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Natural Resource Stewardship and Science

Biodiversity under Siege, Invasive Animals and the National Park Service

A State of the Knowledge Report

Natural Resource Report NPS/NRSS/BRD/NRR—2018/1679

ON THE COVER

Photograph of an invasive Cuban treefrog (*Osteopilus septentrionalis*) eating a non-native Puerto Rican crested anole (*Anolis cristatellus cristatellus*) in an agricultural field adjacent to Everglades National Park, Florida. Cuban treefrogs have become established in peninsular Florida since the 1920s when they likely arrived as hitchhikers in ship cargo containers. The non-native Puerto Rican crested anole is considered a possible predator of the native green anole (*Anolis carolinensis*), likely occurs because of escaped pets, and is spreading widely throughout the state.

Photography by: Dennis Giardina, Florida Fish and Wildlife Conservation Commission

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Natural Resource [Technical] Report NPS/NRSS/BRD?NRR—2018/1679

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Executive Summary

Invasive species are a serious challenge for both urban and natural areas, including national parks. Their impacts are far-reaching; they displace native species and disrupt native ecosystems and ecological processes, and pose threats to sensitive cultural resources, the visitor experience, and to critical infrastructure. Additionally, invasive species often worsen the effects of other threats such as climate change, predator loss, and land-use changes. These effects ripple throughout the 417 sites of the National Park System and threaten the ability for the National Park Service (NPS) to achieve its legislated mission. Momentum has been building throughout the country and the NPS to more comprehensively address the threat posed by invasive species. A national approach by the NPS is needed to increase the effectiveness of preventing invasions, control and slow the spread of existing invasions, and provide a central hub to ensure that these efforts are coordinated and cost effective. However, previous efforts to develop a servicewide program to address invasive animals have not been able to gain traction. The 1999 Natural Resource Challenge, the ensuing Detailed Action Plan for Exotic Species, and a draft 2006 Invasive Species Action Plan all highlighted the need for an organized servicewide approach to address invasive animals. Yet, little has been done to actually implement these plans.

The NPS Biological Resources Division (BRD) competed and received funding from the Servicewide Comprehensive Call (SCC) starting in 2016 for a three-year project to develop an organizational framework to address invasive animal issues and solutions across the Service. This report takes the initial step in presenting the state of the knowledge of invasive animals in the NPS by summarizing the occurrence of invasive animals in parks and the needs and efforts at the park, regional, and national level to address them. The report summarizes the authorities and policies guiding invasive animal management (Chapter 1), provides a description of invasive animal efforts and organization at the national office (Chapter 2), and presents a 2016 snapshot of the information received from parks through the annual invasive annual data call (Chapter 3). Chapter 4 provides insights from interviews with staff in each regional office and Chapter 5 provides insights to park needs inferred from park foundation documents, park planning and environmental documents, and park project proposals. Chapter 6 examines the current early detection and response effort capacity of the NPS invasive plant program for lessons learned, and lastly, Chapter 7 summarizes the current state of data, information systems, and risk assessments in the NPS as relates to invasive species. Key points from the report are provided in the concluding chapter. The expressed purpose of this report is to provide insights that inform components of the NPS Strategic Invasive Animals Management SCC project from which the organizational framework and implementation plan will develop.

Feral swine in Cumberland Island National Seashore. NPS Photo.

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Introduction

Statement of Need

The National Park Service (NPS) protects an incredible diversity of natural, cultural, and historic national treasures. The 417 units that comprise the NPS represent a multitude of designations such as Parks, Monuments, National Historic Sites, Natural Recreation Areas, and Preserves (often referred to generically as "parks"). Each park has unique enabling legislation that directs the park's management focus. Despite diversity in park purpose, however, every unit in the National Park System shares the same mission to "conserve the scenery and the natural and historic objects and the wild life therein… [to] leave them unimpaired for the enjoyment of future generations" (1916 Organic Act). The NPS Inventory and Monitoring (I&M) Program has identified more than 280 parks as having significant natural resources. Twenty-two of the 32 I&M vital signs monitoring networks identify invasive animals as a major concern to ecosystem health. Invasive species on park lands and in park waters are a serious threat to maintaining healthy ecosystems and the landscapes that the public expect the NPS to protect, pose an imminent threat to the NPS' mandate, and are a mission-critical issue.

"Invasive species" means, with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health (Executive Order 13751). Invasive species are thus a subset of non-native species that meet the criteria of the Executive Order. Native species as defined in Section 4.4.1.3 of NPS Management Policies 2006 (NPS 2006b) are "… all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system." Non-native species are defined as "…those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities (NPS 2006b)." This means that while all invasive species are by definition non-native to areas where they have been introduced, not all non-native species are invasive. Many categories of invasive species slip through the cracks when it comes to identifying established mechanisms for management. Executive Order 13751 added to the scope of the National Invasive Species Council. However, there is longstanding prevention and control of human and animal pathogens by federal, state, and local agencies. The expanded scope of Executive Order 13751 provides an opportunity to better coordinate protection of human and animal health from the threat of invasive species. However, since pathogens are not animals, but are bacterium, viruses, or other micro-organisims, they are not addressed in this report.

Aedes mosquitoes live in tropical, subtropical, and temperate climates throughout the world and in the United States. *Aedes aegypti* and *Aedes albopictus* (pictured) are two of the most important to NPS, as they are invasive and can transmit non-native diseases such as Zika, dengue, chikungunya, and other viruses to humans and wildlife. CDC/James Gathany Photo.

Confusion understandably abounds across the Service as staff struggle with nuances in the meaning of "non-native" and "*invasive* non-native." Clarification on related concepts, issues, and definitions is needed at all levels of NPS management. When considering definitions of "native" and "non-native" provided in NPS Management Policies 2006, one may need to consider, among other things, the reality that native species are shifting their ranges in response to climate change (Nackley et al. 2017), the possibility of managed migration or relocation of at-risk species, and the fact that not all non-native species are invasive. Work groups have recently been assembled by Natural Resource Stewardship and Science Directorate (NRSS) and regional staff to examine the concept of "native" species. Further complicating matters, there have been, and still are, native species being intentionally (and in some cases, illegally) moved outside of their native ranges by members of the public to increase hunting or fishing opportunities (e.g., feral swine at Great Smoky Mountains National Park). There are also examples of federal or state agencies introducing populations of native species outside their native range to expand recreational hunting, fishing, or viewing opportunities; some of these non-native populations have become invasive (e.g., virile crayfish and rainbow trout). This creates circumstances where a species native to one area of the U.S. is not native, and may be invasive, to another area

In waters where rainbow trout were introduced, either by intentional, historic stocking or by invasion from a downstream source, the result has been a serious degradation of the cutthroat trout population through interbreeding of the two species. Cutthroat/rainbow trout hybrids, such as in this photo, will have characteristics (coloration and spotting patterns) that are consistent with both species, making identification difficult. NPS Photo.

where it was introduced or where it subsequently migrated to after being introduced.

Rainbow trout provide an interesting example of a species for which management is complex. Rainbow trout are native to all of Oregon, most of Washington, much of California and Idaho, some areas of Alaska, and a small portion of northwestern Montana. Rainbow trout are managed as invasive species in many parks, including some waters in Yellowstone National Park, where they are non-native and pose a serious threat to native fish such as Yellowstone and Snake River cutthroat trout. They compete with cutthroat trout for food and habitat, and are capable of crossbreeding with them. However, there are NPS waters where rainbow trout are native and managed as such, and other waters where they are non-native but are managed to provide sport fishing opportunities. In some instances, non-native rainbow trout fisheries occur in waters where habitat has been altered so that it is no longer suitable for native species. In other instances, such as the Bighorn River in Montana, no negative impacts by the presence of non-native rainbow trout have been detected. This begs the question: At what level do impacts need to be detectable for a non-native species to be managed as invasive? Asked slightly differently: What level of impact to native species or ecosystems is acceptable for a non-native species to not be treated as invasive? The "environmental harm, or harm to human, animal, or plant health" caused by a non-native organism is what qualifies it as "invasive" – but where does the threshold of harm lay?

Degree of "invasiveness" lies on a spectrum and impacts can vary greatly across species and the ecosystems in to which they are introduced. The NPS does not currently classify non-native species by their degree of invasiveness. Species reported during the annual NPS invasive animals data call vary from species that are of minimal concern (e.g., chukar partridges in most habitats) to species that are massively destructive (e.g. Burmese pythons). In 2016, the International Union for Conservation of Nature (IUCN) implemented the Environmental Impact Classification of Alien Taxa (EICAT) system to standardize classification of invasive species based on the magnitude of their impacts (Blackburn et al. 2014, Hawkins et al. 2015). While EICAT is not a formal risk assessment and does not provide a statutory list of harmful invasive species, it does greatly inform the prioritization, implementation, and evaluation of management methods, actions, and policies of management actions and the evaluation of management methods.

A plethora of scientific literature already establishes the negative and often severe impacts of invasive animals on native species, habitats, and ecosystems across the United States. In our national parks, terrestrial and aquatic invasive animals can have significant impacts on park biological and cultural resources as well as the visitor experience and the landscapes and communities which they have invaded. Invasive species are a problem in every NPS region (Figure 1) and are a critical servicewide issue. Quagga and zebra mussels at Lake Mead and Glen Canyon national recreation areas are killing off native species, clogging drains and pipes of critical dam infrastructure, rendering power boats inoperable, and are threatening the integrity of underwater cultural resource sites and structures. As affected boats are transported elsewhere, even more resources across the country become at-risk.

Feral swine at Big Cypress National Preserve and Big Bend, Pinnacles, and Great Smoky Mountains national parks destroy surface and subsurface archeological sites, historic structures, and cultural landscapes; they also prey on small native animals, degrade wetland and riparian ecosystems, facilitate the proliferation of invasive plants, and are vectors for both human and zoonotic disease. Until they were eradicated, invasive rats at Channel Islands National Park impacted reptiles, plants, invertebrates and, most severely, nesting seabirds. Invasive rodents, feral cats and mongoose are currently having similar impacts at Virgin Islands National Park and parks in the Hawaiian Islands and U.S. Territories. Invasive ungulates such as feral livestock (cattle, horses, goats, pigs, and sheep) are causing habitat destruction, soil erosion, and severe deterioration of Hawai'i Volcanoes National Park's watershed and those of many western parks.

This photo was taken outside Ozark National Scenic Riverways, Missouri where feral swine have been degrading riparian habitat. Missouri Department of Conservation Photo.

Invasive lionfish now exist in nearly all coastal park habitats in the south Florida and Caribbean region where they prey on and displace native species in coral reefs. Brown

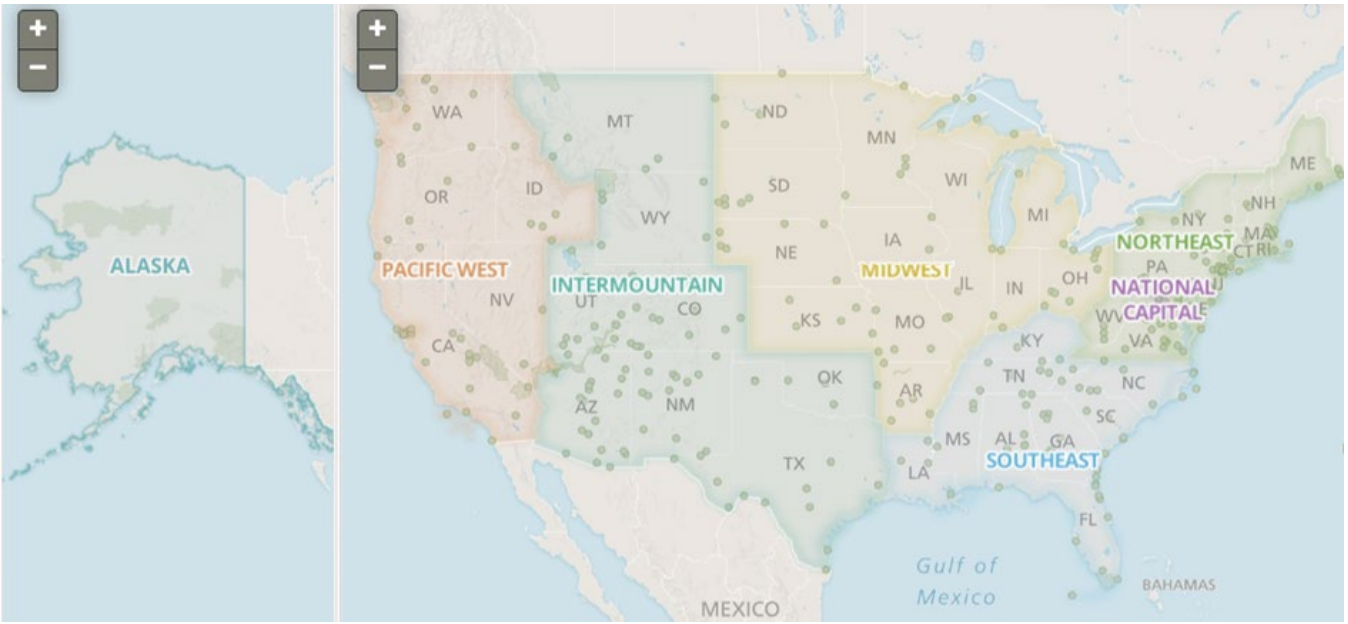


Figure 1. The National Park Service preserves the natural and cultural resources and values of 417 units that include over 84 million acres of lands and waters in every state, the District of Columbia, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands. There are seven organizational Regions of the National Park Service.

trout (considered native to Europe, western Asia, and northwestern Africa) at Grand Canyon, Grand Teton, Rocky Mountain, North Cascades, and Shenandoah national parks displace native trout species such as brook trout and cutthroat trout, compete for food, and in some cases, directly prey on native species. Burmese pythons and other constrictor and non-native herpetofauna at Everglades National Park and Big Cypress National Preserve have become a top ecosystem predator, killing multitudes of native birds, mammals, and reptiles in the process. Another example in south Florida is the tegu lizard which impact native wildlife by competing for both food and habitat, and most notoriously preying directly on eggs of ground-nesting birds, crocodiles, alligators, and gopher tortoise. The list of examples continues and is unfortunately long.

Over half of U.S. national parks report invasive animal species distributed among multiple taxonomic groups (e.g., amphibians, birds, fishes, invertebrates, mammals, reptiles). Of over 1,400 reported populations of invasive animals in the NPS, only a small percentage can be considered under some form of control (i.e., suppressed, contained, or eradicated). This trend is expected to not only continue, but to increase with the growing impact of stressors such as increased globalization of trade that facilitate the arrival of invasive species, and environmental changes such as habitat fragmentation and climate change that facilitate invasive species establishment and expansion. Dominant invasion vectors appear to occur between high-income countries (from imports, particularly of plants and pets) and low-income countries (from passenger air and ship travel) (Early et al. 2015).

Despite wide-ranging impacts that affect almost every NPS unit with land and water to manage, the NPS has not yet developed a servicewide organizational approach to invasive animal management. Consequently, parks employ a variety of management solutions at the local level and spend millions of dollars annually doing so but without a larger (e.g., multi-park or regional) strategy or necessarily with effective outcomes. This piecemeal approach is utilizing increasingly larger levels of resources – both in funding and personnel – and yet is highly unlikely to effectively manage these species within parks, with conservation partners on adjacent lands or waters, and across the greater landscape.

