A photograph of two individuals working in a field of tall grass and shrubs. The person on the left is wearing a red hat, a green long-sleeved shirt, and brown pants, and is bent over, working with the vegetation. The person on the right is wearing a green t-shirt and blue pants, also bent over and working. Both are wearing backpacks. The background shows a valley with rolling hills and mountains, some with snow on their peaks, under a clear blue sky.

STEWARDED CALIFORNIA'S BIODIVERSITY: EARLY DETECTION AND RAPID RESPONSE (EDRR) FOR INVASIVE PLANTS

October 2020

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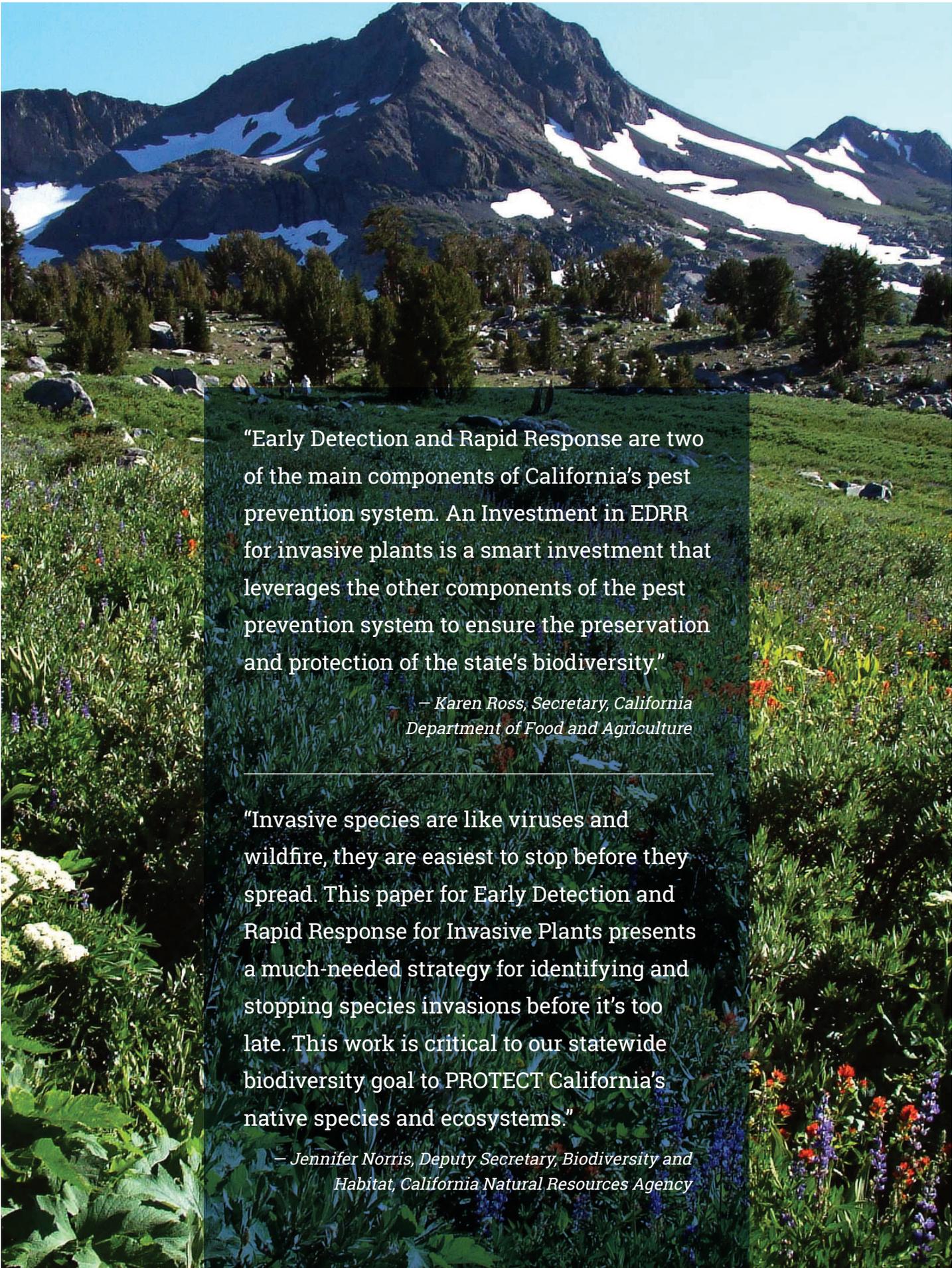
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Cover photo: Removing invasive plants is an uphill battle. An “early detection and rapid response” (EDRR) approach addresses new invasive plant species before they become widespread and more difficult and expensive to control. Pictured are volunteers for the Salmon River Restoration Council tracking down Italian thistle (*Carduus pycnocephalus*) plants in Siskiyou County. Photo by Emily Ferrell.

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“Early Detection and Rapid Response are two of the main components of California’s pest prevention system. An Investment in EDRR for invasive plants is a smart investment that leverages the other components of the pest prevention system to ensure the preservation and protection of the state’s biodiversity.”

– Karen Ross, Secretary, California Department of Food and Agriculture

“Invasive species are like viruses and wildfire, they are easiest to stop before they spread. This paper for Early Detection and Rapid Response for Invasive Plants presents a much-needed strategy for identifying and stopping species invasions before it’s too late. This work is critical to our statewide biodiversity goal to PROTECT California’s native species and ecosystems.”

– Jennifer Norris, Deputy Secretary, Biodiversity and Habitat, California Natural Resources Agency

EXECUTIVE SUMMARY

In 2018, then-Governor Jerry Brown established the California Biodiversity Initiative, setting biodiversity protection as a top state priority. The Biodiversity Collaborative is the next phase in the evolution of California's biodiversity conservation movement, integrating and building on efforts started by the California Biodiversity Initiative launched by Governor Brown. Like California's State Wildlife Action Plan and Climate Adaptation Strategy, the Biodiversity Collaborative identifies the importance of controlling invasive species as part of attaining a sustainable future.

Indeed, hundreds of entities across California are engaged in strategic efforts to limit the scope and magnitude of the damage that these species do to the state's biodiversity and natural resources. When possible, land managers use a strategic approach called early detection and rapid response (EDRR) that focuses on stopping new invasive plants before they become widespread. As with a raging wildfire, a surging infectious disease, or a leaking oil pipeline, the longer one waits to act, the more difficult and costly the task and the greater the damage that has already been done.

While the concept is simple, its implementation is complex. Effective EDRR requires timely data, proactive effort, landscape-level coordination among public and private landowners, and a consistent and sustained approach. In California, many pieces of an effective EDRR system are already in place, from an online network for sharing botanical information to a statewide network of land managers. But steady funding to implement EDRR systematically across the state's 100 million acres is lacking. With the new Biodiversity Collaborative in place, the time has come for an increased commitment to invasive plant EDRR.

While technical challenges remain—such as predicting how each plant's distribution will shift with land use and climate change—EDRR's primary challenges are structural: How can agency missions, mandates, programs, and funding be aligned to support landscape-level conservation? This paper identifies the institutional and financial support needed for invasive plant EDRR to succeed in California. Of the many recommendations made (see "Recommendations to Strengthen EDRR for Invasive Plants in California"), these are the top priorities.

1. Fund invasive plant EDRR through the California Department of Food and Agriculture's (CDFA's) statewide Weed Management Areas (WMA) program. Because CDFA is the state lead for invasive plant management, discontinuity in funding for this critical program greatly reduces its effectiveness. Funding should not go below \$1.5 million per year, even during budget crises.

2. Build invasive plant expertise and capacity at the California Department of Fish and Wildlife (CDFW) and integrate it into collaborative management efforts. Identify invasive plants as a top threat to the state's biodiversity, and one that CDFW must address to fulfill its mission. This would complement CDFA's more agriculturally focused efforts.

3. Enhance bond funding for invasive plant EDRR. Implement a variety of approaches, including: creating grant programs focused on invasive plant EDRR, looking for ways to use Greenhouse Gas Reduction Funds for invasive plant EDRR, being flexible about landowner permission documentation and site identification requirements, extending grant duration, and funding project planning activities.

For biodiversity protection, for fire safety, for water supply, for food security, for climate change adaptation—for all of these reasons we need to invest in stopping the spread of invasive plants.

Invasive species are those species brought into California—on purpose or by accident—that cause harm here. Invasive species represent a small subset of the many “nonnative” organisms in California. For plants, the general rule is that 10% of nonnative plants will be able to grow outside of cultivation, and of those, 10% will cause harm. This harm comes in the form of impacts to native plants and wildlife, water resources, wildfire, agriculture, recreation, and more.

INTRODUCTION

“Acting now to strengthen our response to invasive species is vital to protecting California for future generations.” This is the conclusion of *Stopping the Spread: A Strategic Framework for Protecting California from Invasive Species*,¹ a blueprint for action released in 2013 by the interagency Invasive Species Council of California (ISCC) and its California Invasive Species Advisory Committee (CISAC).

This blueprint dedicates an entire section to one key management approach that is also the focus of this white paper: early detection and rapid response (EDRR). EDRR is the most cost-effective way to address the damaging effects of invasive species that find their way here despite prevention efforts.

This white paper focuses on one type of invasive species: plants. Plants underlie the entire food web within which life exists. They harness the energy of the sun and pass it on to the rest of the world’s organisms, including us, and in doing so, support the planet’s biodiversity. They are integrally connected to wildfire, water, and climate. However, plants that become invasive undermine the food web and biodiversity as well as the natural resources that we depend upon.

California’s work toward a sustainable future makes the state a global model. It has enacted landmark legislation to reduce greenhouse gas emissions and build climate resilience while maintaining one of the world’s largest economies. Likewise, it has established the Biodiversity Collaborative to galvanize work to protect the species and habitats that make it a global biodiversity hotspot.



Invasive plants threaten wildlife as well as the native plant habitats that they depend upon. According to the National Wildlife Federation, 42% of threatened or endangered species—such as California’s San Joaquin kit fox (*Vulpes macrotis*)—are at risk in part due to invasive species. Photo from the U.S. Fish and Wildlife Service.

However, addressing climate change and biodiversity loss necessitates addressing invasive species. *The National Fish, Wildlife and Plants Climate Adaptation Strategy*² lists the need to “prevent, control, and eradicate invasive species” as a key strategy under the goal to “reduce non-climate stressors to help fish, wildlife, plants, and ecosystems adapt to a changing climate.”

1 Retrieved from <http://www.iscc.ca.gov/docs/CISAC-Strategic-Framework.pdf>

2 Retrieved from <https://www.st.nmfs.noaa.gov/Assets/ecosystems/documents/NFWPCAS-Final.pdf>

“Invasive plant EDRR is one of the most important things we can do to protect California’s biodiversity and help the environment adapt to climate change. Helping the environment adapt is the most important thing we can do to help ourselves adapt. We need to get this done.”

