

SAFEGUARDING AMERICA'S LANDS AND WATERS FROM INVASIVE SPECIES

A National Framework for Early Detection
and Rapid Response



Invasive Species on Cover:

Nutria, *Myocastor coypus*

(photo credit U.S. Fish and Wildlife Service)

Green Crab, *Carcinus maenas*

(photo credit U.S. Geological Survey)

Burmese Python, *Python bivittatus*

(photo credit U.S. Geological Survey)

Silver Carp, *Hypophthalmichthys molitrix*

(photo credit Asian Carp Regional Coordinating Committee)

Red Lionfish, *Pterois volitans*

(photo credit REEF)

Water Hyacinth, *Eichhornia crassipes*

(photo credit Bureau of Reclamation)

Asian Longhorned Beetle, *Anoplophora glabripennis*

(photo credit U.S. Fish and Wildlife Service)

Cheatgrass, *Bromus tectorum*

(photo credit U.S. Fish and Wildlife Service)

Zebra Mussel, *Dreissena polymorpha*

(photo credit U.S. Fish and Wildlife Service)

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In addition, this report has been prepared with the active consultation and assistance of the National Invasive Species Advisory Committee's Early Detection and Rapid Response subcommittee, including states, tribes, academic institutions, environmental organizations, industry, and other organizations.

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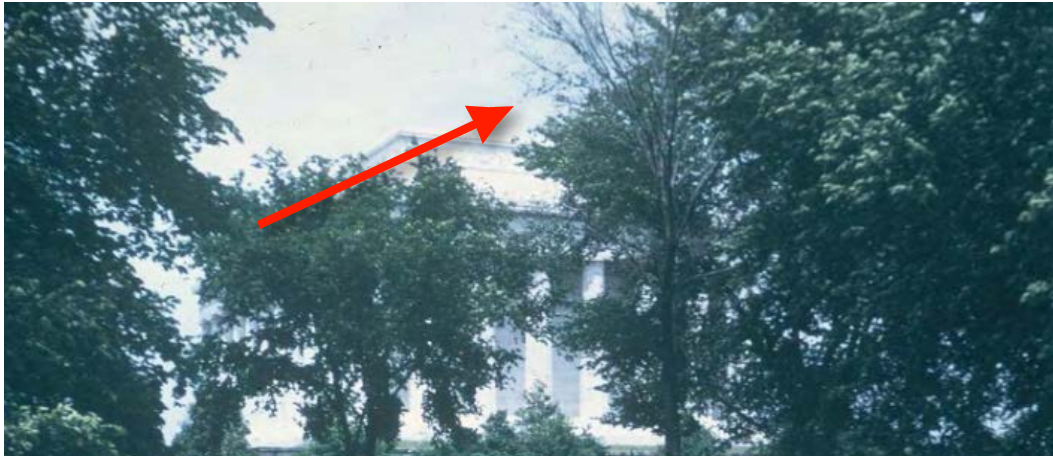
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First elm found to be infected with Dutch elm disease in Washington, D.C.; Lincoln Memorial, 1947
(photo credit NPS)

FOREWORD

Invasive species pose one of the greatest ecological threats to America's lands and waters. Their control can be complex and expensive and is often conducted in perpetuity; their harm can be irreversible. Early detection and rapid response (EDRR) actions can reduce the long-term costs and economic burden that invasive species have on communities.

Some invasive species, such as the pathogens that cause chestnut blight and Dutch elm disease, staked their claim in the United States in the early 1900s. As a result, American chestnut and American elm trees were nearly eliminated from the Nation's forests, leaving in their wake devastating economic, social, and ecological impacts. Invasive annual grasses, such as cheatgrass, are rapidly replacing native plant species across enormous areas of western rangelands. Consequently, wildfire frequency and intensity are increasing while the ability of the vulnerable landscapes to support native wildlife, livestock operations, and agriculture are on the decline. A wide variety of additional species are poised to arrive at U.S. borders, many of them with the potential to cause adverse impacts. For example, a deadly salamander pathogen commonly known as 'Bsal' (short for *Batrachochytrium salamandrivorans*) could cause massive die-offs of salamanders across a wide range of species and have cascading impacts on forest and freshwater ecosystems.

These are just a few examples of a vast number of invasive species that threaten the country's wildlands, waterways, and coastlines. Their management plays a fundamental role in the success of achieving the Administration's conservation priorities, such as enhancing climate resilience, promoting pollinator health, and restoring landscapes.

The invasive species challenge can seem overwhelming, but strategic solutions can forestall future invasive species impacts. This report, *Safeguarding America's lands and waters from invasive species: A national framework for early detection and rapid response*, outlines opportunities to detect populations of non-native species that pose the greatest risks to landscapes and aquatic areas before they can have adverse impacts, and swiftly respond to eradicate them. A shared commitment to problem solving among Federal agencies, states, and tribes will lay the foundation for more effective and cost-efficient strategies to stop the spread of invasive species. This national EDRR Framework proposes to connect efforts among a diverse array of stakeholders at multiple scales. It emphasizes a shared, renewed focus on coordination and partnerships, science and technology, and strategic on-the-ground action to reduce the threat of invasive species and help protect the Nation's lands and waters, as well as the livelihoods that rely upon them.

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Silver Carp
Hypophthalmichthys molitrix
(photo credit
Asian Carp Regional
Coordinating
Committee)

EXECUTIVE SUMMARY

Invasive species pose one of the greatest threats to the Nation's natural resources. The stakes are high: if left to spread, invasive species cost billions of dollars to manage and can have devastating consequences on the Nation's ecosystems (Pimentel 2003, Pimentel et al. 2005, Aukema et al. 2011). For example, rapidly increasing lionfish populations have drastically reduced the abundance of coral reef fishes and degraded already stressed coral reefs. Highly flammable cheatgrass and other invasive grasses fuel more intense wildfires that put people and livestock in harm's way, degrade rangeland, and damage critical habitat for wildlife, such as the greater sage-grouse. Asian carp seriously impact native fish populations and are poised to degrade economically-important sport and commercial fisheries. These and other invasive species transform the Nation's lands and waters, leaving extensive economic and environmental costs in their wake.

While the invasive species challenge is daunting, opportunities exist to turn the tide. Preventing the introduction of invasive species is the first line of defense against biological invasion. However, for invasive species that circumvent prevention systems, early detection and rapid response (EDRR)—a coordinated set of actions to find and eradicate potential invasive species before they spread and cause harm—can help stop the next lionfish, cheatgrass, or Asian carp.

More can be done to strengthen the Nation's EDRR capacity to get ahead of the next invasive species. While there are well-established EDRR programs to protect agricultural resources, there is a need to extend efforts for EDRR programs that protect

non-agricultural areas, such as rivers and streams, coastal waters, forests, and grasslands. Where they exist, EDRR networks often focus only on select species or geographic areas and are not always well-coordinated with neighboring efforts. In addition, EDRR networks frequently lack access to financial resources, decision making tools, and other EDRR capabilities necessary to find, contain, and eradicate potentially invasive species populations before they become widely established. These gaps result in costly and often irreversible harm.

The site-based nature of EDRR actions also requires partnerships and coordination across multiple scales – however, there is no national EDRR framework nor is there a coordinated strategy for funding EDRR actions. Given the breadth of their missions, authorities, technical capability, and funding, Federal agencies are essential to addressing high-risk invasive species and can provide crucial national leadership and coordination. The continuous arrival of potentially invasive species—and the expanding ranges of current high-risk invasive species—necessitates a national EDRR framework. A national EDRR framework would build capacity to forecast which species pose the greatest risks to the country, bolster monitoring and response actions underway across the country, and position public and private partners to be prepared when the next invasive species arrives. Because EDRR is always site-based and specific localities are often resource limited, it is imperative that such a framework have a structure that functions effectively from the top down and the bottom up in a fluid, reciprocal, and mutually beneficial manner.

In October, 2014, the White House Council on Climate Preparedness and Resilience released its *Priority Agenda: Enhancing the Climate Resilience of America's Natural Resources*, which identified invasive species as one of the most pervasive threats to ecosystem resilience in a changing climate and called upon the U.S. Department of the Interior (DOI), working with other members of the National Invasive Species Council (NISC), states, and tribes, to develop a framework for a national EDRR program, including a plan for emergency response funding.

As called for in the Priority Agenda, this report proposes a national EDRR framework (EDRR Framework) that provides an organizational structure for national coordination and communication among Federal and non-Federal entities to increase the overall effectiveness of EDRR efforts, and thus protect 'priority landscapes and aquatic areas' from the impacts of invasive species. In the context of the EDRR Framework, priority landscapes and aquatic areas are generally regarded as those lands and waters (freshwater, coastal, and marine) identified by Federal, state, or tribal entities as areas of importance, such as for natural resource stewardship, conservation, or biodiversity purposes.

The EDRR Framework will:

1. Connect and build upon existing initiatives.
2. Identify gaps in EDRR coverage (e.g., taxonomic groups, monitoring programs, and localities) and needs (e.g., tools, techniques, skills, and human and financial resources).
3. Augment Federal, state, and tribal EDRR capabilities, capacities, and partnerships.
4. Establish a coordinated funding process and/or mechanism(s) to support preparedness and response activities.

RECOMMENDATIONS:

The Secretaries of the Departments of the Interior, Agriculture, and Commerce, as co-chairs of NISC, working with other members of NISC, should take the following five steps to implement a national EDRR Framework:

1. **Establish a National EDRR Task Force and designate a National EDRR Coordinator within the NISC structure to address invasive species that affect priority landscapes and aquatic areas.** An important step in implementing the EDRR Framework is to establish a combined Federal/non-Federal Task Force within the NISC structure that would improve coordination among agencies, help set shared priorities, and assess and close important gaps in EDRR actions. A designated National EDRR Coordinator is essential to provide coordination across Federal agencies and serve as the liaison with state, tribal, regional, and other partners and experts to facilitate communications and identify efficient means to share information, technologies, and other resources.
2. **Convene high-level decision makers (i.e., Assistant/Under Secretaries) and senior budget officials within NISC agencies to better align funding or guide the formation of more effective funding mechanisms to support preparedness and emergency response activities.** A range of financial, operational, and human resources are necessary to implement EDRR actions. An initial step in addressing funding challenges is to evaluate current agency EDRR capacities, capabilities, flexibilities, limitations, and magnitude of needs. This includes an assessment of how current EDRR efforts are supported through various agency programs. Guidance from decision makers and budget officials will be essential to developing a plan to establish a coordinated funding process or mechanism that can effectively address EDRR needs and help build capacity to mobilize resources to partners on the ground.

- 3. Incorporate EDRR actions into NISC agency programs and partnerships at national, regional, and local scales.** Establishing lead contacts in Federal agencies working on EDRR is an important step in implementing the EDRR Framework and increasing communications and collaboration across the range of Federal, state, tribal, and local jurisdictions. Understanding Federal agency authority to implement EDRR is another critical step. Given differences across authorizing legislation, the NISC should work with member Federal agencies to assess their capacity and capability under existing authorities to implement EDRR. This assessment should be conducted through a centralized process that is coordinated among the Federal agencies and identify gaps, inconsistencies, and conflicts in authorities and policies as well as enforcement capacity. Building on this review, the NISC should work with member Federal agencies to develop and implement a strategy requesting supplemental authorities, if needed, to fully implement the EDRR Framework. This strategy should consider the role of EDRR within the broader context of invasive species prevention and management activities. Federal agencies should also identify crosscutting initiatives, such as climate preparedness plans, where EDRR applies and incorporate appropriate EDRR actions.
- 4. Advance multiple pilot EDRR initiatives in priority landscapes and aquatic areas.** Current EDRR capacities vary across the country. Implementation of the EDRR Framework likely will occur in a staged approach. As an initial step, agencies should identify several priority landscapes and aquatic areas to pilot elements of the EDRR Framework. Such efforts would be instrumental in the identification and application of performance measures and other metrics for the effectiveness and value-added contribution of EDRR activities.
- 5. Foster the development and application of EDRR capabilities, including technologies, analytical and decision making tools, and best practices.** A range of capabilities (e.g., risk assessments, monitoring programs, identification support, alert systems, eradication techniques etc.) is necessary to support effective EDRR. EDRR capabilities will help determine priority invasive species and actions for national EDRR efforts as well as priority pathways to be addressed and areas most vulnerable to invasion. Analytics and decision tools will help determine what rapid response measures should be taken and when. While some of these tools currently exist, a coordinated effort is needed to assess, prioritize, enhance, develop, disseminate, and apply them in the field. This includes the research to support these EDRR capabilities.

It is imperative to stop the next invasive species from staking a claim in the Nation's lands and waters. Taken together, these steps will operationalize a national EDRR Framework that supports the detection, identification, and eradication of invasive species populations before they spread and cause significant harm. The EDRR Framework provides the structure to identify strategic and shared priorities for focusing limited resources and enhancing partnerships and on-the-ground actions necessary to stem the tide of invasive species.



Invasive Species

An invasive species is an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13112). An alien species is, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem (Executive Order 13112). For the purposes of this report, the terms 'alien' and 'non-native' are regarded as synonymous.

Biological Invasion, Early Detection & Rapid Response

Biological invasion is the process by which non-native species breach biogeographic barriers and extend their range (McGraw-Hill 2003). In the context of biological invasion, early detection is the process of surveying for, reporting, and verifying the presence of a non-native species, before the founding population becomes established or spreads so widely that eradication is no longer feasible. Rapid response is the process that is employed to eradicate the founding population of a non-native species from a specific location.

Purple Loosestrife
Lythrum salicaria
(photo credit NPS)



Kudzu
Pueraria lobata
(photo credit NPS)

I. INTRODUCTION

The Charge

In October 2014, the White House Council on Climate Preparedness and Resilience released *Priority Agenda: Enhancing the Climate Resilience of America's Natural Resources*. One of the Priority Agenda's four strategies is to foster climate-resilient lands and waters, calling upon Federal agencies to "Identify Landscape Conservation Priorities to Build Resilience."

More specifically, the Council on Climate Preparedness and Resilience delivered the following charge to DOI and NISC¹:

"The Secretary of the Interior, working with other members of the National Invasive Species Council, including Department of Commerce (National Oceanic and Atmospheric Administration [NOAA]), the Environmental Protection Agency (EPA), and the U.S. Department of Agriculture (USDA), will work with states and tribes to develop a framework for a national Early Detection and Rapid Response (EDRR) program that will build on existing programs to assist states and tribes in forestalling the stress caused by the establishment and spread of additional invasive species populations, thereby improving the resilience of priority landscapes and aquatic areas. This will include the development of a plan for creating an emergency response fund to increase the capacity of interagency and inter-jurisdictional teams to tackle emerg-

ing invasive species issues across landscapes and jurisdictions." (Council on Climate Preparedness and Resilience 2014)

This charge furthers priorities set forth in Executive Order 13112 (Invasive Species) and advances work directed by the National Invasive Species Management Plans.

Invasive Species Management and Resilience

Invasive species are one of the most significant drivers of environmental degradation and species extinction worldwide and are generally considered the primary cause of biodiversity loss in freshwater and island ecosystems. Invasive species are responsible for the endangerment and extinction of a wide range of taxa; degradation of freshwater, marine, terrestrial ecosystems; and, the alteration of biogeochemical cycles. They contribute to social instability and economic hardship, consequently placing constraints on the conservation of biodiversity, sustainable development, and economic growth. The globalization of trade, travel, and transport is greatly increasing the number and type of non-native species that are being moved around the world, as well as the rate at which they are moving. At the same time, changes in climate and land use are rendering some habitats, even the best protected and most remote natural areas, more susceptible to biological invasion (McNeely 2001; Reaser et al. 2004).

¹ Established by Executive Order 13112, the NISC membership includes 13 Federal Departments and Agencies. It is co-chaired by the Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Commerce. The NISC provides national coordination on the broad array of activities intended to protect the environment, economy, and human and animal health from the adverse impacts of invasive species.