Evolution of NPS Efforts to Develop an Invasive Animal Program

During the 1980s and 1990s, numerous NPS reports began to document the risk of not properly inventorying and managing natural resources. Awareness of invasive species issues across the federal government culminated in at least the mid to late1990s when interagency initiatives started taking shape. One example is the broadening of the U.S. Department of Agriculture's (USDA) Interagency Forum on Invasive Species beyond its focus on gypsy moths. The NPS announced a major effort in 1999 to substantially improve how the bureau manages natural resources under its care—the Natural Resource Challenge. One of the primary challenges highlighted by the Natural Resource Challenge (NPS 1999) was non-native species. The stated strategy was to:

Part of the President's Fiscal Year (FY) 2000 budget strategy included the Native and Exotic Species Management

> "…continue to establish field-based teams to assess, plan for, and control non-native species invasions, especially new invasions and invasions in smaller parks. We will also provide larger parks that have significant and ongoing non-native species invasions with the capability to continuously control targeted species. [p. 5]"

proposal (funded at $3.45 million) to focus on coordination and assistance to parks in applied management activities. As a result of this budget increase, the Biological Resources Management Division (now Biological Resources Division (BRD)) was established in Fort Collins, Colorado. About 60% of the funding from the Native and Exotic Species Management proposal was to address non-native species control, including establishing field-based non-native species teams that were to assist in meeting the nearly $75 million in non-native species-related project needs identified in park resource management plans at the time. As part of the Natural Resource Challenge, the NPS developed in 2000 a Detailed Action Plan for Exotic Species (O'Neil et al. 2000). This action plan provided goals, objectives, and implementation guidance for addressing both invasive plants and invasive animals. However, several action items (and earlier efforts identified in the plan) never came to fruition. The ultimate product of the Natural Resource Challenge's Detailed Action Plan for Exotic Species focused on vegetation and the result was establishment of the Exotic Plant Management Team (EPMT) program. The EPMT program has flourished and become a model approach for

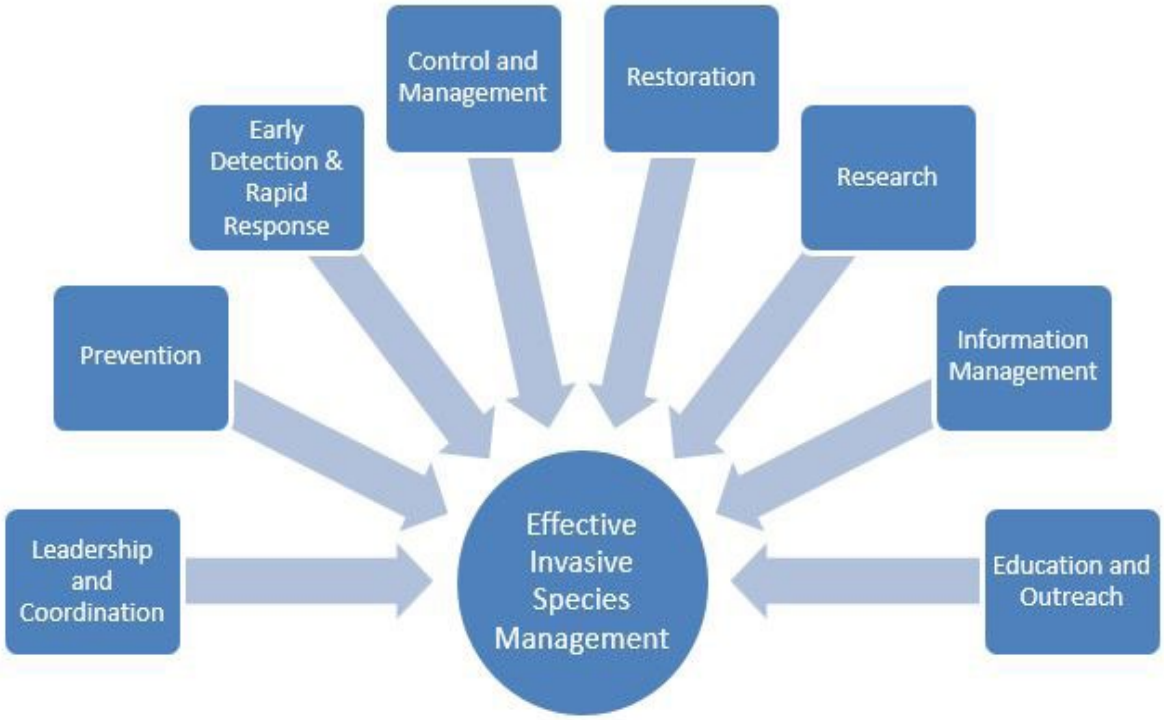


Figure 2. The eight different components to effective invasive species management that were identified in an Invasive Species Action Plan authored in 2006 by a team of NPS representatives. The Action Plan was never finalized or published.

field-based invasive plant management. However, invasive animals were overlooked at the time.

In July 2006, an Invasive Species Action Plan (for both plants and animals) was developed by a team of 18 NPS park, region, and I&M program representatives (NPS 2006a). The action plan expanded upon the Natural Resource Challenge Detailed Action Plan for Exotic Species (O'Neill et al. 2000) by detailing actions, responsible parties, and timeline in eight different areas needed for effective invasive species management: leadership and coordination, prevention, early detection and rapid response, control and management, research, information management, restoration, and education and public awareness (Figure 2). Despite the established need and servicewide support of such an initiative, for unknown reasons the Invasive Species Action Plan was never finalized. Starting in 2007, BRD responded to the issue by submitting a series of proposals to NPS' Servicewide Comprehensive Call competitive funding source for seed money to lead development of a coherent, servicewide invasive animal strategy. Funding for the 3-year project "NPS Strategic Invasive Animals Management" was awarded and initiated in 2016.

The NPS Social Science Program commissioned in 2000 a "National Park Service Comprehensive Survey of the American Public" (Social Research Laboratory NAU 2001) which included two questions to assess public opinion toward management of non-native plants and animals in the National Park System. Analysis of the responses resulted in a technical report (Solop et al. 2004). A subsequent NPS Comprehensive Survey of the American Public was performed in 2008-2009 (Wyoming Survey and Analysis Center and NPS-NRSS 2011). Although the differences in wording and response choices dictate caution in interpreting comparisons between the 2000 and 2008-2009 surveys, public attitudes toward management non-native species appear to be quite polarized and remain fairly stable through that decade. In both survey years, nearly half of respondents favored removing non-native animals but well over one-third disagreed with such removal (Taylor et al. 2011). Important to note is that both of these surveys describe "non-native" species without describing them as being "invasive". The terms are not synonymous and this may have skewed survey responses towards higher tolerance of the species. There is opportunity in future surveys to compare the effect of

terminology on responses (i.e., using the term "invasive" versus "non-native").

It is unknown whether results of the 2000 and 2008-2009 surveys were incorporated into invasive species management decisions at the park, regional or national office level. Given increased interest in invasive animal issues by elected officials (e.g., feral swine), and heightened awareness of invasive animal issues due to interest by the media and general public (e.g., Burmese python), a new survey using updated terminology to assess current public opinion may be warranted. Results could then be used to help managers become aware of public perceptions and expectations when selecting the timing, extent, and strategies for non-native species management; and for designing information, education, and outreach strategies for the public.

Purpose of This Report

The first initiative undertaken by the FY16-18 NPS Strategic Invasive Animals Management project was to recruit a panel of experts to evaluate the extent of the problem, assess management needs, review best management practices, and assess potential organizational models that could serve as a servicewide organizational framework for the NPS. To inform the panel's efforts, the project's second initiative was to prepare a report on the state of the knowledge of invasive animal occurrence in parks and the NPS' efforts and needs at the park, regional, and national levels to address them. The expressed purpose of this report is not to provide recommendations, but rather to inform the components of the NPS Strategic Invasive Animals Management project from which the organizational framework and implementation plan could develop. A draft of this report and an accompanying presentation was given to the independent panel at the 2017 George Wright Society conference. This publication in the Natural Resource Report Series is the final version of that draft report and serves as a companion document to the panel's report (Redford et al. 2017).

Sea squirt covered by red sheath tunicate is an invasive species within the Boston Harbor islands. NPS Photo.

1. Overview of NPS Authorities and Policies Guiding Management and Control of Invasive Animals

This chapter is intended to serve as a comprehensive (but not exhaustive) summary of the core laws, regulations, and policies that can be used by the NPS to address invasive animals. The primary purpose is to describe existing authorities and not interpret or recommend amendments to any of these authorities. Only the authorities pertaining to invasive animals (or invasive species generally) are presented. As summarized by a recent Congressional Research Service report (Johnson et al. 2017), no single law provides coordination among federal agencies and no comprehensive legislation on the treatment of invasive species has ever been enacted.

The current legal framework is largely governed by a patchwork of laws, regulations, policies, and programs with some laws tailored to individual species or narrowly focused on what is affected by those species, and other laws having a broader intended purpose and only peripherally addressing invasive species.

This chapter is presented in hierarchy order of authorities: Public Law (general and specific authorities), Executive Orders, Federal Regulations (including Superintendent Compendia), and NPS Policy, Director's Orders, and Reference Manuals.

Public Law: General NPS Authority

The NPS preserves the natural and cultural resources and values of over 400 units of the National Park System for the enjoyment, education, and inspiration of current and future generations. These national treasures, owned by U.S. citizens, exist in every state, the District of Columbia, American Samoa, Guam, Puerto Rico, and the U.S. Virgin Islands. The NPS also manages a variety of programs in cooperation with multiple partners to extend the benefits of natural and cultural resource conservation and outdoor recreation throughout the United States and the world.

All parks in the NPS system share in the common mission of stewardship of America's national heritage. The NPS is directed and has authority to manage its lands and resources (including native, non-native, and invasive animals) in a manner consistent with Federal legislation, servicewide NPS guidelines and directives, and park-specific management policies and objectives. As stewards of public lands and waters, the NPS protects resources through a variety of internal programs, and strives to be an active conservation partner with other state, federal and non-governmental agencies and organizations. NPS currently manages 417 sites (generally referred to as "parks"), comprising over 84 million acres. These sites include national parks, national monuments, national seashores, national historic sites, national battlefields, national historic trails, national scenic rivers, national recreational rivers, national recreational areas, and national preserves. Additionally, the NPS administers the National Register and Historic Landmark, the National Natural Landmark, and the National Heritage Areas programs.

The NPS has both general and specific authority to manage invasive animals within the boundaries of units in the National Park System through the NPS Organic Act, the General Authorities Act (as amended), and the Consolidated Natural Resources Act.

Three species of invasive rats have been reported in U.S. national parks. In this photo, black rats (*Rattus rattus*) feed on eggs in a thrush nest. On Anacapa Island in Channel Islands National Park, California black rats were having large impacts on nesting seabirds, preying heavily on eggs and checks as their food sources. Rats were also preying directly on the native island deer mouse (*Peromyscus maniculatus*). Ten years after eradicating rats from Anacapa, the island is showing profound recovery. NGA Manu Images Photo.

National Park Service Organic Act of 1916 (54 U. S. Code (U.S.C.) § 100101)

Commonly referred to as the Organic Act, this law establishes the National Park Service and its fundamental purpose "… to conserve the scenery, natural and historic objects, and wild life in [NPS] units and to provide for the enjoyment of the scenery, natural and historic objects, and wild life in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Changes to the natural communities from human actions in parks, including the continuous and unabated invasion of invasive and feral species, are contrary to the intentions of the Act. Additionally, the NPS Organic Act (specifically 54 U.S. Code § 100752) states that the Secretary of the Interior may "… provide for the destruction of such animals and of such plant life as may be detrimental to the use of any [National Park] System unit." Therefore, comprehensive control of non-native (and native) species to protect park resources in the National Park System is allowed, and could be considered strongly encouraged, by law.

General Authorities Act of 1970, as amended by the Redwood National Park Expansion Act of 1978 (54 U.S.C. § 100101(b)(1)(D) and (b)(2))

The General Authorities Act of 1970 clarifies that all the different types of areas within the National Park System (National Recreation Areas, Seashores, Parkways etc. as well as National Parks and Monuments) are to be managed as one system under the standard set by the Organic Act and that no derogation of those areas (e.g., allowing invasive species) is to be permitted unless directly and specifically authorized by Congress. This law confirms that the same authorities and standards of protection apply to all NPS-administered areas.

Consolidated Natural Resources Act of 2008 (54 U.S.C. § 101702(d))

This Act expands NPS opportunities for cooperation and collaboration by the authority for NPS to use its resources and funds on land outside park boundaries for activities benefiting park natural resources. Specifically, it authorizes the Secretary of the Interior to "enter into cooperative agreements with State, local, or tribal governments, other Federal agencies, other public entities, educational institutions, private nonprofit organizations, or participating private landowners for the purpose of protecting natural resources of units of the National Park System through collaborative efforts on land inside and outside of National Park System units." It requires that the agreements "provide clear and direct benefits to [National Park] System unit natural resources and provide for… preventing, controlling, or eradicating invasive exotic species that are within a [National Park} System unit or adjacent to a [National Park] System unit….". Invasive species were one impetus behind this Act and BRD was heavily involved in its development and passage into law.

Public Law: Additional Specific Authorities

Listed in chronological order are other applicable statutes enacted by Congress and signed into law by the President, or enacted into law by Congress over Presidential veto. Additional laws, particularly as pertains to aquatic invasive species, can be found in the recent Federal Policy Options paper (ANSTF and NISC 2015), from which many of the summaries below are derived.

Lacey Act of 1900, as amended (16 U.S.C. § 3371 et seq.)

One of the oldest wildlife-related laws, the Lacey Act (18 U.S.C. § 42) authorizes the Secretary of the Interior to prohibit the importation and shipment between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico (or any possession of the United States) of species (including offspring and eggs) designated through regulation to be injurious to the health and welfare of humans, the interests of agriculture, horticulture or forestry, and the welfare and survival of wildlife resources of the United States. Wild mammals, wild birds, fish, mollusks, crustaceans, amphibians, and reptiles are the only organisms that can be added to the injurious wildlife list. The U.S. Fish and Wildlife Service (FWS) adds species to the list of injurious wildlife to prevent their introduction or establishment through human movement in the United States. An injurious wildlife listing would not prohibit intrastate transport or possession of that species within a State where those activities are not prohibited by the State.

The recent court ruling *United States Association of Reptile Keepers, Inc. v. Zinke, No. 15-5199 (D.C. Cir. April 7, 2017)* reached a definitive judgement on the meaning of the "shipment clause" to not prohibit transport of injurious wildlife between States within the continental United States. This reversed previous interpretations by the courts that injurious species could not be moved between States. As the agency responsible for enforcing the Lacey Act, the far-reaching implications of the court's decision are discussed on the FWS website[1].

1 https://www.fws.gov/injuriouswildlife/pdf_files/USARK_ruling_talking_points_and_Q_A_final%20(1).pdf

Animal Damage Control Act of 1931, as amended (7 U.S.C. § 8351-8353)

Under this Act, the USDA's Animal and Plant Health Inspection Service (APHIS) is given authority to control wildlife damage on federal, state, or private land. Protects field crops, vegetables, fruits, nuts, horticultural crops, commercial forests; freshwater aquaculture ponds, and marine species cultivation areas; livestock on public and private range and in feedlots; public and private buildings and facilities; civilian and military aircraft; public health. In addition, it provided broad authority for investigation, demonstrations, and control of mammalian predators, rodents, and birds. Some NPS units have entered into cooperative agreements with APHIS for control of invasive animals on park lands.

Sikes Act of 1960, as amended (16 U.S.C. §670 et seq.)

The Sikes Act of 1960 directs the planning, development, maintenance, coordination, and implementation of programs for the conservation and rehabilitation of wildlife, fish, and game species. This includes specific habitat improvement or species management (including invasive species) on lands and waters under the jurisdiction of affected agencies. It also provides for implementation of wildlife and fish conservation programs on federal lands and waters including authority for cooperative state-federal plans and authority to enter into agreements with states to collect fees to fund the programs identified in those plans.

Wilderness Act of 1964, as amended (16 U.S.C. § 1131 et seq.)

The Wilderness Act of 1964 established a National Wilderness Preservation System and authorizes the Secretaries of the Interior and Agriculture to administer certain congressionally designated lands managed by each, respectively, as Wilderness. It directs the protection and preservation of these wilderness areas in their natural state, primarily affected by nature and not man's actions. Proposed actions to control invasive species, like all proposed actions, require a Minimum Requirement Analysis to determine if the proposed action is necessary and identify the appropriate tool for implementation.

National Environmental Policy Act of 1969 (42 U.S.C. § 4321-4370) (NEPA)

The National Environmental Policy Act of 1969 requires federal agencies to analyze the physical, social, and economic effects associated with proposed plans and decisions, to consider reasonable alternatives to the action proposed, and to document the results of the analysis. Provisions of NEPA and the Council on Environmental Quality (CEQ) regulations for implementation apply to invasive species management and the potential for significant impacts to the environment.

Endangered Species Act of 1973, as amended (16 U.S.C. § 1531 et seq.) (ESA)

The Endangered Species Act of 1973 provides for the conservation of threatened or endangered species of plants and animals. Section 7.a.1 of the ESA requires all federal agencies to utilize their authorities in furtherance of the purposes of the ESA by carrying out programs for the conservation of endangered species and threatened species. Section 7.a.2 prohibits agencies from taking actions that would likely jeopardize the continued existence of a species and sets out the requirement for federal agencies to engage in consultation to ensure this does not happen. The ultimate goal of this Act is the recovery and long-term sustainability of endangered and threatened species and the ecosystems on which they depend. Recovery includes arresting or reversing the decline of an endangered or threatened species, and removing or reducing threats (including invasive species) so that the species' survival in the wild can be ensured.