Christy Brigham, Chief of Resources Management and Science, Sequoia/Kings Canyon National Parks



Looks can be deceiving. Many invasive plants add color to the scenery, which is not surprising since many, like the Scotch broom (*Cytisus scoparius*) shown here being treated at Point Reyes National Seashore, were initially brought to California for landscaping. Several types of broom from the Mediterranean region now grow extensively in California, Oregon, and Washington, increasing wildfire fuel loads. Photo by Nicholas Novero.

Furthermore, *California’s Climate Adaptation Strategy*³ says that “invasive species can significantly contribute to habitat degradation and decrease resiliency,” and that “invasive species detection and removal can help to reduce existing non-climate stressors to support ecosystem function and structure and reduce potential vulnerabilities to climate change.”

The need for institutional and financial support for invasive plant EDRR in California is clear. Likewise, a growing stewardship ethic, one in which every person has a stake and a responsibility to steward the natural world that sustains us, means we can make individual differences, too. Together, we must effectively address the threat invasive plants pose to a thriving and healthy future.

THE CHALLENGE OF CONTROLLING INVASIVE PLANTS AND THE NEED FOR EDRR

Nonnative plants enter California’s natural areas in many ways. For example, seeds arrive in a bale of straw used for feed. A horticultural plant spreads outside of cultivation. Prolific nonnative plants are used by well-meaning engineers for erosion control. Once established, these plants spread in many ways—by seeds borne on wind or water, birds eating berries, burrs that adhering to fur or clothing, and more.

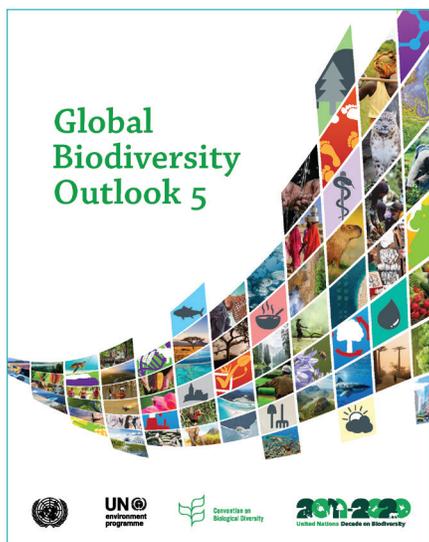
California’s modern weeds started with European colonization four centuries ago. Since then, many thousands of plant species have been brought to California, both deliberately and accidentally. A relatively small number of these have taken hold outside of cultivation. We have more long-distance travel and trade than ever before, increasing the potential for organisms to be transported across natural barriers into new regions where they may become invasive. At the same time, we have more awareness of this potential threat and have designed laws and practices to reduce its risk.

Nonnative plants that become invasive in a new place do not do so immediately upon arrival. They often exhibit a “lag phase” of years or decades, during which they adjust to new conditions and their population numbers slowly increase. Thus, the wildland weeds we contend with today include both new arrivals as well as older ones that are just beginning to spread into natural areas. Detecting and controlling these plants before they become widespread are critical to effectively reducing future impacts and controlling costs. This is EDRR.

This section describes the consensus on invasive species as a major threat, the harm and financial costs caused by invasive plants in California, the benefits to the state of taking an EDRR approach to invasive plant control, and how working collaboratively across jurisdictional boundaries is essential for achieving landscape-level conservation goals.

³ Retrieved from <https://resources.ca.gov/CNRALegacyFiles/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>

The goal of EDRR is to detect and address new problems as early as possible, before they become widespread—whether that is an entirely new invasive species or an existing invasive plant showing up in a new, previously uninvaded part of the state.



Invasive weeds are a global threat.

Target 9 for protecting global biodiversity under the United Nations Secretariat of the Convention on Biological Diversity is “Invasive alien species prevented and controlled.”⁶

The Recognition of Invasive Species as a Major Local, National, and International Issue

Operating under the United Nations Environment Programme, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) is the global body charged with assessing the status of Earth’s biodiversity and the ecosystem services it provides to society. In its most recent *2019 Global Assessment*, IPBES lists invasive species as one of the top five direct drivers of biodiversity loss, together with changes in land and sea use, direct exploitation of organisms, climate change, and pollution.⁴

In the United States, executive orders from 1999 and 2016 also recognize invasive species as a major threat to national security.⁵

The 2016 document, *Safeguarding the Nation from the Impacts of Invasive Species*,⁷ begins:

It is the policy of the United States to prevent the introduction, establishment, and spread of invasive species, as well as to eradicate and control populations of invasive species that are established. Invasive species pose threats to prosperity, security, and quality of life. They have negative impacts on the environment and natural resources, agriculture and food production systems, water resources, human, animal, and plant health, infrastructure, the economy, energy, cultural resources, and military readiness. Every year, invasive species cost the United States billions of dollars in economic losses and other damages.

The U.S. Department of the Interior staffs the National Invasive Species Council, which brings together secretaries from 13 federal agencies to “provide the high-level vision and leadership necessary to sustain and expand Federal efforts to safeguard interests of the United States by preventing, eradicating, and controlling invasive species, as well as restoring ecosystems and other assets impacted by invasive species.”⁸

The U.S. Forest Service’s *National Strategic Framework for Invasive Species Management*⁹ commits to addressing invasive species because they “pose some of the greatest environmental and economic threats to the Nation’s forests, grasslands, and waterways.”

In California, invasive species are likewise widely recognized as a major problem. The *California State Wildlife Action Plan: A Conservation Legacy for Californians* (SWAP)¹⁰ recognizes invasive species as one of the top pressures on wildlife. Invasive plant control is called out in the strategies for protecting sensitive species and habitats in many regions. The SWAP says:

Human introduction (directly or indirectly) of invasive species is a critical existing pressure that is expected to continue, and be exacerbated by climate change. ...California is particularly vulnerable to invasive species because of its diverse ecosystems and communities. ...For preventing the spread of invasive weeds, the area affected is only part of the equation, it is also important to consider the area that could be affected in the future, if the species is allowed to spread.

4 Retrieved from <https://ipbes.net/news/Media-Release-Global-Assessment>

5 See <https://www.invasivespeciesinfo.gov/executive-orders-invasive-species>

6 See <https://www.cbd.int/gbo/gbo5/publication/gbo-5-en.pdf>

7 Retrieved from <https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species>

8 Retrieved from <https://www.doi.gov/invasivespecies/about-nisc>

9 Retrieved from https://www.fs.fed.us/foresthealth/publications/Framework_for_Invasive_Species_FS-1017.pdf

10 Retrieved from <https://wildlife.ca.gov/SWAP/Final>

*Safeguarding California Plan: California's Climate Adaptation Strategy*¹¹ also includes invasive species control as part of the restoration needed to increase the natural landscape's climate resiliency. The *California Biodiversity Initiative: A Roadmap for Protecting the State's Natural Heritage*¹² directs the California Natural Resources Agency and the California Department of Food and Agriculture (CDFA) to address "the challenges posed by weeds and invasive species," which "have tremendous impacts on native biodiversity, nearly eliminating susceptible species and transforming ecosystems and environmental services."

Nonprofit organizations, including the Wildlife Society, Defenders of Wildlife, Audubon Society, Rocky Mountain Elk Foundation, and others, have also made invasive species a critical focus. The Nature Conservancy's Global Invasive Species Team provided important resources in the early part of the century. Today, the California Invasive Plant Council (Cal-IPC)¹³ provides resources to the state's land managers and collaborates at the regional, national, and international level through partnerships, including the National Association of Invasive Plant Councils and the North American Invasive Species Network. The nonprofit California Native Plant Society (CNPS) has a longstanding policy stating that invasive plants can alter ecosystem function, modify wildlife habitat, threaten endangered plants, and impair biological function. CNPS urges government agencies and partners to coordinate at all levels to take management action to address the spread and impacts of invasive plants.¹⁴

SOME OF CALIFORNIA'S WORST INVASIVE PLANTS

Yellow starthistle (*Centaurea solstitialis*) is a spiny annual that grows in open grassland areas across roughly 14 million acres of the state. This thistle degrades wildlife and livestock forage quality and consumes enormous amounts of water—as much as one million acre-feet from the Sacramento Valley, or the equivalent of one-quarter of Lake Shasta's storage capacity.¹⁵

Giant reed (*Arundo donax*) is a 25-foot-tall bamboo-like plant that clogs coastal and Central Valley waterways, increasing flood damage, decreasing groundwater, degrading wildlife habitat, and adding abundant wildfire fuel in riparian areas.¹⁶

Water hyacinth (*Eichhornia crassipes*) is an aquatic plant native to the Amazon basin that forms huge mats in the Delta each year, damaging aquatic habitat and impeding recreational boat traffic.¹⁷

Atlantic smooth cordgrass (*Spartina alterniflora* hybrids) takes over marshes and mudflats in San Francisco Bay, degrading migratory waterfowl habitat and lessening future sea resiliency. A South American cordgrass has caused similar damage in Humboldt Bay.¹⁸

Scotch broom (*Cytisus scoparius*) is a woody shrub that spreads in the Sierra, adding ladder fuels that amplify wildfire danger. Invading broom may inhibit the regeneration of forests that have died from drought for decades to come.¹⁹

11 Retrieved from <https://resources.ca.gov/CNRA/legacyfiles/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>

12 Retrieved from <https://www.californiabiodiversityinitiative.org/pdf/california-biodiversity-action-plan.pdf>

13 See www.cal-ipc.org

14 Retrieved from <https://www.cnps.org/wp-content/uploads/2018/04/exotics.pdf>

15 See <https://www.cal-ipc.org/plants/profile/centaurea-solstitialis-profile/>

16 See <https://www.cal-ipc.org/plants/profile/arundo-donax-profile/>

17 See <https://www.cal-ipc.org/plants/profile/eichhornia-crassipes-profile/>

18 See <https://www.cal-ipc.org/plants/profile/spartina-alterniflora-x-spartina-foliosa/>

19 See <https://www.cal-ipc.org/plants/profile/cytisus-scoparius-profile/>



Even widespread weeds can be EDRR targets in some places. For example, yellow starthistle already infests some 15% of the state, but when found in an area that has not yet been infested it merits focused attention to remove it before it can spread. Photo by Jenna Allred, Santa Lucia Preserve in Monterey County.

The Impacts of Invasive Plant Species

The effects of invasive plants are best understood for widespread species such as those described in the table (previous page). However, even widespread species can often only be controlled locally. EDRR can be used on widespread species while they are still uncommon within a particular region. Landscape-scale progress against these weeds can be made with substantial funding for large, strategic control projects.

For instance, the State Coastal Conservancy leads a multimillion-dollar effort to eradicate invasive cordgrass from San Francisco Bay. Likewise, the California Wildlife Conservation Board (WCB) funds multimillion-dollar efforts to remove giant reed (*Arundo donax*) from watersheds across the state. The goal of EDRR, however, is to keep target species from ever becoming problems of this scale.