Priority Landscapes and Aquatic Areas

In the context of this proposed national EDRR Framework, 'priority landscapes and aquatic areas' are generally regarded as those lands and waters (freshwater, coastal, and marine) identified by Federal, state, or tribal entities as areas of importance, such as for natural resource stewardship, conservation, or biodiversity purposes.

The Need for a National EDRR Framework

Federal and non-Federal partners have long recognized the need for a national Early Detection and Rapid Response (EDRR) framework to protect landscapes and aquatic areas from the impacts of invasive species. Some of the more recent documents recommending the formation of an EDRR framework include the National Invasive Species Council's Management Plans, the Aquatic Nuisance Species Task Force's Strategic Plans, the National Ocean Policy, the Implementation Plan for the National Strategy for the Arctic Region, the Recommendations to the President from the State, Local and Tribal Leaders Task Force on Climate Preparedness and Resilience, and most recently in the Western Association of Fish and Wildlife Agencies' Invasive Plant Management and Greater Sage-Grouse Conservation Plan and the Rangeland Fire Task Force's Integrated Rangeland Fire Management Strategy.

The Aquatic Nuisance Species Task Force (ANSTF)/ NISC Ad Hoc Working Group on Invasive Species and Climate Change (2014) identified numerous ways in which the interactions between invasive species and climate change can exacerbate the risks and impacts associated with both ecological threats. For example, changing climate conditions may contribute to the increase of invasive species through faster species growth rates (e.g., changing levels of CO₂ and precipitation may favor some invasive species), species range shifts (e.g., increases in temperature may enable some invasive species to survive in ecosystems where cold temperatures were previously lethal), and new pathways of species spread (e.g., travel, trade, and extreme weather events may influence invasive species dispersal). Likewise, the impacts of invasive species can substantially hinder ecosystem resilience to other stressors, especially climate change (Burgiel and Muir 2010, U.S. Environmental Protection Agency 2008).

It, therefore, follows that ecological resilience to climate change can be improved by preventing the adverse impacts of invasive species. Prevention (border control and pathway management²) is generally regarded as the first line of defense against biological invasion. Yet, despite the best available prevention efforts, in time, some non-native species will be introduced and/or spread into new ecosystems. EDRR then becomes the most cost-effective response strategy; eradication of the founding population of the non-native species alleviates the need for expensive invasive species control programs that would have to be enacted over the long-term. [See Diagram: The Invasion Curve (Fig. 1).] Effective EDRR can also be viewed as a conflict mitigation strategy since it prevents the conflicts that invariably arise over land use and land management approaches once invasive species become well established.

While recognizing that investments in border control and pathway management are the logical priority to prevent the introduction and spread of invasive species,³ this report focuses on the eradication of those non-native species which circumvent prevention systems. In particular, it responds to the Council on



When introduced outside their native ranges, nutria (*Myocastor coypus*) and beach vitex (*Vitex rotundifolia*) are known to degrade wetland and coastal dune systems, respectively, making impacted areas more vulnerable to erosion and storm surges. Detecting and eliminating incipient populations of these species in new areas can forestall the immediate degradation of these ecosystems, and help maintain the ability of these ecosystems to serve as buffers from severe weather events (Westbrooks and Madsen 2006, Carter et al. 1999).

Climate Preparedness and Resilience's charge to develop a framework for a national EDRR program that ultimately improves the resilience of priority landscapes and aquatic areas through the eradication of emerging invasive species.

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- 2 Pathways are the means by which invasive species are moved, intentionally or unintentionally, into new areas. Pathways can broadly be categorized in relation to trade and the movement of goods (e.g., horticultural products, firewood, pets, wooden packaging materials); transportation (e.g., ballast water and hull fouling of commercial and recreational vessels; construction and off-road vehicles); and, infrastructure and resource management (e.g., energy development and construction equipment and habitat restoration practices).
 - 3 Federal activities related to preventing the introduction and spread of invasive species include work at national borders and within the United States using both regulatory and non-regulatory approaches to address the pathways of invasion. These activities represent the most significant share of spending by Federal agencies (see page 21).
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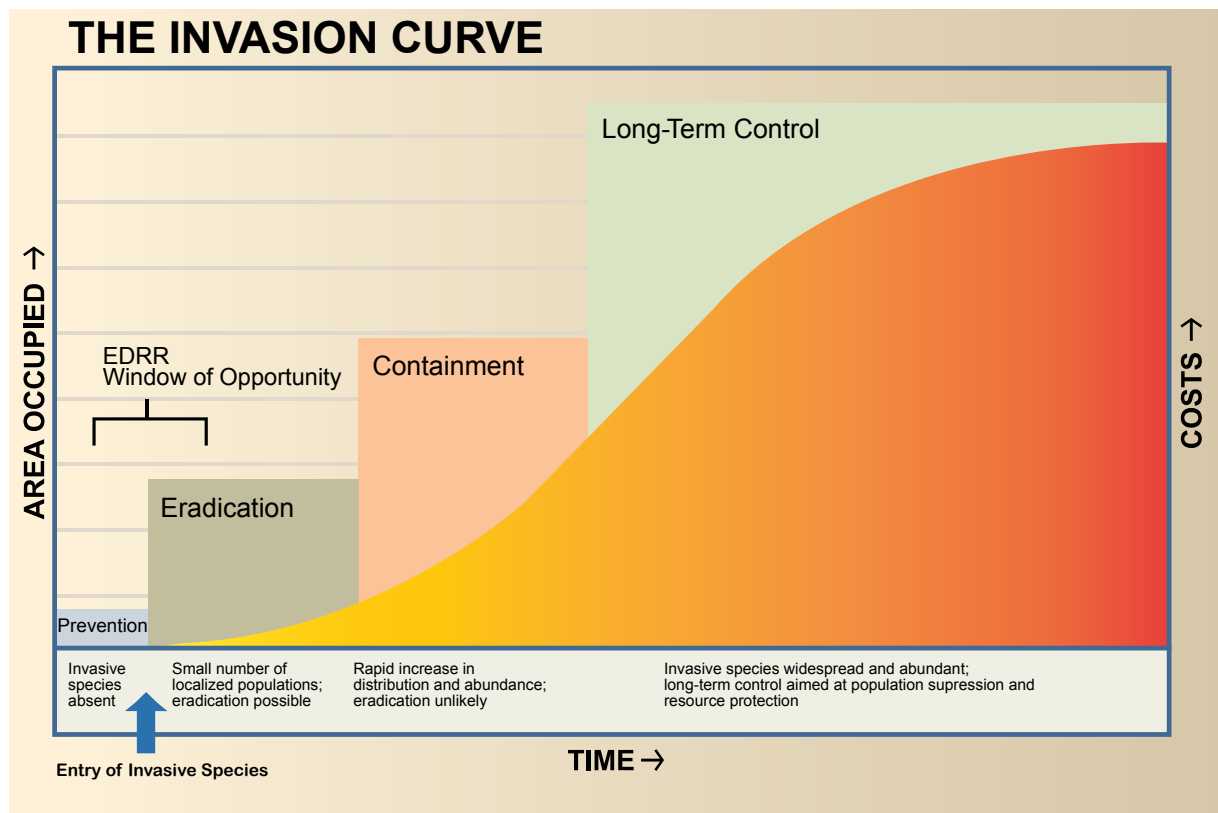


Figure 1: Phases of the Invasion Curve (Rodgers, Adapted from Invasive Plants and Animals Policy Framework, State of Victoria, Department of Primary Industries, 2010, modified with permission). Preventing the introduction (e.g., border controls, pathway management) of invasive species is the first line and most cost-effective defense against biological invasion. The second line of defense is eradication, where the approach is to eliminate founding populations of invasive species while doing so is feasible. EDRR is generally necessary to achieve eradication. When eradication is no longer feasible, then containment or long-term control of an invasive species population is the last remaining management option. Long-term control programs require substantial financial investments in perpetuity.

The Need for Early Detection and Rapid Response (EDRR)

The continuing arrival of potentially invasive species and range expansions of existing invasive species necessitates coordinated EDRR actions. In recent years, several invasive species introductions were detected early, but without a nationally coordinated response effort, those populations continued to spread to an extent where eradication is no longer feasible. Examples include redbay ambrosia beetles (*Xyleborus glabratus*), which carry the laurel wilt fungus (first detected in Georgia in 2002); lionfish (*Pterois volitans*), a major predator in coastal systems that damages coral reef habitats (first detected off of Florida in 1985); and, the raspberry crazy ant (*Nylanderia fulva*), a major insect pest with impacts

on wildlife, livestock, and electrical equipment and other infrastructure (first detected in Texas in 2002). In these cases, the lead agency, the authorities to respond, and/or the potential risks and impacts were not clear when these invasive species were first detected. In other cases, the lead agency—when faced with limited funding—was not able to respond.

EDRR can work, and, there are examples of success from across the country. A number of effective EDRR efforts brought together the necessary players, management techniques, and resources, such as eradication of *Caulerpa taxifolia*, an invasive alga, in southern California (2006); removal of the sacred ibis (*Threskiornis aethiopicus*) in Miami-Dade and Palm Beach counties, Florida (2008-2011); detection and removal of floating docks infested with potential aquatic invasive species (AIS) that were washed

ashore in Oregon and Washington in the wake of a Japanese tsunami (2013); and, ongoing monitoring and response efforts to keep the Great Lakes free of Asian carp. These efforts helped to protect native fish and wildlife populations and investments made by other conservation and restoration programs in these areas and prevented future costs and damages from these invasive species.

The elements of this national EDRR framework take into account past successes with EDRR, as well as current initiatives, particularly in areas where states, tribes, Federal agencies, and other partners are jointly investing in EDRR activities. For example, Western states are increasingly collaborating around watercraft inspection and decontamination efforts to keep quagga and zebra mussels out of Western waterbodies. Similarly, a range of experts from academia and state and Federal agencies are developing surveillance and response protocols for a deadly fungus of salamanders—*Batrachochytrium salamandrivorans* or *Bsal*—that has yet to be detected in the United States. These are but two examples of a range of initiatives targeting some of the many terrestrial and aquatic invasive species that threaten the Nation’s natural resources. The Federal Government’s leadership and targeted coordination and resources through a national EDRR framework could mean the difference between failure and success of these types of EDRR activities.

The Federal Government has a natural role in helping to address high-risk invasive species given the breadth of Federal agency missions, authorities, technical capability, and funding. A structured, strategic, national approach for EDRR, coupled with sufficient funding, are necessary to effectively stop potentially invasive species before they can establish and spread and cause widespread, costly damage. The proposed national EDRR Framework would help turn that tide by facilitating coordination on multiple scales, designating responsible points of contact within government agencies, identifying technical expertise and tools, and providing financial assistance.

The Process for Preparing this Report

To develop a national EDRR Framework (hereafter the EDRR Framework), DOI and NISC convened a group of Federal experts to identify central elements, parameters, and critical stakeholders. They formed a broader advisory team under the umbrella of NISC’s Invasive Species Advisory Committee (ISAC) to serve as a forum for engaging states, tribes, and other parties interested in assessing the national needs and strategic considerations for the design, coordination, and implementation of a national EDRR framework. The DOI and NISC also shared progress and key concepts with various Federal working groups during this report’s development and held a tribal listening session and a tribal consultation to solicit further input on tribal issues and perspectives.

The following sections address the principles of an EDRR Framework and the particular phases of the EDRR process. The EDRR Framework is divided into components focused on preparedness, early detection, rapid assessment, and rapid response. Coordination and the identification of responsible institutions and partnerships are also critical elements for the EDRR Framework’s implementation.

Financial resources and flexible funding mechanisms are fundamental needs to implement the EDRR Framework successfully. Section IV (page 25) is dedicated to this topic.

The recommendations provided on page 29 are intended to serve as guidance in the establishment and initial implementation of the EDRR Framework, and are explicitly directed at the Secretaries of the Departments that co-chair NISC.

Supporting appendices include a template for an EDRR decision making process, the stages of the EDRR process and general action steps, examples of current invasive species networks, examples of financing models, and the members of the Federal work group and its advisory team that assisted with developing the EDRR Framework.

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Burmese Python
Python bivittatus
(photo credit USGS)

II. A NATIONAL EARLY DETECTION AND RAPID RESPONSE FRAMEWORK

Purpose

The EDRR Framework is a proposed organizational structure that enables national coordination and communication among Federal and non-Federal entities to increase the overall effectiveness of EDRR efforts to forestall the establishment and spread of invasive species, and thus protect priority landscapes and aquatic areas, as well as the ecosystem services they provide. In the context of the EDRR Framework, priority landscapes and aquatic areas are generally regarded as those lands and waters (freshwater, coastal, and marine) identified by Federal, state, or tribal entities as areas of importance, such as for natural resource stewardship, conservation, or biodiversity purposes. Identifying the criteria and decision making processes to determine priority landscapes and aquatic areas where the EDRR Framework would apply is outside of the scope of this report. Those details are fundamental to the

implementation of the EDRR Framework and will need to be developed, in cooperation with states and tribal partners. Implementation will occur in a phased approach and be informed by science-based assessments.

Implementing the EDRR Framework will:

1. Connect and build upon existing initiatives.
2. Identify gaps in EDRR coverage (e.g., taxonomic groups, monitoring programs, and localities) and needs (e.g., tools, techniques, skills, and human and financial resources).
3. Augment Federal, state, and tribal EDRR capabilities, capacities, and partnerships.
4. Establish a coordinated funding process and/or mechanism(s) to support preparedness and response activities.

The national EDRR Framework focuses on invasive species—plants, animals, and other organisms—that may adversely impact (harm) priority landscapes and aquatic areas in the United States. The work done under the EDRR Framework will not be redundant or overlap with the work of agencies with specific statutory charges to address invasive species, such as USDA's Animal and Plant Health Inspection Service (APHIS). Rather the work will focus on coordinating EDRR in areas where gaps in EDRR leadership and resources exist and working toward a goal of being complementary and mutually supportive but not duplicative.

Under the EDRR Framework, actions may be taken to eradicate populations of potentially invasive species that are new to the United States or contain the spread of known invasive species by eradicating satellite populations that could result in range expansions. Appendix A provides a template for a general decision making process for EDRR events (i.e., when a detection occurs) and describes the general flow of information and decision points in the EDRR process.

The national scope of the EDRR Framework necessitates the involvement, coordination, and cooperation of Federal agencies, particularly those with natural resource management and regulatory responsibilities, scientific expertise, information management capabilities, and emergency response capacity. Leveraging the vision and resources for an EDRR Framework at the national level will enhance regional, state, tribal, and local EDRR efforts by providing additional leadership, guidance, and access to human, technical, and financial resources. Because EDRR is always site-based and specific localities are typically resource limited, it is imperative that a national EDRR Framework have a structure that functions effectively from the top down and the bottom up in a fluid, reciprocal, and mutually beneficial manner.

Guiding Principles

Complementarity: The EDRR Framework draws from existing programs; numerous models, plans, and protocols informed its structure. It seeks to enhance and not duplicate existing efforts. It achieves this by having involved a broad range of Federal and non-Federal partners in its development and building their involvement into its structure and implementation.

Partnership: The involvement of and support for states, tribes, non-governmental organizations, industry, and others working to address invasive species is a key aspect of the EDRR Framework's cooperative intent. Given the myriad of players and different jurisdictions associated with connecting lands and waters, as well as the numerous authorities related to their management, the development of effective partnerships is critical to mitigating the potential impacts of invasive species at the landscape scale. The EDRR Framework can facilitate cooperation and communication across regulatory agencies as appropriate.

Scale: Some of the components of the EDRR Framework are scale independent and can be models for the national, regional, state, tribal, or local level. For example, the EDRR decision making template (see Appendix A) and general EDRR stages and action steps (see Appendix B) are applicable at any scale.

Implementation: The intent of the EDRR Framework is to guide the transition from existing conceptual models, particularly at a national scale, to a practical, operational structure through which implementation can progress. The EDRR Framework necessarily addresses the funding, identification of the responsible institutions and other participants, authorities, and skills and capacities necessary for effective EDRR.