Clean Water Act of 1977 (33 U.S.C. § 1251 et seq., Public Law (P.L.) 95-217)

This Act amends the Federal Water Pollution Control Act of 1948. Section 313 is strengthened to stress federal agency compliance with federal, state, and local substantive and procedural requirements related to the control and abatement of pollution to the same extent as required of nongovernmental entities. Invasive species management to improve watershed condition supports the Act's charge to maintain the ecological integrity of our nation's waters, including the physical, chemical and biological components.

Cooperative Forestry Assistance Act of 1978, as amended (16 U.S.C. §2101 et seq.)

The Cooperative Forestry Assistance Act of 1978 authorizes USDA's Forest Service to enter into cooperative agreements to assist other federal, state, and private entities in controlling and managing invasive species on other federal lands and nonfederal lands. USDA is authorized to conduct activities and provide technical assistance relating to insect infestations and disease conditions affecting trees on National Forest System lands and on other federal lands (in cooperation with other federal agencies).

Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. § 4701 et seq.) as amended by the National Invasive Species Act of 1996 (Pub.L. 104-332)

This Act established the Aquatic Nuisance Species Task Force (ANSTF) to identify areas where ballast water does not pose an environmental threat, assess whether aquatic nuisance species threaten the ecological characteristics and economic uses of U.S. waters (other than the Great Lakes), determine the need for controls on vessels entering U.S. waters (other than Great Lakes), and identify and evaluate approaches for reducing risk of adverse consequences associated with introduced invasive aquatic species. The U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration were assigned responsibilities to develop a program of prevention, monitoring, control, and study of introduced aquatic nuisance species and the brown tree snake. Although no directives were assigned to NPS by this Act, NPS has reporting and compliance responsibilities as a member of ANSTF.

Alien Species Prevention and Enforcement Act of 1992 (39 U.S.C § 3015)

The Alien Species Prevention and Enforcement Act of 1992 makes illegal the shipment of certain categories of plant pests and injurious animals through the U.S. mail including plants and animals prohibited under 18 U.S.C. § 42-43 or the Lacey Act.

Hawaii Tropical Forest Recovery Act of 1992 (16 U.S.C. § 4502a, 4503a et seq.)

This Act created a variety of measures to address problems within the native forests of Hawaii, including the introduction of non-native invasive species, such as pigs, goats, and mosquitoes. The law authorized USDA's Forest Service to develop a program to assist Hawaii and U.S. territories to protect native species from non-native species, and to establish biological control agents for the non-natives. The law also created a short-term task force of specified federal (including NPS) and state agencies, and other individuals. Among its other responsibilities, the task force developed an action plan, which has become the framework for Forest Service management and research budget requests in this area.

Wild Bird Conservation Act of 1992 (16 U.S.C. § 4901 et seq., Pub.L. 102-440)

This Act limits or prohibits imports of exotic bird species to ensure that their wild populations are not harmed by international trade. While this law does not specifically address introductions of non-native species, it may have the incidental effect of reducing non-native "hitchhiker" parasites and diseases. Regulations limiting species imported reduces the potential number of non-native species and individuals of a non-native species that may escape from captivity and become invasive.

Government Performance and Results Act of 1993 (Pub.L. 103-62) as amended by the Government Performance Results Modernization Act of 2010 (Pub.L.111-352)

The Government Preformance and Results Act of 1993 designed to improve government performance management by requiring government agencies to set goals, measure results, and report progress annually. The Department of the Interior (DOI) decides what performance measures it wants to track and re-evaluates the measures as part of the DOI Strategic Plan process. GPRA (of 1993) required agencies to develop goals and measures to support an agency Strategic Plan and update that plan every five years. The GPRA Modernization Act (of 2010) now requires an update every four years – in line with the presidential election cycle. The current DOI Strategic Plan is for FY2014-2018 and includes two performance measures related to invasive species: one for Invasive Animals (percent of invasive animal species populations that are controlled) and one for Invasive Plants (percent of baseline acres infested with invasive plant species that are controlled).

Violent Crime Control and Law Enforcement Act of 1994 (34 U.S.C. § 12641)

The Violent Crime Control and Law Enforcement Act of 1994 authorizes the creation of a law enforcement task force in Hawai'i and criminal penalties relating to the illegal conveyance, sale, or introduction of nonindigenous plant and animal species.

Nutria Eradication and Control Act of 2003 (Pub.L. 108-16)

The Nutria Eradication and Control Act of 2003 authorizes the Secretary of the Interior to provide financial assistance to the State of Maryland and the State of Louisiana for a program to implement measures to eradicate or control nutria and restore marshland damaged by invasive nutria.

Brown Tree Snake Control and Eradication Act of 2004 (Pub.L. 108-384)

This Act provides for the control and eradication of the invasive brown tree snake on the island of Guam and the prevention of the introduction of the brown tree snake to other areas of the United States.

Asian Carp Prevention and Control Act of 2010 (Pub.L. 111-307)

This Act added species of invasive carp to the list of injurious species that are prohibited from being imported or shipped in the U.S. under the Lacey Act.

Executive Orders

Executive Orders (EOs) are orders related to invasive species issued by the President to the executive branch that has the force and effect of law include:

Executive Order 11987 – Exotic Organisms (1977)

Executive Order 11987 is the first executive order to address non-native organisms, it stated simply that the federal government should restrict the introduction of exotic organisms on land that it owns or leases, and encourage states, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the U.S. It also stated that the federal government should restrict the importation and introduction of exotic species and restrict the use of federal funds to export native species for the purpose of introducing them into ecosystems outside the U.S. The Order included a provision stating it did apply to the introduction of any exotic species, if the Secretary of Agriculture or Secretary of the Interior determines that such introduction will not have an adverse effect on natural ecosystems.

Executive Order 13112 – Invasive Species (1999)

This executive order revoked EO 11987 and expanded concerns from only preventing the introduction of invasive species to also providing for their control; and minimizing the economic, ecological, and human health impacts that invasive species cause. It defined invasive species as "alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" and directs federal agencies to: (1) identify actions that may affect status of an invasive species; (2)(a) prevent introduction of such species, (b) detect and control such species, (c) monitor population of such species, (d) provide for restoration of native species, (e) conduct research on invasive species and develop technologies to prevent introduction of such species, (f) promote public education of such species; and (3) not authorize, fund, or carry out actions likely to cause the introduction or spread of invasive species in the United States or elsewhere unless the benefits of the action clearly outweigh the harm and the agencies take steps to minimize the harm. Under this authority, it also established the National Invasive Species Council, NISC).

Executive Order 13751 – Safeguarding the Nation from the Impacts of Invasive Species (2016)

Amending EO 13112, this exceutive order incorporates considerations of human and environmental health, climate change, technological innovation, and other emerging priorities into Federal efforts to address invasive species. It maintains the NISC and the Invasive Species Advisory Committee and directs NISC to "publish an assessment by 2020 that identifies the most pressing scientific, technical, and programmatic coordination challenges" to the government's efforts to prevent the introduction of invasive species. It also strengthens coordinated, cost-efficient Federal action and revised the definition of invasive species to mean "with regard to a particular ecosystem, a non-native organism whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health."

Federal Regulations

Federal regulations are general statements issued by an agency, board, or commission that have the force and effect of law. Interpretive rules, policy statements, and other guidance documents can also be published to help explain how an agency interprets or applies existing laws or regulations but these are not enforceable. Title 54 of the United States Code provides the National Park Service with broad legal authority to manage public and recreational use within parks, including the promulgation of regulations that may be more restrictive than generally allowed in other NPS units. These regulations are found in Title 36 (Parks, Forests, and Public Property), Chapter I, Parts 1-199 of the Code of Federal Regulations (CFR). Four regulations are particularly important for invasive species management:

36 Code of Federal Regulations § 2.1(a)(2) Preservation of natural, cultural and archeological resources

Except as otherwise provided in NPS regulations, this C.F.R. prohibits introducing wildlife, fish or plants, including their reproductive bodies, into a park area ecosystem. While this prohibition on introductions includes invasive species, it

does not regulate transporting invasive species onto, off of, or within NPS areas. Wildlife is defined in 36 C.F.R. § 1.4 as meaning any member of the animal kingdom and includes a part, product, egg or offspring thereof, or the dead body or part thereof, except fish.

36 Code of Federal Regulations § 2.2(a) Wildlife protection

This C.F.R. prohibits taking of wildlife by the public except where hunting or trapping are authorized, and prohibits the public from possession of unlawfully taken wildlife or portions thereof. It allows the superintendent to establish conditions and procedures for transporting lawfully taken wildlife (i.e., individuals taken by hunters/trappers) through the park area. According to 36 C.F.R. § 1.4, wildlife means any member of the animal kingdom and includes a part, product, egg or offspring thereof, or the dead body or part thereof, except fish.

36 Code of Federal Regulations § 2.3(d)(2) Fishing

This C.F.R. prohibits possessing or using as bait for fishing in fresh waters, live or dead minnows or other bait fish, amphibians, non-preserved fish eggs or fish roe, except in designated waters. Waters which may be so designated shall be limited to those where non-native species are already established, scientific data indicate that the introduction of additional numbers or types of non-native species would not impact populations of native species adversely, and park management plans do not call for elimination of non-native species.

36 Code of Federal Regulations § 2.15 Pets

This C.F.R. prohibits possessing a pet in a public building, public transportation vehicle, or location designated as a swimming beach, or any structure or area closed to the possession of pets by the park superintendent. Pets may be kept by residents of park areas consistent with the provisions of § 2.15 and in accordance with conditions which may be established by the superintendent; violation of these conditions is prohibited. It also states that pets or feral animals that are running-at-large and observed by an authorized person in the act of killing, injuring or molesting humans, livestock, or wildlife may be destroyed if necessary for public safety or protection of wildlife, livestock, or other park resources.

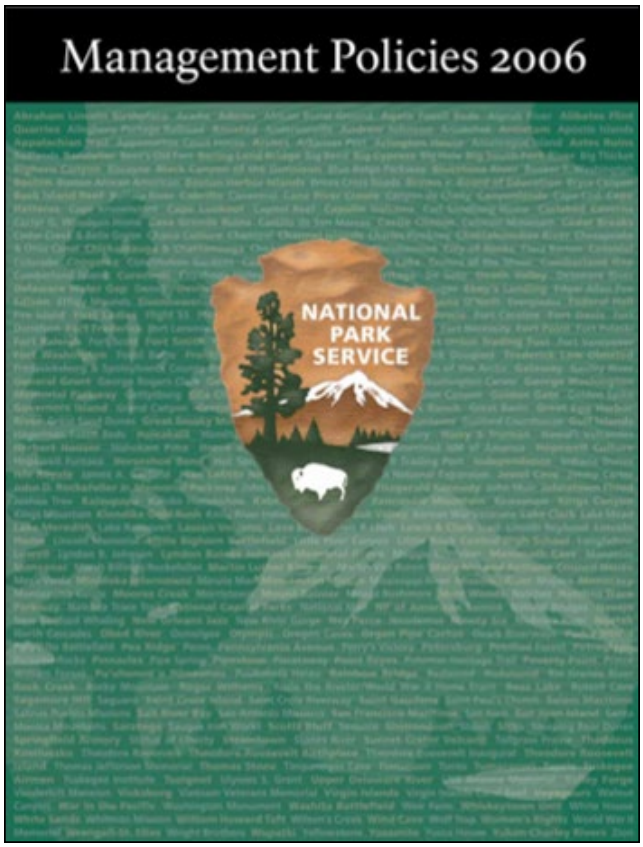
Special Regulations

NPS regulations cannot be contrary to Federal statutes or in derogation of park values but special regulations may be written to address activities that take place within park boundaries on federal and non-federal land as well as on submerged lands and waters. Special regulations can be an effective way to protect park resources that are not sufficiently protected by general NPS regulations. However, the process of promulgating a special regulation includes a number of policy, procedural, and timing considerations, including National Environmental Policy Act compliance and public involvement. Park-specific or "special" regulations are generally found in 36 CFR § 7 and 36 CFR § 13. Special regulations also establish the authority of superintendents to limit activities in parks (36 CFR § 1.5) and promulgate these authorities through an annual Superintendent's Compendium (36 CFR § 1.7(b)).

Park Compendia

Pursuant to 36 CFR § 1.5, park superintendents may put conditions on uses or activities in park units or even close areas to uses. Thus, they have the authority to create more (and more specific) invasive species regulations. Under 36 CFR § 1.7, notice of these actions and restrictions, as well as permit requirements and many other actions taken pursuant to other NPS regulations is provided through an annual Superintendent's Compendium. Examples of compendium provisions include: backcountry permits and camping capacities; fishing permits and limits; and weapons, areas, and access for waterfowl hunting in parks where such hunting is authorized by legislation. Compendium provisions have the force and effect of regulation; a violation of the provision is treated as a violation of 36 CFR § 1.5 or of whatever other applicable regulation served as the basis for the compendium provision. (Generally, a compendium may adopt local limits and conditions for activities that are otherwise allowable under the park's enabling legislation, NPS Management Policies, and NPS regulations but may not permit activities or uses that are inconsistent with those authorities.)

The compendium is mainly for actions that are temporary in nature or may change from year to year (e.g., a closure for nesting eagles). Superintendents may take immediate action in the event of an emergency under 36 CFR § 1.5 to address threats to public safety or park resources. Some permanent actions, such as small area closures or visitor center hours, are permissible as long as they do meet any of the criteria in § 1.5(b), in which case a special regulation will be required. Compendium provisions generally require a written determination and justification by the superintendent that is made available to the public.



National Park Service Management Policies 2006 provides the most current guidelines for management of invasive animals.

National Park Service Policy

The NPS has several sources of detailed written guidance to help managers make day-to-day decisions. The primary source of guidance is the 2006 edition of NPS Management Policies which is also the foremost element of the Service's directives system. Management of invasive animals by the National Park Service follows general and specific direction found in NPS Management Policies 2006 (NPS 2006b). Paraphrased below are the most relevant policies:

NPS Policy Section 1.4.7 Actions regarding Impairment of NPS Natural Resources

If it is determined that there is, or will be, an impairment, the decision-maker must take appropriate action, to the extent possible within the Service's authorities and available resources, to eliminate the impairment. The action must eliminate the impairment as soon as reasonably possible, taking into consideration the nature, duration, magnitude, and other characteristics of the impacts on park resources and values, as well as requirements of the National Environmental Policy Act, National Historic Preservation Act, Administrative Procedure Act, and other applicable laws.

The Service will also strive to ensure that park resources and values are passed on to future generations in a condition that is as good as, or better than, the conditions that exist today. In particular, the Service will strive to restore the integrity of park resources that have been damaged or compromised in the past.

NPS Policy Section 1.6 Cooperative Conservation Beyond Park Boundaries

This directs the NPS to work cooperatively with others to protect park resources and address mutual interests, including implementing management strategies to prevent introductions and spread of invasive species within and beyond park boundaries.

NPS Policy Section 1.9.1.6 Volunteers in the Parks

The Service welcomes the efforts of volunteers and will continue to use its authority under the Volunteers in the Parks Act of 1969 to protect park resources and values; improve its service to the public; foster stronger ties with the public; and provide opportunities for the public to learn about and experience the parks. Pursuant to this statute, volunteers may be recruited without regard to civil service regulations; are covered for tort liability and work-injury compensation; and may be reimbursed for out-of-pocket expenses while participating in the program. However, volunteers cannot be used for law enforcement work or in policymaking processes, or to displace NPS employees. Volunteers may perform hazardous duties only if they possess the necessary skills to perform the duties assigned to them. Volunteers can be an important and cost-effective component of invasive species management programs in parks.

"Authorized Agents"

Everglades National Park has a program of qualified volunteers that act as authorized agents to remove Burmese pythons by lethal or non-lethal means from park lands. The sale or commercial use of natural products is prohibited under 36 CFR 2.1 (c)(3)(v), thus the pythons are handed over to NPS staff for scientific research that may be used to develop control programs. Destroyed animals are returned to natural areas of the parks to decompose and only biomass necessary for research is retained. This program is distinguished from public hunting (unsupervised, licensed sportsmen) that is not legal given existing laws, policies, and regulations.

NPS Policy Section 2.1.2 Management Decisions are Science-Based

Scientific, Technical, and Scholarly Analysis, indicates that decision-makers and planners will use the best available scientific and technical information and scholarly analysis to identify appropriate management actions for protection and use of park resources, including invasive species management actions

NPS Policy Section 4.4.1.3 Definition of Native and Exotic Species

Native species are defined as all species that have occurred, now occur, or may occur as a result of natural processes on lands designated as units of the national park system. Native species in a place are evolving in concert with each other. Exotic species are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as non-native, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place. Genetically modified organisms exist solely due to human activities and therefore are managed as exotic species in parks.

