ensure consistent spelling, spacing, etc. Autofill dates, latitude, and longitude whenever possible. Implementing these tips will depend in part on what primary data management system you incorporate. ArcGIS and its mobile apps - Collector and Survey 123 - and Calflora with its app - Observer Pro - allow for custom forms, domain values, and some auto-populated values. Note that Calflora contains many functions including Weed Manager. You can create a Weed Manager group for your district and use many of its features with or without a subscription. Plan to pilot your data collection form and amend it between field season one and field season two.

Weed Manager Fields	Shapefile Export Fields	Field Type	Field Description
Gross Area (M)	Gross_Area	Double	Size of the area where the population was observed - derived from radius value (square meters). Auto-populated for polygons
Habitat	Habitat	Text	Habitat type the plant was detected in (e.g. Herbaceous wetland, Grassland, Coastal Scrub, etc.)
Latitude	Latitude	Double	Latitude (y) coordinates of species record. Auto-populated
Longitude	Longitude	Double	Longitude (x) coordinates of species record. Auto-populated
Management Status	Mgt_Status	Text	Specifies the status of the population (e.g. none, verified - population was verified, searched but not found, under management, extirpated)
Notes	Notes	Memo	General notes about the record; publicly viewable
Number of Plants	NumPlants	Text	The estimated range of the number of plants at this location.
Observation Date	ObservDate	Date/Time	Date and time of record. Auto-populated.
Observer	Observer	Text	Name of the observer who entered the record. Auto-populated
Percent Cover	PctCover	Text	Percent cover of the plant in the patch
Phenology	Phenology	Text	The life stage for the population when detected (e.g. bolting, bud, dead/skeleton, flowering, mature, rosette, seed set, seedling) **.
Taxon	SciName	Text	Scientific name of the species. Have a pre-loaded species list to chooses from plus a field for unknowns.

Figure 4. Abbreviated and adapted data dictionary documented by the San Francisco Bay Area Network of National Parks Inventory and Monitoring program. This program uses Calflora Weed Manager for data collection. Annually the group downloads the data to a geodatabase. This schema allows documentation of both the Weed Manager and ArcGIS field names.

**-Early detection uses early onset of phenology. When 10% of the patch reaches a more advanced stage of phenology that value is selected. For example, if 10% of the population is flowering but 90% is bolting, flowering would be selected. Weed treatment teams not engaged in early detection apply a dominant phenology approach. In the previous example, those teams would record the population as bolting.

Review the data collection form with surveyors for clarity and consistency. Talk about how to record attributes like phenology. Is a patch flowering if one individual is flowering? Or is it flowering when half the population is flowering? For early detection, consider implementing an advanced onset approach: when at least ten percent of the patch is flowering, record as flowering. Use the same benchmark for fruiting. This will help ensure that the timing of follow- up treatments is scheduled conservatively. Go through other attributes and talk about how to interpret them so that your data is recorded consistently. Document decisions in a data dictionary for your form. This will become a training resource itself!

Defining a patch of weeds can appear highly subjective. Rather than leaving this up to each surveyor, we recommend implementing a standard of a 20-meter inter-patch distance. This means that when you find a patch of weeds, you look 20 meters beyond the plants that you see. If you don't find more weeds, your patch is clearly defined. If you keep finding plants within 20 meters, map them together as one patch. (See exercises in Appendix C for distance calibration and practice with all surveyors at the beginning of each field season)

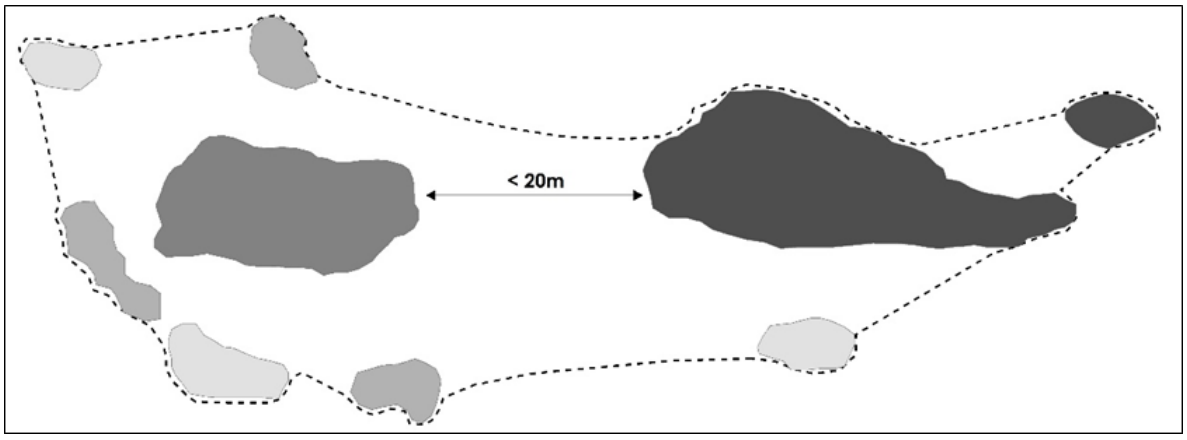


Figure 5. Patches of the same species within 20 meters of each other are mapped together as a single polygon (dotted line), despite differences in density. Adapted from Williams et al. 2009 by Kesel and Greenberger 2020.

If feasible, use polygons to map early detection species. Polygons provide fairly accurate area estimations without relying on a surveyor. Area calculations are important for estimating labor and chemical resources for treatments. In many partnerships and also in grant applications or reports, an important metric is gross area, which can be more accurately derived from polygons than point data with estimated area. Many programs assess net or infested acres by multiplying the gross area by the percent cover. This metric can be very useful in characterizing weed populations with the public. Imagine showing a weed distribution map for a heavily invaded area. Perhaps the cover of an annual grass is 15% across 10 acres. That might look terrible on a map, but when you explain that the net acreage is only 1.5 acres, management goals become more clear to the interested public. Additionally, polygons can help you track the growth or successful management of a population or patch over time.

If taking point data, include an estimate of area and train all surveyors in area estimation techniques. Calflora's Observer Pro app includes a feature for points with radius that will auto-generate a polygon when it is imported to the database. Consider using this feature if you feel that

polygons are slowing down your field work or you are otherwise unable to take polygons in the field. Give staff a cheat sheet on their mobile device with commonly used radii for reference. (Appendix C).

If surveyors are unsure about the identification of a species, they should map it as "unknown" and assign it a collection number in the comments field. A specimen, including ground-level leaves and underground parts, should be bagged in an individual bag, labeled with the number in the comment field, collector name, date, and general location and taken back to the office for identification. For more information on plant identification, see page 21.

Photo documentation

Many data systems allow you to capture photographs, which can be very helpful for identification of unknown species in addition to collecting a specimen. Photos are also helpful for returning to treat a patch of weeds. Take a habitat photo that includes a permanent or long-lived feature like a boulder, gate, or tree. Try to capture some horizon when feasible to give a sense of scale. A specimen photo should show defining features and often several photos are necessary to adequately depict flowers, leaves, stems, fruits, and the overall plant.

Tracklogs

Regardless of which data system you use, you will need to document the surveys in a spatial format like a tracklog. Creating tracklogs lets you and others know which survey areas have been completed and how many miles have been covered. They can also be referred to in subsequent years to note changes and patterns such as repeat invasions. Tracklogs are required for annual submittal to NRD.

You can develop your tracklog in a variety of ways. You can upload an existing road and trail GIS layer to any application if working along a mapped road or trail. Collector can create tracklogs of a surveyor's route. If using Observer Pro or Survey 123, you can add a third-party app, like GPS Logger for Android, to document tracks. Calflora's Survey Entry application allows you to add a plant list and to buffer a line to your sight distance. For example, if you were on a trail and assume you could see 3 meters on either side of the trail, you can buffer a line by 3 meters to generate a polygon of your survey area.