Along with invasive plants, California funds major EDRR programs for several species of invasive wildlife and for invasive agricultural pests. The California Department of Fish and Wildlife (CDFW) conducts EDRR for quagga (*Dreissena bugensis*) and zebra mussels (*D. polymorpha*), an effort mandated by state law.²⁰ The CDFW also has a dedicated nutria (*Myocastor coypus*) eradication program to eliminate this invasive rodent from Central Valley waterways. For invasive agricultural insect pests, CDFA partners with county agricultural commissioners (CACs) to conduct EDRR surveys throughout the state and screen people and materials at border stations, airports, and shipping docks. If they find an actionable pest, they are then able to mount a major campaign to control its spread.

Translating the impacts of invasive plants into economic terms can be difficult; however, they are clear, and they are profound. In the long run, EDRR is typically less expensive than simply letting an invasive plant spread and managing it in perpetuity. Given limited resources, conservation investments need to be highly strategic and aimed at yielding a high rate of return and meeting critical goals. There are a handful of resource management approaches that merit such investments. Among the most cost-effective is EDRR, which seeks to avoid large problems down the road by acting on small problems promptly.

The 2017 report, *Economic Impacts of Invasive Species: Direct Costs Estimates and Economic Impacts for Washington State*,²¹ calculated the financial repercussions of 23 select invasive plants and animals. They found \$1.3 billion in impacts each year to crops, timber, fisheries, livestock, and recreation, 80% of which were caused by plant species. The results are summarized in the “Economic Impact of Invasive Species to Washington State” fact sheet.²² California is much larger than Washington—2.3 times as big in land area, 4.9 times in population, and 5.2 times in GDP—so the economic impacts of invasive species are no doubt much greater as well. Scaled by land area, the comparable impacts in California are \$3 billion annually.

A 2008 survey by Cal-IPC and the nonprofit Sustainable Conservation²³ estimated that public agencies and private land trusts in California spend \$82 million on invasive plant control each year. Even so, land managers consider

20 See *Fish and Game Code Section 2302* and *14 CCR § 672.1*

21 Retrieved from <https://invasivespecies.wa.gov/wp-content/uploads/2019/07/EconomicImpactsRpt.pdf>

22 Retrieved from <https://invasivespecies.wa.gov/wp-content/uploads/2019/07/SpeciesEconomyFactSht.pdf>

23 Retrieved from https://www.cal-ipc.org/docs/ip/research/pdf/Cost_of_Invasive_Weeds_in_California.pdf



Dense biomass from invasive plants can fuel wildfires. Here, prison crews remove giant reed in San Benito County. This species carries wildfire through river corridors that once served as natural fuel breaks. Photo by Ron Ross.

invasive plant control to be vastly underfunded, as this level of funding meets only a small percentage of the total need.

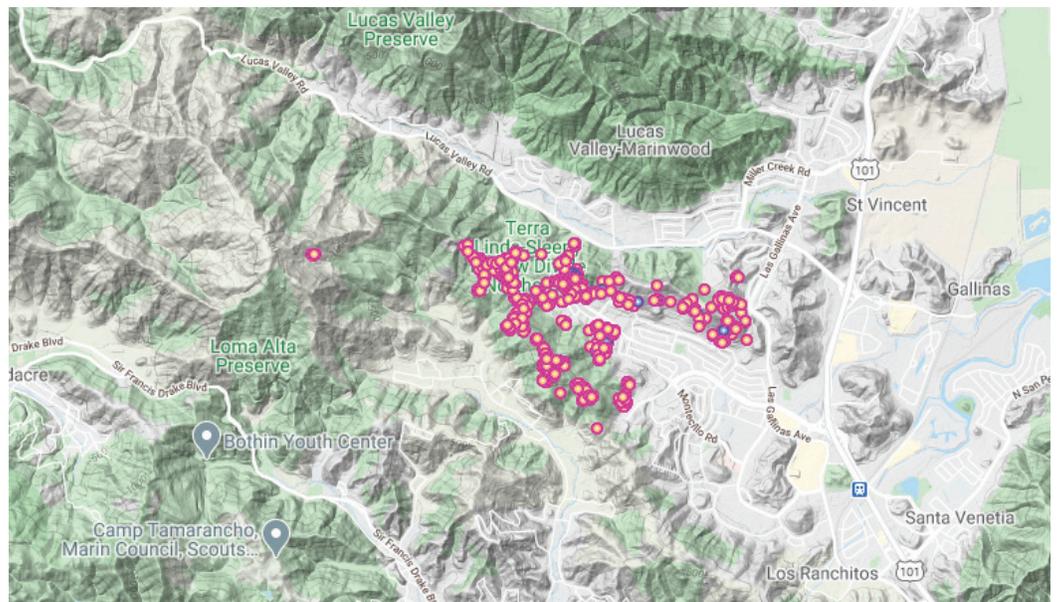
Invasive plants consume groundwater, fuel wildfires, and destroy crops—direct impacts that are easy to grasp but not necessarily simple to translate into dollars. Estimating the economic impact to California's tourist economy is also complex but important. Take the case of desert knapweed (*Volutaria tubuliflora*) in Borrego Springs, a small town in eastern San Diego County. Here, the local economy revolves around tourists who visit each spring to see desert wildflower blooms. The spread of this new invasive plant has so alarmed the Chamber of Commerce that they have organized a task force to respond. They recognize that degradation of the native wildflower displays would trigger what economists call the multiplier effect, sending financial hardship rippling through the broader community.

As an example of how control costs grow when action is delayed, consider the case of invasive Japanese knotweed (*Reynoutria japonica*)—one of the world's top weeds—along the Toutle River, which flows from Mt. St. Helens. The Washington State Department of Agriculture estimated the cost of removing the relatively small infestation at \$3,400. However, projected costs jumped to \$150,000 when they modeled its spread into adjacent suitable habitat.

As another example, in 2006, the Marin County Open Space District (MCOSD) invested in controlling an isolated infestation of barbed goatgrass (*Aegilops triuncialis*), a state-listed noxious weed, in Terra Linda/Sleepy Hollow Open Space Preserve before it could spread throughout the area (Figure 1). Their approach integrated prescribed fire, herbicide application, mowing, and hand pulling. Two years of aggressive control efforts reduced the known infestation to 10% of its original size. Managers continue to find new populations so ongoing efforts aim to contain the infestation and prevent further spread. Had MCOSD not detected, responded to, and stayed on top of this incipient infestation, barbed goatgrass would have spread widely across the region, and associated costs would have multiplied along with it.

Figure 1.

Map of the barbed goatgrass infestation at Terra Linda/Sleepy Hollow Open Space Preserve in Marin County, California. Source: Calflora.org.



THE IMPORTANCE OF INVASIVE PLANT EDRR

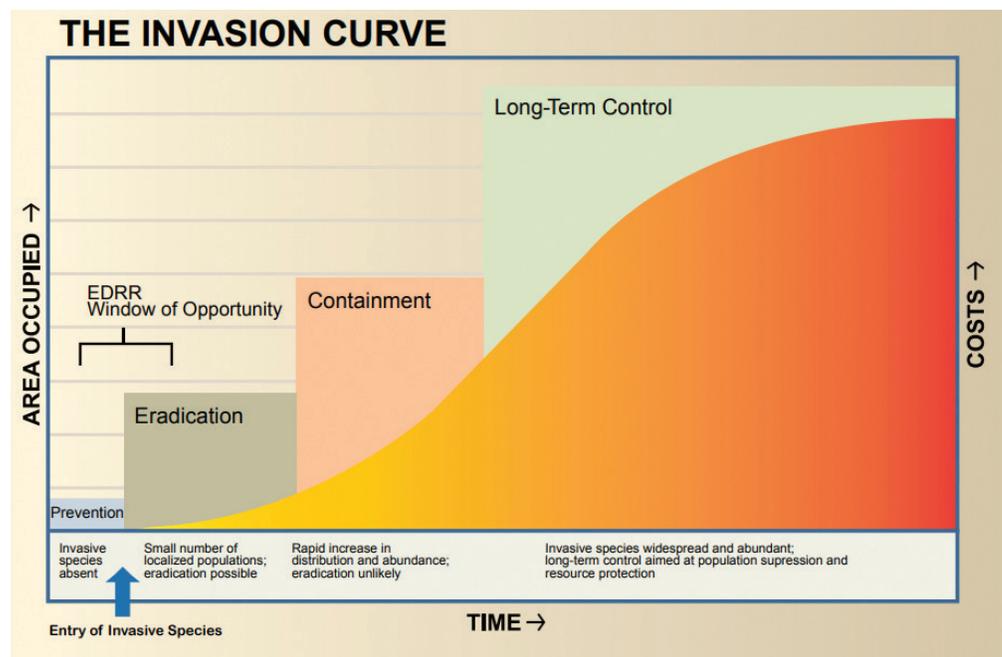
“A stitch in time saves nine.” “An ounce of prevention is worth a pound of cure.” Common sense and economics tell us that addressing problems early can keep them from becoming larger and harder to manage. EDRR embodies this idea by finding an invasive species soon after it has colonized a new area and controlling it. Ideally, it can be eradicated completely before it becomes fully established and spreads. The damage it causes can be reduced as well, and is likely to even be reversible.

For example, in 2000, a population of the invasive seaweed *Caulerpa taxifolia* was found near San Diego, presumably as a result of someone dumping an aquarium.²⁴ This plant was known to have spread widely in the Mediterranean Sea. Because the population was found while it was still small, biologists were able to eradicate it through tarping and chlorination. A second population was found in the Los Angeles area and also eradicated. This quick response, which required extraordinary collaboration and streamlined permitting, was driven by major concerns about the weed spreading swiftly beyond a scale at which it could be controlled and causing major marine ecosystem damage. Unfortunately, success stories like this one, in which a species was fully eradicated, are rare. But controlling a species to the point where it persists only at low levels can be extremely useful as well.

In 2016, the U.S. Department of the Interior led publication of a national EDRR blueprint, *Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response*.²⁵ The conceptual “invasion curve” graph from this taken from the report (Figure 2) shows the pattern of an invasive species establishing and becoming widespread over time. It illustrates the finite window of opportunity for implementing EDRR, the duration of which depends on how quickly a given species spreads.

Figure 2.

The stages of species invasion, from *Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response*.



24 See <https://www.fisheries.noaa.gov/west-coast/habitat-conservation/aquatic-invasive-species-west-coast-caulerpa-taxifolia>

25 See <https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf>

Determining which plants may become invasive in the future can help us get ahead of the curve. We can evaluate the risk of plants already in California, and of those that could be on their way here from neighboring states or through trade and travel pathways.

The successful eradication of *Caulerpa taxifolia* in southern California provides an idealized EDRR example: small populations of a known invasive species found far from where it had previously been seen were completely eradicated through a quick response. The factors that need to converge to produce an optimal EDRR situation like this one include:

- **Scale:** Both number of populations and the size of populations, with fewer and smaller populations being more conducive to effective EDRR
- **Severity:** The potential for damage from the species
- **Isolation:** The distance from other populations of the species
- **Feasibility:** The probability of effective control

Scale relates to both eradication feasibility and also to species detection. While finding a smaller new invasion is ideal, it is rare to detect the very first individuals. Detection depends on several factors, starting with a knowledgeable observer being in the right place at the right time. Even then, the species may be missed if it is not obvious. Fortunately, *Caulerpa's* distinctive appearance was unlike the native flora. Furthermore, it may be difficult to know that the population(s) detected represent the complete extent, even if resources are available to conduct surveys. Finally, to be useful, the observation needs to be passed along to those who can respond appropriately.