NPS Policy Section 4.4.3 Harvest of Plants and Animals by the Public

Public harvesting of designated species of plants and animals, or their components, may be allowed in park units when hunting, trapping, subsistence use, or other harvesting is specifically authorized by statute or regulation and not subsequently prohibited by regulation; recreational fishing is not specifically prohibited; or commercial fishing is specifically authorized by statute or regulation. Where harvesting is allowed and subject to NPS control, the Service will allow harvesting only when (1) certain criteria have been met, and (2) the Service has determined that the harvesting will not unacceptably impact park resources or natural processes. In consultation and cooperation, as appropriate, with individual state or tribal governments, the Service will manage harvesting programs and any associated habitat management programs intended to restore and maintain habitats supporting harvested plant or animal populations to conform to applicable federal and state regulations.

The Service may encourage the intensive harvesting by the public of exotic species in certain situations when

What's in a Definition?

Definitions related to invasive species, even the term "invasive" itself, have been the subject of much debate and discussion for several years. Following the trend at the time, NPS Management Policies 2006 adopted "exotic" species as an official term for "non-native". It also states "Exotic species are also commonly referred to as non-native, alien, or invasive species" suggesting these terms are synonymous Indeed, the Natural Resources Management Guideline (NPS-77) actually states "Exotic, non-native, introduced and alien are synonymous terms". This interpretation is outdated and out of step with more widely accepted definitions of invasive species in current professional literature and among federal (and some state) agencies which now avoid the value-laden terms "exotic" and "alien". NPS-77 acknowledges that "exotic" has a different connotation among some audiences. Although the global invasive species community still commonly uses "invasive alien species (IAS)"), Executive Order 13751 (2016) removed the word "alien" from its formal definition of "invasive species" which had existed since Executive Order 11987 (1977).

Distinguishing between "non-native" and "invasive" is also complex and occasionally the subject of debate between state and federal agencies. Further complicating the matter, current definitions of "native" and "non-native" may be inadequate when considering the possibility of managed migration or relocation of at-risk species, the fact that species are shifting their ranges in response to climate change, the emerging application of genetically modified or engineered organisms to mimic former native species or be resistant to certain diseases (e.g., the blight-resistant American chestnut tree), and other factors. Updating the terms and definitions used by NPS in order to bring them into alignment with current conservation issues and our federal and state partners is necessary to provide parks with clear, consistent management guidance and facilitate NPS' ability to manage invasive species across jurisdictional boundaries. NPS has recently assembled work groups to address these issues.

needed to meet park management objectives. In some special situations, the Service may stock native or exotic animals for recreational harvesting purposes, but only when: Such stocking will not unacceptably impact park natural resources or processes and when the stocking is of fish into constructed large reservoirs or other significantly altered large water bodies and the purpose is to provide for recreational fishing, or the intent for stocking is a treaty right or is expressed in statute, other applicable law, or a House or Senate report accompanying a statute. The Service will not stock waters that are naturally barren of harvested aquatic species.

NPS Policy Section 4.4.4 Management of Exotic Species

Exotic species will not be allowed to displace native species if displacement can be prevented.

NPS Policy Section 4.4.4.1 Introduction or Maintenance of Exotic Species

In general, new exotic species will not be introduced into parks. In rare situations, an exotic species may be introduced or maintained to meet specific, identified management needs when all feasible and prudent measures to minimize the risk of harm have been taken and it is used to control another, already established exotic species; or is needed to meet the desired condition of a historic resource but only where it is noninvasive and is prevented from being invasive by such means as cultivating (for plants) or tethering, herding, or pasturing (for animals); or parks are directed by law or expressed legislative intent.

Domestic livestock such as cattle, sheep, goats, horses, mules, burros, reindeer, and llamas are exotic species that are maintained in some parks for commercial herding, pasturing, grazing, or trailing; for recreational use; or for administrative use for maintaining the cultural scene or supporting park operations. The policies applicable to the grazing of commercial domestic livestock are discussed in Policy Section 8.6.8. The Service will phase out the commercial grazing of livestock whenever possible and manage recreational and administrative uses of livestock to prevent those uses from unacceptably impacting park resources.

NPS Policy Section 4.4.4.2 Removal of Exotic Species Already Present

All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed, up to and including eradication—if (1) control is prudent and feasible, and (2) the exotic species interferes with natural processes and the perpetuation of natural features, native species or natural habitats; or disrupts the genetic integrity of native species; or disrupts the accurate presentation of a cultural landscape; or damages cultural resources; or significantly hampers the management of park or adjacent lands; or poses a public health hazard as advised by the U.S. Public Health Service (which includes the Centers for Disease Control and the NPS public health program); or creates a hazard to public safety.

High priority will be given to managing exotic species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controlled. Lower priority will be given to exotic species that have "almost no" impact on park resources or that probably cannot be successfully controlled. Where an exotic species cannot be successfully eliminated, managers will seek to contain the exotic species to prevent further spread or resource damage. The decision to initiate management should be based on a determination that the species is exotic. For species determined to be exotic and where management appears to be feasible and effective, superintendents should (1) evaluate the species' current or potential impact on park resources; (2) develop and implement exotic species management plans according to established planning procedures; (3) consult, as appropriate, with federal, tribal, local, and state agencies as well as other interested groups; and (4) invite public review and comment, where appropriate. Programs to manage exotic species will be designed to avoid causing significant damage to native species, natural ecological communities, natural ecological processes, cultural resources, and human health and safety. Considerations and techniques regarding removal of exotic species are similar to those used for native species (i.e., Policy Section 4.4.2.1 NPS Actions That Remove Native Plants and Animals).

NPS Policy Section 4.4.5 Pest Management

All park employees, concessioners, contractors, permittees, licensees, and visitors on all lands managed or regulated by the National Park Service will comply with NPS pest management policies. Pests are living organisms (native or exotic) that interfere with the purposes or management objectives of a specific site within a park or that jeopardize human health or safety. Exotic pests will be managed according to both the pest management policies in this section and the exotic species policies in section 4.4.4.

NPS Policy Section 4.4.5.2 Integrated Pest Management Program

This policy directs the National Park Service and each park unit to use an Integrated Pest Management approach to address pest issues, regardless of whether the pest is native or exotic.

Policy Section 4.4.5.4 Biological Control Agents and Bioengineered Products

The application or release of any bio-control agent or bioengineered product relating to pest management activities must be reviewed by designated IPM specialists in accordance with Director's Order #77-7 and conform to the exotic species policies in section 4.4.4. [However, Director's Order #77-7 only exists in draft form and has not yet been finalized.]

Director's Orders

Aside from NPS Management Policies 2006, other elements of the NPS' directives system includes Director's Orders (DOs), Handbooks, and Reference Manuals. Below are the DOs relevant to invasive animals:

Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-Making

The purpose of this Director's Order is to set forth the policy and procedures by which the NPS complies with NEPA (42 U.S.C. § 4321 et seq.). The provisions of NEPA and the Organic Act jointly commit NPS to make informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations. It also states that NPS management decisions (1) be scientifically informed, and (2) insist on resource preservation as the highest of many worthy priorities. All "major Federal actions" must comply with NEPA, including actions to manage invasive species.

Director's Order #41: Wilderness Stewardship

This Director's Order guides servicewide efforts in meeting the requirements of the Wilderness Act (16 U.S.C. § 1131 et seq.), clarifies specific provisions of Management Policies 2006, and establishes specific instructions and requirements. In relation to invasive species, section 6.9 of this Director's Order states:

Non-native invasive plant and animal species must not be brought into wilderness. Parks should be managed with the goal of early detection and rapid response in areas adjacent to wilderness to prevent the spread into wilderness. Parks should have information and programs to inform the visiting and non-visiting public about the impacts of non-native invasive plants and animals and how to prevent their introduction and spread. Regulations (e.g., requiring certified weed-free hay, grain and hay cubes for stock) may need to be put in place within a park's compendium in order to prevent the introduction and spread of non-native invasive species. Parks should use Integrated Pest Management (IPM) to guide invasive species planning and implementation and develop management plans using IPM that may require NEPA and minimum requirements compliance. Elements include prevention, inventory, prioritization, treatment, monitoring, research, education, and outreach. An inventory and assessment of non-native invasive species should be conducted before any treatment actions are proposed. The objective of treatment within wilderness should be the eradication of the invasive species. If eradication is not feasible, the objective of treatment should be to contain the invasion, preventing spreading. The management of non-native invasive species can result in both positive and negative impacts to wilderness character. A Minimum Requirement Analysis will be conducted on proposed actions to inventory, monitor, control or eradicate non-native invasive species. The Minimum Requirement Analysis will be the basis for managers to determine if the proposed action is necessary and will identify the management activity which has the least negative impact on wilderness. Also see Management Policies 2006, Section 4.4.1.

Reference Manuals

No official comprehensive NPS handbook or guidance document currently exists related to invasive species, but the Natural Resources Management Guideline (NPS-77; NPS 1991) published in 1991 combines existing guidance with documentation of unwritten NPS resource management practices and procedures. Chapter 2 of NPS-77 is dedicated to Natural Resources Management. Although NPS-77 is over 25 years old and in need of updating, many of the management practices it describes are still relevant today. The "Exotic Species Management" section starts on page 284 of Chapter 2 and provides guidance on prevention of exotic species invasions, management of established exotic species, management of special categories of exotics in cultural landscapes, research and monitoring, biological control, integrated pest management and pesticide use, environmental compliance and planning documents, and roles and responsibilities.

Adequacy of Existing Legal Authorities

No single law provides coordination among federal agencies and no comprehensive legislation on the treatment of invasive species has ever been enacted. The current legal framework is largely governed by a patchwork of laws, regulations, policies, and programs with some laws tailored to individual species, or narrowly focused on what is affected by those species, and other laws having a broader intended purpose and only peripherally addressing invasive species.

There is need to clarify existing authorities for NPS management, ensure NPS regulations articulate prohibitions that law enforcement can realistically enforce, clearly communicate guidance to regions and parks, and consider if additional authorities are needed. One example to help improve park understanding is clarification and consistency between the national solicitor's office and regional solicitors' offices on interpretation of invasive species laws and policies. Another example is developing fast-track NEPA options so that parks can quickly undertake Early Detection, Rapid Response and remain in compliance with NEPA requirements to consider potential impacts on park resources. Other areas where clarification would help are: (a) Does NPS still technically have authority in a situation where a control activity is disallowed under a NEPA-vetted proposed action? (b) In what explicit circumstances is a NEPA Categorical Exclusion not allowed to be used for invasive animal management? and (c) What is the extent of NPS authority to regulate the transport of invasive species onto, off of, or within NPS units? Prompted by the Aquatic Nuisance Species Task Force, NPS' Natural Resource Advisory Group requested NRSS (Water Resources Division / Biological Resources Division) to convene a work group with the purpose of: (a) reviewing NPS invasive species regulations for adequacy and (b) making recommendations for revisions or new regulations if appropriate. The ad-hoc NPS Invasive Species Regulations Work Group was formed with representatives from all seven NPS regions, the Office of Regulations, Law Enforcement, NPS solicitors, affected parks, and the Water Resources and Biological Resources divisions of NRSS. The work group started convening (by telephone) in fall 2017.

Burmese python in Everglades National Park. NPS Photo.

2. Invasive Species Organization In the Natural Resource Stewardship and Science Directorate

The Natural Resource Stewardship and Science (NRSS) Directorate is a component of the National Park Service's Washington Support Office. NRSS, in collaboration with NPS regions, parks, and programs, provides servicewide natural resource leadership and support through coordinated and strategic approaches that are grounded in a conservation ethic of science, critical analysis, knowledge synthesis, and informed decision making (NRAG 2016). It helps NPS adapt and respond to continuous change, with a focus on long-term ecological integrity and viability. Although three divisions of the NRSS Directorate (Figure 3) undertake activities directly related to management of both invasive animals and animals. This chapter summarizes those activities.

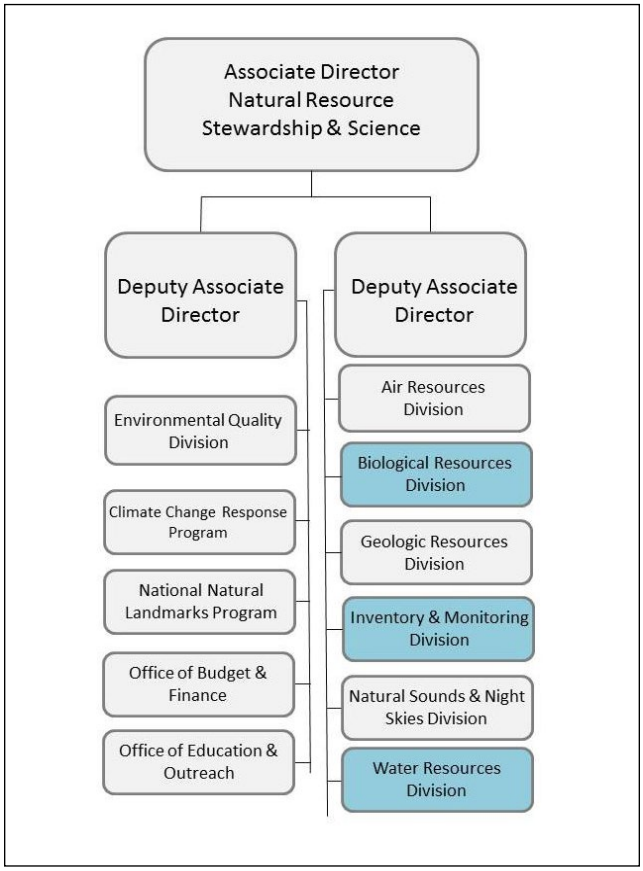


Figure 3. Divisions and programs within the Natural Resource Stewardship and Science Directorate of the National Park Service Washington Support Office. The three highlighted divisions host the primary programs, program areas, or activities related to invasive animal (and plant) management.

Amistad National Recreation Area is at the confluence of the Rio Grande, Devils, and Pecos rivers in Texas and is at high risk of invasion by zebra and quagga mussels. During 2017, NPS' Biological Resources Division provided funding to pilot test using a detection canine and handler to conduct boat inspections at the park. ©ALISON FRASER Photo.

Most invasive species issues are addressed by the Biological Resources Division (BRD) with support and input from the Water Resources Division (WRD) on aquatic species. The BRD is home to the only NRSS program with dedicated permanent funding and staff to address invasive species (discussion of Exotic Plant Management Teams (EPMTs) and Integrated Pest Management (IPM) is included in this chapter.) The IPM Program has historically handled all pest issues with invertebrate animals but it also addresses some issues with plants and vertebrate animals. Terrestrial vertebrate animals and aquatic species are presented as "program areas" below as they do not have permanent dedicated funding or personnel. There is much overlap between divisions and programs in the taxonomic groups, specific species, and issues addressed (Table 1). Thus, coordination and communication among staff, particularly in the BRD and WRD divisions, is necessary, frequent, and ongoing. Like many other conservation issues, invasive species require an interdisciplinary approach. Thus, continued collaboration is essential across other NPS programs and divisions such as the Office of Public Health, Climate Change Response Program, Cultural Resources Division, Law Enforcement Division, and Facilities Management Division.

Feral sheep (*Ovis aries*) degrade fragile native ecosystems in the Hawaiian Islands through browsing, trampling, and stripping bark from native trees. Since 2013, Hawai'i Volcanoes National Park has undertaken an ambitious control program to eradicate them from the park's Kahuku Unit (469 sq km) where this photo was taken. NPS Photo.

Primary responsibilities for invasive species in the Washington Support Office are shared across three divisions of the Natural Resource Stewardship and Science Directorate: the Biological Resources Division, Water Resources Division, and Inventory and Monitoring Division.

The three NRSS invasive species leads, the NPS Invasive Animal Coordinator (BRD), NPS Invasive Plant Program Manager (BRD), and NPS Aquatic Invasive Species Coordinator WRD), regularly collaborate with the DOI Invasive Species Coordination Group and National Invasive Species Council on various initiatives as well as participate in NPS, federal, and multi-stakeholder projects that relate to invasive species. Recent initiatives include the Early Detection Rapid Response Federal Work Group, DOI Invasive Animal Performance Metrics Work Group, and DOI Invasive Plant Performance Metrics Work Group. The NPS is currently participating in two DOI work groups to develop performance measures for: (a) preventing new species invasions to the U.S. or its territories, and (b) preventing invasive species already existing in the U.S. or its territories from spreading onto DOI lands. In addition, the BRD Division Chief resides on the Department of the Interior Invasive Species Task Force that meets at least monthly via teleconference and annually in person, and is also ked a federal representative on the Association of Fish and Wildlife Invasive Species Committee.