Absence Data

When you survey an area but do not detect a target species, you still have created valuable information: absence data. Tracklogs are an important component of absence data. They help document the absence of a species in a given area at a given time.

Another valuable form of absence data occurs when you re-survey a weed occurrence that has been successfully treated such that no aboveground plants are detected. This can be noted as "searched for but not found" in systems like Calflora. It is recommended that you use a data field for Management Status and include the values "verified", "under management", "searched for but

not found", and "extirpated". "Verified" can be used to denote occurrences where a species is detected but not treated. "Extirpated" should be used only after an occurrence is searched for but not found for at least five years. This tracking ensures that staff follow through on treated occurrences.

Pre-survey Field Exercises

Surveyors will need training on these standards and the interpretation of the data form. There are several tools, including pacing and estimating exercises. These will help surveyors determine how many paces it takes them to reach 20 meters or to calibrate with each other on percent cover estimations. Area and distance estimation exercises are also included in Appendix C. Exercises should be repeated at the beginning of each field season along with reviewing other field methods to ensure that all surveyors are recording data consistently both with each other and year to year.

Plant Identification

In addition to these field exercises, surveyors need training on plant ID. Several tools can help you deliver this training. A presentation with key botanical characters for identification, including look-alike species in the area, is useful. Sources of plant photos include Cal-IPC, CalPhotos, Calflora, iNaturalist, and other online resources. Use multiple pictures to show all parts of the plant with some sort of scale.

As mentioned previously, a plant list with photos and a short synopsis can be turned into a PDF and put on GPS devices used in the field to support surveyors. The process of assembling the species list with illustrations and key descriptive features can be an educational exercise in itself. Consider involving several staff members and having them present their results to each other as a collaborative way to learn the target plants.

Mounted pressed specimens are immensely helpful in trainings. Collect specimens as you come across them in the field for this purpose, particularly for the most infrequent species. Scanned specimens from other agencies can also be sent digitally. Details on vouchering a specimen are available in the National Parks Service protocol by Williams et al. 2009. (https://irma.nps.gov/DataStore/DownloadFile/460898 (Vouchering section starts on page 157)

There are additional sources for help with plant identification including staff with botanical expertise from NRD or neighboring districts, university herbaria, CNPS chapters, county agricultural offices, online resources, and others.

Additional Techniques

Additional techniques or specific methods may require discussion or vetting. For example, some work groups use two surveyors on every road or trail with one person looking on each side of the trail. If resources allow, take this approach. If your resources are more constrained, you can consider out and back surveys in which the person looks on one side of the trail on the out segment and the other on the return segment. If you have loops in your schedule and only one

surveyor, train the staff person to go slowly and thoroughly inspect both sides of the trail. Be realistic about how far you can see off the trail. For some species, like a sapling in a grassland, you will be able to see farther than for smaller, more cryptic species like a grass within a grassland.

Software

Mobile technology changes quickly and while most people are familiar with smartphones and tablets, you will need to train the data collection system both for mobile and desktop. Teach staff and volunteers the caveats and quirks of your chosen program. Use screenshot-based workflows and online tutorials. Ensure that surveyors have the proper equipment and know how to use it.

Hardware

While most people have used smartphones and tablets, you may have supplemental devices like Trimble units or GPS pucks, which improve GPS accuracy. Upload user guides and any tricks or tips for hardware to a location that is easy to access remotely. For any recurring glitches, provide a resource on the mobile device for troubleshooting or contact the IT HelpDesk or NRD for assistance.

Student interns from Humboldt State University collecting EDRR data at Little River State Beach, NCRD.

WHAT-TO-TREAT CHEAT SHEET

DO TREAT IF

- Patch <100m^2,
- AND is at least 20m from another patch of the same species,
- AND the treatment can be completed in 10 minutes,
- AND the amount of weeds to carry away is manageable.

DO NOT TREAT IF

- Patch >100m^2,
- OR patch <100m^2 but near more patches of same species,
  - For example, if you find a 1 square meter patch of *Ehrharta erecta* every 21m, it is not feasible to treat
- OR patch requires >10 minutes to remove,
- OR amount of plant biomass that must be hauled away is prohibitive.

EXCEPTIONS

- For high priority species, it may be prudent to push these numerical boundaries. If you find a patch that will take 30 minutes to remove but it's ready to seed and it is unlikely anyone else will be able to treat it in time, initiate treatment.
- It's sometimes justifiable to treat just a portion of a large patch of a high priority species, such as to push the patch edge out of a creek or trail corridor.

WHEN-TO-BAG GUIDELINES

- Plants with reproductive propagules should be bagged.
- Many grasses and asters can mature to reproductive viability even after being pulled out of the ground. Bag plants from these two families even if they're only flowering.

Adapted from Kesel and Greenberger 2020.

Finally, do a mock survey with your trainees by walking through a trail survey together. You might consider adding a common weed to the list for this exercise to ensure you have something to map. Take data in the field. When you come back into the office, upload your data and do quality control checks to demonstrate that process.

Treatment Strategies

Another decision point in early detection planning is how you will execute rapid responses.

<u>Treatments on Surveys</u>

It is highly recommended that you incorporate treatments during surveys to the extent feasible in order to ensure rapid response occurs. For an assessment of that feasibility, review One Tam's *When to Treat Cheat Sheet* for tips. Bring along an assortment of small hand tools for treating detections and removing propagules.

<u>Rapid Response Days</u>

In the course of early detection surveys, you will likely encounter patches too large to treat during surveys or species which require specialized tools or techniques for treatment. Budget one to two days per month into the calendar in the primary growing season for conducting follow-up rapid response. If you do not find populations needing follow-up treatment, you can direct that time to additional surveys, data management, or ongoing treatments of widespread weeds.

In order to determine which populations rise to the importance of an additional rapid response day, staff managing weed treatment decisions must have an active loop with surveyors. This may be easy to facilitate through shared data if those data are promptly uploaded. Or a

standing weekly synopsis via email of important finds may be a better fit. A standing phone call twice a month to check in could be another mechanism for spurring these conversations. The key is that the information is timely. Work with surveyors to create a culture of forthcoming communication as needed to ensure that prompt reporting of time sensitive detections. You will need to decide how your district will effectively elevate time sensitive detections in a way that ensures rapid responses.

Data Management Strategies

Determining which data collection system to use for EDRR surveys will inform what equipment and oversight is needed for the program, as well as which surveyors are most appropriate and aspects of their training. If you are already taking GIS and GPS data in a particular system, you may wish to continue in that fashion. Here are some considerations when choosing a data system:

- Is new or updated software required? Is that budgeted?
- Is new or updated hardware required? Is that budgeted?
- Can the data be easily shared to facilitate rapid response? This is particularly important in partnerships.
- Is the data system intuitive or easy to train?
- Are there any associated fees? Can the district support them on an ongoing basis?

Encourage surveyors to upload data daily. A lost device with weeks of data can mean lost data and wasted work hours. Additionally, prompt quality assurance checks ensure that surveyors do not forget details. A ratio of four to one for field to office time is a standard used in some EDRR programs. This can mean one office day for every four in the field, or two hours of office time after an eight-hour field day. Allow staff time to process data promptly to ensure data longevity and comprehensiveness.

In addition to choosing a data system, someone will need to take ownership over the management of data. Someone will need to ensure data are quality controlled, properly named, stored, sent to NRD in a timely manner, and more. Determine who this person should be and empower them to keep surveyors on standard. This person can also serve as a liaison with NRD staff on data transfer at the end of each season.