Severity is not always apparent. In the case of *Caulerpa*, the plant had become widely known by marine biologists after its explosive spread in the Mediterranean, so there was immediate alarm when it was found in the wild in California. A less familiar or unknown invasive species will not likely raise alarm unless it spreads very quickly. But by then, the scale may no longer be sufficiently limited for complete eradication to be feasible.

Isolation relates to the distance from other populations of the same species. For an invasive species that is new to California, such as *Caulerpa*, the nearest known populations were on another continent. A species already known to be a problem in California can still be a good EDRR target if it is found in a new region of the state.

Taken together, severity and isolation dictate the priority level of an EDRR detection.

Feasibility of eradication is determined in large part by the scale of the population in relation to the level of resources available to manage it. Unfortunately, it is not uncommon for an invasive species population to grow beyond an eradicable scale during the delay between being initially detected and implementing a response, given the difficulties that can arise in securing funding, landowner permissions, and environmental permits. Indeed, landscape-level EDRR requires a high degree of cross-boundary coordination and cooperation, as invasive plants are not constrained by jurisdictional borders and are often found growing on multiple properties.

EDRR also depends on information. It requires botanical expertise about the target plant species, ecological information about its impacts, and management expertise about eradication techniques. In addition, this information must be

timely and cover a wide geographic area. However, with all of this in hand, managers can set EDRR priorities to optimize conservation outcomes for the level of available resources.

Detection may be lucky, the result of an individual observing a plant of interest in the field, then passing information along to others who can evaluate the need for response. A more proactive approach requires implementing regular surveys to look for both known and unknown targets and educating community volunteers to “be on the lookout” as well. However, mounting a response requires organizational management infrastructure and resources.



Volunteers provide welcome help. From corporate groups to school kids, volunteers provide essential support for agency- and nonprofit-led invasive plant removal efforts. Here, Bolsa Chica Conservancy volunteers remove crystalline iceplant (*Mesembryanthemum crystallinum*) in Orange County. Photo by Kenneth Perez.

The national framework²⁶ also stresses the need for preparation that “establishes the plans, coordination networks, tools, training, and necessary resources for deployment of detection, rapid assessment, and rapid response actions.” This preparation includes “horizon scanning”—identifying which plants might be invasive in the future—to increase awareness of potential new threats before they arrive. These might be known invasive plants that could be introduced to the area, or nonnative plants that could become invasive.

As is pointed out in the introductory article of a special issue of the journal *Biological Invasions* dedicated to this topic,²⁷ EDRR is not so much a precise list of linear steps but rather a guiding principle for minimizing the impact of invasive species in an expedited yet effective and cost-efficient manner. EDRR in real-world situations is situation-specific, iterative, and nonlinear.

In distilling a dozen articles for this special issue on EDRR, several general aspects stand out as particularly important: leadership and legal authority, coordinated stakeholder partnership at multiple levels, and strategic information resources. These, along with the critical need to secure funding, permits, and landowner permission, are reviewed in the following section on EDRR in California.

26 See <https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf>

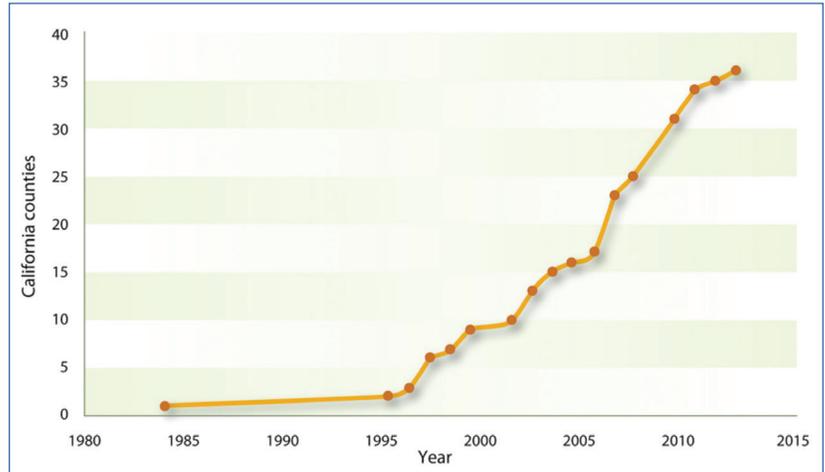
27 See <https://link.springer.com/journal/10530/22/1>

Figure 3.

Three examples from across California illustrate the importance of early detection and treatment to managing invasion levels.

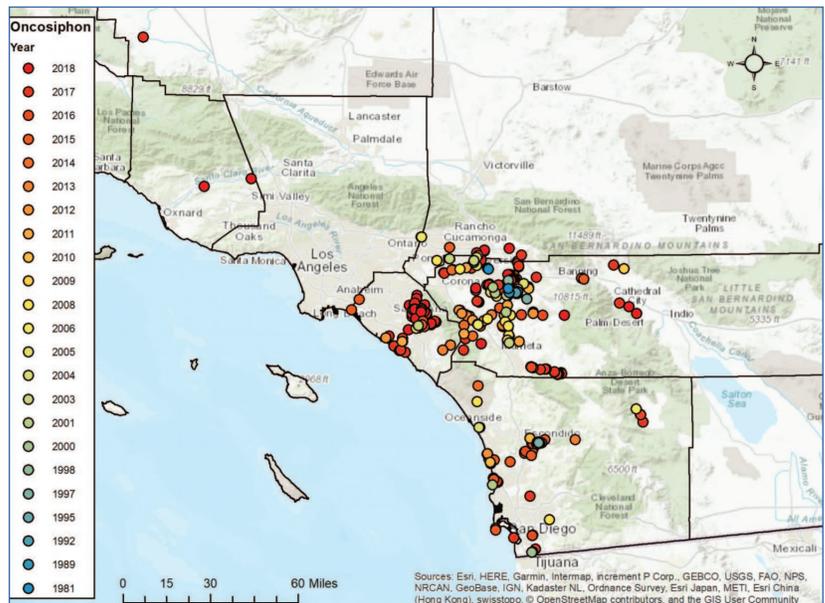
One that got away 25 years ago...

Stinkwort (*Dittrichia graveolens*) was first found in Santa Clara County in the 1980s. Since then, it has spread to more than half of the counties in the state. (Graph from *California Agriculture* magazine, retrieved from <http://calag.ucanr.edu/Archive/?article=ca.v067n02p110>).



One that got away 10 years ago...

Stinknet (*Oncosiphon piluliferum*) is native to South Africa. It became established in a few southern California locations in the 1990s. In recent years, it has spread widely in southern California, and pioneer populations are now being found moving northward into the Central Valley. (Map from Cal-IPC's *Dispatch* newsletter, article by Christopher J. McDonald, Natural Resource Advisor, University of California, Cooperative Extension, retrieved from https://www.cal-ipc.org/wp-content/uploads/2019/04/Cal-IPC_Dispatch_Spring_2019_FINAL.pdf).



One that is getting away now...

Desert knapweed (*Volutaria tubuliflora*), a new invasive plant from northern Africa, has recently been found in four locations in southern California. While three small coastal infestations are under control, a large infestation of about 25 square miles was found around the town of Borrego Springs in eastern San Diego County in 2015. Climate-suitability modeling predicts that the plant can spread over a large area of California and beyond. To date, no agencies have taken responsibility for stopping its spread. (Map generated at <http://websites.greeninfo.org/plantright/finder/>. Currently infested regions are indicated by the black lines, with the potential range based on modeling of climatic conditions in green.)



The CDFA and the Natural Resources Agency are charged with leading the California Biodiversity Collaborative and the Invasive Species Council of California. Their leadership is essential for implementing effective invasive plant EDRR.



Leadership and funding are essential to protect California’s biodiversity.

California’s ecologically rich grasslands provide forage for everything from bees to pronghorn. However, while many agencies recognize the urgent need to protect the exceptional biodiversity of places like these from invasive species, few have the resources to do so, especially at scale. Here, a treatment crew spot-sprays invasive red brome (*Bromus madritensis*) in the Cleveland National Forest in San Diego County. Photo by Stevie Steele.

CURRENT STATUS OF EDRR FOR CALIFORNIA’S INVASIVE PLANTS

Many key pieces of EDRR for invasive plants are already in place across the state. Land managers are familiar with the concept as part of integrated pest management (IPM), and several have already developed EDRR programs. Implementing the approach at a landscape level, however, requires more substantial infrastructure. The state’s current EDRR support system is described in this section, and recommendations for ways to sustain current capacity and expand opportunities are included in the section that follows.

In 2013, state and federal agencies involved in invasive plant management agreed to principles outlined in a *Blueprint for Coordinated Landscape-Scale Management of Invasive Plants in California*.²⁸ The blueprint describes key players and available resources, some of which are updated below. Actions recommended in the blueprint are integrated into the following section.

Leadership, Legal Authority, and Funding

Issues of EDRR leadership and legal authority are critical at both the state and local levels. Because weeds were historically viewed as an agricultural problem, CDFA is the lead state agency working in partnership with local CACs. These efforts are guided by a regulatory “noxious weed” rating system²⁹ that prioritizes EDRR. For instance, an “A” rated weed is one that is targeted for statewide eradication. In the mid-to late-1900s, this coordinated system eradicated 20 weed species at the state level and extirpated thousands of key populations. Since then, resources allocated for such efforts have decreased significantly. Most state funds for pest control go to control insects and diseases that can devastate commodity crops. A succession of economic recessions has also severely reduced General Fund budgets for weed control by state and county agencies.

CDFA created and oversees the state’s network of county Weed Management Areas (WMAs), which are most typically coordinated by CACs. The WMA system is a key element of invasive plant EDRR, as described later in this report. After eight years with no state funding for WMAs, CDFA received renewed funding in 2019 through the state’s Biodiversity Collaborative. Then, as a result of the 2020 budget crisis, this funding was cut—whether temporarily or permanently remains to be seen. Meanwhile, a new revenue stream from the Unclaimed Gas Tax Fund has been directed to an invasive plant management grant program for CACs through CDFA.

CDFA has the authority to regulate plant sales via Section 4500 of the Food and Agriculture chapter of the California Code of Regulations. It also has the authority to mandate invasive plant removal from a site, though this is rarely enforced due to lack of capacity. CDFA uses similar authority to remove insect threats that pose a high agricultural risk.

²⁸ See https://www.cal-ipc.org/resources/library/publications/cinipc_blueprint/

²⁹ There is significant overlap between the state noxious weed list and Cal-IPC’s invasive plant list, but Cal-IPC includes additional plants based on environmental impact.



Aquatic weeds impact the Delta and beyond. Researchers from UC Davis, the USDA Agricultural Research Service, and DBW are working hard to find the best control techniques for water hyacinth (*Eichhornia crassipes*) and other aquatic weeds. Photo from UC Weed Science blog post by Guy B. Kyser and John Madsen.