Timeliness: The EDRR Framework reflects the importance of *early* detection and *rapid* response to identify, assess, and respond quickly to the introduction of a potentially invasive species. The window of opportunity for a timely response depends on the invasive species (e.g., under its own power, an introduced invasive plant is likely to spread slower than an introduced invasive fish). The EDRR Framework emphasizes the need for a streamlined and continuous process from detection to eradication that prevents delays.

Resource availability: The availability of resources (financial, technical, and human) and flexibility of funding mechanisms determines the timeliness and range of actions that can be successfully implemented once a potentially invasive species is detected. Targeted funding will be necessary to fully implement EDRR for potentially invasive species and should allow resources to be transferred among partners without delay.

Metrics: The activities associated with the EDRR Framework will require a set of performance measures to evaluate their efficiency and effectiveness, as well as to enable adaptive management. These will be developed in the implementation phase of the EDRR Framework. Analysis of metrics will enable improvements to the design and implementation of the EDRR Framework over time.

Early Detection and Rapid Response

A national EDRR Framework needs to consider non-native species that are new to the United States (i.e., first time introductions), as well as invasive species that are already in the United States but have been introduced to a new ecosystem or have spread beyond the area occupied by the founding population.

Detecting and responding to invasive species requires a series of sustained and coordinated actions with associated responsible agencies and partners. The EDRR Framework identifies four general categories or stages of the EDRR process (see Fig. 2), and each of these categories involves numerous action steps (see Fig. 3 and Appendix B):

- ◆ **Preparedness:** Establishes the plans, coordination networks, tools, training, and necessary resources for deployment of detection, rapid assessment, and rapid response actions.
- ◆ **Early detection:** Through surveys and monitoring activities,⁴ provides initial evidence on the occurrence of a potentially invasive species and the mechanisms for reporting and verifying species identification.
- ◆ **Rapid assessment:** Determines the distribution and abundance of the species occurrence, if possible, and evaluates its potential risks with regard to environmental, health, and economic impacts. It also identifies options for rapid response based on the particular circumstances associated with the occurrence of the species (e.g., species type, specific location, extent of spread, relevant jurisdictions/authorities).
- ◆ **Rapid response:** A set of coordinated actions to eradicate the founding population of an invasive species before it establishes and/or spreads to the extent that eradication is no longer feasible.

Eradication of the targeted invasive species is the primary goal of the EDRR process. Appendix A provides a template for a general decision making process for responding to non-native species in new localities and describes the general flow of information and decision points in the EDRR process.

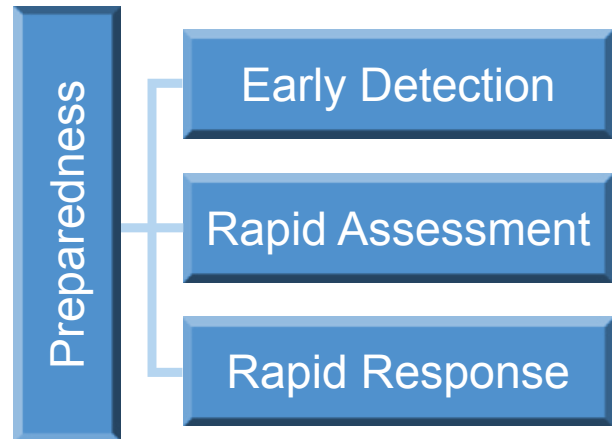


Figure 2: General stages of the EDRR Process. Preparedness actions are necessary in advance of early detection and throughout each stage of the EDRR process.

The following types of indicators help to evaluate the extent to which an EDRR response is successful (NISC 2003):

1. **Timeliness of the detection:** Potentially invasive species are detected upon introduction.
2. **Availability and accessibility of resources:** Technical, financial, and human resources are readily available to support assessment and response efforts.
3. **Timeliness of the response actions:** Rapid response to the introduction forestalls the establishment, spread, and adverse impacts of the invasive species.
4. **Timeliness of information:** Information is provided to decision-makers, the public, and to partners.
5. **Adaptive management:** A systematic approach is used for improving resource management by learning from management outcomes from EDRR.⁵

4 In the context of this report, references to monitoring include one-time surveys (aka inventories), as well as monitoring activities (i.e., surveys repeated over time).

5 See Glossary for a detailed definition of adaptive management.

Coordination, Roles, and Responsibilities

Jurisdictional boundaries do not limit invasive species infestations; thus, coordination among neighboring jurisdictions is essential for EDRR to be successful. Active partners in EDRR activities may include Federal, state, tribal, and local governments, as well as regional authorities and a range of site-based partners, including landowners, local naturalists, and issue experts. The descriptions below outline the general interests of the primary stakeholders in the national EDRR Framework.

Federal Agencies: Federal agencies have a number of key roles in EDRR including responsibilities for managing Federal lands and waters, enforcing Federal laws, exercising regulatory authorities, and providing technical expertise in management, research, and information systems. The Federal government manages approximately 635 million acres in the United States, the majority of which are administered by the Bureau of Land Management, U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), U.S. Forest Service (USFS), and Department of Defense (CRS 2012). The NOAA is responsible for marine sanctuaries. The U.S. Coast Guard enforces laws protecting waters from non-native species. The Bureau of Indian Affairs (BIA) plays an important role as trustee and advisor for tribally owned lands.

Some relevant Federal regulatory authorities include the ability to prohibit the import into the United States and the interstate transport of listed invasive injurious species, approve specific pesticides and their applications, engage in emergency response actions, and manage risks associated with certain major pathways of invasive species introduction. Many Federal agencies are active in the development and application of tools for invasive species assessment, detection, reporting, species monitoring and surveillance, management, and identification. Such agencies are a key resource for the collection of data regarding invasive species ecology, impacts, and geographic distribution.

State Agencies: In many ways, state agency activities mirror those at the Federal level but within the bounds of their state borders. States have a wide range of authorities to manage invasive species and often have a more direct line of communication to the counties, municipalities, and private landowners at the site level. States have a vested interest

in cooperating with neighboring states to address common priorities, such as particular invasive species of concern and ecosystems that extend across jurisdictional borders. For example, Great Lakes states are collaborating on efforts to prevent the spread of Asian carp, and Western states are working together to conserve the sage-grouse and sagebrush steppe ecosystem from invasive annual grasses, such as cheatgrass. In addition, many states have established or are forming invasive species councils, invasive plant councils, statewide networks of local invasive species cooperatives⁶, and aquatic nuisance species (ANS) management plans that provide an important basis for coordinated planning and action.

Tribes: There are 567 recognized American Indian tribes. The BIA is responsible for the administration of 55 million surface acres and 57 million acres of subsurface mineral estates held in trust for American Indian tribes and Alaska Natives. Tribal governments govern approximately 275 land areas in the United States designated as Indian Reservations. Millions of off-reservation acres, particularly in the Pacific Northwest and Great Lakes regions, are also under inter-tribal co-management with states for conservation purposes and fish, wildlife, shellfish, and plant gathering activities. Under the doctrine of trust responsibility, the U.S. Federal government views Federally recognized tribal nations as domestic dependent nations that have an inherent authority for self-governance.

Tribal nations have authority to lead EDRR activities on tribal lands and waters and have traditional ecological knowledge of the natural resources and cultural practices on these lands and waters, including ceded lands. Tribal engagement in EDRR activities varies from extensive (e.g., having staff, plans, funding, and working relationships with adjacent landowners) to nonexistent due to limited to no capacity or resources. In 2014, BIA initiated an annual invasive species competitive funding program for tribes that helps to support a range of activities, such as invasive species planning, monitoring, mapping, control, and education and outreach.

Regional Bodies: Governmental and non-governmental entities play a critical role in identifying and coordinating activities across states and geographies. Regional governors associations and interstate cooperatives provide a mechanism for multi-state collaboration on shared priorities. Federal agencies,

⁶ Local invasive species cooperatives include cooperative weed management areas (CWMAs), cooperative invasive species management areas (CISMAs), and partnerships for regional invasive species management (PRISMs), among others.

such as the USFS, USFWS, and EPA, have networks of regional offices to support work on Federal lands and waters and with states at the site level. The ANSTF Regional Panels are a valuable network that serves at the interface of Federal and state activities on ANS. [See Appendix C, Fig. C1, which shows the coverage of ANS Regional Panels that focus on a range of AIS strategies, including EDRR.] State and regional invasive plant councils provide a similar support function on terrestrial plant issues. [See Appendix C, Fig. C2, which shows the coverage of state and regional invasive plant networks that address invasive plant issues, including EDRR.]

A range of regional entities, such as the Landscape Conservation Cooperatives, DOI's Climate Science Centers, and NOAA's estuarine research reserves and marine sanctuaries enhance research and management issues relevant to the EDRR of invasive species.

While the focus of the EDRR Framework is domestic, there may be cases where EDRR activities require collaboration with neighboring countries, and thereby could involve relevant bi-national entities, such as the U.S.-Mexico International Boundary and Water Commission, the U.S.-Canada International Joint Commission, and the Border Environment Cooperation Commission.

Site-Based Partners and Other Technical Experts: Counties, municipalities, water management and irrigation districts, private citizens, corporations, land trusts, and other non-governmental organizations own and manage lands and waters. A range of entities support EDRR activities, such as local invasive species cooperatives⁷, citizen science initiatives, master naturalist groups and natural history clubs, and stewardship programs. [See Appendix C, Fig. C3, which illustrates a range of EDRR networks and Fig. C4, which shows the coverage of hundreds of local invasive species cooperatives that span the United States.] They provide important mechanisms for local coordination and often are the first to observe and report new invasive species.

Academic, industry, and non-governmental organizations provide access to significant expertise on species, pathways, and EDRR methods and tools. For example, universities and the private sector can play a critical role in developing detection technologies and diagnostic methods for the identification of potential invasive species. The private sector has also played an important role in the development of

A wide range of EDRR efforts are underway in the United States. These initiatives vary across species of concern, geographies, legal jurisdictions, and agency authorities. A unifying vision and national framework will help ensure effective coordination and timely communication among these efforts. The USDA Animal and Plant Health Inspection Service (APHIS) operates an EDRR program on plant and animal health that primarily focuses on agricultural and livestock concerns. Additionally, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW) and the U.S. Forest Service (USFS) have EDRR models for use in terrestrial systems. Taxonomic and/or geographic-specific efforts such as the Aquatic Nuisance Species Task Force's (ANSTF) Aquatic Nuisance Species (ANS) Regional Panels may also support and engage in EDRR activities. In addition, a wide array of local EDRR initiatives is underway through invasive species cooperatives involving citizen scientists; in some cases, these local cooperatives form statewide networks (e.g., in Florida, New York, and Hawaii). A nationally coordinated EDRR framework that provides the rapid communication and organizational development mechanisms, EDRR tools that can be readily accessed and shared, training and other forms of capacity building, and sufficient funding would greatly enhance the effectiveness of all of these initiatives, as well as fill the gaps in EDRR coverage that currently enable invasive species to diminish the value of priority landscapes and aquatic areas.

⁷ See footnote 6.

control techniques and products, as well as in monitoring activities that may relate to their corporate activities or environmental footprint.

Finally, non-governmental organizations play a key role in the development, use, and application of technologies, working across governmental and non-governmental entities, and helping to identify priority habitats and species.



The national EDRR Framework will connect and enhance existing efforts across all stages of the EDRR process: preparedness, early detection, rapid assessment, and rapid response. For example, EDRR actions benefit from a variety of detection networks. Many monitoring programs exist, including paid professionals and an increasing number of volunteer citizen scientists and naturalists. Monitoring efforts often focus on specific species or groups of species (e.g., lionfish or aquatic invasive species), high-risk pathways (e.g., ports of entry and urban environments), and/or protecting high-value locations (e.g., Great Lakes). There is a need to expand these existing programs and to engage other types of monitoring efforts to aid in invasive species detection. Examples include ecological monitoring programs, tree health monitoring networks, and marine monitoring efforts, among others. Enlisting the assistance of field personnel, such as foresters, fire program staff, and transportation staff also will help broaden the reach of detection efforts.

Detections may also occur outside of formal monitoring networks, such as by private citizens, who have a strong knowledge of local plants and wildlife. Federal, state, local, tribal, and private sector entities are all important partners in early detection. Education and training programs to inform personnel, practitioners, volunteers, and the public about potentially invasive species are critical to help increase the likelihood of detecting new introductions.

Red Lionfish
Pterois volitans

The EDRR Framework builds upon and integrates the services and capabilities that this range of entities offers, while also helping to identify key geographic, taxonomic, programmatic, and skill-based gaps.

Some of initial gaps in EDRR capabilities and capacities that the EDRR Framework would aim to enhance include conducting national risk assessments to determine high-risk species that threaten priority landscapes and aquatic areas, priority pathways, and priority areas vulnerable to invasion; prioritizing species to help focus monitoring and research critical to improving detection and eradication technologies and methods; strengthening monitoring programs and taxonomic capacity/tools for rapid specimen identification; supporting information systems to inform decision making; and, developing a well-coordinated national alert system.

Federal agencies play a critical role in addressing some of these gaps, such as conducting horizon scanning⁸ and risk analysis to determine the invasive species that pose the highest risk to the Nation; developing and providing access to EDRR tools; or, helping to support emergency responses for priority invasive species⁹. For others, non-Federal partners may play a critical role, such as coordinating citizen science monitoring programs, defining site-specific reporting protocols, and engaging private landowners. It is important to note that the roles and responsibilities across the range of EDRR action steps (see Fig. 3) are fluid. For example, lead agencies will vary among EDRR events based on the species, the location of the population, the authorities, and the availability of resources.

The EDRR Framework aims to ensure that the work of Federal and non-Federal partners is well coordinated, mutually beneficial, and provides for the full range of EDRR actions necessary for successful EDRR.

8 Horizon scanning is the systematic examination of future potential threats and opportunities that can contribute to the prioritization of invasive species of concern and the means to address their introduction and spread (Roy et al. 2014).

9 Priority invasive species will need to be identified. They would include those that pose the greatest risks to priority landscapes and aquatic areas, as well as those unforeseen introductions (i.e., those potentially invasive species not previously identified) evaluated as high-risk through a rapid science-based risk assessment process.

Preparedness

Horizon Scanning and Risk Analysis Planning (Leadership, Communications, Resources etc.)
 Research
 Tool Development and Sharing
 Monitoring Programs

Early Detection

Training and Monitoring
 Detection and Reporting
 Identification and Vouchering
 Incorporation and Evaluation of "Sight Unseen" Data
 Data Recording and Sharing
 Communications and Outreach

Rapid Assessment

Rapid Assessment of Species Risks
 Risk Management (Options Identified)
 Risk Communications (Strategy Developed and Employed)

Rapid Response

Leadership and Coordination
 Emergency Containment and Quarantine Treatment (Eradication)
 Monitoring, Evaluation, and Reporting
 Communications and Outreach

Figure 3: General EDRR Action Steps. Initial overview of a range of activities necessary for effective EDRR. See Appendix B for full descriptions of these concepts. The roles and responsibilities of Federal and non-Federal (state/tribal/other partner) entities vary across this suite of EDRR actions.