Biological Resources Division Invasive Animals Program Area

The Biological Resources Division provides servicewide perspective, expertise, and leadership in developing and communicating biological resource science and policy, and identifying and implementing new approaches to biological resources stewardship to help the National Park Service fulfill a core mission: to preserve unimpaired the natural

resources and values of the National Park Service for the enjoyment, education, and inspiration of this generation and future generations. The BRD Invasive Animal Program Area is new within BRD since 2014 and provides assistance and expertise on: species of servicewide interest (e.g., feral swine), species that warrant special concern (e.g., Burmese pythons), environmental reviews associated with other federal or interagency initiatives (e.g., FWS injurious listings under the Lacey Act and USDA-APHIS national approach to feral swine management), technical assistance and policy guidance to parks and regions on matters related to invasive animal prevention, containment, management and monitoring, federal reporting requirements and information requests, advising NPS senior management on invasive species policy and regulations, and representing NPS on interagency and multi-stakeholder groups that focus on invasive species. The NPS Invasive Animal Coordinator leads the annual data call to parks for reporting progress on invasive animals per GPRA, summaries from which are presented for fiscal year 2016 in the following chapter. There is no permanent staff in the invasive animal program area. Historically, responsibilities for invasive animals were handled as an ancillary duty by the invasive plant program manager.

Biological Resources Division Integrated Pest Management Program

The IPM program provides policy and guidance on use of the IPM process as per federal and NPS policies, technical assistance to parks and regions (pest prevention, detection, and management), servicewide IPM training, and review and tracking of proposals and actual use of pesticides, biocontrol agents, and genetically modified organisms through the NPS Pesticide Use Proposal System. IPM uses an 11-step science-based decision-making process that guides park managers when investigating damage or potential damage to park resources or threats to human health and safety from organisms (pests). The IPM process is used for managing pest species, both native and non-native, that interfere with the site-specific management objectives or that jeopardize human health or safety. NPS' IPM program (housed in BRD) is the lead for invasive invertebrate species but also addresses some issues with invasive plants and terrestrial vertebrate species (Table 1).

The IPM program provides technical expertise for the detection, prevention, and management of forest pest species such as hemlock wooly adelgid, Asian long-horned beetle, emerald ash borer, and gypsy moth. The national program support staff coordinates the annual funding call (approximately one million dollars) for regions to secure program funding from the U.S. Forest Service Forest Health Pest Suppression Program. The IPM program also assists with management of a variety of terrestrial and aquatic species in natural and developed areas. These include detection, prevention, and management recommendations in accordance with other experts (NPS, external partners, academia, and others). Species that interfere with site management objectives (i.e. have "pest" status) include rodents and floating aquatic plants, fish, shellfish, mollusks, and invertebrates such as mosquitoes.

The Federal Insecticide Fungicide and Rodenticide Act (7 U.S.C. § 136 et seq.) directs federal agencies to use IPM techniques in carrying out pest management activities. NPS' program adheres to the IPM process prescribed in Director's Order #77-7: Integrated Pest Management (currently in draft). The IPM program generally consists of one full-time permanent program lead and one full-time permanent support staff member; both interact with professionals in the NPS Public Health Program. Recent changes to the program have included the development of a team approach to address IPM issues that includes other BRD staff as well as the Cultural Resources and Visitor Resources Protection directorates. The IPM program team provides comments on

Table 1. Four NRSS invasive species program areas in the NPS national office are involved with managing, monitoring, or controlling invasive species.

Life Form	Type of Life Form	Invasive Animals	Invasive Plants	Invasive Aquatics	Integrated Pest Management
Animals	Terrestrial vertebrates	BRD	–	–	BRD
	Terrestrial invertebrates	BRD	–	–	BRD
	Aquatic vertebrates and invertebrates	BRD	–	WRD	BRD
	Semi-aquatic vertebrates and invertebrates	BRD	–	BRD, WRD	BRD
Plants	Terrestrial	–	BRD, IMD	–	BRD
	Aquatic	–	BRD, WRD, IMD	BRD, WRD	BRD
	Semi-aquatic	–	BRD, IMD	BRD, WRD	BRD

Emerald ash borer (*Agrilus planipennis*) is the cause of extensive decline and mortality of native North American ash trees in at least 24 states. The larvae (top photo) tunnel into the bark, girdling and ultimately killing the tree within two to four years. The adults (bottom photo) are active from late May through July, feeding on ash trees and laying eggs on their bark. U.S. Geological Service Photo/©DAVE CAPPERT Photo.

plans and other documents that address IPM issues; advises parks, regions, and NPS senior management on IPM policy and regulations; represents NPS on interagency and multi-stakeholder groups; and assures that the NPS complies with legal requirements related to the use of pesticides, in part, through the use and maintenance of a Pesticide Use Proposal System. The full NPS IPM Program consists of a network containing the national program staff mentioned above, an IPM Coordinator in each regional office funded by the region (many regional IPM Coordinators also have other duties), and an IPM Coordinator designated (and funded) by each park as part of other assigned duties.

Biological Resources Division Invasive Plants Program

While not a program that addresses invasive animals, its structure and function is nonetheless informative and important to describe in some detail. This program is the lead for invasive terrestrial plant issues but also addresses some aquatic and semi-aquatic plants (Table 1). The current invasive plant program (based on EPMTs) was created in 2000 as a result of the NPS Natural Resource Challenge. The program provides "boots-on-the-ground" invasive plant management assistance, expertise, restoration support, training, and education and outreach to approximately 290 park units across the NPS.

The parks serviced by each team were organized into the 17 teams we have today based on commitment by parks to support the work of the EPMTs and travel logistics for each of the teams. Each team has its own team lead, titled as Liaison, but the structure and funding of each team varies based on the opportunities and challenges unique to the ecoregion(s) and/or parks that they serve. The NPS national office funds 15 teams. One additional team was formed to serve multiple parks in the NPS Southeast Region through a base increase at Congaree National Park and another was formed from a base increase for a new Inventory & Monitoring Network (described later in this chapter). The invasive plant program uses a geodatabase (National Invasive Species Information Management System) that NPS adapted from the Bureau of Land Management (BLM). EPMT invasive plant management data have been collected in this geodatabase and parks are encouraged to use the same.

There is dedicated funding for the EPMT program and staff consists of one full-time permanent program lead serving as the NPS Invasive Plant Program Manager with support provided by BRD's data manager and an intern. Invasive plant program staff communicates with the field through the EPMT Liaisons, the EPMT Advisory Group, regional offices, and may work directly with parks for some projects. The program manager provides technical assistance and policy guidance to parks and regions on matters related to invasive species prevention, containment, management, and monitoring. Comments are also provided on plans, other documents and proposed legislation that address invasive plant species issues or may result in invasive plant introductions. Other responsibilities include advising NPS senior management on invasive plant species policy and regulations, representing NPS on interagency and multinational groups that focus on invasive species, and conducting the annual data call to parks for reporting

progress on invasive plants per GPRA. The program manager is currently a co-chair of the Federal Interagency Committee for the Management of Noxious and Exotic Weeds.

Water Resources Division Invasive Aquatics Program Area

The Water Resources Division (WRD) provides assistance, expertise, and guidance for aquatic ecosystem stewardship in national parks. The invasive aquatics program area is housed in WRD and is the lead for most invasive aquatic plant and animal issues, although some aquatic or semi-aquatic plants and animals are addressed by other program areas (Table 1). Current initiatives include working with regional and park staff to improve effectiveness of aquatic invasive species prevention and management, coordinating and reporting on quagga and zebra mussel prevention efforts including the DOI / NISC initiative Safeguarding the West, pursuing federal approval for sharing data regarding recreational trailered boats, and establishing a national working group to review NPS regulations for invasive species.

This program area does not have dedicated funding and consists of one full-time, permanent staff for which aquatic invasive species is only one area of responsibility. The unofficial role that this staff member serves is as the NPS Aquatic Invasive Species Coordinator to provide technical assistance and policy guidance to parks and regions on matters related to aquatic invasive species prevention, containment, management, and monitoring. The coordinator also advises NPS senior management on policy and regulations regarding aquatic invasive species, develops proposals for funding, and represents the NPS on interagency and multi-stakeholder groups that focus on aquatic invasive species. The coordinator represents NPS on the Western Regional Panel for Aquatic Nuisance Species, Aquatic Nuisance Species Task Force, and is one of the NPS representatives on the Association of Fish and Wildlife Agencies' Invasive Species Committee. Additionally, the coordinator oversees a variety of short term park-based funded projects that address invasive and non-native aquatic species management.

Inventory and Monitoring Division Invasive Species Activities

The NPS Natural Resource Inventory & Monitoring Program was created by Congressional mandate in 1998. The program's purpose is to conduct inventories and long-term monitoring (50 years +) of select natural resources to support stewardship of park species and ecosystems. The Inventory and Monitoring Program consists of the

Lionfish being captured by a resource manager in Biscayne National Park, Florida. Native to the Indo-Pacific region, they are voracious predators and also compete for food resources of ecologically and commercially important native fish. As lionfish populations grow, they put additional stress on coral reefs already struggling from the effects of climate change, pollution, disease, overfishing, sedimentation, and other stressors that have led to the listing of seven coral species in lionfish-infested areas of the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea. NPS Photo, Yasmeen Smalley.

NRSS Inventory and Monitoring Division and field staff organized into 32 ecoregional inventory and monitoring networks servicing 272 parks across the NPS. Supporting parks with invasive species issues occurs in the context of routine inventory and monitoring activities conducted by the Inventory and Monitoring Program. Mapping invasive plants is conducted in nearly two-thirds of the parks supported by the Program. Mapping includes identification of invasive plants, recording their spatial distribution, and is frequently conducted in areas considered "entry pathways" into parks.

These efforts are intended to detect new plant invasions so that they can be treated before populations become established and to monitor effectiveness of control treatments. In addition, as staff collects field data on vegetation, soils, and other resources, they identify and mark locations of invasive plants they opportunistically encounter to fill in knowledge gaps of species occurrence and distribution. Ideally, information is then provided to the respective park and EPMT team serving the park, if there is one. Decisions on whether and how to conduct control actions are up to the park and EPMT program. Limited work is conducted specifically for invasive animals and is focused on benthic marine systems (monitoring populations of lionfish and other invasive species that affect coral systems) and freshwater fish in south Florida. As with invasive plant species, Inventory and Monitoring Program staff also document (and report to parks) any opportunistic sightings of invasive animals they encounter when conducting routine activities.

These inventory and monitoring activities are performed by locally-based NPS personnel funded by the IMD working in partnership with parks. Similar to the EPMT program, each Inventory and Monitoring Program Network has its own program lead and differs in terms of focus, expertise, and on-the-ground logistics as a result of opportunities and challenges unique to the particular Network. In concert with the parks they serve, each Network determines its own priority items to monitor and its own monitoring protocols. Each park within a Network determines its own key park resources, known as "vital signs" to monitor. These vital signs are a subset of physical, chemical, and biological elements and processes of park ecosystems that can be unique to the park. The most recent numbers available indicate 22 of the 32 servicewide monitoring networks have identified invasive animals as a major concern to ecosystem health.

3. Servicewide Snapshot of Invasive Animals

Nutria (*Myocastor coypus*) are native to southern South America and were introduced to the U.S. for fur farming. At Jean Lafitte National Historical Park and Preserve, Louisiana where this photo was taken, invasive nutria are degrading wetland habitats and displacing native species such as beaver, muskrats, and mink. NPS Photo.

Government Performance and Results Act

The Biological Resources Division (BRD) annually facilitates servicewide collection and compilation of invasive animal information used to comply with the Government Performance and Results Act (GPRA). Summary information is subsequently reported to the federal Office of Management and Budget (OMB). All park units with invasive animals (aquatic or terrestrial); including parks that have such species but do not perform control efforts, are required to respond to the data call. In addition to fulfilling GPRA reporting requirements, the information is used to communicate the critical need for managing invasive species and addressing healthy landscape management across the NPS system. It is also used for budget justifications and resource allocation, as well as for outreach to Congressional staff, non-governmental partners, and interagency committees. Examples include NPS Budget Justifications[1] ("Green Book"), Scorecards, and State of the Parks reports[2]; the Department of the Interior (DOI) Annual Performance Plan and Report[3] and Annual Financial Report[4] provided to Congress; briefings to DOI senior officials on the progress of bureaus meeting the goals and metrics in the DOI Strategic Plan; and information requests from Congress and NPS leadership regarding efforts to control and manage specific invasive species. Summaries are also prepared for each region to help them keep informed about invasive animals in their parks.

1 https://www.nps.gov/aboutus/budget.htm
2 https://www.nps.gov/stateoftheparks/
3 https://www.doi.gov/bpp
4 https://www.doi.gov/pfm/afr

The GPRA Invasive Animals performance measure tracks efforts to control invasive animals on DOI lands. Reporting to GPRA Invasive Animals is not cumulative but presents a "snapshot" of NPS conditions during a given fiscal year. Each performance measure has a goal that is set at the bureau level, rather than at the park level as NPS has done in past years. For invasive animals, the goal is a percent that indicates the number of invasive animal populations that NPS projects to be under control within the following fiscal year. Setting this goal is not a scientific exercise and usually takes the form of a semi-educated guess, informed only by the data call. Updating the performance measures (and their associated performance goals) was required every five years under the original GPRA (of 1993) in conjunction with updates to the DOI Strategic Plan. The GPRA Modernization Act of 2010 now requires the update to occur every four years – in line with the Presidential election cycle.

Progress towards the GPRA Invasive Animals goal is measured for each DOI bureau by the percent of invasive animal species populations that are known to be under control at the end of the reporting period. Specifically, the DOI GPRA Invasive Animals Performance Metric is a ratio of the numerator *Invasive Animal Populations Under Control* (the number of populations of invasive animal species that are known to be suppressed, contained, or eradicated) and the denominator *Invasive Animal Populations* (the number of invasive animal species populations that are known to occur).

Although species-level data has been reported by parks since at least 2005, comparing data across years is very difficult. Definitions, guidance, and scope of the data collected changed frequently – sometimes annually.

The NPS has been reporting annually to the GPRA's Invasive Animal performance measure since at least 2005 (Figure 4). Comparing data across years is difficult given that reporting guidance from the OMB, and associated NPS guidance to parks, changed almost annually for a number of years. Parks have understandably been confused about what to report. For example, until 2012 parks reported for GPRA directly through the OMB's Performance Data Management System

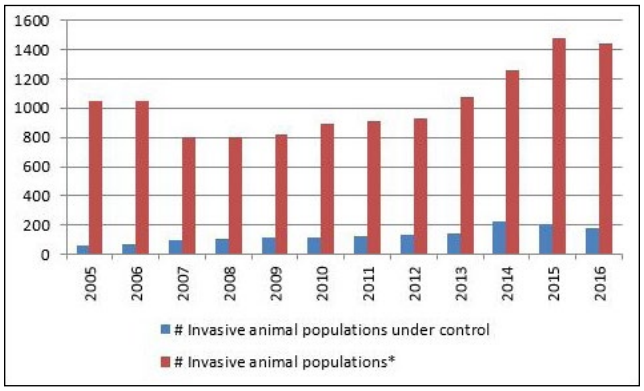


Figure 4. Number of invasive animal populations reported to the NPS invasive animals data call (2005–2017).

*Guidelines for what constituted "number of invasive animal populations" was not consistent between years. Starting in 2014, it included the total number of populations occurring in parks. Previously, it included only the populations that parks were trying to control.

web application. Parks were not ask for species information and were required to report only the number of populations under control, the number of populations for which control was being attempted (rather than all populations that exist in a park), and the associated total dollars spent. The NPS was expected to concurrently conduct a data call in order to document what species parks' numbers referred to, and subsequently to reconcile the numbers. Not surprisingly, the numbers never lined up.

This contributed to the OMB's decision to hand full responsibility for reporting invasive animal population numbers (but not expenditures) over to the bureaus in 2014. Summary numbers could then be generated directly from the source data collected through each agency's species-level data call. Concurrently, guidance also changed to report all invasive animal populations occurring in parks regardless of whether parks are attempting to control them. This accounts for the surge in total number of populations reported that started in 2014. Reporting also improved in 2014 with progression from a Microsoft Excel-based reporting system, where every park submitted an individual spreadsheet that was subsequently collated by regions and the national office, to a single web-based spreadsheet for each region that parks populate. Responsibility for reporting invasive animal expenditures was retained by the OMB who extracts the information from data park budget office reports to the Financial and Business Management System. Unfortunately, the system relies on existing budget codes that include only

$$\frac{\#\ Invasive\ animal\ populations\ under\ control}{\#\ Invasive\ animal\ populations} = \%\ Invasive\ animal\ populations\ under\ control$$

one for "invasive species" generally and does not allow differentiation between invasive plants and invasive animals, or other useful data partitions such as aquatic and terrestrial, which would be extremely useful for management. From 2008 to 2012, the NPS asked parks to report expenditures for controlling invasive animals. Since the OMB did not assign responsibility for reporting expenditures to the bureaus, and to reduce the burden of information requested from parks, a decision was made in 2013 to discontinue collecting expenditure information as part of the data call until NPS had specific application(s) for the data that could justify the reporting burden to parks. Expenditure information reported to the annual data call from 2008–2012 (Figure 5) reflects an overall increase in invasive animals expenditures of 18%.