Data sharing is a valuable component of an EDRR program. The data you collect can help other land managers make decisions about their land. Whenever possible, share your data with a public repository like CalWeedMapper or Calflora. Data provided to NRD through ArcGIS is shared with Calflora on an annual basis. Data uploaded into Calflora will go to CalWeedMapper. You can also set up weekly email weed alerts in Calflora for any new observations posted of the species you specify.

Observations made with iNaturalist are uploaded into Calflora monthly. You may consider creating iNaturalist projects for each of your park units to track observations made by visitors. This community science data can provide a source of early detections, especially along trails that staff may not otherwise visit. When creating projects in iNaturalist, NRD recommends informing the

NRD Botanist or Data Manager so they can also follow your projects in addition to other district staff.

Significant new invasive plant finds should also be shared and advertised through early detection channels facilitated by Cal-IPC, CDFA, WMAs, and other regional organizations and groups. If you have not engaged this network before or if you have any questions about a suspected new occurrence, please contact NRD's Technical Team for assistance.

Download and analyze data for management purposes

Field data should be downloaded and checked as soon as possible after EDRR searches are completed. This assures that data is actually being collected and that the spatial location of collection is correct. Then the locations can be cross-referenced with EDDR activities outlined yearly in the district Ongoing Maintenance work plan.

EDRR data may be filed on the local GIS hard drive and must be uploaded to the statewide GIS server (MSHQGEO) J:\DataDevelopment\ under the district's sub-folder when transmitted to NRD. EDRR data will be compiled for analysis at a state-wide level annually. If data is stored on Calflora, the Natural Internal Technology Administrator (NITA) can extract the data as long as the NITA is included as a participant in your Weed Manager groups. Communicate directly with the NRD Data Manager or NITA for instructions or to discuss options for data transfer.

After yearly EDRR data collection is completed, managers should revisit the program and revise it based on the progress made. Time estimates may be low or high and the level of effort can be gauged based on the distance covered, number of EDRR targets found, and staff or volunteers available for additional searches. Continue to hold time for rapid response in the treatment schedule for new detections.

Annual Reporting Requirements

Once a district has started implementing an EDRR program, there are specific reporting requirements for data to send to NRD headquarters by December 31st each year. The information is collated into an annual report to track the results of the program and to help justify additional funding. Labor hours, tools, and material costs should be included in the appropriate Maximo "New, Incidental, and Unplanned" exotic plant work order for each management unit.

Required information includes:

- Shapefiles and tracklogs from your surveys, which include the fields listed on page 16 in the attribute table
- A brief written report of results with:
    - Any highlights, changes made to the district's program, or any recommendations
    - Any changes made to your target species list, especially noting any completely new, unexpected, or significant invasive species encountered
    - The application used to collect the data

- Number of staff/volunteers that were involved and number of hours spent conducting EDRR (if available)

SUMMARY – USING THESE METHODS TO DEVELOP YOUR EDRR PROGRAM

Early Detection Rapid Response is an ongoing approach to weed management intended to move work to the left side of the invasion curve, improving efficacy and reducing costs while complementing other invasive species management activities in an integrated program. Successful implementation will require some shift in how districts utilize their weed management resources. Maintaining a flexible attitude toward how some portion of treatment budgets are applied will help tremendously as new detections are made and successfully treated.

Approach the first season of EDRR as a pilot and prepare to make changes before the second season. Your EDRR program will evolve over time as you refine it to meet the needs and resources of your district. Availability of volunteers and partners may change over time to augment your labor force and increase your regional effectiveness. Finding ways to effectively integrate EDRR surveys into your workflow can also change over time. As you implement these methods, remember that prevention, early detection, and rapid response are vital components in an effective, well-executed weed management program and essential tools in our multifaceted IPM toolkit.

Staff and volunteers with CSPF Park Champions celebrate successful English ivy removal at Patrick's Point State Park.

EDRR HANDBOOK

APPENDICES

Appendices Table of Contents

APPENDIX A - Initial Considerations in Implementing a District EDRR Program

As you gather within your district staff to determine how to implement EDRR, you can inventory both needs and resources to create this program. Consider having at least two preliminary conversations. In the first you may mostly explore the following questions, determining who will follow up in each district to answer any determined essential to the process. In the second meeting you may be ready to prioritize within or across Park Units. Or you may be ready to develop criteria for prioritization at a later date. Completion of these steps may vary by district. In this discussion, you don't have to answer every question; you are still brainstorming to determine the overall needs of Park Units to be aggregated into the needs of a district as a whole.

While aggregating needs is important for communicating resource limitations and opportunities to headquarters, you may need to customize some elements of the EDRR program to Park Units or groups of Units (Sectors), depending on your organization and level of staffing. Document the way you approach this for internal clarity.

Guiding Questions:

District Needs for EDRR Surveys

1. What Park Units would we like to survey?
   Recommendation – survey all Park Units to some extent whenever feasible.

2. What areas within Park Units are the highest priority?
   Recommendation: If you cannot survey an entire road and trail network within a Park Unit, consider starting with a combination of heavily trafficked trails and infrastructure areas (parking lots, campgrounds, maintenance yards) and more remote, high quality habitats with lower visitation. In this way, you are covering areas most likely to get new weeds and areas most important to protect. Usually you will find that trails cut through both of these zones and hit some middle ground as well. You can also start with these high priority areas and then rotate through the rest of the Park Unit in subsequent years, creating a 3 – 5-year cycles in which all roads, trails, and infrastructure areas are covered.

3. How many miles of roads and trails fall within the high priority areas identified in question #2?

4. How many days would it take to survey the high priority areas for the first time? How many surveyors will you need?
   Early Detection surveys take varying lengths of time based on the density of target species, complexity of vegetation, roughness of terrain, and distance of the survey area from offices or work sites. Think about it roughly: You know you want to survey a five-mile loop trail at a Park Unit an hour from the office. That might take a day if you include a rigorous search of the adjacent parking lot and non-system spurs to viewpoints, etc.

But it might go quickly if there are few weeds. Make this estimate as a rough guide to the overall need but be loose about it. Think in workdays or fractions of days, if feasible.

5. When should surveys occur, based on the habitat of the high priority areas and phenology of target species?
   Are there any limitations on timing based on factors like heat, water levels, etc?
   You will need to integrate target species phenology after the creation of a species list. At this stage, you may have some knowledge of how target species influence timing. Integrate that information if you know it or come back to it later.

6. Do you want to do treatments on surveys? Or will you separate treatment and surveying?
   Many EDRR programs integrate surveying and treatment when feasible. Feasibility can be defined by a population size, time needed to treat population (no more than 10 minutes), access limitations, etc. Some detections happen after a plant has gone to seed or are made of species that are not treatable with equipment one can carry on a survey. These will require separate follow up treatment. The strength of surveyor's plant ID skills should also factor into whether to treat on surveys.

7. Which specifics of your protocols do you want to determine? Decide if points or polygons make sense for your program. What is the minimal data necessary to accurately record and complete follow-up treatments (if necessary)? What % flowering will you use for phenology definitions, etc.

Surveyors

1. Who is available to perform surveys?
   Whenever feasible, integrate year-round district staff into your planning. These staff are most likely to know what is out of place. Supplement with seasonal staff and knowledgeable contractors who are willing to execute the district's protocol diligently. If you have experienced volunteers who will diligently execute the protocol, consider using them as a supplement to the core effort.

2. Based on your expected labor source, how often will you need to provide training and support?
   Expect to provide more support for seasonal staff and volunteers. Training should include plant identification as well as data collection methodology and protocols, and database training (e.g. Calflora).

3. Who will manage and analyze the data?
   If you are using volunteers and seasonal staff, you need a point person to QC and manage the data. Regardless of who surveys, the data are only useful if you integrate it into work plans, which means someone has to review it both in season to allocate resources to rapid response and annually to integrate new projects into work plans.