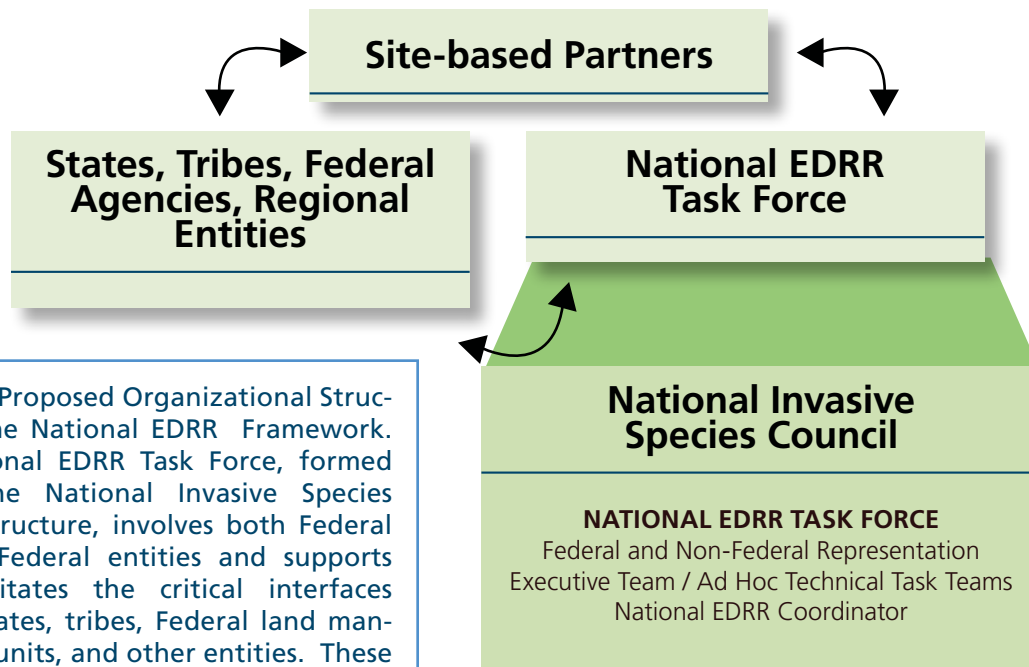


Figure 4: Proposed Organizational Structure of the National EDRR Framework. The National EDRR Task Force, formed within the National Invasive Species Council structure, involves both Federal and non-Federal entities and supports and facilitates the critical interfaces among states, tribes, Federal land management units, and other entities. These entities support and further facilitate the work of site-based partners, who often are the first to observe and report new invasive species.

Organizational Structure

An effective EDRR Framework requires focused coordination across the range of Federal and non-Federal entities to fund and implement preparedness, early detection, rapid assessment, and rapid response activities. That coordination requires an organizational structure with well-defined roles and responsibilities, as well as the means to ensure that those roles are implemented.

Executive Order 13112 directs that, among other things, Federal agencies whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law, and subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner. Executive Order 13112 also establishes NISC¹⁰ and directs that it shall provide national leadership regarding invasive species, oversee the implementation of Executive Order 13112, and see that Federal agency activities concerning invasive spe-

cies are coordinated, complementary, cost-efficient, and effective.

It is envisioned that an EDRR Task Force (hereafter Task Force), operating within the NISC structure and composed of Federal entities and representatives of states, tribes, and regional initiatives, would serve as a standing body to facilitate nationwide coordination among Federal agencies and non-Federal partners. This Task Force would help formalize existing ad hoc and informal arrangements and would establish lines of communication between Federal and non-Federal partners. Figure 4 outlines a proposed structure for connecting some of the major EDRR networks. Appendix C provides examples of existing invasive species networks that, through effective partnership and increased capacity, would become critical components of a national EDRR program.

The Task Force would be informed by ad hoc task teams that focus on technical issues, including scientific advice (e.g., horizon scanning, risk assessment, prioritization, specimen identification), capacity building (e.g., training and protocol development), communications and outreach (e.g., providing information about potentially invasive species and response actions), and operations (e.g., permitting, information management, training, fund transfer), but would generally remain a small, agile forum for improving EDRR effectiveness and coordination. The Task Force would oversee the development of

¹⁰ NISC includes the Secretaries or Administrators of 13 Federal Departments and Agencies with the Secretaries of the Interior, Agriculture, and Commerce serving as co-chairs. The NISC's responsibilities include the preparation and implementation of a national management plan, coordination of interagency activities on invasive species, facilitation of information sharing, and encouraging action at local, tribal, state, and regional levels to achieve the goals of the NISC Management Plan (Executive Order 13112).

criteria to identify priority invasive species that may warrant response as well as develop priority invasive species watch lists¹¹. The Task Force would also oversee the development of criteria for developing and evaluating project proposals for EDRR funding (see Scope of Activities, page 26).

A small executive team of high-level Federal agency representatives would oversee the Task Force. The executive team would approve the composition of the Task Force, designate a National EDRR Coordinator, set priorities, and make funding recommendations.

At the site level, there is a more complex interaction of regional bodies, states, tribes, and Federal agencies with land management units and responsibilities at national and/or state borders. Interaction across these units is critical. Those specific entities and their roles will vary according to geography and invasive species/taxa of concern. Another critical set of stakeholders are local governments, site-based partners, and other technical experts (professionals and amateurs). The role of the Task Force at the site level will focus on helping link EDRR efforts among sites (especially monitoring); establishing lines of communication for information sharing; providing access to protocols and best practices; and, providing technical expertise and training.



Volunteer weed warriors pull bull thistle (*Cirsium vulgare*) in front of Half Dome, Yosemite National Park. (photo credit NPS)

11 See footnote 9. The term does not connote an official regulatory or listing status.

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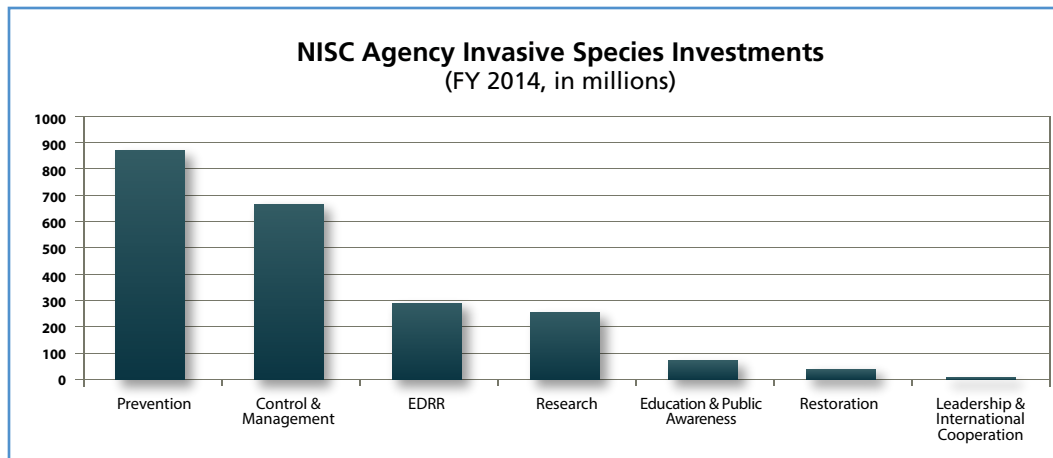


Figure 5: Federal agency investments on invasive species activities across all taxa, FY 2014 (NISC 2015).

III. THE EDRR COSTS OF COMBATting INVASIVE SPECIES

This EDRR Framework views investments in EDRR as investments in the future of the Nation's lands and waters; the economic cost of inaction is expected to be high, with newly-introduced invasive species and long-term control of established invasive species imposing significant economic and ecological costs on the Nation. For example, estimates of long-term control costs, losses, and damages of aquatic and terrestrial invasive species currently established in the United States exceed \$120 billion per year (Pimentel et al. 2005). The AIS controls cost more than \$9 billion per year (Pimentel 2003). Forest pests and pathogens cost nearly \$1.7 billion in local government expenditures and approximately \$830 million in lost residential property values (Aukema et al. 2011).

These figures typically include only monetized damages that are more easily estimated and often do not include non-market values, such as the loss of ecosystem services, such as flood control, pollination, and recreation (Cardno ENTRIX and Cohen 2011). In comparison to the cost of these impacts, a conservative estimate of annual investments by Federal agencies to address invasive species is estimated at \$2.2 billion across all taxa and stages of the invasion curve. Figure 5 shows the breakdown of investments according to different categories of activity with prevention being the largest investment (\$872 million for FY 2014), followed by Control and Management (\$670 million for FY 2014), and then EDRR

(\$290 million for FY 2014) (NISC 2015)¹². Thus, investments in EDRR, the second line of defense according to the invasion curve (see Fig. 1) receives less than half of the resources dedicated to longer term control and management efforts.

Focusing on EDRR, NISC agencies reported a total of \$290 million in investments during FY 2014. USDA reported approximately \$265 million—90 percent of total Federal investments—the vast majority of which was allocated to the protection of agriculture and livestock (see Fig. 6) (NISC 2015).¹³ This provides a sense of scale in terms of the amount of funds directed primarily at EDRR priorities centered on agricultural, economic, and food security concerns, in contrast to the funds currently available for EDRR efforts that would fall under this EDRR Framework.

While Figures 5 and 6 portray total Federal agency investments in EDRR, it is also useful to get a sense of the cost of specific EDRR activities. Despite the disparity, USDA investments are illustrative of the costs associated with different EDRR activities necessary to implement the EDRR Framework. For early detection, APHIS received \$27.4 million for its Pest Detection Program in FY 2015.

12 The NISC Interagency Crosscut Budget represents a conservative estimate of spending by NISC member agencies on invasive species. The Federal budget process is complex, and the crosscut accommodates differences across reporting agencies regarding how they program their invasive species activities (e.g., set budget lines vs. project or grant funding).

13 There is some crossover of USDA EDRR efforts that also benefit areas outside of agriculture and livestock. For example, work on forest pests such as Asian longhorned beetle and emerald ash borer benefit natural resources.

For specific response activities, USDA investments in FY 2015 ranged widely depending on the invasive species, including (York USDA 2015, personal communication):

- ◆ Avian influenza (caused by various viruses adapted to birds): \$989.1 million¹⁴
- ◆ Asian longhorned beetle (*Anoplophora glabripennis*): \$41.6 million
- ◆ European grapevine moth (*Lobesia botrana*): \$5.0 million
- ◆ Sudden oak death (caused by *Phytophthora ramorum*): \$1.4 million

For invasive species that impact natural resources, several examples from Western states illustrate the magnitude of rapid response costs:

California total investments on large AIS rapid response/eradication projects over the period 2000 to 2009 (Cardno ENTRIX and Cohen 2011):

- ◆ Northern pike (*Esox lucius*) eradication: \$19.5 million
- ◆ Invasive Spartina (*Spartina spp.*) project: \$14.0 million
- ◆ Quagga and zebra mussel response (*Dreissena bugensis* and *D. polymorpha*): \$13.5 million
- ◆ *Caulerpa taxifolia* (marine algae) eradication: \$7.7 million

Japanese tsunami marine debris (removal of floating docks infested with potential AIS) (NOAA Marine Debris Program 2014; Oregon Department of Fish and Wildlife):

- ◆ \$628,000: dock removal from a remote beach in Washington's Olympic National Park and Olympic Coast National Marine Sanctuary.
- ◆ \$85,000: dock removal from a beach near Newport, OR; the Oregon Department of Fish and Wildlife estimated an additional \$31,000 in staff time invested over a ten-month period.

From a geographic perspective, the South Florida Ecosystem Restoration Task Force reported approximately \$3,767,000 in EDRR investments over FY 2013-14.¹⁵ This includes (South Florida Ecosystem Restoration Task Force 2015):

- ◆ \$3,468,007: EDRR activities focused on invasive animals
- ◆ \$298,607: EDRR activities focused on invasive plants

From the perspective of a single invasive taxon, the ANSTF's Quagga-Zebra Mussel Action Plan identifies the following future funding needs just for the phase of early detection (WRP 2010):

- ◆ \$500,000: development of standard field protocols
- ◆ \$2.6 million annually: expansion of monitoring programs to all Western water jurisdictions

Finally, when considering general preparedness activities, USFWS and ANSTF provide a useful model for supporting regional and state-based comprehensive and integrated AIS activities. For more than a decade, USFWS provided the following support (MacLean USFWS 2015, personal communication):

- ◆ Approximately \$50,000 annually to its six regional panels¹⁶
- ◆ \$1 million to divide among states or interstate collaboratives with approved ANS Management Plans¹⁷

By contrast, the total amount of state requests to USFWS for annual plan implementation exceeds the amount available; it was \$14 million in FY 2012¹⁸ (MacLean USFWS 2015, personal communication).

These examples are illustrative of the range of investments in EDRR activities. While these are not intended to capture the full scope of activities, they are suggestive of the types of activities that might warrant funding (i.e., preparedness efforts and rapid response) and the scope of resources required (i.e., low to high investments).

14 The Commodity Credit Corporation (CCC) transferred these funds at the request of the Secretary of Agriculture. The CCC was created to support farm incomes and prices and to stabilize agricultural commodity markets, and it also provides access to emergency funds to address related threats from pests and diseases. Those funds can be used for indemnification (i.e., paying private individuals for their crops or livestock losses).

15 This total includes figures from state and Federal agencies, which use different fiscal calendars.

16 This figure has declined with budget cuts and sequestration.

17 In FY 2015, this included requests from 40 of the 42 states with plans, which resulted in an average of approximately \$24,300 per plan. ANS plans are encouraged but not required to include an EDRR component with the intention of supporting preparedness activities.

18 This data was last gathered in 2012.

EDRR Investments by Federal Agency (FY 2014)

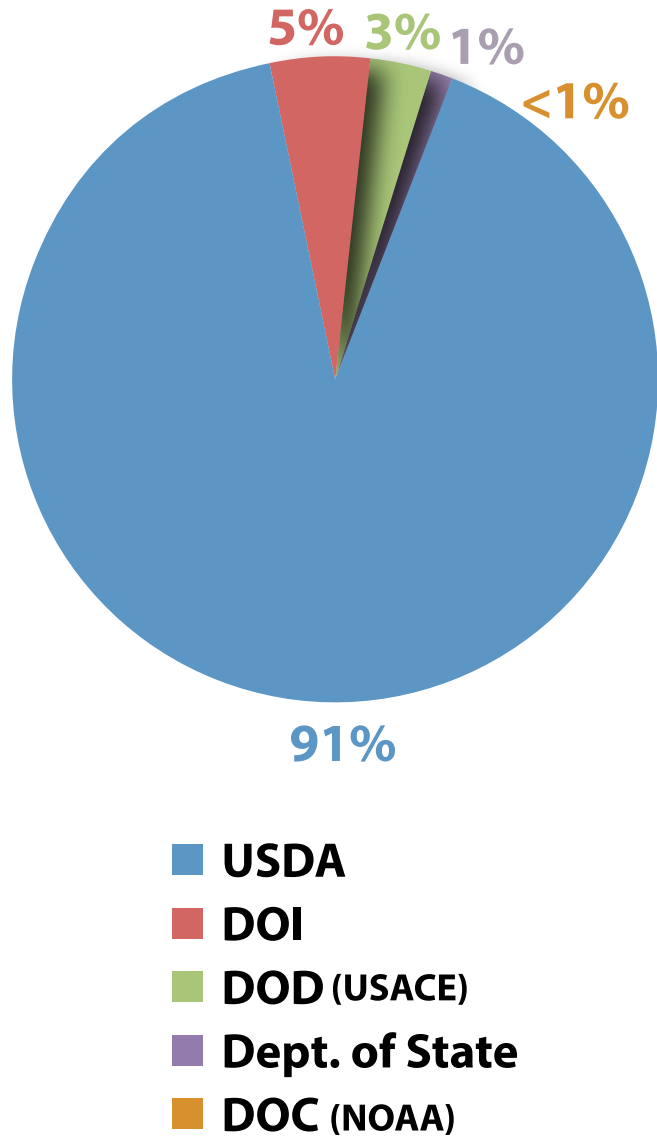


Figure 6: Percentage of total EDRR investments reported by Federal agencies, FY 2014 Enacted (NISC 2015). NISC agencies reported a total of \$290 million in investments during FY 2014. USDA reported approximately \$265 million—90% of total Federal investments—the vast majority of which was allocated to the protection of agriculture and livestock. This provides a sense of scale in terms of the amount of funds directed primarily at EDRR priorities centered on agricultural, economic, and food security concerns, in contrast to the funds currently available for EDRR efforts that would fall under this EDRR Framework.