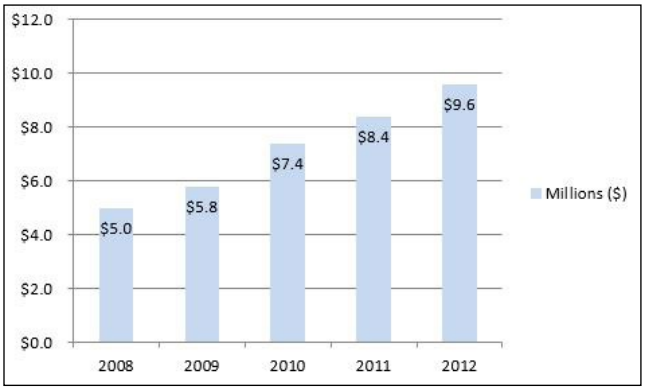


Figure 5. Expenditure information for controlling invasive animals was requested in the annual NPS invasive animals data call from 2008 to 2012.

Definitions

Definitions related to invasive species, even the term "invasive" itself, have been the subject of much debate and discussion for several years (see "What's in a Definition?" in the Introduction). Consequently, definitions have evolved in an attempt to be more specific and reduce subjective interpretation. Due to differing interpretations of current GPRA definitions (Appendix A), and ambiguities in other elements of the performance measure, DOI bureaus that reported to GPRA Invasive Animals (FWS, NPS) and GPRA Invasive Plants (BLM, BOR, FWS, and NPS) proposed updates in fall 2016. These updates clarify the definitions and were developed collaboratively by the DOI Invasive Species Coordinator, NRSS and BRD senior leadership, the NPS Invasive Animal Coordinator, NPS Aquatic Invasive Species Coordinator, and the FWS National Invasive Species Coordinator. The updated template (Appendix B) has been approved by the OMB and is planned for implementation with the upcoming reporting cycle (FY2018).

This black and white tegu (*Tupinambis merianae*) was caught by a camera trap making off with a chicken egg near Everglades National Park, Florida. Tegus are native to South America but have become established in Florida likely due to pet releases or escapes. A highly intelligent species, black and white tegus are opportunistic predators that eat a wide variety of small prey, including eggs and young of ground-nesting birds and turtles such as the threatened gopher tortoise. Florida Fish and Wildlife Conservation Commission Photo.

Methodology of Annual Data Call

The NPS Invasive Animal Coordinator leads the annual data call to collect information from parks required by GPRA. Each year, the Associate Director of NRSS distributes a memorandum to the field providing guidance for the invasive data call and instructing parks to respond. As some NPS units do not manage any land or waters, not all units are required to respond. The NPS Invasive Animal Coordinator and NPS Invasive Plant Program Manager work with regional staff to identify park units that should report, those for which reporting is optional, and those that are not required to report.

The NPS Invasive Animal Coordinator develops and maintains the mechanism through which parks report invasive animal information. Parks are responsible for providing species-level data for invasive animals at their park unit. Each region is provided with its own web-based spreadsheet that individual parks populate to the best of their knowledge. Access to the spreadsheet is managed by the NPS Invasive Animal Coordinator and is by permission only. Parks are provided with a copy of the memorandum that authorizes the data call, detailed guidance on how to report, definitions of key terms (listed in the previous section), a list of frequently asked questions, and detailed descriptions of pick-list options.

Information provided by parks responding to the data call includes the following fields for each individual line entry: park name, species common name, species scientific name, taxonomic group, occurrence status, existence of management plan, does park spend money to manage the species, is the species under control, park contact information (name, phone, email), and verification of the record by the park contact. Two fields for open-ended park commentary are provided: Data Citations and Park Comments. Starting in the FY2014 reporting period, parks were also asked to select one of two options when reporting a species: (a) non-native, and invasive, or (b) non-native, not sure if invasive. This has provided important information about the level of understanding for what species parks considered "non-native" and of those which further qualify as "invasive."

Quality Assurance and Quality Control

Regional NPS staff are responsible for review and quality assurance of parks' data. The NPS Invasive Animal Coordinator subsequently conducts final quality assurance/quality control, collates and summarizes data for all regions, and reports servicewide numbers to the OMB.

The invasive animals data call essentially collects a narrative from each park that is entirely reliant on park staff for completeness and accuracy. Therefore, the data collected must not be considered an authoritative inventory of all invasive animal species occurring in NPS units, but rather the best information we are able to collect at this time. To minimize error and allow for data to be easily summarized, standardized pick-lists and data validation coding are programmed into the spreadsheet so that parks can self-correct errors. For reference, parks are also provided with the previous year's information they submitted. As information rarely changes from year-to-year, the ability to copy/paste entries from the previous year and then modify as necessary has proven to be a huge time saver for parks. For this reason, a form-based reporting system is not used. An action item could be developing a more sophisticated reporting mechanism.

For 2016, 245 parks (out of 326 responding to the FY2016 data call) reported a total of 331 invasive animal species occurring within park boundaries in 1,409 populations throughout NPS, of which only 150 (11%) populations were considered under control. Within reasonable inference, this also indicates that at least 1,250 invasive animal populations are currently not under control in or adjacent to national parks.

Summary of NPS 2016 Invasive Animal Data

Representativeness of Data Collected

The response rate of parks to the invasive animals data call has been steadily increasing (9% annually on average) since the presence of an NPS Invasive Animal Coordinator to overhaul and streamline the data call, mobilize parks and regions to report, and provide relevant summaries back to parks and regions. The response rate of 81% (Table 2) is now 40% higher than it was FY2012 when the coordinator first assumed responsibility for the data call. This annual outreach and dedicated effort by the NPS Invasive Animal Coordinator continues to significantly improve both the quantity and quality of information reported by parks.

Despite these improvements, there is inherently variability between 417 units of the National Park System in terms of mission (part of parks' enabling legislation), management focus (e.g., historical resources, cultural resources, natural resources), number of staff, amount of funding, and staff

Table 2. Park response rate to the 2016 GPRA Invasive Animals data call.

Category	Type of Metric	NPS	AKR	IMR	MWR	NCR	NER	PWR	SER
Representativeness of Data Call	# parks queried in data call	404	16	83	53	42	83	65	62
	# parks responding	326	16	82	37	12	66	51	62
Response Rate	% parks responding	81%	100%	99%	70%	29%	80%	78%	100%
	% targeted* parks responding	88%	100%	100%	86%	48%	85%	80%	100%

*Targeted parks are those with land to manage.

expertise. Complete and accurate information varies widely by region, and by parks within each region. Some of this is inherent to the fact that smaller parks do not have natural resource staff and may assign a park interpreter, cultural resource specialist, law enforcement ranger, or facilities staff to respond to the data call. Other reasons affecting the quality of data include: staff are overwhelmed with other responsibilities and the data call is not a priority, parks do not have staff with the necessary expertise for reporting to the data call, or parks do not see value in the data call and simply do not respond. Therefore, information collected by the data call is not considered to be an authoritative inventory of all invasive animal species occurring in NPS units. Ultimately, many parks do not have the resources to conduct systematic surveys so they report what they know as best they can.

Information Used for GPRA Reporting

After completing the annual data call, the NPS Invasive Animals Coordinator assembles a subset of the data to be used for GPRA reporting. Current guidance is for NPS to include all park populations that are reported as present within park boundaries. Populations reported with an occurrence value of "Not present in park this year; but occurs adjacent to park" are also included if the park either spent money to manage or prevent incursion of the adjacent populations, or if a management plan exists or is in progress. Eradicated populations are only included if it's either the first year the species is confirmed eradicated from a park or if the park continues to spend money on the species to maintain the eradication (e.g., feral swine exclusion fencing). Using these parameters for GPRA, NPS reported 1,444 total invasive animal populations in FY2016, of which 182 populations (12.6%) are under control.

Summarizing Information Reported by Parks

Information collected during the data call is categorized by the occurrence value each park assigns to the species populations it reports: (a) present in park this year, (b) not present in park this year but occurs adjacent to park, or (c) eradicated from park (this year or a previous year). Of note, the data call does not ask parks to rate level of concern for species they report.

NPS currently has no systematic means to distinguish between species that are non-native and those that are both non-native and invasive, nor between species that are native to one area of the country but are non-native (and invasive) to another area where they have been introduced. Sometimes the determination is clear but often it is not since site-specific circumstances and the existence (and degree) of impacts need to be considered. Currently, the national office does not have capacity to categorize the invasive animal populations reported in the servicewide data call. The information reported for GPRA and the summaries presented in this report are thus a direct reflection of what parks submitted during the data call.

Invasive Animals within Park Boundaries

Information for invasive animals reported as occurring within park boundaries during 2016 are summarized in Table 3. Appendix C provides further summaries of these data (number of species and populations by taxonomic group, and top 25 species reported as occurring in parks). Recall that park populations are the collective group of individuals of a species that occur within park boundaries (even if they also spend time outside of park boundaries). A park may report more than one population if there are discrete groups of individual animals that do not interact with other groups of the same species in a park. For example, an NPS unit could report separately on two populations of rainbow trout located in two disconnected waters.

Invasive Animals Adjacent to Parks

Parks are expected to report expenditures for preventing an invasive species from being introduced to their park. This may include species that are further away than immediately "adjacent". For example, zebra and quagga mussels are most likely to colonize a new park by attaching to recreational boats in previously visited, infected waters. These trailered boats can spread invasive aquatic species across long distances. Parks are encouraged (but not required) to report other invasive animal populations that are adjacent to, but not within, park boundaries and for which they do not currently expend funds. Although many parks opt to provide this information (72 parks did in 2016), not all of them do. Therefore, Table 4 provides some, albeit not complete, information about invasive animals that are encroaching on parks. Appendix C provides a table summarizing the top 25 species reported as occurring adjacent to parks.

Invasive Animals Eradicated from Parks

Populations of invasive species eradicated from parks are reported under the data call regardless of whether the eradication occurred during the current, or a previous reporting period. Table 5 provides information on completed, successful eradications. A species is only considered eradicated once all individuals of a population have been eliminated from a localized area, as verified using monitoring and inventories. The population is considered suppressed (i.e., "controlled") until monitoring verifies that eradication has been successfully achieved; this is a species and context-specific decision. Once eradication has been achieved, expenditures may still be required to prevent re-invasion (e.g., fence repairs to prevent incursion of feral swine from adjacent lands); 43% of eradicated populations required ongoing expenses in 2016. Appendix C includes a table summarizing all species reported as eradicated in 2016 or a previous year.

Management Plans and Expenditures Reported by Parks

As previously explained, parks might expend funds to manage invasive animals that either occur within, "adjacent" to, or are eradicated from the park. Similarly, a park may have a management plan whether or not the species is currently occurring in the park. Important to note is that regardless of whether or not an invasive animal is present, adjacent, or eradicated, a park may expend funds to manage or control the species but not have (or need) a management plan for that species. As such, information is best presented as a combined summary. Appendix C includes two tables listing the top 25 invasive animal species for which parks have a management plan and for which parks expended funds to control or manage. Parks may have used the Consolidated Natural Resources Act to enter into cooperative agreements with agencies or entities for collaborative efforts on land inside and outside NPS units. An expanded data call to ask such management-related questions would allow better characterization of NPS' collaborative efforts. Although data collected through the annual data call cannot be considered a complete and authoritative inventory of all invasive animal species occurring in NPS units, it is informative to staff in both the national and regional offices for observing trends. Appendix D includes the same information described in the servicewide tables above (and in Appendix C) but summarized separately for each region.

Table 3. Invasive animal data reported in 2016 for species populations occurring within park boundaries.

Category	Type of Metric	NPS	AKR	IMR	MWR	NCR	NER	PWR	SER
Occurrence	% parks reporting at least one species	68%	25%	75%	62%	44%	68%	66%	89%
	# species reported*	331	5	107	53	19	70	151	94
	# park populations reported	1409	6	355	161	59	202	337	289
Management	# populations under control	150	0	28	6	6	36	21	53
	% park populations under control	11%	n/a	8%	4%	10%	18%	6%	18%
	# park populations w/ expenditures	384	1	62	25	22	59	102	113
	% park populations w/ expenditures	27%	17%	17%	16%	37%	29%	30%	39%
	# park populations w/ management plan	327	0	73	17	15	62	85	75
	% park populations w/ management plan	23%	n/a	21%	11%	25%	31%	25%	26%

*The Servicewide ('NPS') statistic for number of species reported reflects the total number of unique species reported by NPS units. Therefore, as some of the species were reported by multiple regions, the number of "NPS" species is smaller than the sum of numbers reported for each region.

Table 4. Invasive animal data reported in 2016 for species populations occurring adjacent to (but not within)[A] park boundaries.

Category	Type of Metric	NPS	AKR	IMR	MWR	NCR	NER	PWR	SER
Occurrence	% parks reporting at least one species	22%	44%	12%	19%	4%	28%	15%	39%
	# species reported[B]	115	7	56	10	2	19	11	34
	# park populations reported	204	15	64	10	2	43	15	55
Management	# populations under control	87	7	15	4	2	22	10	27
	% park populations under control	43%	47%	23%	40%	100%	51%	67%	49%
	# park populations w/ expenditures	35	0	10	2	0	10	6	7
	% park populations w/ expenditures	17%	n/a	16%	20%	n/a	23%	40%	13%
	# park populations w/ management plan	33	0	8	2	0	10	3	10
	% park populations w/ management plan	16%	n/a	13%	20%	n/a	23%	20%	18%

[A] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

[B] The Servicewide ('NPS') statistic for number of species reported reflects the total number of unique species reported by NPS units. Therefore, as some of the species were reported by multiple regions, the number of "NPS" species is smaller than the sum of numbers reported for each region.

Table 5. Invasive animal populations reported as eradicated from a park in 2016 or a previous year.

Category	Type of Metric	NPS	AKR	IMR	MWR	NCR	NER	PWR	SER
Occurrence	% parks reporting at least one species	15%	n/a	1%	n/a	1%	1%	6%	6%
	# species reported[A]	18	0	1	0	1	2	9	8
	# park populations reported	21	0	1	0	1	2	9	8
Management[B]	# populations under control	17	0	1	0	1	1	8	6
	% park populations under control	81%	n/a	100%	n/a	100%	50%	89%	75%
	# park populations w/ expenditures	9	0	0	0	0	1	5	3
	% park populations w/ expenditures	43%	n/a	n/a	n/a	n/a	50%	56%	38%
	# park populations w/ management plan	10	0	0	0	0	0	7	3
	% park populations w/ management plan	48%	n/a	n/a	n/a	n/a	n/a	78%	38%

[A] The Servicewide ('NPS') statistic for # Species Reported reflects the total number of unique species reported by NPS units. Therefore, as some species were reported by multiple regions, the number of "NPS" species reported is smaller than the sum of numbers reported for each region.

[B] In some cases, eradication can occur within a park but expenditures are needed to maintain the eradication. For example, maintaining boundary fences intended to prevent incursion of feral swine from adjacent lands after all individuals have been removed within park boundaries.

An invasive lake trout is caught while eating a native mountain whitefish at Quartz Lake, Glacier National Park, Montana. The lake trout removal project at Quartz Lake aims to protect the lake's native fish populations from invasive lake trout. NPS Photo.

4. Insights from Regional Offices

This feral cat was captured with bird in mouth by a camera trap at Santa Monica Mountains National Recreation Area. NPS Photo.

To comprehensively understand the current state of invasive animal management across the NPS, observations and experiences from parks are pivotal in developing a relevant and effective servicewide invasive animal management strategy. The NPS Natural Resource Stewardship and Science Directorate coordinated with regional staff to work with parks to gather this information. The NPS is divided into 7 administrative regions (Figure 1), each with a regional office serving its parks. The role and function of regional offices is to directly support parks and program areas within their region by providing specialized expertise, current information and policy, and filtering and interpreting necessary information from the national office.