Treatment Strategy

1. Will treatments occur on surveys?
   Recommendation – treat during surveys whenever feasible. Consider any extra tools or equipment needed to bring on surveys for treatments or when not feasible, develop protocols for reporting and follow-up (rapid response).

Weed workers from Redwoods Rising are ready to assist North Coast Redwoods District staff with an assortment of tools.

APPENDIX B - Developing a Target Species List Using CalWeedMapper

CalWeedMapper is a website (http://calweedmapper.cal-ipc.org/) that enables natural resource managers to create maps and reports of invasive plant distribution, to identify management opportunities in a region, and to maintain up-to-date species distribution data statewide. CalWeedMapper is integrated with Calflora (http://calflora.org/) and Consortium of California Herbaria (CCH) (http://ucjeps.berkeley.edu/consortium/) databases, such that any new occurrence data submitted to either database updates the statewide distribution in CalWeedMapper nightly. Calflora and CCH contain a compilation of specific plant occurrence data throughout California, including both user observations and herbarium specimen data. The CalWeedMapper website contains this occurrence data as well as data from Cal-IPC's statewide mapping effort, combining expert knowledge data and occurrence (GIS) data into one statewide system whose resolution is at the 7.5 Minute USGS Quadrangle level. Another function of CalWeedMapper is the ability to generate a management opportunity report for designated regions of the State. The management report for an area breaks down the species listed into the following categories:

- Surveillance: Survey to detect new infestations of species not yet present but nearby (occurs 50 miles from the boundary of your selected region)
- Eradication: Complete removal of infestations (occurs within isolated quads)
- Containment: Limit spread from existing populations

As part of this project, Cal-IPC added State Parks Early Detection Regions to the CalWeedMapper website. These regions are roughly based on Parks sectors, so districts with large geographic areas will be able to split their land base into smaller regions which may have different EDRR target plants.

Steps for generating a Management Opportunities Report using CalWeedMapper:

- Go to (http://calweedmapper.cal-ipc.org/)
- Click on Go to Maps
- Click on Advanced Tab in upper left
- Click Select Region Type, choose State Parks Early Detection Regions
- Select your region of interest
- Click on the "Get Management Opportunities Report" button for a .pdf or select the "Create a Report" dropdown to get a report in either PDF or Excel format. The PDF format gives a formatted report with pictures showing the three types of species, while the Excel report is the same info in a table including a list of the species with the categories in separate columns.
- Choose one of them and click "Get Report for Map Extent"

This CalWeedMapper report can be used as the starting point to choose your EDRR target species.

APPENDIX C – EXERCISES AND CHECKLISTS

We suggest creating your own custom checklists. Here is an example to get you started.

EDRR Equipment List - Example from One Tam

- Hiking pack
- GPS device for data collection
- Notebook and writing utensil
- Plastic bags for weed debris
- Gloves
- Water
- Lunch
- Mt. Tam trail map
- Specimen bags
- First aid kit
- Radio

Hand tools for treatment and detection. At least one of each tool per pair of surveyors

- Handsaw
- Hori hori
- Hand pruner
- Binoculars
- Boot brush for BMPs

Japanese hori hori garden tool

Each mobile device should be loaded with the following:

- One Tam EDRR Illustrated Plant List
- Annotated Plant List in pdfs
- Observer Pro app
- GPS Logger for Android app
- Red Cross First Aid app
- iNaturalist app
- Avenza Maps app
- Collector app (or other apps as appropriate)

QUICK CALCULATIONS FOR THE FIELD

Length:

- Feet x .305 = Meters
- 10ft = 3.05m
- 25ft = 7.62m
- 50ft = 15.24m
- 100ft = 30.48m
- Yards x .91 = Meters

Area:

- Circle: $3.14r^2$
- Circle (1m): 3.14 m^2
- Circle (5m): 78.5 m^2
- Circle (10m): 314 m^2
- Circle (20m): 1,256 m^2
- Circle (100m): 31,400 m^2
- When recording a radius, do not record anything less than .6m (= 1 square meter)

- 1 Hectare = 10,000 m^2 (length and width are 100m)
- Acres x .4046 = Hectares (1 acre is about 2.5 hectares)
- Acres x .0016 = $Miles^2$
- Acres x .4047 = $Meters^2$
- $Feet^2$ x .093 = $Meters^2$

SIGHT ESTIMATIONS:

- 1 Acre = half of a standard size soccer field
- 1 Mile^2 = 320 standard size soccer fields
- From 49 Sky Oaks Road to Bon Tempe Lake Trailhead = .5 mile (example; pick your own familiar local landmarks)
- 100 Meters^2 = ~1 residential car intersection or ~half of a tennis court
- 1 Meter^2 = half of the area of a doorway
- This German shepherd is inside a square meter box.

<u>Calculating Labor Hours (for Weed Manager):</u>

- 15 min = .25
- 20 min = .33
- 40 min = .66
- 55 min = .92

DISTANCE ESTIMATION EXERCISES

1. Pacing

A pace is two steps. Knowing how many meters in a pace, or 10 paces, will help you in many mapping, monitoring, and orienteering situations. Understanding how your paces change with differences in terrain will make your distance estimates more accurate.

Lay out a meter-tape to 20 meters over a piece of flat, level ground. Walk as you usually would, counting your paces over the 20 meters. Record the number of paces in 20m, turn around, and walk back, counting your paces. Repeat this 5 times. Repeat the exercise on a slope.

# of paces in 20 meters:

	Flat ground	Uphill	Downhill
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____
Total	_____	_____	_____
Meters/ pace	_____	_____	_____

To determine the number of meters in your pace, divide the number of meters by the number of paces (e.g., if it took me 25 paces to go 20m my pace would be 0.8m, and in 10 paces I would travel about 8m). How different is it in each situation?

2. Estimating

Often you will want to estimate distances, and practicing this skill helps hone that ability. We will take a meter tape and a rangefinder out into the field and estimate shorter and longer distances; check with the rangefinder and tape.

When are you most accurate in estimating distance?

Do you consistently over- or under-estimate?

3. Finding your location on a topo map or airphoto

Using landmarks and topographic features

Things most/all maps should have

Checking distance estimations with maps

4. Cover Estimation

Cheat sheet with different cover levels represented

Notice how lifeform skews cover estimates

Using cover classes

Gross area and infested area: gross=the area of the polygon around the entire infestation; infested=the area actually covered by the plant ("squished" to 100% cover), sometimes obtained by multiplying gross area by % cover (or midpoint of cover class)

Practice estimating cover of trees (all types and split by species), broom, coyote brush, and grass.

When collected: All quadrat species
Field width: 1 digit
MQO: No errors, at least 80% of the time