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Quagga Mussel
Dreissena bugensis
photo credit NOAA

IV. OPTIONS FOR FUNDING THE EDRR FRAMEWORK

A fully operational EDRR Framework requires that resources (financial, technical, and human) are readily available and accessible when a potentially invasive species is detected and appropriate decision makers determine rapid response is necessary. Successful rapid response is contingent on preparedness: having the plans, tools, training, resources etc. in place to mount eradication efforts.

At this time, there is limited capability and capacity to fully implement the EDRR Framework, due to limited funds. Even focused engagement in priority landscapes and aquatic areas may be difficult to achieve within existing resources. The capacity of existing EDRR activities is focused on combating select invasive species and focusing on select geographic areas. Eradication efforts can be disconnected from neighboring activities and often lack financial resources and decision-support tools. A well-supported EDRR Framework would address these gaps and prevent potentially irreversible harm from the continued establishment and spread of invasive species.

Developing options for targeted EDRR funding and/or more effective funding mechanisms (governmental, non-governmental, and/or in partnership with governments) is one of the next steps in implementing the EDRR Framework. This should include an assessment of current Federal EDRR programs and costs, opportunities for a coordinated strategy to align EDRR funding, and an evaluation of current and/or new funding mechanisms. This analysis is necessary to advance the EDRR Framework from concept to reality.

Several core capabilities of targeted EDRR funding that would support the EDRR Framework include timeliness of funding, consistency of funding, and cost sharing.

Timeliness: EDRR funding should be readily accessible to finance EDRR actions and support effective eradication activities. The speed at which funding requests are evaluated, decisions are made, and the funding is dispersed is critical to avoid delays in mobilizing EDRR activities.

Consistency: Some EDRR activities (e.g., monitoring) are continuous, thus EDRR funding should also be continuous; gaps in funding can erase past gains. Further, EDRR funding should be available over a number of consecutive years to be most effective in eradicating an invasive species and monitoring treatment effectiveness. This would avoid shortfalls at the end of one fiscal year that would necessitate postponing an EDRR response until a new budget is in place.

Cost Sharing: Cost sharing, matching, and/or in-kind contributions are a critical part of EDRR efforts because such arrangements create incentives for entities to participate, leverage resources (financial, technical, and human), and are often necessary because EDRR actions typically cross jurisdictions, necessitating Federal and non-Federal partnership approaches.¹⁹

EDRR funding approaches should be informed by experience gained in other areas with the provision of resources for conservation objectives and/

¹⁹ EDRR preparedness activities in regard to cost sharing could include the inter-jurisdictional identification of resources, such as sharing of equipment, personnel, technical expertise, and materials.

Interagency efforts at various scales are underway across the country to bolster EDRR efforts through preparedness activities; however, they require additional support to be fully operational. For example, Great Lakes entities have undertaken some aspects of EDRR. In addition to support for response actions, support is needed for preparedness activities including intensive monitoring for many taxonomic groups, rapid response training, tools for containment and eradication, and interagency data management. In south Florida, the South Florida Ecosystem Restoration Task Force developed an "Invasive Exotic Species Strategic Action Framework," a comprehensive and integrated plan informed by a diverse partnership of stakeholders. Some of the specific EDRR needs include development of a prioritized monitoring plan, early detection tools and reporting mechanisms, increased capacity in Federal and state agencies, and rapid assessment protocols. Similarly, as part of the 100th Meridian Initiative, a Columbia River Basin Team formed to identify and address the special needs of the region, including development of an early detection monitoring program, web-based data information system, and response plan for invasive mussels and other non-native species. These types of preparedness activities, among others, are critically important to support for EDRR to be effective.

or short-term priority actions, such as APHIS's Plant Protection Program for EDRR, the Commodity Credit Corporation, the National Fish and Wildlife Foundation, the Wildland Fire Management accounts, the Emergency Stabilization funds (e.g., Burned Area Emergency Response, Burned Area Rehabilitation programs), and entities with existing successful emergency response funds.²⁰ Appendix D provides initial examples of different financing models that could be considered when identifying and/or developing EDRR funding approaches.

Scope of Activities

EDRR funding should support both preparedness activities (e.g., initial capacity and capability building efforts for coordination, planning, monitoring etc.) and emergency response (e.g., response to priority invasive species and extreme events). As new funding mechanisms are developed, support for administering EDRR funding would also be necessary.

Preparedness Activities: Implementing EDRR effectively requires a variety of capabilities (see Fig. 3, page 17, and Appendix B). There is currently a patchwork of efforts and capacities where some states, tribes, and regions are better equipped, although most have significant gaps. Building the full suite of capacities and capabilities will be an iterative process that takes time, as witnessed by the ongoing EDRR efforts in places like the Great Lakes, south Florida/Everglades, and the Columbia River Basin, which are more advanced in their preparedness but still require further work on their EDRR systems.

Funding to support preparedness across the suite of action items from early detection to rapid response will be instrumental in building a network of Federal, state, tribal, and other partners that can respond to invasive species introductions in a timely and effective manner to protect priority landscapes and aquatic areas.²¹

One or more funding mechanisms could provide grants to agencies, states, tribes, regions, and other entities to enhance their preparedness, with a particular focus on grants for multi-jurisdictional and multi-state coordination. Depending on the legal

²⁰ Some states, such as Idaho and Oregon, and regional entities, such as the Lake Champlain Basin Program, designated funds for EDRR emergency response.

²¹ In some cases, these funds may support rapid response efforts for species of local concern. For example, the Northeast Aquatic Nuisance Species Panel allocated a small portion of its funding from the ANSTF to establish an EDRR fund (although that fund is presently dormant given funding cuts).

Memorandums of Understanding (MOU) and Federal Interagency Agreements (IA) help to facilitate timely collaboration by setting forth principals and procedures jointly agreed to by the signatories. Mutual Aid Agreements, such as that signed by the Great Lake states and provinces, can expedite multi-state response efforts by outlining opportunities for lending assistance and sharing resources across jurisdictional boundaries. Guarantees for reimbursement of expenditures may be another mechanism to ensure that response efforts are rapid. Grants, cooperative agreements, procurement contracts, or other legal arrangements also can be put in place in advance to allow funds or other resources to flow from the Federal government to its partners.

authority, source, amount, and administrative requirements, funding could be disbursed through a request for proposals, block grant, or other competitive processes.

Emergency Response: Funding should also support emergency EDRR response: those urgent situations where major EDRR actions are needed to address priority invasive species or to respond to the risks posed by large-scale disasters and extreme events.

Priority invasive species would include those identified by the National EDRR Task Force as posing the greatest risks to priority landscapes and aquatic areas, as well as those unforeseen introductions (i.e., those potentially invasive species not previously identified) evaluated as high-risk through a rapid risk assessment process.²² Funding also could be used to address the spread of known or potentially invasive species resulting from large-scale disasters and extreme events, which may require emergency invasive species monitoring and eradication efforts. Examples include flooding on the Mississippi River throughout the Central Plains; hurricanes along hundreds of miles of coastline; earthquakes, such as

the earthquake in Los Angeles, which brought up subsurface micro-organisms; tsunami marine debris, such as that in the Northwest, that carried potential AIS; and, wildfires and volcanoes, which may not disperse invasive species but disturb landscapes making them ripe for invasion.

Emergency response activities are time sensitive and need to have an expedited process for requesting support, decision making, and dispersing funds.

Administration: Administering EDRR funding through new funding mechanisms would require dedicated program management resources, particularly in the initial years, to set up the administrative structure. The number of projects reviewed and funded, the magnitude of the funds available for disbursement, and the institutional and administrative structure would define the appropriate resource level.

²² Risk assessment criteria to identify priority invasive species may include the potential to cause environmental, human health, and/or economic harm; current distribution; projected climate niche under climate change scenarios; potential distribution; and, the cost-benefit of taking action. Consideration would also be given to the likelihood of successful eradication and prevention of reintroduction. Such species could include those already established in the United States but limited in their distribution, as well as many that are not established but likely to become established.

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Volunteers in
National Parks
(photo credit NPS)

V. RECOMMENDATIONS

The comprehensive set of EDRR actions—from coordination and planning to monitoring and eradication—must be effectively and efficiently implemented. If one or more actions are not implemented or implemented inadequately (e.g., the response is too slow), then EDRR activities will fail and the invasive species will continue to spread. This national EDRR Framework focuses on those actions where Federal agencies can play a unique role to enhance the capabilities and capacities of entities working on EDRR. The EDRR Framework provides the mechanism to establish lines of communication and coordination; facilitate critically important partnerships; identify strategic shared priorities on which to focus limited resources; and, help support the work of Federal agencies, states, tribes, and other partners to address invasive species.

The Secretaries of the Departments of the Interior, Agriculture, and Commerce, as co-chairs of NISC, working with other members of the NISC, should take the following five steps to implement a National EDRR Framework:

1. **Establish a National EDRR Task Force and designate a National EDRR Coordinator within the NISC structure to address invasive species that affect priority landscapes and aquatic areas.**
 - ◆ **Establish a National EDRR Task Force within the NISC structure.** Effective EDRR requires efficient communication and collaboration across the range of Federal, state, tribal, and local jurisdictions, as well as other stakeholders and issue experts. While there are net-

works and other capabilities in some places that can effectively conduct EDRR, gaps remain, and no national scale coordination mechanism exists for priority landscapes and aquatic areas. A Task Force established within the NISC structure is a critical step for the full realization of a national EDRR Framework. The Task Force would play a key role in the identification and assessment of priority invasive species, identification of critical EDRR tools and technologies, drafting of protocols and other guidance, and determination of priorities for the allocation of funding for emergency response and preparedness activities. The Task Force would also help identify roles and responsibilities of various entities and decision making criteria within the context of the EDRR Framework.

- ◆ **Designate a National EDRR Coordinator within the NISC to facilitate the implementation of the national EDRR Framework.** A designated coordinator is essential to provide coordination across Federal agencies and to assess how the sum of Federal EDRR capacities can support the EDRR Framework. The coordinator would serve as the liaison with state, tribal, regional, and other partners and experts to facilitate communications and identify efficient means to share information, technologies, and other resources. Additional actions could include laying the groundwork for decision making and identifying steps to progress from short-term to long-term priorities.

2. **Convene high-level decision makers (i.e. Assistant / Under Secretaries) and senior budget officers within NISC agencies to better align funding or guide the formation of more effective funding mechanisms to support priority preparedness and emergency response activities.**
 - ◆ **Assess current Federal EDRR programs and costs.** A range of EDRR activities are underway in Federal agencies, such as conducting risk assessments, developing detection and eradication technologies, and implementing EDRR actions on the ground through such efforts as invasive species strike teams and exotic plant management teams, among other actions. An initial step in addressing funding challenges is for agencies to describe their current EDRR capacities, capabilities, flexibilities, limitations, and magnitude of needs. This includes an assessment of how current EDRR efforts are supported through various agency programs and at what levels and whether potential sources of existing funding could be allocated to particular aspects of the EDRR Framework including those that could be shared with non-Federal partners (e.g., for training, stewardship of particular sites, etc.). A similar effort should be undertaken to understand non-Federal spending and anticipated needs.
 - ◆ **Develop a plan to establish a coordinated funding process or mechanism(s) with targeted EDRR funding for preparedness and emergency response.** A range of financial, operational, and human resources are necessary to implement EDRR actions. To be effective, the national EDRR Framework should include targeted funding that could support emergency responses to priority invasive species and build and enhance overall capacity and capabilities to implement the full range of EDRR actions (e.g., planning, risk assessments, monitoring, identification support, research, etc.). EDRR is an ongoing process and must be maintained over time to be effective. A variety of funding sources and structures could be considered. Aligning and/or pursuing targeted resources will require leadership and guidance from high-level decision makers within NISC agencies (i.e. Assistant/Under Secretaries), senior budget officers, the Office of Management and Budget, and Congress.
3. **Incorporate EDRR into Federal programs and partnerships at national, regional, and local scales.**
 - ◆ **Identify Federal agency EDRR leads at national, regional, and state levels to facilitate and help coordinate EDRR efforts with states, tribes, and other partners.** Establishing Federal agency lead contacts and other points of contact working on EDRR within Federal agencies is an important first step in Federal implementation of the EDRR Framework, as well as increasing communications and improving coordination among Federal and non-Federal entities. Timeliness in implementing EDRR actions is essential; thus, knowing the appropriate contacts in the event of an early detection and throughout the EDRR process will help to promote efficiencies.
 - ◆ **Assess Federal legal authorities, regulations, and policies to conduct EDRR.** A national EDRR Framework should facilitate compliance with relevant Federal regulations, particularly with regard to rapid response actions and eradication techniques. Some EDRR activities may be possible within existing authorities, yet may require changes to agency policies and practices. Given differences across authorizing legislation, the NISC should work with member Federal agencies to assess their capacity and capability under existing authorities to implement EDRR. This assessment should be conducted through a centralized process that is coordinated among the Federal agencies and identify gaps, inconsistencies, and conflicts in agency authorities and policies, as well as enforcement capacity. The assessment should consider Federal agencies' abilities to partner with non-Federal entities to conduct EDRR activities on non-Federal lands and waters and any restrictions on their ability to address particular species or geographies.
 - ◆ **Strengthen, if necessary, Federal legal authorities, regulations, and policies to conduct EDRR.** Building on this review and analysis, the NISC should work with member Federal agencies to develop and implement a strategy requesting supplemental authorities, if needed, to fully implement the proposed EDRR Framework, particularly with regard to

their ability to work with and support states, tribes, and other partners. This strategy should consider the role of EDRR within the broader context of invasive species prevention and management activities.

- ◆ **Integrate EDRR into Federal initiatives.** Federal agencies should identify cross-cutting initiatives where EDRR applies. For instance, when developing activities on climate preparedness, Federal agencies could integrate EDRR activities, such as identifying priority invasive species and pathways that may affect a particular site and the monitoring and response measures needed. Federal agencies can focus on particular geographies that have already been identified as critical to promote climate resilience to maximize the effectiveness of EDRR and climate adaptation efforts.
- 4. Advance multiple pilot EDRR initiatives in priority landscapes and aquatic areas.**
- ◆ **Identify initiatives in priority landscapes and aquatic areas where elements of this EDRR Framework can be implemented.** Current capacities to conduct EDRR vary across the United States. The development of a national EDRR Framework likely will occur in a staged approach. As an initial step, agencies should identify several priority areas to pilot elements of this EDRR Framework. This could include working through existing EDRR efforts, as well as building EDRR elements into sites identified as priorities for climate resilience, such as the landscapes identified under the Resilient Lands and Waters Initiative.²³ Such efforts would be instrumental in the identification and application of performance measures and other metrics for the effectiveness and value-added contribution of EDRR activities.
- 5. Foster the development and application of EDRR capabilities, including technologies, analytical and decision making tools, and best practices.**
- ◆ **Identify current EDRR capabilities and prioritize needs.** EDRR capabilities help determine invasive species that are priorities for national EDRR efforts, as well as priority pathways to be addressed and geographies most vulnerable to invasion. Analytics and decision tools help determine what rapid response measures should be taken and when. A coordinated effort is needed to identify current EDRR capabilities and prioritize needs. Federal and non-Federal partners identified some of the immediate, key capabilities necessary for EDRR activities:
 - » A national EDRR alert system to distribute notifications about potential and identified threats to priority landscapes and aquatic areas
 - » Advanced threat assessment and horizon scanning
 - » Risk assessments of invasive species, sites, and pathways of introduction
 - » Predictive modeling of invasive species distributions, pathways of spread, and vulnerable areas
 - » Research on and development of novel detection and eradication methods and optimized approaches for monitoring and eradication
 - » Development and distribution of protocols for implementing stages of the EDRR process
 - » Training in the use of operational response strategies, such as the Incident Command System, and the application of technical and analytic tools
 - » Effective monitoring networks inclusive of known high-risk species and sensitive to the detection of new species
 - » Taxonomic capacity/tools for rapid specimen identification
 - » Information systems that support decision making
 - » A mechanism (clearinghouse) for distributing technical and analytic tools and case studies to states, tribes, and other partners involved in EDRR activities
 - ◆ **Enhance/develop, disseminate, and apply EDRR tools.** The development and application of these advanced technologies, analytics, and science-based decision tools will greatly improve the capability to prepare for, anticipate, detect, and respond to invasions.