Regional offices are the best sources of park-level information other than the parks themselves, and are the conduit through which the NPS national office primarily communicates with parks. Parks are focused on day-to-day park operations and have limited resources. So as to avoid burdening parks, surveys and information requests from the national office are judiciously implemented in collaboration with regional offices, requiring reviews and approvals from NRSS leadership and the Regional Director. This chapter summarizes the interview process and valuable insights gleaned regarding invasive species management concerns within the seven NPS regions.

Interview Methodology

The NPS Invasive Animal Coordinator (the Coordinator) from BRD worked with two members of the NPS Invasive Animal Science Panel to develop open-ended interview questions (Appendix E) centered on four themes: informing decisions, factors in making decisions, management of invasive animals, and related regional office support activities. The Coordinator arranged interviews with the primary invasive animals contact in each regional office as a means of gaining insights to parks' perspectives. For five of the seven regions, that contact was the regional IPM coordinator. Contacts were encouraged to invite any other regional office staff dealing with invasive animal issues to join the interview as time and scheduling allowed. Region representatives participating in the interviews are included in Appendix E. Organizational structure of each regional office may vary depending on priorities determined by the Regional Director. Each region has an IPM Coordinator that is funded by the regional office. All but one region (Pacific West) has a Regional Wildlife Biologist. All regions have an ecologist or biologist on staff (National Capital and Northeast regions

share one) that addresses aquatic, fish, or marine issues throughout the region; however, their emphasis may be on issues other than invasive species, such as recovery of federally-listed species.

The Coordinator provided interview questions to regional respondents prior to conducting phone interviews. Each interview began with an introduction by the Coordinator explaining both the purpose of the NPS Invasive Animal Science Panel and the purpose of the interviews. Interviews were recorded to augment notes taken by the Coordinator during the interview. After completion of the interviews, a separate BRD staff member listened to the recordings and reviewed the Coordinator's notes (augmenting or correcting when necessary) to ensure objectivity and accuracy. These refined interview notes were then reviewed and analyzed; responses were assessed for commonalities among regions and anomalies unique to regions.

Interview Results

Seven telephone interviews were conducted in March and April of 2017 that ranged in duration from 1.5–2.5 hours. Common for all interviews were statements expressing difficulty generalizing for all parks in the region due to the variability among parks in their mission (as stated in the enabling legislation of each park), management focus (e.g., historical resources, cultural resources, natural resources), number of staff, amount of funding, and staff expertise. Regardless, interviewees unanimously expressed: (a) appreciation for the opportunity to share their insights, (b) support for a cohesive servicewide approach to addressing invasive animals, and (c) interest in participating in efforts to envision and implement such a program. Interview results are summarized below from the perspective of regional representatives that speak on behalf of parks. A unique response from a particular region, or one that demonstrates a concept particularly well, may be included to reinforce a point.

Informing Decisions

Types and Sources of Information Used

There is currently no NPS repository of information that parks can reference for timely, relevant, and rigorous management information about invasive animals. One respondent commented how this presents a unique challenge for parks that do not have "good communication" with the regional office, yet have invasive animals present in their park. Information from a variety of sources is used by parks depending upon the species in question and the level of expertise of park staff. Information sources are highly variable among parks but most rely on the internet (easily-accessible journal articles, local extension agents, state or partner agencies), their regional office, state agencies, their own personal network of contacts, and park monitoring or survey information if they have it. Many parks do not have natural resource staff so rely heavily on natural resource information from external entities, particularly state agencies.

Parks seek basic information about the ecology of a species (e.g., species distribution, survivability, mechanism of transport to the park) and suggestions for prevention, management or control options. Parks in the National Capital region are unique in having access to superb resources in the Washington, D.C. area (e.g., scientific meetings, trainings, several universities). However, ability for park and regional personnel to actually attend events off-site is severely hampered by lack of financial resources and/or perceived importance by supervisors. Despite not having many invasive species, Alaska has developed interagency work groups to address invasive animals that do exist (mostly marine). Cooperative Invasive Species Management Areas (CISMAs) – partnerships of federal, state, and local government agencies (as well as tribes, individuals, and various interest groups) that manage invasive species within a defined area – exist throughout the country and are utilized by some parks (notably so in south Florida). Park managers may use these types interagency work groups to gain knowledge on invasives in a particular area.

Information Sources that May be Underutilized

Parks are often reactive when seeking assistance with an invasive animal issue; in these cases, management of these issues may be limited in their effectiveness given the importance of rapid response in isolating invasions. In general, peer-reviewed sources and technical documents are underutilized (as a result of accessibility and usability issues); parks are more likely to assume state extension agents or regional staff are up on the science and refer directly to these resources rather than assimilating original reports, papers, and research studies. With regards to information about new invasive species or shifts in species ranges to help parks prepare for or respond to localized threats, this information often can't be found because it doesn't exist. Thus, the information that is available may be underutilized simply because park staffs don't know who to ask or where to look.

At least two regions found shortcomings with the lack of threat forecasting for new invasives; environmental condition

projections could be used to predict changes in habitats and model potential invasive species distribution and range shifts. Trainings and some relevant conferences are good sources of information but are generally viewed as not available to park or regional staff due to financial constraints and agency limitations on travel. Regions stated that knowledge from other parks is underutilized — knowing what management actions for a particular invasive species have been tried at other parks and what has worked (or not) would be especially helpful to parks and regions.

Perceptions about the Usability and Accessibility of Science

Lack of ability to find scientific information that is easy to obtain, understand, or use (i.e., "accessible") is in issue for all regions, particularly with regards to scientific journals. No park or regional staff has ready access to journals unless a staff member happens to have a personal subscription. Some regions reported that, regardless of access, scientific information is not be particularly helpful to parks unless it is delivered in a more digestible format for a broader audience (i.e., staff without a natural resource background). General biology information may be available for most species but information needed for management decisions (impact to resources, management control options, methods, feasibility studies) may or may not exist or is not available from a centralized source.

One region commented that while biological information may be available, there is little to no social science available to help parks determine what to do given the social landscape. The same region recommended a centralized NPS repository to include species information, any social science tools available, management recommendations, contact information, etc. Regions noted that accessibility of science is greatly impacted by limited staff at all levels of NPS – lack of adequate staff to pursue information limits the amount, sources, and types of information that parks can assimilate. Many parks don't have information simply because they can't spare the staff time to find it. Lack of ability or means to share information to other parks outside of their region, or to the national office, was also viewed as impeding accessibility of science.

Decision Support Tools

Parks may be able to identify they have a problem, but they don't know what to do about it. Several regions expressed that a decision support tool may be helpful, but only if it were taxa- or locale- specific. Decision support tools generally ranked much lower in importance than need for additional resources to assimilate information and implement such tools (staff, training, and funding). In most cases, regional staff thought they essentially serve as the decision support tool for parks since they walk parks through the process of figuring out what to do. Regional staffs seem to think this arrangement works for most parks and regions.

Virile crayfish (*Faxonius virilis*) were found in waters at Grand Canyon National Park, Arizona during a feasibility study to reintroduce the endangered razorback sucker (*Xyrauchen texanus*). Virile crayfish are native to the Great Lakes and upper midwest region of the U.S. but invasive to other areas of the U.S. where it was introduced through bait buckets and intentional stocking for forage. NPS Photo.

What Are Decision Support Tools?

Decision support tools refer to a wide range of techniques, methods, scenario building, and simulation models developed to support decision analysis and participatory processes. Decisions about how to address current and potential invasive species in parks are complex, nuanced, and context-specific. Further, the impacts of invasive species often must be inferred long before they are experienced. Decision support tools enable decision-makers to identify and assess response options, apply complex and uncertain information, clarify tradeoffs, account for perceptions of risk, strengthen transparency, and generate information on the costs and benefits of different choices (Peterson et al. 2003, Machlis and McNutt 2010, Moss et al. 2014, Fischhoff 2015).

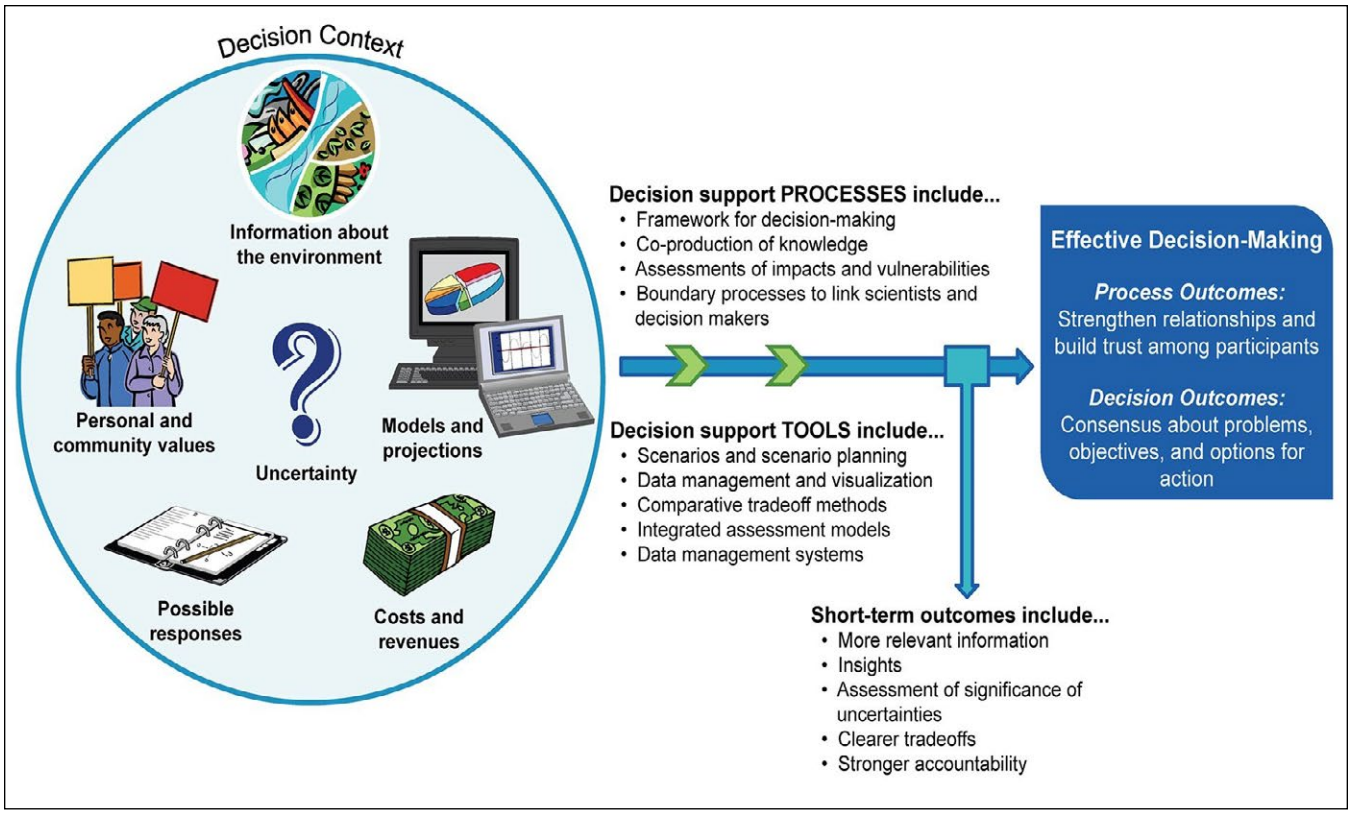


Figure 6. Decisions can take place within complex contexts. Decision support processes and tools can help structure decision-making, organize and analyze information, and build consensus around options for action. (Source: Moss et al. 2014)

The Coordinator notes that varying interpretations about what decision support tools are may have affected region responses and follow-up may be needed on this topic (Figure 6).

Because invasive animal issues are often species and park-specific, two regions suggested a simple layperson's manual to guide parks in: (a) what to do when a new invasive animal species is discovered in a park, and (b) how to prevent invasive animals from invading their park in the first place. Another recommendation was to adapt the "11 Step Process to Developing and Implementing an Integrated Pest Management Strategy" to make it specific to invasive species. One regional IPM coordinator has taken the lead to develop a "decision worksheet" with input from other regional IPM Coordinators and suggested it could be modified to be applicable for invasive animals.

Regardless of the method, consistent across regions was the need for assistance to both make management decisions (using an interdisciplinary approach) and explain those decisions internally and to external stakeholders. Park superintendents are ultimately who decides whether (real or potential) impacts are significant enough to warrant allocation of limited park resources given competing needs. Park staff must be able to effectively explain management options and consequences to their superintendent who in turn must be prepared to justify their decisions to the public. Interview responses underscored the need for supporting park staff in decision-making and justification for implementing invasive species management strategies.

Factors in Making Decisions

Social Factors

Regions were quick to identify two social factors that impact parks' abilities to make decisions about managing invasive animals – staff capacity and public perception (from park visitors, stakeholder groups, and the general public). [The Coordinator notes that staff capacity is tied to funding (among other things, such as superintendent priorities) and funding was identified as the primary non-social factor. This is discussed further in the next section.] One region stated that social factors may be more of a factor than non-social factors and that the general public is often not the one exerting pressure; rather it comes from NPS partners (e.g.,

states, federal agencies, tribes). When charismatic species are involved (e.g., mountain goats, feral cats, feral horses) or visitor experiences are impacted (including public health or safety issues) there is more interest and pressure from the public regarding how they will be managed. Most regions mentioned that public opinion greatly influenced the control methods that are ultimately feasible and public pressure can result in different Parks, Regions and the NPS making very different decisions on the same invasive species with similar impacts.

Non-social Factors

Every region identified funding (lack thereof) as the largest deciding factor for managing invasive animals, even more so than public opinion. Lack of resources in most parks, combined with uncertainty about effective management options, pushes invasives down the list of park priorities particularly if the options available are not palatable to park leadership or some factions of the public. Regions also identified uncertainty about the level of environmental compliance needed (e.g., National Environmental Policy Act, EIS, EA or CE), and resources to complete required compliance, as playing a role in deciding when or how to respond.

External Entity Factors

All regions recognized that without coordination and cooperation beyond park boundaries, prevention or management efforts inside parks are most often ineffective and not a wise use of limited resources. Most regions indicated that collaboration with external entities is important, overall pretty good and improving, but challenges remain. Differing priorities of (often multiple) adjacent landowners was the predominant challenge mentioned whether ownership is private, tribal, state, federal, or international (e.g. Mexico, Canada). One region observed that these types of jurisdictional challenges across large landscapes merit a more ecosystem-based rather than park-based approach. Aligning priorities with other federal agencies was seen as less of an issue than it is with states; some states were reported as being easier for parks and regions to work with than others. One region offered the insight that success of a park in dealing with invasives depends on how well parks maintain relationships with neighboring landowners, which is often a product of how much outreach they do (especially by park superintendents). The U.S. Forest Service Forest Health Initiative was highlighted as a good example of a federal agency encouraging cooperative projects by prioritizing projects higher for funding when they involve multiple landowners and requiring commitments from all parties before granting funding.

Management of Invasive Animals

Constraints and Challenges

All regions mentioned funding (e.g., resources, training, staff capacity) as the predominant challenge, followed closely by issues with compliance (e.g. NEPA). Also mentioned by several regions was the ability for parks to understand and deal with social constraints. One region reflected that parks are stuck in a reactionary mode because they are behind in threat forecasting, prevention, and monitoring for early detection – the region would like to see more collaboration with the NPS Inventory and Monitoring Program or another agency for capacity to conduct early detection of invasive animals at parks. Regions also conveyed the struggle of park staff to present convincing arguments to park leadership regarding the importance of taking action, and simply the lack of priority and on managing invasive species. Two regions mentioned the challenge of sustaining financial resources to: (a) complete a management action, (b) monitor

Feral, or free-ranging, cats can have direct negative impacts on park biodiversity and ecosystem services. Cats are highly skilled predators with potentially devastating consequences to native wildlife (including sensitive and threatened or endangered species). They are directly responsible for the local or total extinction of mammal, reptile, and bird species particularly on islands (Nogales et al. 2004, Doherty et al. 2016). Likewise, feral cats may contribute to declines or extirpations of continental bird populations confined to habitat "islands" such as parks (Dauphiné and Cooper 2011). Aside from predation, cats also effectively compete with native mesopredators (e.g., skunks, opossums, raccoons, foxes) for prey, and serve as vectors for transmission of disease to native wildlife (including terrestrial, avian, and both freshwater and marine species). The number of free-ranging pet cats, strays, and feral cats in the U.S. was estimated between 117 to 157 million in 2009 (Dauphiné and Cooper) and has likely increased since then. Due to their popularity as pets, management of feral cats is highly contentious and yet remains one of the largest threats to native biodiversity in this nation and throughout the world.