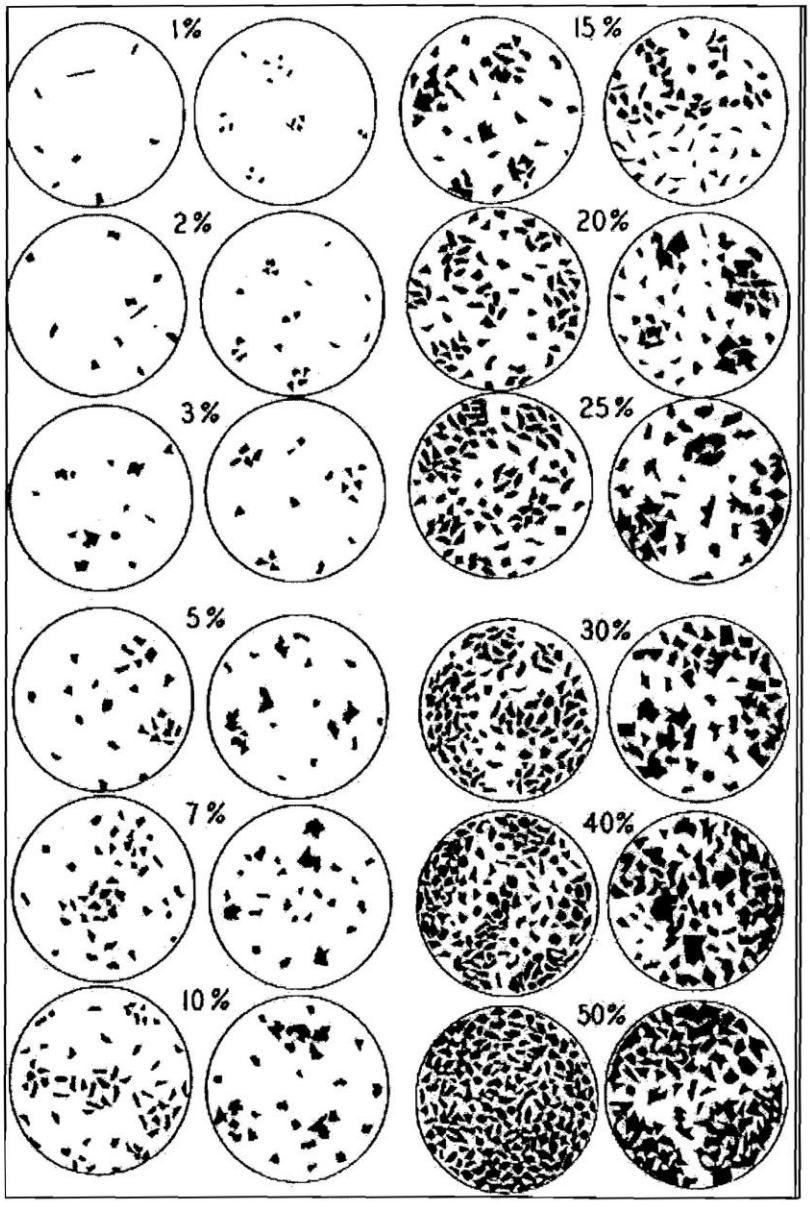
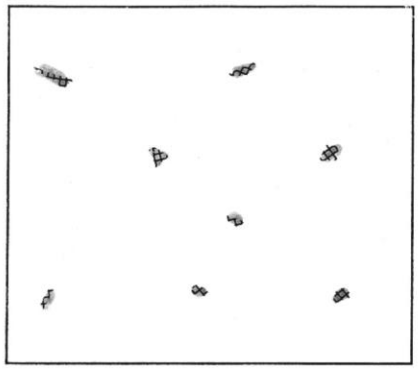


Figure 13-4. Reference plots for cover estimation.

CNPS COVER DIAGRAMS



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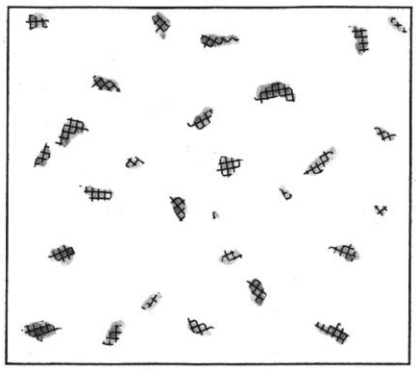

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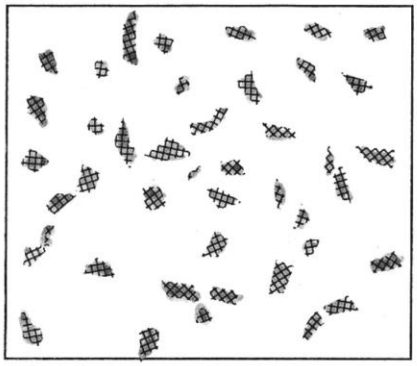

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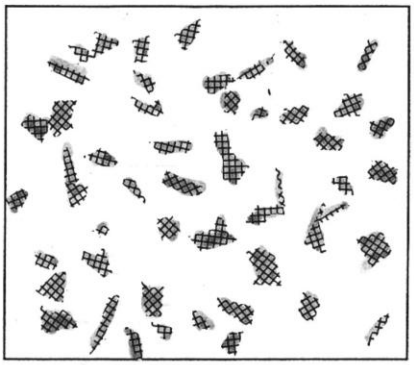

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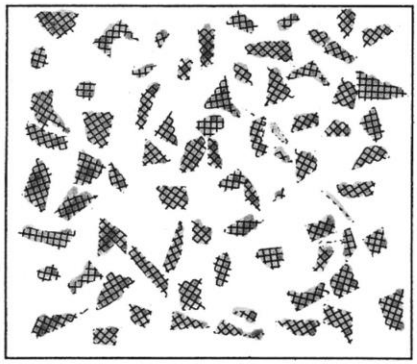

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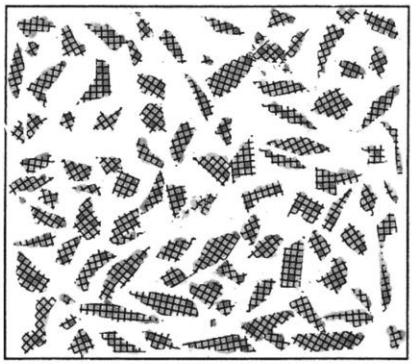

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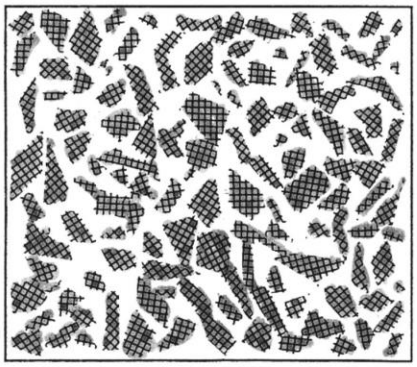

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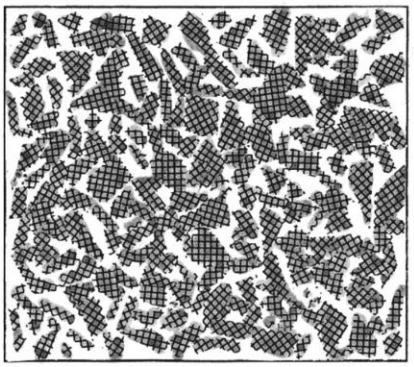

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APPENDIX D – BEST MANAGEMENT PRACTICES

Preventing the Spread of Invasive Plants: Best Management Practices for Land Managers
https://www.cal-ipc.org/resources/library/publications/landmanagers/

Preventing the Spread of Invasive Plants: Best Management Practices for Transportation and Utility Corridors
https://www.cal-ipc.org/resources/library/publications/tuc/

Best Management Practices for Wildland Stewardship: Protecting Wildlife When Using Herbicides for Invasive Plant Management
https://www.cal-ipc.org/resources/library/publications/herbicidesandwildlife/

List of Purchasable Equipment and Tools for Weed BMPs

Gaiters
For keeping vegetative debris out of shoes and socks while hiking off trail. Wear over boots when traveling through dense vegetation. Options come in a variety of colors and sizes.

Vendor:
https://www.outdoorresearch.com/us/rocky-mountain-low-gaiters-243097?cat=129,25,6

Boot brushes for field packs
For brushing off boots in the field and on the go. Give weeds the brush off when traveling in between work sites or across diverse habitats. Use after hiking through areas with weed seeds and before entering areas with sensitive habitat to avoid contamination. Pick can be used to get mud out of boot tread and other crevices.

Vendor:
https://www.statelinetack.com/item/plastic-hoof-pick-brush-combo/SLT901729%20BLK/
https://www.amazon.com/Tough-Great-Grip-Hoof-Brush/dp/B00EJFD91E/

Scrub Brush
Brushes that can be used for additional boot cleaning, scouring the sides and bottoms of boots. Attach to packs with carabiner for field use.