Departments within the California Natural Resources Agency have developed invasive species management programs as scientists' understanding of the environmental impacts of invasive species has grown. The missions of the CDFW, WCB, California (State Parks), the California Department of Water Resources (DWR), the Department of Conservation, and CAL FIRE all intersect with invasive plants. However, these agencies do not have sufficient funding to fully address invasive plant management. For example, State Parks has stated that invasive plant management is one of their top stewardship challenges, but that stewardship as a whole is funded at less than 15% of the total need.

It is also important to note that none of these resource agencies has either the mandate or funding to oversee a coordinated statewide invasive plant response, despite acknowledging that it is critical to meeting their missions. This paradox is most evident with CDFW, an agency charged with protecting the state's wildlife and whose own State Wildlife Plan presents invasive species as a top stressor.

Occasionally, funding and leadership have emerged for programs that focus on individual species that attain a sufficiently high level of political visibility to capture legislative champions, from *Caulerpa* to nutria to shot hole borer beetles (*Euwallacea sp.*). Similarly, programs have been catalyzed for species with a logical funding mechanism, like quagga and zebra mussels, which are chiefly moved between water bodies by boaters, who pay fees. But a proactive EDRR program, no matter how cost-effective, no matter how essential for meeting an agency's mission, has not had the political clout to attract funding support.

CDFA and the Natural Resources Agency have committed to collaborating via multiple efforts, including the interagency ISCC and the Biodiversity Collaborative, both of which they co-chair. This is a powerful collaboration, particularly when funding is made available as it initially was through the Biodiversity Collaborative.

EDRR is particularly critical for aquatic invasive plants because they can spread so quickly. Responsibility for aquatic invasive plants is split between the California State Parks Division of Boating and Waterways (DBW) in the Delta and Suisun Marsh and CDFA elsewhere in the state. For DBW to work on a new invasive plant species, a risk assessment must be performed by CDFW, which can delay the response if it is not done immediately. These efforts are not fully funded, and what has happened with species like alligator weed (*Alternanthera philoxeroides*), found in northern California, demonstrate the cracks in the system when neither agency owns the problem (described in detail in a later section).

Strong leadership at the local level is also essential for initiating and sustaining regional EDRR programs. CACs retain key invasive plant management authority in connection with the CDFA. Resource Conservation Districts (RCDs), special districts set up to conserve natural resources on both public and private land, are another key local entity working on invasive plant management. The size and capacity of CACs and RCDs vary considerably across the state. Both are critical for overseeing implementation of EDRR control measures because both can serve as lead agencies for CEQA permitting and can also hold land-owner access agreements.

Coordinated Regional Collaboration

Controlling invasive plants is a quintessential landscape-level challenge—“weeds don’t recognize fences,” as the saying goes. Historically, CDFG maintained a network of regional biologists across the state who worked with CACs to track and control invasive plants. Unfortunately, the budgets for those partners decreased over time while the problem only got worse.

In 1999, California created a structure for local WMAs, borrowing an idea that originated in the Yellowstone region and has since spread across the country. A WMA brings together all agencies and stakeholders in a geographic area to work on invasive plant management. State funding for the program (through CDFG) has been cut and restored several times since then, most recently with \$3 million per year included in the 2019 budget as part of the Biodiversity Collaborative (which was then cut due to the budget crisis).

The importance of the state’s network of WMAs cannot be overstated. As described in the previous section, EDRR requires extensive information-sharing and cross-jurisdictional coordination. The only way to accomplish this is with an organized network of land managers, structured from the local to the state level. That is precisely what is provided by the organizations and individuals in the WMA network. However, the network requires statewide agency leadership and funding to function.

Other networks provide resources where possible. Cal-IPC’s statewide membership of land managers share information via an annual conference, newsletter, website, listserv, and social media channels. With grant funding from CDFG’s Biodiversity Collaborative, Cal-IPC is working with CDFG, CACs, and WMAs across the state to develop regional EDRR priorities. Local CNPS chapters also work to control invasive plants. For instance, the CNPS Orange County Chapter runs an Emergent Invasive Plant Management Program³⁰ that collates reports on nonnative plants in the region and coordinates with local authorities to organize a response. Given the growing community interest in collecting biological data via smartphone applications such as iNaturalist and Calflora, those engaged in CNPS chapters and other local environmental groups will be an important resource for eyes-and-ears on the ground.

Regional partnerships are further evolving to coordinate land management activities. At the national level, the Network for Landscape Conservation³¹ supports such efforts by “advancing conservation at scale by promoting cross-border, collaborative efforts.” In California, the California Landscape Stewardship Network³² counts 30 such partnerships across the state at various scales. The following are several examples of regional partnerships working on invasive plant EDRR.

- **The San Diego Management and Monitoring Program** (SDMMP)³³ brings together 83 partner agencies and groups to oversee work on Multiple Species Conservation Plans and Habitat Conservation Plans that span all of San Diego County except the desert (an area of 1.7 million acres), with

The WMA network provides the essential collaborative infrastructure needed to get invasive plant EDRR work done.

“For land to be ‘protected’ means more than just acquisitions and easements; it also must include long-term adaptive management. Invasive species are a transcendent landscape-level management issue. It’s like a slow-moving wildfire across the entire landscape.”

*Michael O’Connell, CEO,
Irvine Ranch Conservancy*

30 See <https://occnps.org/invasives/emergent-invasive-plant-management-program.html>

31 See <http://landscapeconservation.org/>

32 See <https://calandscapestewardshipnetwork.org/>

33 See <https://sdmmp.com/>



Cross-jurisdictional collaboration is essential. The One Tam EDRR program enables Marin County Parks, California State Parks, the Marin Municipal Water District, and the Golden Gate National Recreation Area to tackle invasive plants at a landscape scale. The land managers and volunteers shown here are training each other to identify new invasive plants at various growth stages. Photo: David Greenberger.

funding from a county sales tax that raises funds for transportation projects. The SDMMP developed a tiered invasive strategic management plan, with 24 plant species identified for EDRR. Currently, 13 plant species at 34 sites are being actively controlled.

- **One Tam** brings together Mount Tamalpais State Park, Golden Gate National Recreation Area, Marin County Parks, Marin Municipal Water District, and Golden Gate National Parks Conservancy to coordinate stewardship of more than 53,000 acres of natural areas. One Tam prescribes active surveys for 23 "priority one" invasive plant species that are either rare in the region or not currently known in the region but found nearby in Marin or neighboring counties. Over three years, One Tam surveyors covered 462 miles of roads, trails, drainages, and known disturbed sites, resulting in 724 detections of priority-one species.
- **The Orange Coast Collaborative** brings together the City of Irvine; Orange County Parks; Orange Coast District of State Parks; and other local, state, and federal agencies to coordinate land management for a 38,000-acre Natural Communities Conservation Plan/Habitat Conservation Plan and a larger 100,000-acre planning area. The collaborative divides the region into more than twenty management units based on watersheds and land ownership, and prescribes EDRR surveys for trailheads, facilities, roads, and trails on a regular basis, depending on their level of vulnerability to new invasive plant introductions.

These regional stewardship collaboratives seek funding from diverse sources and, along with WMAs, provide essential connectivity among landowners and stakeholders for implementing invasive plant EDRR.

Strategic Information Resources

The key information needed for EDRR are the impacts and invasiveness of the plant species and their spatial distribution on the landscape. Of course, information on funding, permitting, and IPM approaches is also important for all invasive plant management efforts.

Impacts and invasiveness: Information on the impacts and invasiveness of a plant species is provided by Cal-IPC's California Inventory of Invasive Plants.³⁴ The inventory uses a criteria system and transparent review process to evaluate and rate invasive plants in the state. Cal-IPC undertakes this effort in collaboration with researchers and practitioners from universities, agencies, and NGOs. In 2018, the Inventory was expanded to list "Watch" species, nonnative plants already growing in the wild in California that ranked high for potential future invasiveness when evaluated using a UC Davis screening tool.

Other available sources of information on invasive plant species include the Invasive Species List and Scorecards for California,³⁵ created by the Invasive Species Council of California and maintained by UC Davis. This list builds on the Cal-IPC Inventory and adds plant species from other states deemed a potential threat for moving into the state. The list also includes invasive organisms of other taxonomic groups, totaling some 1,700 total species. In addition, the Weed Research and Information Center at UC Davis serves as a portal to Cooperative Extension research on distribution, impacts, and effective control techniques.³⁶

Spatial distribution: Spatial information on the distribution of invasive plant species allows land managers to gauge the geographic isolation of an invasive plant population from other populations of the same species. The more isolated, the more potential concern about the population spreading the into a new area. In 2010, the U.S. Forest Service and CDFA used federal stimulus funds to help Cal-IPC build CalWeedMapper,³⁷ an online tool designed to help land managers use invasive plant distribution to set landscape-level management priorities. The tool provides statewide distribution maps for each of the invasive plant species listed in the Cal-IPC Inventory, based on data from two sources: observations contributed to the online Calflora database from both individuals and organizations, and expert knowledge collected through interviews across the state. The latter data are much coarser resolution, but critical for filling in areas where a plant has not been mapped in Calflora. CalWeedMapper receives a daily feed from Calflora, as new data is being contributed all the time.

Most importantly, CalWeedMapper is designed to provide users with potential EDRR priorities for their selected region. They can learn which invasive plant species are relatively rare and therefore potential eradication targets. They can also see which ones are not in the region of concern but are found nearby and so are potential EDRR targets to be on the lookout for in case they move in. CalWeedMapper has been used to set priorities in some parts of the state, and WCB has funded two regional eradication projects based on these plans. CDFA endorses the process and funded Cal-IPC to generate basic plans for all the state's regions.



Invasive plants are on the move. An El Dorado County agricultural biologist monitors the spread of perennial pepper weed (*Lepidium latifolium*) along a mountain highway in the Sierra Nevada. Climate change is making conditions at higher elevations more hospitable for invasive plants in areas that have been relatively free of weeds. Photo by Jesse Honeycutt.

³⁴ See <https://www.cal-ipc.org/plants/inventory/>

³⁵ See <http://ice.ucdavis.edu/invasives/>

³⁶ See <https://wric.ucdavis.edu/>

³⁷ See <https://calweedmapper.cal-ipc.org/>

The WHIPPET tool (abbreviation for Weed Heuristics: Invasive Population Prioritization for Eradication Tool)³⁸ is another prioritization tool deserving mention. Its development was funded by CDFA to prioritize management for populations of different invasive plant species based on a range of factors, from how much impact they are likely to have to how feasible it will be to control them. Regional partnerships like One Tam have used WHIPPET to set priorities in their work.