23 The Resilient Lands and Waters Initiative currently includes the following seven priority landscapes: California Headwaters, California's North-Central Coast and the Russian River watershed; Crown of the Continent; Lakes Huron and Erie Coastal Wetlands to Maumee River; Puget Sound/Snohomish River Watershed; Southwest Florida; and, West Hawai'i, West Maui, He'eia Watershed (O'ahu).

Federal agencies are positioned to help build or augment such tools that can be used by various entities that, in turn, can provide valuable feedback for refinement. This includes research to support these EDRR capabilities.

While some of these tools currently exist, a coordinated effort to develop, enhance, disseminate, and apply them in the field will entail staff time and resources not immediately available to Federal agencies.



Native tufted poppy and wildflower display (photo credit NPS)

VI. CONCLUSION

Invasive species are among the top threats to the Nation's lands and waters, and climate change is amplifying and accelerating their impacts. Many entities have formed EDRR networks that focus on a specific invasive species or geographic region, yet there is no national EDRR Framework for priority landscapes and aquatic areas, nor a coordinated strategy to provide the funds required to support EDRR and emergency response activities. These gaps result in inefficiencies at multiple scales; meanwhile, invasive species continue to arrive, spread, and cause costly, irreversible harm to the environment and human health.

A national EDRR Framework designed to support the detection and identification of invasive species populations before they spread, and eradicate them before they cause significant harm, is both ecologically sound and cost-effective. Opportunities exist to connect and build upon existing networks, identify and close important gaps, provide crucial services and resources to those working on EDRR, and leverage engagement so that the whole is greater than the sum of its parts. The EDRR Framework provides the necessary structure to identify strategic and shared priorities for focusing limited resources and enhance partnerships and on-the-ground actions to stem the tide of invasive species.

ACRONYMS

AIS:	Aquatic Invasive Species
ANS:	Aquatic Nuisance Species
ANSTF:	Aquatic Nuisance Species Task Force
APHIS:	Animal and Plant Health Inspection Service
BIA:	Bureau of Indian Affairs
BLM:	Bureau of Land Management
CISMA:	Cooperative Invasive Species Management Area
CWMA:	Cooperative Weed Management Area
DOD:	Department of Defense
DOI:	Department of the Interior
EDRR:	Early Detection and Rapid Response
EPA:	Environmental Protection Agency
FICMNEW:	Federal Interagency Committee for the Management of Noxious and Exotic Weeds
ISAC:	Invasive Species Advisory Committee
NISC:	National Invasive Species Council
NOAA:	National Oceanic and Atmospheric Administration
NPS:	National Park Service
PRISM:	Partnership for Regional Invasive Species Management
U.S.:	United States
USDA:	U.S. Department of Agriculture
USFS:	U.S. Forest Service
USFWS:	U.S. Fish and Wildlife Service
USGS:	U.S. Geological Survey

GLOSSARY

Adaptive Management: A decision process that promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advances scientific understanding and helps adjust policies or operations as part of an iterative learning process. Adaptive management also recognizes the importance of natural variability in contributing to ecological resilience and productivity. It is not a ‘trial and error’ process, but rather emphasizes learning while doing. Adaptive management does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits. Its true measure is in how well it helps meet environmental, social, and economic goals, increases scientific knowledge, and reduces tensions among stakeholders (Williams et al. 2009).

Alien Species [also Non-native]: With respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem (Executive Order 13312).

Biological Invasion: The process by which non-native species breach biogeographical barriers and extend their range (McGraw-Hill 2003).

Climate Resilience: The capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts (Nelson et al. 2007, Folke 2006).

Early Detection: A process of surveying for, reporting, and verifying the presence of a non-native species before the founding population becomes established or spreads so widely that eradication is no longer feasible.

Eradication: The elimination of all individuals and propagules from an area with low likelihood of needing to address the species in the future.

Established Species: A species with a self-sustaining, reproducing population.

Horizon Scanning: The systematic examination of future potential threats and opportunities that can contribute to the prioritization of invasive species of concern and the means to address their introduction and spread (Roy et al. 2014).

Incident Command System: A management system designed to enable effective and efficient incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure (FEMA).

Invasive Species: An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health (Executive Order 13312).

Native Species: With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem (Executive Order 13112).

Non-native Species: See Alien Species.

Nuisance Species: Aquatic and terrestrial organisms, introduced into new habitats throughout the United States and other areas of the world, that produce harmful impacts on natural resources in these ecosystems and on the human use of these resources (ANSTF 1994).

Pathway: The means by which invasive species are moved, intentionally or unintentionally, into new areas.

Preparedness: Having the knowledge, financial resources, tools, trained personnel, and coordination structures in place to streamline activities at each of stage in the EDRR process.

Priority Landscapes and Aquatic Areas: In the context of the proposed national EDRR Framework, priority landscapes and aquatic areas are generally regarded as those lands and waters (freshwater, coastal, and marine) identified by Federal, state, or tribal entities as areas of importance, such as for natural resource stewardship, conservation, or biodiversity purposes.

Rapid Assessment: Determination of a species' abundance and distribution, the risks and impacts associated with its occurrence, as well as the potential management responses to address the invasion (NISC 2003).

Rapid Response: A process that is employed to eradicate the founding population of a non-native species from a specific location.

Risk Analysis: The set of tools or processes incorporating risk assessment, risk management, and risk communication, which are used to evaluate the potential risks associated with a species or pathway, possible mitigation measures to address that risk, and the information to be shared with decision-makers and other stakeholders.

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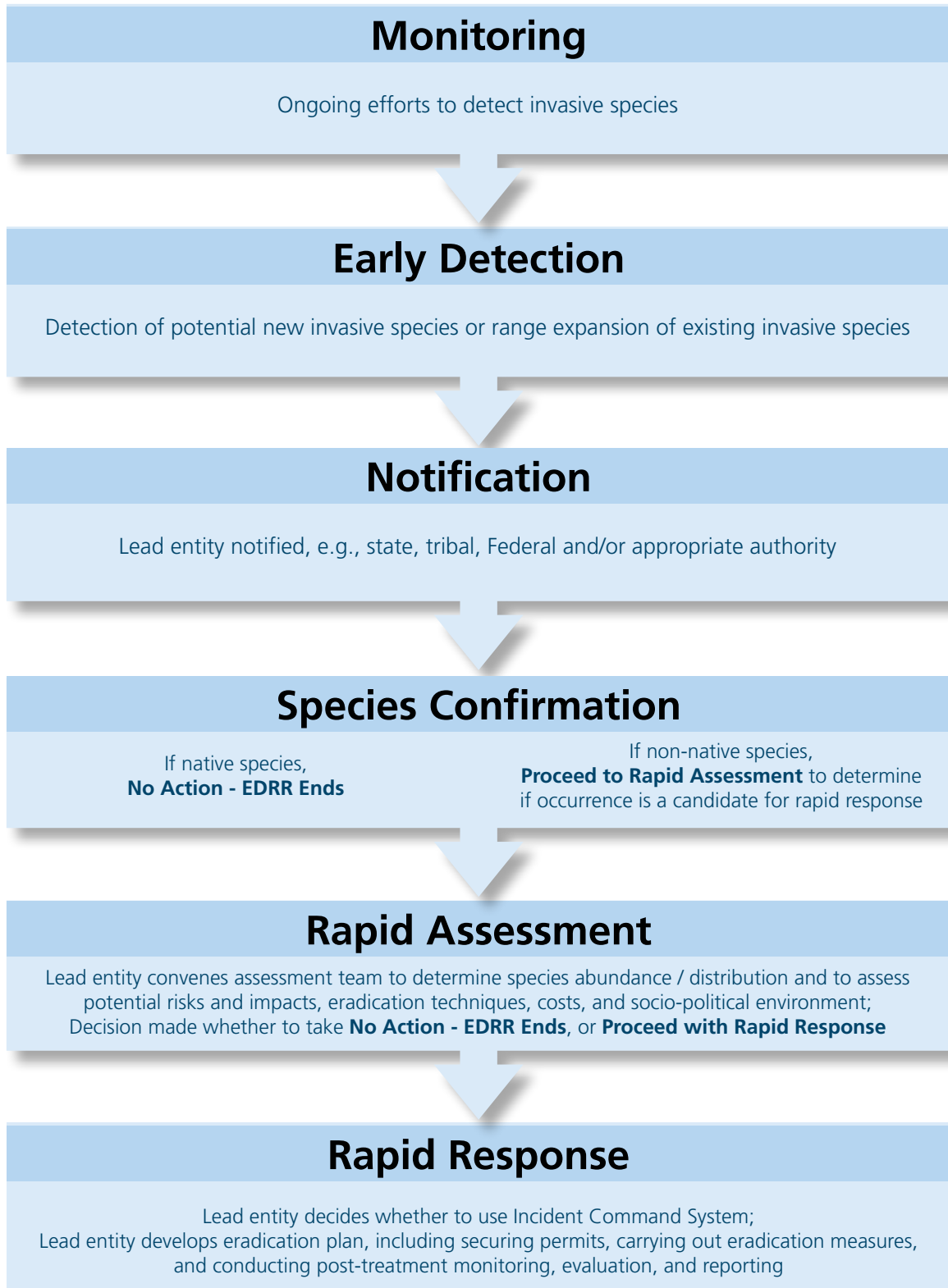
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APPENDIX A: EDRR DECISION MAKING PROCESS TEMPLATE

Stylized depiction of general early detection and rapid response decision making process



APPENDIX B: GENERAL EDRR STAGES AND ACTION STEPS

Early Detection and Rapid Response (EDRR) is a comprehensive set of sustained and coordinated actions generally grouped into four categories or stages:²⁴

- ◆ Preparedness
- ◆ Early Detection
- ◆ Rapid Assessment
- ◆ Rapid Response

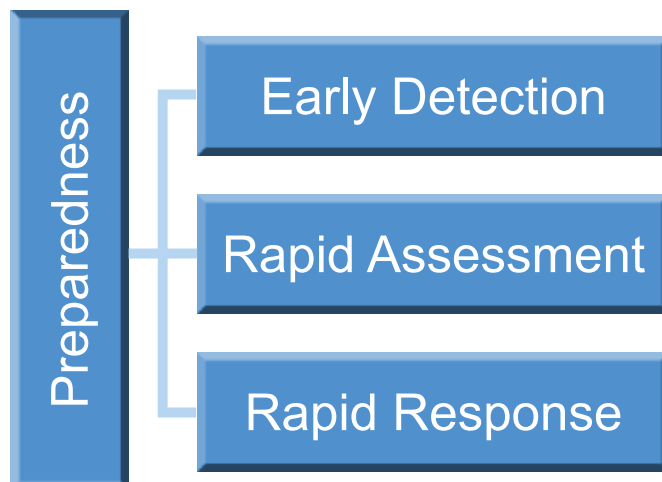
These efforts—if timely—increase the likelihood that invasive species will be addressed successfully while populations are still localized and small enough to be eradicated (NISC 2010). If one or more actions is not implemented or implemented inadequately, then EDRR activities will fail and the invasive species will continue to spread.

EDRR actions may eradicate potentially invasive species that are new to the United States or contain the spread of known invasive species by eradicating satellite populations that could result in significant range expansions.

Eradication of the targeted invasive species is the goal of the EDRR process. The following types of indicators help to evaluate the extent to which an EDRR response is successful (NISC 2003):

1. **Timeliness of the detection:** Potentially invasive species are detected upon introduction.
2. **Availability and accessibility of resources:** Technical, financial, and human resources are readily available to support assessment and response efforts.
3. **Timeliness of response actions:** Rapid response to the introduction prevents the establishment, spread, and adverse impacts of the invasive species.
4. **Timeliness of information:** Information is provided to decision-makers, the public, and to partners.
5. **Adaptive management:** A systematic approach is used for improving resource management by learning from management outcomes from EDRR.²⁵

The sections below outline a generic template of core actions drawn from numerous plans that detail the steps under the categories of preparedness, early detection, rapid assessment, and rapid response.²⁶ These steps are designed with the flexibility for use at a wide range of scales. Identifying responsible agencies and partners associated with each step, and timelines, will help to ensure that EDRR is successful.



General stages of the EDRR Process. Preparedness actions are necessary in advance of early detection and throughout each stage of the EDRR process.

²⁴ A template for a decision making process that incorporates the stages within the EDRR process is described in Appendix A.

²⁵ See Glossary for a detailed definition of adaptive management.

²⁶ Key sources include the Mississippi River Basin Panel on Aquatic Nuisance Species 2010 (excerpts adapted with permission); Lake Champlain Basin Program Aquatic Nuisance Species Subcommittee Rapid Response Workgroup 2009; FICMNEW 2003; Anderson 2005; California Department of Fish and Game 2008; NISC 2010; Pennsylvania Invasive Species Council 2014; Locke and Hanson 2009; and, Response Protocols for Biofouled Debris and Invasive Species Generate by the 2011 Japan Tsunami 2012; among others.

Preparedness

Mounting a response to eradicate invasive species populations can entail a range of regulatory and technical challenges. The potential for success in a response effort is greatly enhanced by preparedness, or having the knowledge, financial resources, tools, trained personnel, and coordination structures in place to streamline activities at each stage in the EDRR process. Preparedness includes the following types of actions:²⁷

- ◆ Horizon scanning and risk analysis
- ◆ Planning
- ◆ Research
- ◆ Tool development and sharing
- ◆ Monitoring programs

Horizon Scanning and Risk Analysis

Horizon scanning and risk analysis involve identifying short- and long-term future invasive species threats, conducting risk assessments, and prioritizing species, sites, and pathways for EDRR activities. Risk assessments may be completed for species in advance of their introduction or spread (i.e., anticipated threats) or performed rapidly once a species is detected. Risk assessments also can be used to determine sites, or hot-spots, where invasive species may be likely to arrive (such as transportation hubs or areas highly vulnerable to climate change) and pathways that are likely to transmit invasive species (such as recreational boating and live plant and animal imports). Criteria within risk assessments may include species biology, history of invasiveness and invasion potential, impacts, ease of eradication, pathways of spread, and climate matching between native and introduced ranges, among others.

Planning

Planning involves the consideration of a number of important steps that will aid in efficient implementation of EDRR actions by identifying and developing streamlined procedures before a response is triggered. It may also involve preparing written EDRR plans for specific species, locations, or pathways. Generic EDRR plans also can be useful to guide general processes or procedures.

Leadership: Preparedness includes designating entities that will be responsible for leading, coordinating, and implementing various components of the response. The entity that has the authority over the lands or waters where the invasion occurs, and the responsibility for enforcing laws that support the goals of rapid response, usually serves as the lead agency. The roles and responsibilities of all participants should be clearly articulated in writing and understood. Legal requirements and management tools that enhance or hinder the ability to undertake a rapid response should be identified and steps taken to develop solutions to promote EDRR actions.

Coordination: Coordination involves identifying key agencies, partners, and stakeholders and points of contact who will be involved in EDRR activities and developing mechanisms of communication for decision making and action (including identifying taxonomic experts to aid in species identification and a scientific panel to advise when a response is warranted and what actions should be taken).

Training: Training equips those involved to be proficient and increases the likelihood for the delivery of efficient and effective EDRR. Training is necessary for a variety of actions including species identification, monitoring, mapping, reporting, Incident Command System (ICS), and control techniques. All personnel involved with planning or implementing a rapid response should be trained and develop a familiarity with ICS. Responders should be adequately trained to be technically proficient in the safe execution of the procedures and protocols established in rapid response plans. Specific training required for regulatory compliance should be identified and kept up to date. Response preparedness should be maintained through continual training, EDRR exercises, and updating of current plans and procedures.