Vendor:
https://www.lowes.com/pd/Scotch-Brite-Utility-Brush/1000622077

Boot Brush Station
For brushing off boots when returning to the office from the field. Stationary unit can be placed in a location outside office building ideally near a hose and where any seeds will not travel to sensitive areas while cleaning occurs.

Vendor:
https://www.amazon.com/Personal-Security-Products-BB2-Scraper/dp/B000T9SQQW

Chemical Resistant Spray Bottle
For use with isopropyl alcohol or Quat disinfectant to clean after exposure to different pathogens. It is important to choose a bottle that is chemical resistant so that plastic does not break down between uses. Spray boots with isopropyl alcohol when finished visiting a site and returning from field or moving from *Phytophthora sp.* infected areas to non-infected areas. Spray equipment with Quat disinfectant after exposure to creeks with New Zealand mudsnails before changing creek systems.

Vendor:
https://www.uline.com/Product/Detail/S-16187/Spray-Bottles-and-Nozzles/SprayMaster-Chemical-Resistant-Spray-32-oz-Bottle?pricode=WB0997&gadtype=pla&id=S-16187&gclsrc=aw.ds&&gclid=Cj0KCQjw6eTtBRDdARIsANZWjYa1HGnk_bieWLZgxZo46iS4iGnnzZEKVpFChAcKowWO8aFy18APEIcaAmQeEALw_wcB

Isopropyl Alcohol
For cleaning off boots after exposure to areas with *Phytophthora sp.* Spray boots after visiting a site and before returning from the field or moving from *Phytophthora* infected areas to non-infected areas.

Vendor:
https://www.uline.com/BL_6718/Alcohol?keywords=Isopropyl+Alcohol

Bucket in a crate
Option for storing boot brushes and other BMP tools/equipment to make a BMP travel kit. Choose a size that best fits your equipment and storage space needs. A link to the Container Store provided below for a larger variety of bin sizes.

Vendor:
https://www.homedepot.com/p/Leaktite-5-gal-70mil-Food-Safe-Bucket-White-005GFSWH020/300197644
https://www.homedepot.com/p/GSC-Technologies-6-5-Gal-Milk-Crate-Storage-Tote-in-Graphite-STMC13131115/306330052

Push Broom
Option for sweeping out back of truck bed or other vehicle areas of soil and debris that may find its way there. For use doing routine vehicle cleaning or after contamination from a field day.

Vendor:
https://www.homedepot.com/p/Alpine-Industries-24-in-Green-Indoor-Outdoor-Multi-Surface-Push-Broom-460-24-1/310106899

Wheel Well Brush
Option for cleaning mud and debris from wheel wells of vehicles that travel off paved roads. Use while washing vehicle.

Vendor:
https://www.uline.com/BL_14/Industrial-Scrub-Brushes?keywords=brushes

One Tam staff brush their boots after removing cheatgrass, a high priority weed in their region, before moving on to another site. Notice they are also wearing gaiters. Photo by Rachel Kesel.

Best Management Practices: *Phytophthora (Sudden Oak Death)* and Weeds

One Tam operates on lands owned by varying agencies, this document combines existing *Phytophthora* protocols. These protocols will also reduce the spread of weeds. By applying the most restrictive BMPs in practice on the mountain, the hope is to contain the spread of these harmful water molds and weeds.

Practices

1. Start clean, end clean.
    a. Boots, gloves, tools, truck.
2. Clean between each worksite and at end of day.
    a. If moving sites, all cleaning should be done prior to leaving.
    b. Remove all organic material from tools, gloves, boots and truck.
    c. Removal can be accomplished using water or compressed air. If needed use a stiff brush or screwdriver to remove material from deep crevices.
        - Make sure if using water that it is dry before moving locations.
        - If using water, make sure that you do not spread contaminated water to non-infected areas. This can be accomplished by cleaning over pavement.
        - It is also important to not flush contaminated water or debris into storm water drainage, but instead the sanitary sewer drain.
        - If you cannot safely decontaminate items in the area you are in, you may bag them and transport to a safe cleaning area.
    d. After material is cleaned off, use rubbing alcohol of at least 70% concentration to sterilize the surface.
        - If any tools were used to clean off infected tools, make sure they are also sterilized.
3. In the field
    a. Avoid the transfer of dirt or organic matter between sites.
    b. Work in areas of low risk, then move to areas of higher risk.

APPENDIX E - REFERENCES AND RESOURCES

California Invasive Plant Council (Cal-IPC)
https://www.cal-ipc.org/

CalWeedMapper
http://calweedmapper.cal-ipc.org/

Cal-IPC Regions Page
http://calweedmapper.cal-ipc.org/regions/

Cal-IPC Invasive Plant Mapping & Prioritization
https://www.cal-ipc.org/solutions/mapping/

Invasive Species ID Cards for EDRR
https://www.cal-ipc.org/solutions/management/edrr/species-id-cards/

Calflora Weed Manager page
http://www.calflora.org/entry/weed-mgr.html

California Department of Food and Agriculture (CDFA) Plant Health and Pest Prevention Services Division
https://www.cdfa.ca.gov/plant/

Weed Research and Information Center
https://wric.ucdavis.edu/

Invasive Species Education Materials
https://www.playcleango.org/invasive-species-education-materials

Other EDRR and Weed Management Plans and Guidance Documents

Invasive Plant Management Plan and Environmental Assessment for Redwood National Park and Santa Monica Mountains National Recreation Area
https://parkplanning.nps.gov/projectHome.cfm?parkID=341&projectID=44351

One Tam EDRR report (Kesel Greenberger 2020)
https://www.onetam.org/sites/default/files/pdfs/Beyond%20Boundaries%20One%20Tam%20EDRR%20Report%202020.pdf

Land Manager's Guide to Developing an Invasive Plant Management Plan
https://www.cal-ipc.org/resources/library/publications/developingplan/

Practical Guidebook to the Control of Invasive Aquatic and Wetland Plants of the San Francisco Bay Region – by the San Francisco Estuary Institute
https://www.sfei.org/nis/

Weed Workers Handbook
https://www.cal-ipc.org/resources/library/publications/wwh/

Stewarding California's Biodiversity: Early Detection and Rapid Response for Invasive Plants.
https://www.cal-ipc.org/resources/library/publications/ca-biodiversity-edrr/

Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response. US DOI, 2016.
https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf#:~:text=A%20national%20EDRR%20Framework%20needs%20to%20consider%20non-,yond%20the%20area%20occupied%20by%20the%20founding%20population.

Early Detection of Invasive Plant Species in the San Francisco Bay Area Network – A Volunteer-Based Approach. NPS, 2009.
https://irma.nps.gov/DataStore/DownloadFile/460898

Five-Year Invasive Plant Management Plan for the Central Reserve of the Nature Reserve of Orange County and Adjacent Lands
https://www.cal-ipc.org/resources/library/publications/nroc-5-year-plan-central/

Weeds and Wildfire:

Managing Weeds after Wildfire, Montana State University Extension, 2019.
https://store.msuextension.org/publications/AgandNaturalResources/EB0230.pdf
and article:
http://www.sarc.montana.edu/documents/weedposts/December%202019_managing%20weeds%20after%20wildfire.pdf

Fire Management and Invasive Plants: A Handbook, US Fish and Wildlife Service, 2008.
https://www.fws.gov/invasives/pdfs/USFWS_FireMgtAndInvasivesPlants_A_Handbook.pdf

Effects of Fire on Nonnative Invasive Plants and Invasibility of Wildland Ecosystems, US Forest Service, 2008. https://www.fs.fed.us/rm/pubs/rmrs_gtr042_6/rmrs_gtr042_6_007_032.pdf

Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants, USDA, US Forest Service, 2008.
https://www.fs.fed.us/rm/pubs/rmrs_gtr042_6.pdf

Integrated Noxious Weed Management After Wildfires, Natural Resources Conservation Service, 2001.
https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1586&context=govdocs

APPENDIX F – Methods for Developing Areas to Search

The following is a description of the methods used in 2012 to develop the initial set of search areas for the pilot program.