Smartphone apps have brought field mapping to the masses, and substantial volunteer observational data is contributed to both to Calflora and to iNaturalist (whose data is shared with Calflora). Calflora has developed professional-grade tools for land managers that can take the place of in-house GIS infrastructure. Many state agencies utilize ESRI products such as Collector and Survey 123 to collect data in the field, and ArcMap and ArcGIS Online to manipulate the data and produce maps. CDFW will soon be releasing a new app for posting observations of California invasive species developed by EDDMapS.³⁹

Together, these tools and data systems not only help the individual land manager, they also create the potential for landscape-level invasive plant mapping by aggregating data from many sources. However, not all data is currently aggregated, and some is sensitive and cannot be publicly shared. There has been an effort to make sure all datasets are shared with Calflora, with agencies like the U.S. Forest Service working to import data from their system on an annual basis. Both EDDMapS and Calflora have also worked to be able to share their data on invasive plants.

While many pieces are in place for effective EDRR of invasive plants in California, none of the efforts previously discussed are fully functioning or integrated at the state level. The following section looks at these shortfalls and what can be done to address them.

HOW TO MAKE EDRR MORE EFFECTIVE FOR INVASIVE PLANTS IN CALIFORNIA

Those involved in land management have identified many ways to address the challenges of conducting truly effective EDRR. Most are not complicated but do require a meaningful investment in institutional leadership and financial support at the state and local levels. Here, we describe ways to address the challenges that stand in the way of successful EDRR. The section that follows this one contains a full list recommended actions.

Focus Stewardship on Collaborative Land Management

Our operational definition of stewardship—the long-term protection of biodiversity, water, and other natural resources—must focus on land-management practices. Much conservation emphasis is put on securing land tenure or easements to head off development. Equally important is how land, regardless of ownership, is cared for. If we neglect the land management component, we risk not attaining our stewardship goals.



Conservation corps play an important role in EDRR. Local and statewide conservation corps provide crews for invasive plant removal. Here, North Bay Conservation Corps members remove broom from coastal wildlands in Marin County. Photo by Danny Franco.

³⁸ See <https://whippet.cal-ipc.org/>

³⁹ See <https://www.eddmaps.org/>

Stewardship of our lands and waters requires collaborative, multijurisdictional work at the landscape level. Invasive plant EDRR is a critical component of this kind of stewardship.

“It’s critically important to incorporate invasive plant removal into ecologically-sensitive vegetation management to promote more resilient, fire-adapted native plant communities and reduce the severity of wildfire.”

Coty Sifuentes-Winter, Senior Resource Management Specialist, Midpeninsula Regional Open Space District

Effective landscape-scale stewardship requires multijurisdictional collaboration through networks of groups. This acknowledgment forms the foundation of the California Landscape Stewardship Network, which places collaboration at the center of conservation.⁴⁰ It is also the basis for the national Network for Landscape Conservation, whose Catalyst Fund⁴¹ supports the belief that:

Working at the landscape scale—the scale nature functions—is the only effective way to tackle pressing challenges such as climate change, habitat loss, and landscape fragmentation;

Extensive and enduring collaboration is essential to achieving successful conservation across whole landscapes; and

It takes dedicated time and resources to build and sustain such collaboration.

Some existing structures—for example, regional Natural Community Conservation Plans or Regional Conservation Investment Strategies—create opportunities for such collaboration. However, they can add funding and significant legal complexities as well. Other collaborations, such as One Tam and the Orange Coast Collaborative, are more flexible in how they are designed but do not create a source of funding for ongoing stewardship.

An understanding that ongoing land management is an essential component of stewardship and that collaboration at the landscape scale is essential to effectively address critical land-management issues such as EDRR should be incorporated into the state’s programmatic infrastructure for conservation. The overlap of EDRR with state agency programs and funding is described below.

Strengthen Institutional Roles

Invasive plants connect strongly with the missions of multiple state agencies, including State Parks, the Department of Water Resources, CAL FIRE, and Caltrans. For example, California State Parks spends more than 40% of its annual ongoing natural resource maintenance budget on invasive species control in alignment with its mission to protect the state’s extraordinary biological diversity.

Because invasive plants impact agriculture and wildlife, the overlap is strongest with two agencies: CDFA and CDFW. CDFA has statewide authority for regulating noxious weeds and has historically had programmatic infrastructure for controlling invasive plants. This includes the department’s mission to protect agriculture and the statewide WMA program, though funding for this program has been intermittent at best in recent years. CDFW manages invasive plants in their wildlife areas and ecological reserves. WCB also provides some grants that support invasive plant control projects throughout the state. But the department has no coordinated statewide program for protecting wildlife from invasive plants, despite the importance of invasive plant control to meeting goals in the State Wildlife Action Plan. This is a significant gap in state infrastructure.

⁴⁰ See *Advancing Collaboration in California* https://calandscapestewardshipnetwork.org/sites/default/files/2020-01/Advancing%20Collaboration%20White%20Paper_Final01192020.pdf

⁴¹ See <http://landscapeconservation.org/catalyst-fund/>

California's State Wildlife Action Plan identifies invasive plants as a top threat. Yet CDFW, the agency mandated to "manage California's diverse fish, wildlife, and the habitats on which they depend," does not receive support to address invasive plants at the statewide level. Instead, this work is left to the agency mandated to protect the state's agriculture, CDFA. This is a fundamental problem because funding for programs critical to the success of CDFW's mission loses out to agricultural priorities when budgets are tight.



Regional coordination is critical. Many invasive plant species get their start in urban areas or on private land, making coordination among many jurisdictions essential to stopping their spread. Some, like Japanese dodder (*Cuscuta japonica*), shown here in an Oakland yard, are able to degrade entire urban creek habitats. Photo by Edmund Duarte.

For invasive aquatic plants, the institutional roles are different. DBW is responsible for controlling invasive aquatic plants in both the Delta and Suisun Marsh. To move forward with control activities on any new invasive plants detected in the Delta, it must first receive authorization from CDFW after completing a risk assessment on the plant.⁴² Previously, authorization had to come through the Legislature, a lengthy pathway that resulted in significant delays in responding to new weeds. This became blatantly apparent with the arrival of South American spongeplant (*Limnobium laevigatum*), which triggered legislation to change the workflow⁴³ by moving authorization to CDFW.

Control of invasive aquatic weeds throughout the rest of the state is ostensibly the responsibility of CDFA (though they do not receive a budget for this). DWR is engaged in protecting water resources from invasive plants, and DWR and DBW have funded CDFA to contain one major invasive aquatic plant, hydrilla (*Hydrilla verticillata*), across the state. However, as the recent case of alligator weed shows, responsibility outside the Delta is unclear. (Both hydrilla and alligator weed are A-rated noxious weeds.⁴⁴) This invasive plant had only been known in southern California but was discovered in the northern part of the state in 2017. For populations found in the Delta, DBW secured a risk assessment from CDFW and proceeded with treatment in 2018. However, for populations outside the Delta (which are now found as far north as the Feather River, likely spread by boaters), CDFA has not been able to respond and no one else has claimed responsibility either.

These gaps in authority, mandates, programs, and funding contribute to lost EDRR opportunities. Consistent engagement in a systematic effort is vital.

As with the departments of agriculture in some other states, CDFA has authority⁴⁵ to abate pests on private property as a public nuisance. CDFA exercises this authority cautiously, using it for insect pests that pose a major threat, and often faces public pushback.⁴⁶ Such authority is used more forcibly elsewhere.⁴⁷ In California, more proactive intervention in these areas could be a powerful tool for incipient invasive plant species (like desert knapweed) that grow primarily on undeveloped private land.

CDFA's authority to define and regulate noxious weeds in the state is the foundation for other authorities, including nursery restrictions and abatement. The list of noxious weeds and ratings can be a powerful tool for guiding control actions and raising public awareness, but this potential is not yet fully realized. The department is working to make the list more easily accessible online.

42 Per Harbors and Navigation Code, see http://leginfo.ca.gov/faces/codes_displaySection.xhtml?sectionNum=64.5.&lawCode=HNC

43 AB 763 (Buchanan) https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB763

44 See USDA *Plants database* <https://plants.usda.gov/java/noxious?rptType=State&statefips=06>

45 Food and Agriculture Code, Division 4, Section 6 https://leginfo.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=FAC&division=4.&title=&part=1.&chapter=6.&article=

46 For instance, "Mandatory insect spraying angers Sacramento County residents" retrieved from <https://www.sacbee.com/article24020152.html>

47 For instance, King County, WA; see <https://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/laws.aspx>

State programs targeting a single invasive species are important, but we also need stable support for programs that look at a broad range of invasive species. This will allow us to be proactive as well as reactive, and help keep little problems from becoming big, expensive ones.

Finally, CDFA and the Natural Resources Agency are co-leads for the Invasive Species Council of California and for implementing the California Biodiversity Collaborative, two efforts that should prioritize strengthening invasive plant management. While engaging multiple partners that cover the wide range of issues addressed by these agencies is a strength, it is also a challenge to coordinate these entities and lead activities to meet goals. Both these efforts have enormous potential as venues for implementing measures needed to strengthen EDRR for invasive plants.

Meet Funding Needs

State funding is a critical catalyst for regional projects. For instance, state funding for WMAs has typically brought in a greater than 2:1 match in other funds and in-kind expenditures. For the most part, the types of projects WMAs have funded have not been funded in any other way.

There are multiple types of state funding, each with its pros and cons. The WMA program, when it has been funded, received General Fund dollars in CDFA's budget. The other main source of funding for invasive plant control projects has been grants from natural resource bond measures. Figure 4 notes some of the differing aspects of these funding sources.

The WMA program, when funded through the General Fund, provides small grants to many local collaborations across the state specifically for invasive plant management. State bond funds support a lesser number of larger invasive plant management projects that have had to compete with a range of other types of conservation projects. Beyond grants, though, the WMA program has had a coordinator and other infrastructure that enables it to function as a statewide network.

Bond funds are dedicated to capital improvement projects that secure long-term conservation outcomes. To fit this requirement, projects focused on invasive plant management are eligible only if they aim to eradicate an invasive plant infestation in a region. This includes EDRR projects designed to eradicate a relatively uncommon weed. It also includes non-EDRR projects for wide-spread weeds, such as eradicating giant reed from an entire watershed. Such control projects are much more expensive than EDRR projects.

The table below compares several aspects of grant funding through these two sources, the WMA program versus bonds.