Protocols: Developing standard protocols helps to ensure consistency in methods and information collection and transfer. Protocols should be developed for the EDRR action steps such as monitoring, mapping, and reporting. A template for an EDRR plan would also help to identify core components and standardize approaches.

Environmental Compliance: Identifying the processes and permits necessary for detection and response activities and understanding how to efficiently navigate those processes and promptly secure those permits helps to increase the likelihood of a timely

²⁷ Some preparedness steps, such as risk analysis and identification of lead agencies, should happen in advance of an EDRR effort, while others occur simultaneously and are ongoing, such as research and outreach.

response. Considerations include land/water ownership and detection and control techniques that may be used. Some examples of environmental compliance to consider include:

NEPA: Prior to the involvement of any Federal agency (including the use of Federal funds by a grantee or cooperator) in the implementation of rapid response actions, compliance with the National Environmental Policy Act (NEPA) is required. The specifics of the situation will determine which NEPA document and process will be used to effect compliance.

Section 7 Consultation: The Endangered Species Act directs all Federal agencies to work to conserve endangered and threatened species and to use their authorities to further the purposes of the Act. Section 7 of the Act, called “Interagency Cooperation,” is the mechanism by which Federal agencies or other entities funded by a Federal agency, ensure the actions they take, including those they fund or authorize, are not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of critical habitat and do not jeopardize the existence of any listed species.

Regulatory Permits: Rapid response actions may require Federal and/or state permits to be in compliance with Federal and/or state regulations, such as the Federal Insecticide, Fungicide, and Rodenticide Act. The normal timeline for obtaining necessary permits may critically delay rapid response actions. Participating agencies should develop an efficient regulatory permitting process for implementing a rapid response plan. Similarly, necessary access agreements for work on private and public lands should be identified and developed. Partner agencies should engage their legal departments early in the process of developing rapid response plans.

Resources: Securing the necessary resources for EDRR in a timely manner is essential. Resources may include financial, physical, technical, and human resources.

Funding: Rapid response efforts can be prohibitively expensive and immediate access to adequate funding is essential. Targeted funding to support early detection and rapid response implementation facilitates the ability of lead agencies to implement rapid response plans when necessary.

Staff, Equipment, and Supplies: Participating agencies should identify the staff (and hire staff when needed), equipment, and resources necessary to implement a response. The lead agency should develop a list of resource needs, available resources, and resource deficiencies. Agreements for integrating resources from different partners during a specific response effort should be developed. Resource deficiencies should be addressed immediately. Partner agencies should direct their procurement units to have Memoranda of Understanding (MOU) and Interagency Agreements (IA) in place before implementation of response plans.

Communications and Outreach

Pre Detection: Rapid response actions can be complex, costly, and controversial. In advance of an EDRR event, stakeholder input in the development of EDRR plans is essential for building consensus; concerns should be addressed prior to the need to implement a response action. Communication with agency administrators, legislators, stakeholders, and the public is essential to build understanding and support for potential actions. A communications plan will help to ensure that agencies, the public, and the media are informed of decisions, actions, and final outcomes.

Post Detection: A coordinated process to notify agencies, partners, the public, and the media should be planned for and timed carefully and decided on a case-by-case basis. This decision is based, in part, on the turn-around time for on-site investigation, if one occurs, and on the type of invasive species discovered and time sensitivity of response actions. For example, for most invasive plants, the extent of the infestation should be known prior to public notification. However, for most invasive animals and pathogens, notification will usually proceed prior to full knowledge of the extent of the infestation because this information may be difficult to obtain.

CA, IA, or MOU: Cooperative Agreements (CA), IAs, or MOUs establish agreed upon commitments, roles, and responsibilities among agencies. They should be prepared and signed early in program implementation. They outline the relationship among agencies when a detection and response occurs and help to promote efficiencies and prevent delays. Rapid response efforts will generally require cooperation among agencies, tribes, organizations, and landowners, whether within an individual state or multiple states. Developing formal agreements on an EDRR plan in advance increases the likelihood of responding in an effective manner.

Research

Increasing understanding through research about various aspects of invasive ecology will improve abilities to successfully prevent, detect, and control invasive species and provide valuable information to inform science-based decision making. Ongoing research is critical for improving capabilities to manage invasive species for which there are few viable control options. Examples of areas of research include:

- ◆ Species biology and impacts
- ◆ Detection techniques and surveillance protocols
- ◆ Eradication techniques
- ◆ Restoration practices
- ◆ Effects of climate change on invasive species, their impacts, and likelihood of eradication
- ◆ Pathway interdiction methods
- ◆ Decision support tools

Tool Development and Sharing

A variety of tools developed in advance of an EDRR event help improve EDRR activities. Examples of tools include:

- ◆ Risk Assessment Tools: systematic guidelines for conducting risk assessments and identifying when action is warranted and the probability of success
- ◆ Detection Protocols: standard protocols for monitoring and reporting invasive species; reference guides for identifying invasive species; support for a network of taxonomists to aid in species identification
- ◆ Response Protocols: templates for who, how, and when to implement response activities
- ◆ Information tracking: guidance on use of databases to track, store, and report on species occurrences, distribution trends, and results of control efforts
- ◆ Education: compilations of identification guides and outreach materials for raising awareness about species threats
- ◆ Evaluation protocols: templates for evaluating components of EDRR activities (for efficacy, timeliness, cost, effort required, monitoring completed etc.)

Monitoring Programs

Detecting invasive species requires a variety of monitoring networks. Many invasive species monitoring programs exist—including paid professionals and an increasing number of citizen scientist volunteers—and are focused on priority species, specific sites (regions or hotspots), or particular pathways of concern. There are opportunities to expand these existing programs and to engage other types of monitoring efforts to aid in invasive species detection, such as ecological monitoring programs, roadside clean-ups, tree health monitoring networks, and marine monitoring efforts, among others. Enlisting assistance of field personnel, such as foresters, fire program staff, and transportation staff also will help broaden the reach of detection efforts.

Early Detection

Early detection encompasses the activities to conduct surveillance for, and verify, the presence of a non-native species in an ecosystem, before the species spreads so widely that eradication cannot be implemented. Detection provides initial evidence of the occurrence of a species new to the country or the region under consideration. Early detection includes the following types of actions:

- ◆ Training and monitoring
- ◆ Detection and reporting
- ◆ Identification and vouchering
- ◆ Incorporation and evaluation of “sight unseen” detection data
- ◆ Data recording and sharing
- ◆ Communications and outreach

Once an infestation is detected, a number of actions occur including collecting specimens, if possible; reporting the infestation to appropriate authorities; identifying and vouchering the species; and, recording the occurrence in a geospatial database. Some detections will require public notification. A carefully timed, coordinated process to notify the public and the media is decided on a case-by-case basis (NISC 2010).

New detections are also indications of where measures to prevent introductions are inadequate. Such detections can thereby provide valuable feedback to improve prevention efforts, which are the first line of defense against new introductions.

Training and Monitoring

Training programs, including outreach and educational materials, provide instruction on the protocols and techniques for invasive species identification, monitoring, and reporting. Monitoring efforts focus on specific species, sites, geographic areas/regions, and/or pathways. (See Preparedness: Monitoring Programs, pg. 44.)

Detection and Reporting

Reports of invasive species may come from a wide variety of sources including the general public, state and Federal agencies, tribes, and partner organizations, among others. A standard reporting protocol should be followed, including a standard sighting report form and instructions. (See Data Recording and Sharing, page 45). Some invasive species sighting reports will be made to various local, state, and other Federal entities and these should be directed to the appropriate entity who will determine next steps. To ensure timely notification of the correct authority, the responsible entity should establish and provide instructions for documenting and forwarding sighting reports. The EDRR process is initiated once notification of a potential new invasive species has been received by the appropriate management authority within the jurisdiction the discovery was made.

Identification and Vouchering

Authorized representatives (taxonomic experts) are needed to confirm the species' identity before any further actions are taken. Once the identification has been confirmed by taxonomic experts, the reported sighting is documented as either a negative or positive potential invasive species and acted upon accordingly. (See Appendix A for a general decision-making process.)

Negative: If the sighting is confirmed to be a native species, or if the species is already known to occur within the designated geography, then no further action is necessary because it is no longer considered an early detection of a new species. The early detection and rapid response process ends.

Positive: If the sighting is confirmed to be a new occurrence of a non-native species within the des-

ignated geography, then the early detection and response process proceeds and a rapid assessment is conducted.

Incorporation and Evaluation of "Sight Unseen" Detection Data

Resource managers are increasingly turning to "sight unseen" detection methods that promise significant cost and efficiency benefits over traditional detection approaches. In particular, developments in the application of environmental DNA (eDNA) technology²⁸ have enabled early detections of invasive species at low population densities, potentially enhancing the capacity of managers to respond at very early stages of invasion. However, the value of such detections can be uncertain for various reasons, principally the often unknown relationship between DNA presence and the underlying distribution of target organisms. Further development of these surveillance approaches should be pursued to assist EDRR efforts, with particular focus on developing decision support tools that translate patterns of positive eDNA detections into risk profiles interpretable by managers.²⁹

Data Recording and Sharing

Once the species identification is confirmed, the species occurrence should be reported to:

- ◆ Specific entities that may be identified in reporting protocols or information transfer protocols designated by agencies, regulation, or law, and/or
- ◆ General entities such as:
 - » USGS Nonindigenous Aquatic Species database, <http://nas.er.usgs.gov/>
 - » PLANTS database (for native and invasive species), <http://plants.usda.gov>
 - » EDDmapS, <http://www.eddmaps.org/>
 - » iMapinvasives, <http://limapinvasives.org/>

Species occurrences may also be reported to a specific agency that hosts a taxonomic collection, such as at the USDA Agricultural Research Service, Smithsonian, or other agency, state, or regional database, as appropriate. Aggregating data from existing da-

28 Environmental DNA is DNA shed by an organism into its environment via excretion, sloughing of skin cells, or various other means. This DNA can be detected and specifically attributed to a particular species even in the absence of any individual organism. Since DNA can often be detected in a very sensitive and specific manner, and since many target species are secretive, cryptic or otherwise difficult to capture and identify, surveillance of eDNA offers a novel alternative to traditional detection methods.

29 The USFS National Genomics Center for Fish and Wildlife Conservation is an example of an organization that provides training and sample processing for eDNA-based invasive species surveillance.

tabases into an interoperable system would support information transfer and awareness of invasive species occurrences and spread.

Communications and Outreach

A coordinated process to notify agencies, partners, the public, and the media should be planned for and timed carefully and decided on a case-by-case basis. This decision is based, in part, on the turn-around time for on-site investigation, if one occurs, and on the type of invasive species discovered and time sensitivity of response actions. For example, for most invasive plants, the extent of the infestation should be known prior to public notification. However, for most invasive animals and pathogens, notification will usually proceed prior to full knowledge of the extent of the infestation because this information may be difficult to obtain.

Rapid Assessment

Once the identification is confirmed, rapid assessment determines the appropriate response to a particular invasion. This stage involves an assessment of the risk posed by the species in question, its distribution and population density,³⁰ and the likely pathway(s) by which it was introduced and where any existing prevention measures may have failed. These steps are incorporated into the process of risk analysis, which includes:

- ◆ Risk assessment
- ◆ Risk management
- ◆ Risk communications

A decision is made whether to proceed with a rapid response or, when response actions do not proceed, to recommend containment measures and/or long-term management to limit spread.³¹

Risk Analysis

Risk analysis involves evaluations of the best available science on the impacts of the invasive species; control techniques; determination about whether eradication is warranted, technically possible, and feasible; and, the means to communicate that information to decision-makers and interested stakeholders.

Risk Assessment: An evaluation of whether the infestation represents a public policy issue sufficient to warrant a rapid response has to be done. The evaluation requires a determination of whether or not the infestation will have significant impacts to the environment, economy, or human health and whether the invasive species can be successfully eradicated. The lead agency should determine who will complete the risk assessment, such as a committee of agency staff, scientists, and natural resource managers, and in what time frame. This step should also include a rapid assessment of the species distribution and population density at the site of its detection and surrounding areas.³² Risk assessments may have been completed in the preparedness step, in which case, the assessments could be evaluated for accuracy and geographic scope based on new information.

Risk Management: Risk management determines appropriate control options and whether invasive species eradication is possible or if ongoing management is all that is technically possible. A clear distinction is made between eradication, which is the goal of rapid response, and management, which is the ongoing control of persistent infestations of invasive species. Should eradication be warranted based on impacts and technically possible, then a broader determination of eradication feasibility is required that entails economic factors and socio-political and stakeholder considerations.

Risk Communication: The assessment of impacts and management options needs to be communicated clearly to the decision-maker responsible for the allocation of resources and approval for the implementation of rapid response actions. Additionally, relevant information also needs to be made available to partners, impacted stakeholders, and the public as appropriate to the circumstances.

If the risk analysis determines that eradication is not technically possible or is infeasible for other reasons, then EDRR ends and the process transitions and may include efforts for long-term containment and management. Activities to contain and prevent the spread of invasive species may be initiated, and ongoing management of persistent infestations may continue; however, these efforts are no longer part of the EDRR process.

30 The delineation of the distribution and abundance of the invasive species occurrence, if possible and appropriate, may occur either during the rapid assessment phase or rapid response phase.

31 Development of a long-term management plan is outside of the scope of the EDRR process.

32 See footnote 30.

Coordinated communications among decision making entities will notify agencies, partners, the public, and the media of the decision and rationale to stop the EDRR process and describe any additional steps that may be taken to prevent or control persistent infestations.

Rapid Response

The decision to proceed with a rapid response triggers a series of actions to eradicate a species from a location. Rapid response must be initiated before the invasive species spreads widely and becomes so abundant that eradication cannot be implemented.³³ Rapid response includes the following types of actions:

- ◆ Leadership and coordination
- ◆ Quarantine and emergency containment
- ◆ Treatment
- ◆ Monitoring, evaluation, and reporting
- ◆ Communications and outreach

Leadership and Coordination

A decision to proceed with a response triggers a number of steps. Many rapid response plans utilize the Incident Command System (ICS) (or Unified Command in which multiple agencies share incident management responsibilities). ICS is a standardized on-scene emergency management process designed to provide an integrated organizational structure that can address the complexity and demands of an emergency without being hindered by jurisdictional boundaries. Not all rapid response actions will require the use of ICS. Criteria should be established for when ICS is instituted.

Emergency Containment and Quarantine³⁴

Based on the assessment of a species' risk, distribution, and population abundance, initial containment measures may be necessary to limit further spread (e.g., installation of temporary barriers, quarantines, access restrictions, etc.), if appropriate/possible for the species. Such measures may involve environmental compliance considerations. (See Preparedness: Planning: Environmental Compliance, pg. 42).

Continuing propagule supply via repeated introductions threatens to undermine the success of initial containment and eradication actions. If knowledge gathered through the rapid assessment process warrants it (i.e. if clear evidence of specific prevention failures can be gleaned), then action to disrupt the pathway(s) leading to the novel introduction should be considered. In these cases, the implementation of heightened prevention measures along with the initial containment response may result in rapid "quarantine" of the newly invaded area with respect to those pathways most likely responsible for propagules movement. Such actions should be considered an integral component of rapid response whenever actionable information is available.

Treatment

Treatment will be species and site specific; however, certain general steps are necessary in each EDRR event:

Evaluation: The lead agency, in consultation with other collaborators, will evaluate treatment options, seek permitting advice from other agencies, and select an appropriate control technique based on the species, site, financial, and socio-political considerations.

Planning: The lead agency, or its designee, will develop the treatment plan. This can be done in advance of the EDRR situation, if possible; the plan can be adjusted for the additional specifics of the EDRR event.

Permitting: The lead agency, or its designee, will prepare and submit the appropriate permits. Special authorizations may be required.

Implementation: The lead agency identifies who will implement treatment, using ICS as appropriate, which may be the lead agency, another agency, a partner, a contractor, or other appropriate organization.

Initial Restoration: Actions to initiate restoration of the site following treatment may be necessary as part of the treatment plan to help increase likelihood of successful eradication.