EDRR search areas were important to develop so staff and volunteers would know where to focus efforts and hopefully find the most new EDRR plant introductions. We chose maps over lists of search areas as names of locations may change over time and would not be helpful for new staff or volunteers without longer-term experience. Maps of search areas can then be provided to EDRR data collectors, along with the identification cards and data collection protocols.

In order to create a state-wide map set, we chose to start with the state-wide GIS layers that are available on the Department's GIS server. While these layers are not complete for all parks, they contain enough base information which could be used as a starting point, and district details could be added to complete them. We called the search area maps generated with GIS layers our "GIS Dumb Model," meaning it was developed with a fixed set of rules applied to an incomplete data set and would certainly have limitations with respect to how "smart" it was when a land manager who knows the area well looked at its output.

We considered the areas in our GIS Model to be those where the likelihood of invasive plant introduction was greatest from visitors and park personnel, namely parking lots, bathrooms, campgrounds, highly traveled/walked/hiked roads, and the start of trails beyond trailheads. This GIS proxy would help to guide natural resource managers to where we thought it would be most effective to search for early detections of invasive plants. The output of this effort was to provide both a draft set of search area maps to land managers and to create a summary table of total lengths and areas to search by unit (aka Park) so that upper management could estimate resource needs for their district's early detection effort. While we knew that land managers in each district would want to refine the GIS model for their district (and indeed, each pilot sector that we worked with did), we thought this was a great place to begin both visualizing and costing the EDRR effort.

Using the "GIS Dumb Model" for selected sectors, our goal was to calculate the number of miles of roads to search by park in every state parks district. To generate this information, we used the State Parks GIS roads (RegRoutes_2014_01_16.gdb) layer. First, we removed (queried out) the roads features that were in Route Class 6 and had Route Categories 7 and 8. We also removed all of the Route Class 9 roads. (To understand these routes and categories, see State Parks GIS Department document describing fields and domains in Route_Collection_FieldsAndDomains_20110829.xls). The remaining roads were then clipped to park boundaries. Finally, we calculated the length in miles of the remaining roads to search for early detection weeds, putting this information both in maps by Unit Name (aka Park) and in one large spreadsheet of miles to search by Unit Name (aka Park).

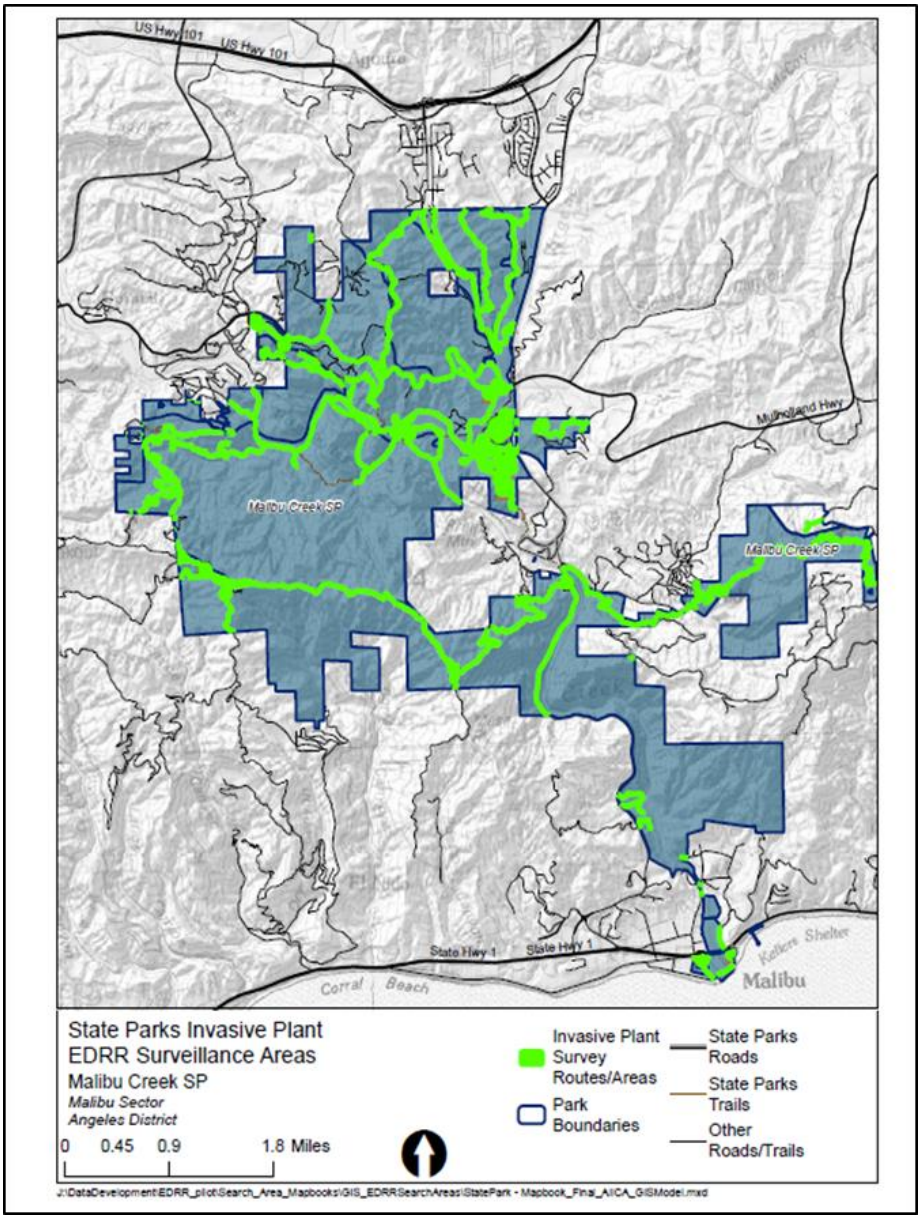
Next, we calculated areas to search (polygons). To do this we took the state park facilities GIS point layers (picnic areas, parking, campgrounds, buildings, structures other, but NOT utilities) and buffered them by 100 meters (m). We then clipped the resulting polygon to State Park boundaries. We included these polygon search areas in the maps by Unit Name (aka Park) that we generated for all remaining CA State Park districts, and we included the area calculations (in acres) in one large spreadsheet of acreages of search areas by Unit Name (aka Park).

After developing the GIS model for search areas, we suggest meeting with the district managers to refine the maps. Here is the meeting information we developed.

> On day one of the District EDRR Start-up Meeting we are developing GIS maps to determine EDRR search areas. These are the areas with frequent use and visitation where there will be staff available to perform EDRR searches at 1 to 3-year intervals. Our goal is to finalize these maps together during the meeting.
>
> Since we have a limited number of staff hours available for this work, we should choose areas with the highest likelihood of new invasive plant introductions. Previous districts have settled on a methodology where they focus on areas like:
>
> - Parking areas
> - Day use areas, including restrooms and picnic areas
> - Campgrounds
> - Parks administrative buildings and housing areas
> - Parks maintenance yards
> - Major roads and highways adjacent to or near the Park boundaries
> - Areas of recent disturbance such as wildfires or construction projects
>
> Before the meeting:
>
> 1. We would like to gather GIS roads, trails, and facilities layers for the selected EDRR Parks. Note: this is particularly critical if what you have is different from what's in the state GIS layers.
> 2. We are asking participants to take a look at the included parks in your district and consider the guidelines above. We ask you to make notes on where the EDRR searches should occur, categorizing them into High (every year), Medium (every 2 years), and Low (every 3 years) search efforts. This may be done on existing state parks maps, through Google Earth, or in a GIS, using existing GIS layers and aerial photos.
> 3. We will have a GIS layer with the roads and trails within the Park, and a buffer around the facilities included in the State GIS layers. We will use this, as well as your district's data, to generate search areas at our meeting.
> 4. During the meeting, we will go over each park and develop an EDRR search area map. These maps are used to guide staff in where to search and to estimate the amount of effort and budget necessary for this program.