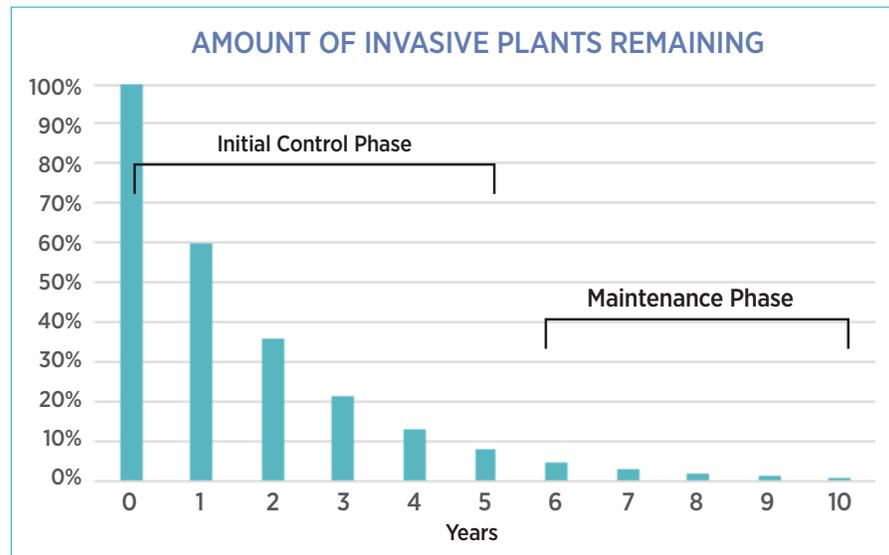
	WMA Program (General Fund)	Grants from Bond Funds
Consistent funding?	no	variable
Focused on invasive plant management?	yes	no
Easy to secure landowner participation?	yes	no
Scale of grants	small	large
Quantity of grants	large	medium
Ease of application and reporting	easy	difficult

Figure 4.
Comparison of different EDRR funding sources

Complete eradication is difficult to achieve and difficult to document, but a project can accomplish the intensive first phase of work, which removes a high portion of the invasive plants, when there is a solid commitment from local managers to maintain the ongoing, low-level management required over time. The simple exponential decay shown in Figure 5 uses a 60% reduction of an invasive species each year to reach a level of less than 10% after five years. Five additional years of work brings the amount to less than 1% of the original number.

Figure 5.

The decreasing percentage of a population remaining over time shows the importance of ongoing maintenance for invasive species control.



This rationale has allowed several collaborative projects to secure grants from state bond funds to implement five-year regional invasive plant eradication projects. Each has strong leadership from the grantee. In Humboldt and Del Norte Counties, the Redwood Community Action Agency is leading an effort to eradicate invasive knotweeds and three other regional eradication targets on the north coast, while the Upper Salinas-Las Tablas RCD is leading an effort in San Luis Obispo and Santa Barbara Counties to eradicate five incipient invasive plant species.

The five-year duration is critical for covering enough control work to bring the invasive plant infestation down to a manageable level for eventual eradication, (e.g., 5% of the original amount). Innovative grant features, such as the ability to set aside a portion (e.g., 20%) in a trust for follow-up work over an extended period (e.g., 10 additional years) could help ensure project success.

Beyond the biological challenges of achieving eradication, there are logistical challenges as well. One is finding a lead entity with sufficient capacity to coordinate a long-term effort over a region that crosses jurisdictions. CACs often serve as leads for WMAs, but they only work within their own county, so they cannot serve as the lead for a landscape-level effort. RCDs are likewise constrained to a given geographic region, though they can arrange MOUs with neighboring districts.

Securing environmental compliance (for CEQA and any other applicable regulations) is another hurdle that will be discussed in the next section.



Cutting Green Tape for conservation and stewardship. Diverse stakeholders have met over the last year to identify critical improvements to California's regulatory structure that will enhance restoration efforts.

State funding from a bond typically requires documentation of landowner permission for work conducted on their land. The desired format is long-term access (typically 10 to 25 years) for the state to be able to verify their investment. Some private landowners are willing to consider this, some are not. However, they are generally more willing to work with local entities like CACs and RCDs and will allow access based on handshake agreements with local entities. Unfortunately, this is not sufficient for accessing state bond funds.

Similarly, state agencies providing grants from bond funds often require that all project sites be identified in advance. For an EDRR project, this is often unrealistic, since new populations may be found during implementation. Inclusion of a buffered survey area in which additional populations may be treated up to a specified acreage is one solution to this challenge.

Minimize Permitting Hurdles

Project permitting is an aspect of any land management project. Figuring out how to best secure necessary permits is a critical hurdle and, of course, the longer permitting takes, the less conducive it is to EDRR.

One of the chief requirements of a state-funded project is that the grantee or project partner serve as a CEQA lead agency, preparing and filing all necessary documents. It can be challenging to find such an entity for a regional project. A CAC can oversee invasive plant control in their county under a CEQA categorical exemption, but for a multicounty regional project, this needs to be done in each county.

RCDs are also able to serve as CEQA leads. As mentioned previously, although they are typically restricted to their district boundary, they can sign MOUs with neighboring RCDs to allow them to lead a project over a larger area. Some RCDs have excellent capacity for serving as CEQA leads, while others have none. Training each RCD or providing consultant support would help more of them sustain such capacity.

Many, but not all, grant programs provide funds for CEQA preparation and other activities to make a project "shovel-ready." Such planning grants are valuable for enabling EDRR projects to fulfill up-front requirements to then apply for implementation grants. These could be used in creative new ways. For instance, small WMA grants from CDFA could be used for planning purposes, which would then allow application for larger implementation grants from an entity like WCB.

Invasive plant EDRR projects sometimes overlap with a federally listed species. This can require consultation with the U.S. Fish and Wildlife Service (USFWS) before a project can be implemented—for instance, to secure a Section 7 or 10 Biological Opinion. Some projects can be configured to avoid "take" (potential harm to a listed species). Others will need more USFWS involvement to proceed, but the agency may not be able to get involved unless the project has the "federal nexus" of occurring on federal land, using federal dollars, or requiring federal permitting. If none of these apply, a potential EDRR project can find itself with no way forward.



Modern mapping technology can greatly enhance invasive plant EDRR. Digital mapping devices help collect high-quality field data while online databases like Calflora aggregate data across jurisdictions to support landscape-level approaches to stopping the spread of invasive plants. Here, Alex Young of the Sonoma Ecology Center collects data on giant reed along a Central Valley waterway in San Joaquin County. Photo by Dana Morawitz.

Projects that occur in wetlands or riparian areas require additional permitting through CDFW 1600 for lake and streambed alteration. Most invasive plant control projects do not result in major disturbance. Recent changes have resulted in an expedited process for projects of less than five acres or 500 linear feet.

There is a significant push for regulatory reform through the “Cutting Green Tape” Initiative, championed by the California Landscape Stewardship Network in partnership with the California Natural Resources Agency. As efforts progress to remove permitting constraints and increase efficiencies and effectiveness for restoration work to move forward, there will be ample opportunity to improve conditions for implementing invasive plant EDRR projects as well.

Enhance Information Resources

As discussed earlier, designing strategic, landscape-level stewardship efforts depends on several types of information, including details about the plants, their distribution, and the best ways to control them.

Posting formal information about the state’s noxious weeds and their ratings⁴⁸ is one important step. CDFA now posts its ratings, but more can be done to facilitate broader use of this information. Continued assessments of potential new problem plants, both by CDFA and by Cal-IPC, should be conducted and shared with the land management community, landscape design professionals, nursery industry, and public at large. Public gardens can play an important role as sentinels by reporting nonnative plants that demonstrate invasive tendencies on their grounds.⁴⁹

Shared online mapping platforms such as Calflora and iNaturalist, which allow users to contribute and use spatial data on plant observations, are indispensable in charting the distribution of invasive plant species. Adopting common data standards for EDRR-related data fields and providing strong metadata enhance information exchange between different platforms. For Calflora, which focuses on California, integration with systems that track similar data in neighboring states⁵⁰ is important for landscape-level efforts.

Overall, education on the tenets of planning for strategic invasive plant management is useful to align efforts across jurisdictions. In 2019, Cal-IPC and the USFWS collaborated to publish the *Land Manager’s Guide to Developing an Invasive Plant Management Plan*.⁵¹ The guide outlines a process for collecting information, involving stakeholders, weighing options, documenting priorities, operationalizing a workplan, and re-evaluating efforts. Trainings based on the guide—as well as training on skills in botanical identification, field mapping, and control techniques—are important for maintaining a strong workforce.

48 See <http://blogs.cdfa.ca.gov/Section3162/?p=1958>

49 See https://www.publicgardens.org/sites/default/files/images/Magazine/May_2019_PG_Magazine_reduced.pdf

50 Such as EDDMapS <https://www.eddmaps.org/>

51 Retrieved from <https://www.cal-ipc.org/resources/library/publications/developingplan/>

RECOMMENDATIONS

A list of the top actionable recommendations is presented first, with a full list following. The more of these actions that can be taken, the more effective the state's future invasive plant EDRR work will be.

Top Recommendations

- 1. Fund invasive plant EDRR through CDFA's statewide WMA program.** Recognize that funding discontinuity in this critical program greatly reduces its effectiveness and determine that funding through CDFA will not go below \$1.5 million, even during budget crises.
- 2. Build invasive plant expertise and capacity at CDFW and integrate it into collaborative management efforts.** Identify invasive plants as a top threat to the state's biodiversity, and one that CDFW must address to fulfill its mission. This would complement CDFA's more agriculturally focused efforts.
- 3. Enhance bond funding for invasive plant EDRR, including:**
 - **Use bond funds to create grant programs dedicated to invasive plant EDRR.** Directly fund invasive plant control to increase the amount of work accomplished and simplify the application process. Block grants may be a useful avenue for providing access to smaller EDRR grants.
 - **Be flexible in requiring up-front site identification for EDRR projects.** Recognize that additional invasion locations are often found during EDRR implementation and allow grantees flexibility in how sites are identified in the initial project scope and budget.
 - **Relax requirements for landowner access agreements.** Adjust requirements so that bond funding can support more EDRR projects, with additional flexibility in landowner access agreement requirements for scope and duration, and with the ability to hold agreements locally with a CAC or RCD and not with a state agency.
 - **Extend grant duration.** Extend grant terms to five years to accomplish the first phase of invasive plant EDRR. For some projects, it would be useful for a portion of the project budget to be held in a trust for a longer period to support the maintenance needed to ensure long-term outcomes.
 - **Access Greenhouse Gas Reduction Funds (GGRF) for invasive plant EDRR.** Fund invasive plant EDRR as a top priority if the allowable use of GGRF money expands to include climate change adaptation.
 - **Fund planning activities.** Recognize that EDRR projects benefit from pre-implementation planning, including mapping and permitting. This can be supported through separate grants or allowed as a portion of implementation grants.

Full List of Recommendations

Focus Stewardship on Collaborative Land Management:

- **Elevate the role of land management in stewardship, including invasive plant control and EDRR.** Recognize that land management is at the core of stewarding biodiversity and natural resources and recognize invasive plant EDRR as a core component of land management.
- **Promote landscape-level collaboration for stewardship, including invasive plant EDRR.** Recognize that taking a collaborative, multi-jurisdictional approach to working at the landscape scale is essential to implementing effective stewardship, including invasive plant EDRR.

- **Integrate collaborative landscape-level land management into programs and budgets.** Incorporate these principles into existing programs and funding as possible and undertake restructuring where existing programs and funding are not conducive to landscape-scale stewardship.