³³ The notion of "rapid" is relative to the particular species and geography, as the time needed to respond to an invasive plant, forest pest, or fish will differ depending on the species' ability to spread by both natural and human-mediated means.

³⁴ The stages of EDRR are a continuum, and emergency containment and quarantine measures may occur concurrently during the rapid assessment and rapid response stages.

Monitoring, Evaluation, and Reporting

The lead agency will monitor control efforts and survival of the invasive species population, evaluate effectiveness of the treatment, determine whether eradication was successful, and assess if additional or other techniques should/can be used. The lead agency will also evaluate the operational aspects of the process and make recommendations for future improvements. The lead agency will gather information from treatment personnel as soon as possible after the rapid response to ascertain which aspects worked well and what could be improved upon. Information and recommendations will be reported, shared, and used in future control efforts. Should an infestation of the invasive species persist after treatment, the EDRR process may transition to long-term management, which would include designation of lead agency to develop a management plan, including preventing species spread (long-term containment), and determine its financing.

Communications and Outreach

The results of response efforts and recommendations for future action will be reported to the lead agency. The lead agency will share lessons learned with other agencies, partners, and stakeholders, including sharing relevant data with appropriate invasive species database(s). The lead agency will use efficient internal communication mechanisms as well as outreach to other agencies, external partners, impacted stakeholders, and the public. (See Preparedness: Planning: Communications and Outreach, pg. 43).

APPENDIX C: EXAMPLES OF CURRENT INVASIVE SPECIES NETWORKS

Figure C1. Regional Panels of the Aquatic Nuisance Species Task Force (Courtesy D. MacLean, USFWS 2015)

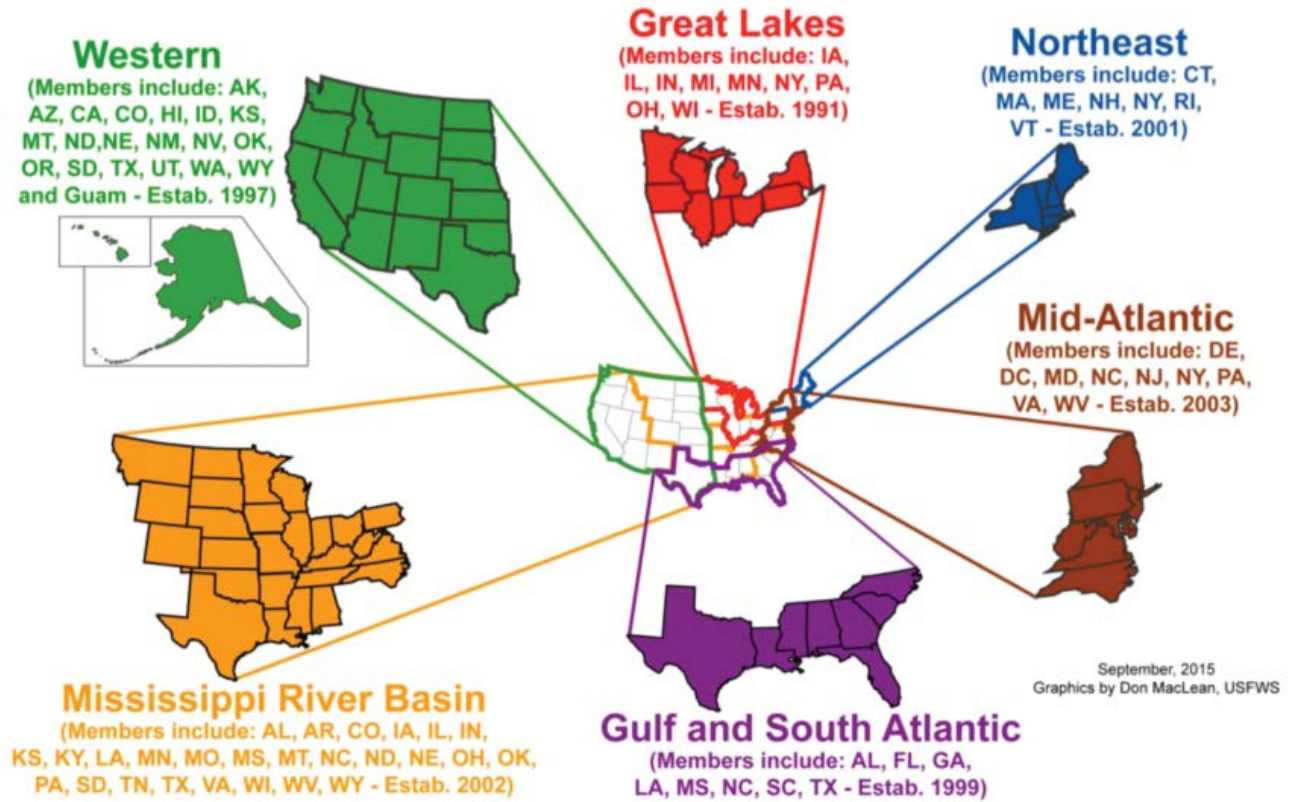


Figure C2. Examples of State and Regional Invasive Plant Councils. Additional Invasive Plant Councils may exist. States also may have invasive species councils, which are broader in scope than invasive plant councils. (Courtesy C. Barger, University of Georgia 2015)

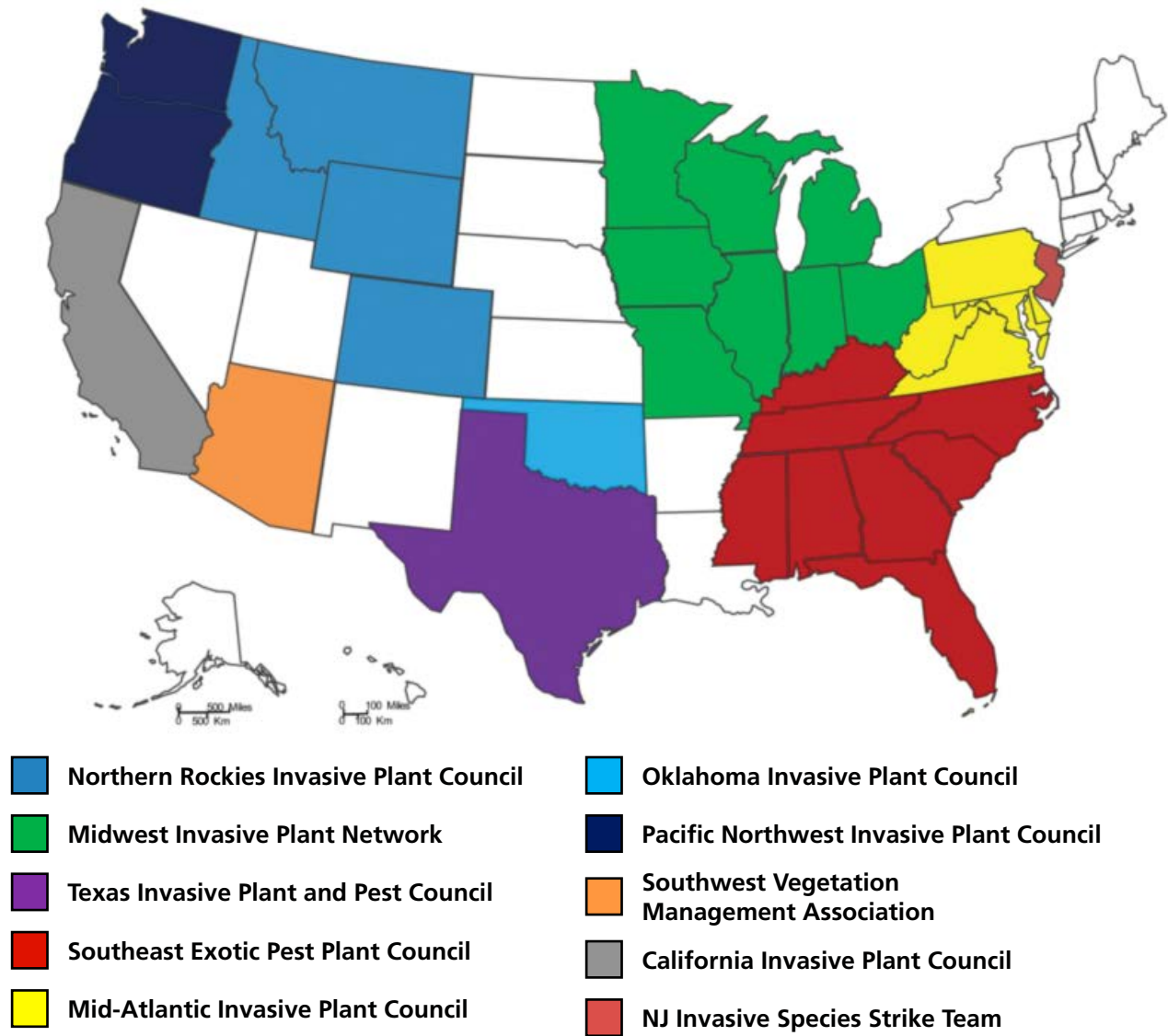


Figure C3. Examples of State and Regional EDRR Networks. The networks vary on level of activity and species focus. Additional networks may exist. (Courtesy C. Barger, University of Georgia 2015)

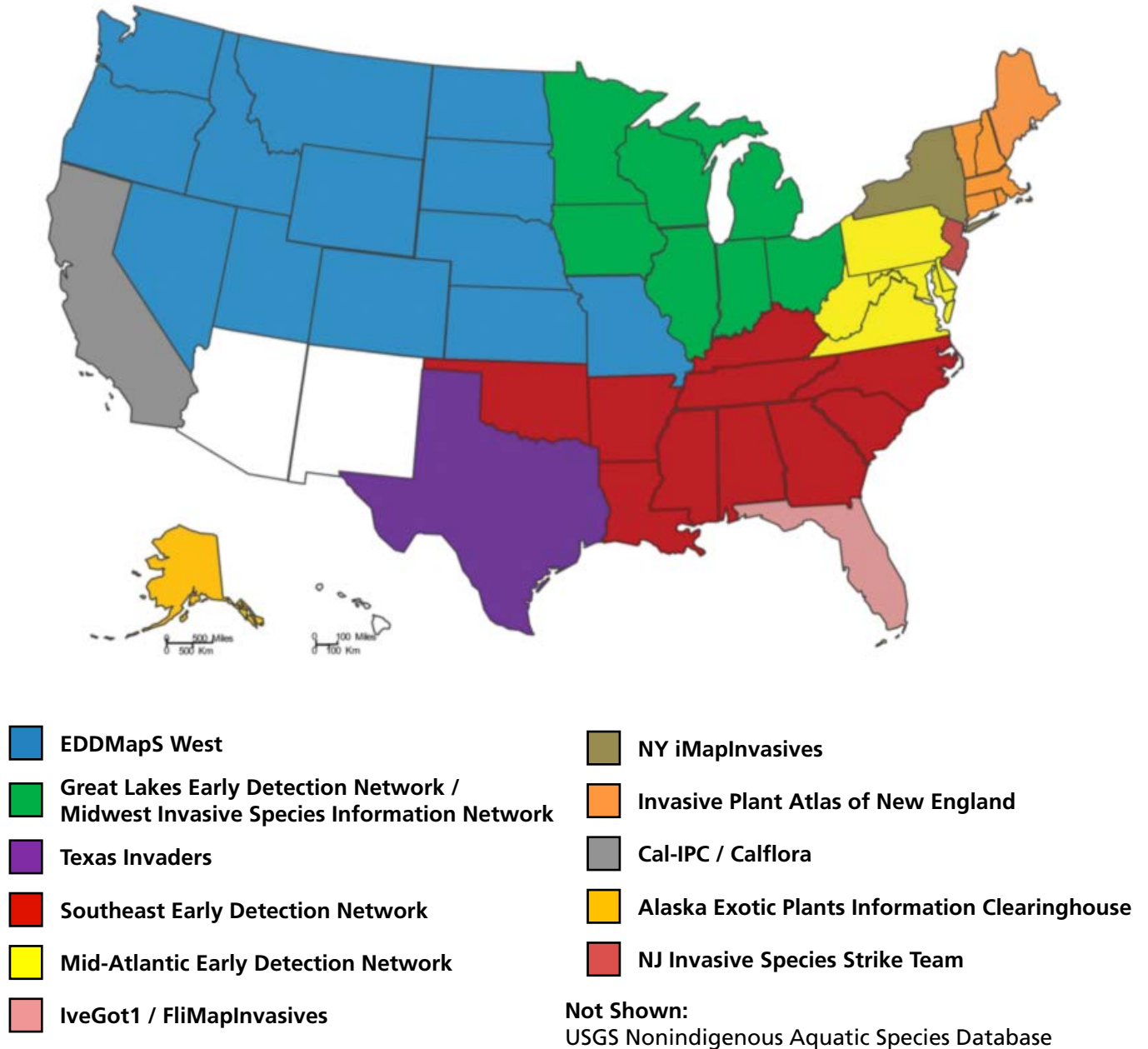


Figure C4. Points represent examples of local invasive species cooperatives, such as cooperative weed management areas, cooperative invasive species management areas, and partnerships for regional invasive species management, among others. Additional cooperatives may exist. (Courtesy C. Barger, University of Georgia 2015)



APPENDIX D: EXAMPLES OF FINANCING MODELS

The examples identified below represent types of models that could inform financing models for EDRR. Additional analysis of the advantages and disadvantages of potential financing models would be a useful next step. Most of the mechanisms identified below would require new legislative authority.

Federal appropriations, state, tribal, and local government funds, and excise taxes are traditional sources of funds for government programs. Other sources of government revenues include government initiated voluntary check off donation programs, such as those on affinity state vehicle license plates and state income tax returns; penalties from judgments and consent decrees in which the defendants provide financial remuneration as part of the settlement; and, permit and license fees as well as Heritage funds from State Lotteries. New legislative authority would be required for using these funding sources for EDRR.

Significant funds are allocated for work on climate change and resilience activities, which could be a potential source of support for relevant EDRR projects.

Funds may be a component of the response to an “all hazard incident,” such as a hurricane. The U.S. Department of Agriculture coordinates Federal support for the protection of the Nation’s agricultural, natural, and cultural resources during national emergencies within Emergency Support Function (ESF) #11. During actual and potential incidents the Federal Emergency Management Agency (FEMA) may request assistance from ESF #11 and provide limited financial support to ensure the protection of natural and cultural resources and historic properties. When invasive species outbreaks are associated with an incident or its response, actions taken under ESF #11 could support the financing of emergency response efforts.

In addition to traditional sources of funds, non-traditional funding mechanisms can also resource conservation efforts. These include the use of funds from programs, such as the Federal Aid in Wildlife Resto-

ration Act (“Pittman-Robertson Act”) and Sport Fish Restoration Act (“Dingell-Johnson Act”). These acts establish excise taxes on sporting arms/ammunition and sport fishing equipment respectively. Funds are apportioned to states on a formula basis for financing a portion of the cost of approved projects. New legislative authority would be required for this type of model for EDRR funding.

The Oil Spill Liability Trust Fund is an example of a Federally-held fund that is funded by “end users.” Established by the Oil Pollution Act of 1990 and administered by the U.S. Coast Guard, the primary source of revenue for the fund is a five-cent per barrel fee on imported and domestic oil. Funds are used to pay for removal costs or damages resulting from discharges of oil in which the responsible party is unknown or refuses to pay.

Superfund is a fund established by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). It created a tax on chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment. Over five years, \$1.6 billion was collected and the tax went to a trust fund for cleaning up abandoned or uncontrolled hazardous waste sites.

Depending on the administrator of EDRR funding, private-sector sources of funds could include support from philanthropic foundations, donations, and the proceeds from the sale of individual gifts of property. Private-sector funds could also be obtained from social media-based “crowd source” funding campaigns and/or from corporate underwriting of projects. Earnings from funds that are held by a foundation or trust could provide additional monies to EDRR.

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