After the meeting we will produce a map book which includes the EDRR search areas, and a set of shape files which can be used by the district and the state-wide program. You will also receive .pdfs of your search areas per each district for use in subsequent years.

We were able to refine the GIS Model into custom GIS search area maps and an accurate table of lengths/areas to survey by Unit Name (aka Park) for the pilot districts and Monterey where we were fortunate to work directly with district staff. In 2015, the map book was expanded statewide to include additional parks using the same methods (example below). It can be found at: J:\DataDevelopment\EDRR_pilot\Search_Area_Mapbooks\GIS_EDRRSearchAreas\State Park - Mapbook_Final_AllCA_GISModel.mxd



APPENDIX G - Case Studies: Santa Cruz District EDRR Program Development and Orange Coast District: Estimates of Staff Time and Engagement with Local Partners

Some preliminary objectives for Santa Cruz District EDRR pilot project were:

1. Produce and distribute 100 sets of "Early Detection Targets Identification Cards" to docents, staff, and cooperating organizations by 2017.

2. Register all the units within the Santa Cruz District as "Parks" in "What's Invasive" and create lists of high priority weeds for those parks by 2016.

3. Incorporate EDRR findings into yearly work planning starting in 2015

Developing EDRR Target List

We started with the CalWeedMapper list for the Santa Cruz Mountain Sector which contains 4 parks. The report gave us 33 surveillance targets and we also reviewed the 11 eradication targets, as well as a selection from the 139 containment targets, that met the criteria of being less than 15% infested within the Sector. We considered Cal-IPC rating, prioritizing High and Moderate ratings over Limited. Next, we considered "detectability" meaning would a non-botanist be able to identify this plant while walking along a trail if they were trained to find it? Using that criteria, we eliminated most of the grasses, aquatic plants, and plants with habitat not occurring in the Mountain Sector.

We also evaluated a local list, the Bay Area Early Detection Network (BAEDN) List, to include additional species of concern and looked at CalWeedMapper climate projections to see expanding or contracting suitable range for each species in 2050. Finally, we narrowed the number of total training species by lumping similar genera. For example, we had three knapweeds on our list and two types of toadflax, each of which were lumped or treated as a single target.

After our internal screening we solicited expert review by other local botanists. This step was useful because it forced us to re-visit the goals of the project. As a result of the review we added 2 more species to our target list.

Narrowing the Search Area

When starting the pilot project, we narrowed it overall to just 4 parks in the Santa Cruz Mountain Sector instead of covering all 30 Parks in the District. This allowed us to focus on methods and after determining time needed to cover the priority areas, scale the project up to make time and budget estimates for the whole District. At first, we assumed we would be covering all roads and trails on foot, but quickly determined that would take too much time. Some areas, such as redwood forests, are very resistant to invasion and invasive plants tended

to occur only in disturbed areas near facilities and high use areas. Therefore, we developed the GIS methods included in Appendix G to guide formation of priority search areas. This method will also allow more frequent coverage of the high use areas by trained NR staff, while the training materials can be distributed to docents and volunteers to generate searches of roads and trails further afield. This approach has the dual benefit of putting the best trained people where they are most likely to encounter weeds and allowing volunteers to search more scenic areas.

What this method does not account for is how valuable an area is, but only its vulnerability. A more complex analysis would account for both how "valuable" (the relative diversity or rarity of a habitat), and "vulnerable" any given area within a park was. This type of analysis may be incorporated in the future.

One unexpected benefit of the Santa Cruz EDRR pilot project has been the interest from volunteer groups. Santa Cruz staff trained more than 200 volunteers who contributed more than 500 hours of surveillance and reported 3 populations of EDRR target species. For Castle Rock State Park, a college class and a trail patrol group volunteered to test the EDRR methods and the docent group for the area requested a presentation.

Estimating Time and Budget

This component of the EDRR pilot program still needs development. Below is an example used for the Orange Coast District pilot.

Estimates of Staff Time Needed to Cover EDRR Priority Search Areas for Orange Coast District

Park Unit	Yearly Length of Survey (miles)[1]	Yearly Hours for Area Survey[2]	Total Yearly Hours Estimate	Cost for team of 2 at $15/hr[3]	GIS "Dumb Model" Areas (acres)	GIS "Dumb Model" Lengths (miles)
Bolsa Chica SB	4.19	2	6.19	185.7	114.10	7.00
Huntington SB	3.17	2.5	5.67	170.1	0	10.86
Crystal Cove SP	11.75	22.9	34.65	1039.5	339.00	46.20
Doheny SB	0.73	3	3.73	111.9	12.71	1.63
San Clemente SB	1.05	10.6	11.65	349.5	20.00	2.52
San Onofre SB	17.65	12	29.65	889.5	61.37	24.37
Totals	**38.55**	**53**	**91.54 * 2 crew**	**$2,746.20**	**547.18 acres**	**92.58 miles**

1. Lengths determined based on estimate for one year of effort. Calculated using total distance for high priority segments, half distance for medium priority, and one-third distance for low priority.
2. Hours for length per year estimate based on an assumption of 2 miles per hour coverage for a team of 2 people, plus travel time. Area estimates based on time estimate for crew to cover area, prepared by local Natural Resources managers.
3. Hourly cost estimates are for an average of rates in Environmental Services Intern and Park Maintenance Aide classifications. Field time only, data management and project oversight not included in these calculations.

Orange Coast District Examples of Engagement with Local Partners

Volunteers:
A special group to consider drawing volunteers from is your local chapter of the California Native Plant Society (CNPS). Members are passionate about native plants and have good identification skills. A very successful collaboration has been developed in Orange County between the local CNPS chapter and local land managers. The Orange County chapter of CNPS developed an Emergent Invasive Plant Program that includes publishing a priority list and watch list, developing resources, tools, and a training program, and recording new detections using Calflora. They also lead EDRR trainings for staff and volunteers that are supported through NCC (Natural Communities Coalition).

Partnerships:
State Parks Orange Coast District works with regional partners connected through NCCP/HCP permits to collectively agree upon management strategies for invasive plants. In 2016, Cal-IPC wrote an invasive management plan (see link below) for the coastal portion of the reserve system defined in the NCCP/HCP, which formally created an EDRR program for the region. Using a valuation system and comparing multiple existing EDRR and watch lists, a prioritized target list of species was created, frequency of searches defined, and search routes identified. The prioritization structure includes three tiers for searching: high, medium, and low priorities. Four tiers exist for treatment prioritization: eradicate reserve-wide, control within watersheds, control opportunistically, or not treating at this time. Each species is assigned a priority for both search priority and treatment. This dual prioritization allows opportunities for data to be collected on a species that is not currently being treated to inform future management decisions. This list is revisited each year with species priorities adjusted based on the previous year's data. The Natural Communities Coalition (NCC), a group that coordinates the NCCP/HCP participants and signatories, pays for a contractor to walk that year's search routes and collect data within Calflora. Once a population is found, either State Parks NRM staff treat the population or an on-call contractor through NCC can be asked to treat.
https://www.cal-ipc.org/resources/library/publications/nroc-5-year-plan-central/