Strengthen Institutional Roles:

- **Recognize CDFA's WMA program as essential to invasive plant EDRR.** Value the key role played by this statewide network of local stewardship collaborations, including strong leadership from CACs and RCDs. (See also the recommendation for steady funding for these programs in the section that follows.)
- **Rejuvenate CDFA weed programs and coordination with CACs.** Rehire regional biologists to provide expert on-the-ground EDRR support across the state, especially in partnership with CACs.
- **Increase CDFW invasive plant expertise and integrate it into collaborative management efforts.** Invasive plants are a top threat to the state's native plants and wildlife, and CDFW must address them to fulfill its mission. This would complement CDFA's efforts.
- **Invigorate the ISCC and the CISAC, and fund ISCC's Invasive Species Account.** Encourage state agencies and partners to make full use of this interagency venue to propel innovative solutions to invasive species issues, including EDRR for invasive plants.
- **Build EDRR into Biodiversity Collaborative capacity.** Include efforts to strengthen invasive plant EDRR when building capacity to support the Biodiversity Collaborative. The collaborative is led by the Natural Resources Agency and CDFA, the same partners who lead ISCC and who must lead EDRR.
- **Clarify responsibility for invasive aquatic plants.** Ensure that an agency is clearly tasked with EDRR for invasive aquatic plants statewide.
- **Support invasive plant EDRR in the Delta and Suisun Bay.** Fund CDFW to conduct risk assessments for newly detected plants so DBW rapid response can be authorized expeditiously.
- **Use CDFA's abatement authority for invasive plants.** Mandate that invasive plants be controlled on private lands to support EDRR efforts under appropriate circumstances.
- **Support Cal-IPC as a valuable nonprofit partner in EDRR planning and implementation.** Support and use Cal-IPC's informational resources, assessment tools, and networks with the land management community to further EDRR efforts.
- **Support RCDs for local capacity.** Recognize the RCDs' unique role in working with public and private landowners to implement invasive plant EDRR projects and serve as CEQA lead agencies (see related recommendation under "Minimize Permitting Barriers" below).
- **Support regional stewardship collaboratives to engage in EDRR.** Catalyze the capacity of existing and emerging landscape-scale partnerships to conduct invasive plant EDRR.

Meet Funding Needs:

- **Fund invasive plant EDRR through CDFA's statewide WMA program.** Recognize that funding discontinuity in this critical program greatly reduces its effectiveness and determine that funding through CDFA will not go below \$1.5 million, even during budget crises.
- **Build invasive plant expertise and capacity at CDFW and integrate it into collaborative management efforts.** Identify invasive plants as a top threat to the state's biodiversity, and one that CDFW must address to fulfill its mission. This would complement CDFA's more agriculturally focused efforts.

- **Build invasive plant EDRR into Regional Conservation Investment Strategies (RCISs).** Include invasive plant EDRR as a top priority for mitigation funding through RCISs.
- **Use bond funds to create grant programs dedicated to invasive plant EDRR.** Directly fund invasive plant control to increase the amount of work accomplished and to simplify the application process. Block grants may be a useful avenue for providing access to smaller EDRR grants.
- **Be flexible in requiring up-front site identification for EDRR projects.** Recognize that additional invasion locations are often found during EDRR implementation and allow grantees flexibility in how sites are identified in the initial project scope and budget.
- **Relax requirements for landowner access agreements.** Adjust requirements so that bond funding can support more EDRR projects, with additional flexibility in landowner access agreement requirements for scope and duration, and with the ability to hold agreements locally with a CAC or RCD and not with a state agency.
- **Extend grant duration.** Extend grant terms to five years to accomplish the first phase of invasive plant EDRR. For some projects, it would be useful for a portion of the project budget to be held in a trust for a longer period to support the maintenance needed to ensure long-term outcomes.
- **Access GGRF for invasive plant EDRR.** Fund invasive plant EDRR as a top priority if the allowable use of GGRF money expands to include climate change adaptation.
- **Fund planning activities.** Recognize that EDRR projects benefit from pre-implementation planning, including mapping and permitting. This can be supported through separate grants or allowed as a portion of implementation grants.

Minimize Permitting Barriers:

- **Provide simple permitting pathways for simple projects.** Support the “Cutting Green Tape” Initiative so requirements designed to protect the environment do not impede restoration and stewardship projects, especially those such as EDRR, which are typically low impact.
- **Support RCDs as CEQA leads.** Take advantage of the RCDs’ ability to serve as CEQA lead agencies, to adjust to a regional scale as needed, and to work well with local landowners—all useful for EDRR projects. Some RCDs could use additional training to improve their CEQA preparation and analysis capacity.
- **Ensure that lack of a federal nexus does not impede invasive plant EDRR.** Assist organizers of invasive plant EDRR projects in areas with federally listed species in securing the USFWS partnership needed for the project to proceed.

Enhance Information Resources:

- **Make CDFG’s noxious weed list a powerful outreach tool.** Support online communication about listed plants and their regulatory ratings to increase EDRR awareness among land managers, decision-makers, and the public, even though this list does not include all invasive plants for EDRR.
- **Maintain the Cal-IPC Inventory.** Screen potential new invasive plants for current and projected future impacts and add them to the inventory as appropriate.
- **Maintain online platforms for landscape-level EDRR planning.** Support the CalWeedMapper and WHIPPET tools to provide analysis of distribution data needed to design and track EDRR projects.

- **Grow online reporting apps.** Recognize the utility of private online data-collection platforms such as Calflora and iNaturalist for both land-management professionals and volunteers.
- **Ensure data sharing and roll-up.** Compile invasive plant distribution data from different agencies and platforms through at least one accessible portal (such as Calflora) to allow the development of a landscape-level EDRR strategy.
- **Engage public gardens as sentinels for EDRR.** Utilize California's public gardens as botanical laboratories that can observe and report information on plant species that may become targets for EDRR.
- **Share information on invasive plant EDRR techniques.** Use conferences, publications, and websites to share up-to-date information on IPM and EDRR generated by university and agency researchers as well as practitioners.
- **Train practitioners on effective EDRR.** Build the capacity of field practitioners, conservation corps members, and community volunteers to implement EDRR.

CONCLUSION

Strategic landscape-scale stewardship is essential for fulfilling the California Biodiversity Collaborative and protecting the state's natural heritage for future generations. Initiatives like the Global "30x30" Initiative to protect 30% of the planet by 2030 provide a compelling foundation for California to show leadership in protecting its biodiversity (and much more) by implementing effective invasive plant EDRR efforts.

Taking action now is well within our reach. As California's leaders envision goals for preserving biodiversity, managing wildfire fuel loads, stretching precious water resources, and adapting to climate change, their success depends in part on managing invasive plants utilizing the EDRR strategies outlined in this white paper. Hundreds of organizations stand ready to work in partnership with the state toward these goals.



We must act now to protect California's biodiversity and climate resiliency. Plants like Saharan mustard (*Brassica tournefortii*) and desert knapweed threaten the resiliency of the desert's fragile water resources and native plant communities—and therefore all the wildlife that depend upon them. It is essential that we act now to secure the level of coordination, funding, and leadership needed to ensure places like these remain vibrant for future generations. Photo by Jennifer Prado in the Coachella Valley National Wildlife Refuge, Riverside County.

RESOURCES

Articles and Reports

Blueprint for Coordinated Landscape-Scale Management of Invasive Plants in California

https://www.cal-ipc.org/resources/library/publications/cinipc_blueprint/

California Biodiversity Initiative: A Roadmap for Protecting the State's Natural Heritage

<https://www.californiabiodiversityinitiative.org/pdf/california-biodiversity-action-plan.pdf>

California State Wildlife Action Plan: A Conservation Legacy for Californians

<https://wildlife.ca.gov/SWAP/Final>

Early Detection of Invasive Plant Species in the San Francisco Bay Area Network: A Volunteer-Based Approach

<https://irma.nps.gov/Datastore/DownloadFile/460898>

Global Biodiversity Outlook 5 from the United Nations Secretariat of the Convention on Biological Diversity

<https://www.cbd.int/qbo/qbo5/publication/qbo-5-en.pdf>

Land Manager's Guide to Developing an Invasive Plant Management Plan

<https://www.cal-ipc.org/resources/library/publications/developingplan/>

National Fish, Wildlife, and Plants Climate Adaptation Strategy

<https://www.st.nmfs.noaa.gov/Assets/ecosystems/documents/NFWPCAS-Final.pdf>

One Tam: Early Detection Beyond Boundaries

<https://www.onetam.org/sites/default/files/pdfs/Beyond%20Boundaries%20One%20Tam%20EDRR%20Report%202020.pdf>

Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response

<https://www.doi.gov/sites/doi.gov/files/National%20EDRR%20Framework.pdf>

Safeguarding California Plan: 2018 Update; California's Climate Adaptation Strategy

<https://resources.ca.gov/CNRALegacyFiles/docs/climate/safeguarding/update2018/safeguarding-california-plan-2018-update.pdf>

Safeguarding the Nation from the Impacts of Invasive Species

<https://www.federalregister.gov/documents/2016/12/08/2016-29519/safeguarding-the-nation-from-the-impacts-of-invasive-species>

The San Francisco Bay Area Early Detection Network

https://www.reabic.net/journals/mbi/2015/3/MBI_2015_Frey_etal.pdf

Special Issue on Early Detection and Rapid Response, *Biological Invasions*, January 2020

<https://link.springer.com/journal/10530/22/1>

Stopping the Spread: A Strategic Framework for Protecting California from Invasive Species

<http://www.iscc.ca.gov/docs/CISAC-Strategic-Framework.pdf>

Websites

Calflora <https://www.calflora.org/>

CalWeedMapper <https://calweedmapper.cal-ipc.org/>

WHIPPET <https://whippet.cal-ipc.org/>

Terminology

Control: Taking action to reduce the numbers and extent of an invasive species and stop its spread.

EDRR (early detection and rapid response): The strategy of eradicating an invasive species at the landscape level before it becomes widespread, thereby minimizing its impact in an expedited, effective, and cost-efficient manner.

Eradication: The complete and permanent removal of an invasive species from an area. It can be difficult to say with certainty that there are no plants (or propagules) within a landscape, so control down to levels below detectability is sometimes a more realistic goal.

IPM (integrated pest management): An approach to controlling pests, including invasive species, in which a variety of tools and strategies are considered to select the one(s) that will be most safe and effective.

Landscape level: A large scale comprising multiple jurisdictions, typically one or more counties in size.

Native, nonnative, invasive: Native plants are those that have been present in an area for a period long enough to be well integrated into food webs. In California, the term “native” is used to refer to plants that were here before European contact. Nonnative plants are those plants brought to California by people since European contact. Invasive plants are the small portion of nonnative plants that grow outside of cultivation and cause environmental and/or economic damage.

Abbreviations/Acronyms

CAC	County Agricultural Commissioner
CAL FIRE	California Department of Forestry and Fire Protection
Cal-IPC	California Invasive Plant Council
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CISAC	California Invasive Species Advisory Committee (advises ISCC)
CNPS	California Native Plant Society
DBW	California State Parks Division of Boating and Waterways
DWR	California Department of Water Resources
EDRR	Early Detection and Rapid Response
IPM	Integrated Pest Management
ISCC	Invasive Species Council of California
RCD	Resource Conservation District
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
WCB	California Wildlife Conservation Board
WMA	Weed Management Area