Feral swine compete directly with many native animals for food and destroy habitat for many other wildlife species. Staff at Great Smoky Mountains National Park in North Carolina and Tennessee set cage traps for feral swine and remove them from the park. NPS Photo.

to assess its effectiveness, and/or (c) keep the species under control. The Pacific West region provided the following insight regarding the utility of contracting out work: Although contracting (with active oversight by NPS staff) requires money, it largely bypasses the issue of adequate staff needed to conduct the work and the associated expenses of training and acquiring equipment. This may be an effective approach for one-off (e.g., eradications) or intermittent interventions, but it may or may not be practical in all situations or when frequent, ongoing control is necessary.

Barriers to Successful Management

Once again, lack of resources (staff, expertise, and funding) and lack of known effective control options were cited as the main barriers to successful management. Four regions also mentioned the social acceptability of effective controls. One region observed that the NPS is not nimble when quick management action is needed (i.e., for Early Detection Rapid Response); every year brings more regulations, and the compliance process gets increasingly complicated and takes longer. Two regions noted, however, that the amount of administrative "red tape" required can sometimes be used as an excuse for not taking action.

Timing of Action

As with other answers, regions responded that the timing of management action is highly dependent on the species in question and the circumstances of the particular park. However, most parks can only afford to be reactive and only address invasive species as a response to resource damage after an invasion occurs. Overall, early detection efforts occur more often than prevention efforts. Funding for labor and equipment to conduct prevention is difficult to obtain, even when it's a priority. Several regions voiced that parks are overloaded and operate in constant triage mode with limited staff, funding, and competing park priorities – some of which have more dire consequences to visitor safety and resource damage. Some level of prevention and EDRR activities were mentioned as occurring in four regions (Alaska, Midwest, Northeast, and Pacific West) but it varies greatly by park. Regions in which these activities aren't currently occurring to a notable degree unanimously expressed it not being due to lack of interest or need, but lack of funding.

The two regions with the most invasive species experience (Southeast and Pacific West) indicate that parks would like to implement prevention activities but funding for it is

Five and a half miles of fencing was constructed to protect 640 acres of nesting habitat for the endangered Hawaiian petrel from feral cat and mongoose predation at Hawai'i Volcanoes National Park. The fence was a collaborative project between the National Park Service, U.S. Fish and Wildlife Service, National Fish and Wildlife Foundation, and the American Bird Conservancy. NPS Photo.

rarely prioritized. In the Southeast region, other agencies lead the way with monitoring, prevention protocols, EDRR, and management control methods with the role of the NPS being to provide manpower and help "hold the line" on the advancing front of invasives using whatever resources they can muster. One region suggested adopting a system to alert parks about invasive animals detected within a specified area.

Funding Sources

All regions stated that funding for invasive species management is not always prioritized by park leadership and as such, base funds are not typically available for work relating to invasive species. At some parks, dollars expended are often carved out of leftover base funds in a given year or cobbled together by whatever means available to parks (e.g., Friends groups or recreational fees). One region mentioned the NPS Servicewide Comprehensive Call (a request for proposals made available to parks through a competitive process) in the context that it is not useful to parks for the vast majority of invasive animal management needs. Primary reasons given were: (a) the time lag in receiving funds once proposals are approved (can be over 3 years), (b) high level of competition with parks across the country, and (c) projects are perceived as too small for the national-level funding source. Similarly, USFS Forest Health funding often arrives too late (outside of the biological window for management) and there is only a short time period to spend all the funds. Three regions indicated that regional NPS block grant funds are considered more helpful by parks because decisions are made at the regional level (less competition), funds are released more quickly, and the process is easier.

Overall, current NPS business practices are seen as inflexible and unable to meet the needs of a problem (invasive animals) that needs rapid action and gets exponentially worse and correspondingly expensive very quickly. Regions suggested a dedicated, sustained, flexible funding source (to capitalize

on biological windows or allow for EDRR) and a simple, clear procedure to apply for funding. One region commented that a smaller amount of reliable, consistent funding was better than a massive amount of funding for only a limited time. As a stop-gap to address funding needs, one region has created a Natural Resource Cyclic Maintenance Program to provide funds for non-native and feral animal management. One region inquired whether a WASO-level dedicated founding source for invasive animals could be a part of the Servicewide strategy. A different region suggested that a list of possible funding sources and how to access them would be very helpful to parks and regions.

Regional Office Insights

Delegation of Responsibilities

Regions handle incoming requests from parks in one of two ways: funneling calls/emails through a single point of contact (either the regional wildlife biologist or regional IPM coordinator or through dispersed contacts in the regional office (all others). Once inquiries arrive, regions take a team approach by dividing responsibilities based on taxa and/or staff expertise. Aquatic issues, both plant and animal, are typically addressed by the regional aquatic or marine ecologist (National Capital shares the Northeast aquatic ecologist). Terrestrial invertebrates are most often handled by the regional IPM coordinator, and terrestrial vertebrates by the regional wildlife biologist (Pacific West doesn't have one, so the IPM coordinator addresses both with support provided by the regional T&E coordinator) although some overlap occurs.

The Pacific West is battling the advancing front of invasive species throughout its region. The Natural Resource Cyclic Maintenance Program has funded projects to build exclusion fencing and help in eradications of pigs, goats, mouflon sheep, and deer at Hawaii Volcanoes National Park (NP), Haleakala NP, Kalaupapa National Historical Park (NHP), National Park of American Samoa, and Pinnacles NP. Other initiatives include the current removal of non-native fish from North Cascades NP, Yosemite NP, and Sequoia & Kings Canyon NPs; Lake Mead National Recreation Area's success in slowing the spread of quagga mussels from the park; Olympic NP poised to remove non-native mountain goats; and plans to restore prairies at San Juan Island NHP may well include a component to manage European rabbits. Crater Lake NP and Santa Monica Mountains NRA are increasingly concerned about invasive crayfish; parks in Hawai'i are struggling with invasive mongoose, wasps, and ants; and the invasive brown tree snake continues to be a huge problem at War in the Pacific NHP and American Memorial Park. This is a model that may prove successful for other regions as well.

Regional Initiatives, Priorities, or Projects

Across the board, regional staff stated their focus is providing support to individual parks. The Midwest region provided the only example of a regional office initiative – staff recently self-organized the Midwest Aquatic Invasive Species Work Group to provide organization and coordination among parks in their region. Two other regions stated they have no projects or initiatives but do have regional priorities. Priorities for the Pacific West include zebra/quagga mussels and invasive aquatic species in general; and priorities for the Southeast include lionfish, constrictor snakes, and invasive aquatics generally.

Help Requests from Parks

Regional offices serve as information clearing houses and sounding boards for parks. Parks most often reach out to the regions for contacts, information on who has done similar work dealing with a certain species or using a particular management option, guidance/assistance with compliance, advice on management options (methods or technical advice), basic biology information, or help with species identification. Regions emphasized that requests are very park, species, and context specific and parks may be looking to discuss thresholds for taking action, management options, or potential issues with the public. One region

This American bullfrog was photographed at Niobrara National Scenic River, Nebraska. Although the species is native to the eastern U.S., it is invasive to other areas of the U.S. where it was introduced. NPS Photo.

The red-eared slider (*Trachemys scripta elegans*) is native to areas of the south and southern midwest region of the U.S. It was introduced, primarily through pet releases or escapes. Little is known about its impact, but it is thought to have great potential for impacting indigenous habitats. U.S. Geological Survey Photo.

commented that the removal of mandatory IPM training for parks, combined with staff turnover, means parks are less knowledgeable on how to approach invasive species issues and more reliant on regional offices.

Regional Office Invasive Animal Needs

No single need stood out among region responses to this question but rather a variety of suggestions that appear to be centered around two themes: capacity and information. All regional offices indicated they are currently operating at capacity with staff often serving multiple roles, invasive animals being just one. Two regions stated that a full-time staff member (in the regional office) dedicated to invasive animal issues would be needed to "move the needle" on this issue. An example was provided with a region's EPMT coordinator that knows the status of invasive plants in various state ecoregions. The region believed a similar capacity for invasive animals would help prioritize control efforts within each region.

Three regions mentioned needing better information about invasive animal issues at parks, either through expanding the annual data call (to included management-related questions) or by other means such as a separate survey. Information needed related to gaining a better understanding of the extent of damage caused by different species (not just species occurrence); and tracking invasive animal issues that other parks have addressed, how they've been addressed, and whether or not control methods were successful. Needing access to peer-reviewed literature was mentioned by one region in response to this question, but mentioned by all regions at some point during their interview. Similarly, two regions responded that flexible funding sources are needed.

Three needs related to networking were identified by regions: (a) high level species-specific "programs" that can provide expertise, knowledge, and help procuring funding, (b) a directory of contacts, either within NPS (park, regional, national staff) or in other agencies, that are knowledgeable with certain invasive species or taxa, and (c) an online repository of all completed management plans for the benefit of all parks to reference (with good examples flagged). Other needs included: (a) help to develop management or monitoring protocols, (b) threat forecasting (what invasive species are coming their way), (c) providing training (webinar or otherwise) for regional and park staff that can present a particular issue and management options, and (d) consistency among regions in terms of what management methods are approved for use.

Region Suggestions for a National Strategy

Many suggestions were similar to those for helping regional offices. Each region mentioned the need for both organization and coordination at the servicewide level as well as dedicated invasive species coordinators in each regional office. As one region put it, "A dedicated invasive species coordinator at each regional office (serving as a direct contact to advise parks on management issues and provide on the ground support to parks) working with a national servicewide coordinator (to coordinate efforts between regions, liaise with other agencies, maintain contacts, attend high-level meetings, and distribute information). A structure similar to either the IPM or EPMT program was suggested. Dedicated funding as part of a national strategy was also highlighted by every region as well as actionable criteria for prioritizing the funding (similar to the NPS White Nose Syndrome funding model).

Successful components of the IPM program and EPMT programs were suggested for incorporation into a national invasive animal program. First, parks and regions like the field-based focus of EPMTs that provide on-the-ground assistance to parks. One region commented that while regional and Washington office staff often are only able to provide technical assistance, which only goes so far if parks don't have the personnel, equipment, training, or funding to do the work. The EPMT program is also admired for the flexibility it allows regions to determine best ways to address invasive plants based on the region's needs; teams are incentivized to continually increase their efficiency. The high variability of EPMT team approaches across the Service is viewed as encouraging innovation.

Hemlock woolly adelgid (*Adelges tsugae*) is an aphid-like insect from Asia that infests nearly half of the native range of hemlock trees in eastern North America. It is easily recognizable by the appearance of tiny cotton balls at the base of hemlock needles such as in this photo from Great Smoky Mountains National Park, North Carolina / Tennessee. NPS Photo.

Conversely, one region felt that high travel expenses for dedicated field teams or strike teams may be cost-prohibitive and suggested a model similar to the Arborist Incident Response program. This program trains staff at various parks to be on-call for downed or hazard tree removal (esp. after large storms) similar to how staff are mobilized for large fires (via the Incident Command System). A similar program could be used for emerging invasive species issues when parks need "rapid response" assistance.

Also suggested was a central clearinghouse for information, expansion of the existing invasive animal database [data call] to collect information that can inform management, and special teams and/or committees to address invasive species issues with regional representatives (similar to the NPS Natural Resources Advisory Group). One region felt strongly that the national framework must include a communication and internal outreach strategy to park managers about invasive animals.

5. Insights from Park Projects and Planning Inventories

Gathering servicewide information regarding park-level initiatives and investments to manage invasive species can be challenging given that the structure of the NPS is by design a bottom-up organization; knowledge of issues about park resources, in most cases, resides at the park. Generally speaking, regional and national office staff are aware of park-level issues only if they are urgent, have a high level of public concern or political interest, if the information is conveyed directly to them by park staff, or through the use of proxy information. In context of invasive animals, sources of proxy information include project tracking systems such as the Planning, Environment and Public Comment (PEPC) system and Project Management Information System (PMIS). It also includes information contained in park foundation documents. These sources of information offer insights into invasive species projects proposed, funded, underway, and completed.

Planning, Environment, and Public Comment

The NPS prepares a variety of planning and environmental documents to help guide management of parks in compliance with laws, regulations, and the NPS mission. Public involvement in the NPS planning process is provided through the PEPC website[1] which posts documents available for public comment, primarily those undergoing the National Environmental Policy Act (NEPA) process. A search of documents posted on the PEPC website during 2010-2016 was conducted by searching project descriptions for key words related to invasive animals. Projects that mention "invasive species" generally or describe invasive animal management in a restoration context may not have been discovered by the query. The data query indicated that at least 139 individual parks (across all regions) submitted at least 268 projects related specifically to invasive animals. Over 80% of the 268 individual projects submitted underwent NEPA and of those, 93% were Categorical Exclusions. Projects in the PEPC system are often funded through competitive funding sources such as the SCC.

Project Management Information System (Servicewide Comprehensive Call)

The Servicewide Comprehensive Call asks parks and NPS program offices to identify unfunded needs for base funding as well as one-time project funding. The SCC is the formal beginning of new rounds of planning for future NPS budgets and aims to increase communication and cooperation at all levels of the Park Service. Since the NPS budget cycle takes nearly two years to complete, the SCC is announced at the beginning of each new fiscal year for planning some years in advance. For a while, SCC funding proposals were required three years prior to a project's start, and for a time it was as long as five years. Recently, the funding lag was reduced to two years in response to parks' need for funding more quickly.

The Project Management Information System (PMIS) was developed in response to a request from the National Leadership Council to create a common database system to keep track of funded, unfunded, and backlogged projects. It is a servicewide intranet application that supports the SCC by managing information about requests for project funding. It enables parks and NPS offices to submit project proposals to be reviewed, approved, and prioritized by park units, regional directorates, and the national office. Approved projects are then formulated for funding by utilizing PMIS. The information in PMIS is used to provide official NPS response to all internal and external inquiries about unfunded project needs and the strategy for addressing those needs.

A recent search of all projects in the PMIS system since its inception (1998) reveals $65.6 million was requested for 610 invasive species projects. Proposed projects (regardless of whether actually funded) that were easily identifiable as primarily invasive animal projects totaled $12.5 million. The information presented in Table 6 includes projects that are only formulated (i.e., planned) for funding during 2000–2023. Not included are projects that were rejected during regional or national office review. Further, it is uncertain what projects were actually funded or how much of the requested funding was actually provided; depending on available funding in a given year, projects may only be partially funded. In theory, the PMIS system should be able to keep track of this information but in practice it does not reliably do so. Although PMIS is a challenging system and search functions are limited, the information portrayed in the table below conveys substantial need for invasive animal management in NPS.

1 https://parkplanning.nps.gov/publicHome.cfm

Table 6. Summary information for 80 feral animal and invasive animal NPS projectWs that were planned for funding 2000-2023. It is unknown what projects were actually funded, nor whether full or only partial funding was provided. Information was retrieved from the NPS Project Management Information System (PMIS) on March 24, 2017.

Category	Subcategory	Number of Projects	Total Cost ($)	Average Cost per Project ($)
NPS Region	Alaska	0	0	0
	Intermountain	12	1,406,000	111,800
	Midwest	3	397,000	112,000
	National Capital	1	226,000	226,000
	Northeast	4	279,000	69,700
	Pacific West	44	9,601,000	218,000
	Southeast	16	584,000	38,000
	Servicewide Total	**80**	**12,493,000**	**156,000**
Feral Animal Project Type	Hogs	11	1,616,000	147,000
	Horse/Burro	8	1,176,000	147,000
	Cat	8	1,642,000	205,000
	Cattle	5	63,000	13,000
	Dog	1	29,000	29,000
	Species not specified	1	166,000	166,000
	Feral Animal Subtotal	**34**	**4,693,000**	**138,000**
Invasive Animal Project Type	Assessment	4	270,000	67,000
	Fencing/Gates	11	4,727,000	430,000
	Inventory & Monitoring	8	541,000	67,000
	Planning	2	135,000	67,000
	Removal	20	2,102,000	105,000
	Training	1	25,000	25,000
	Invasive Animal Subtotal	**46**	**7,800,000**	**169,000**
Servicewide Total		**80**	**12,493,000**	**15,6000**

Park Planning Documents

Each unit of the national park system is required to have a formal statement of its core mission that provides basic guidance for all planning and management decisions – the park foundation document. A foundation document establishes the basis for all future planning and is the core element of each park's planning portfolio. The NPS Park Planning and Special Studies Division in the national office have been working closely with the seven regional planning offices to complete foundation documents for all NPS units by the end of 2018.

Subsequently, the Planning Program's focus will shift to addressing items identified in parks' assessments of their planning and data needs as stated in their foundation documents. As of October 2017, foundation documents had been completed for at least 324 parks. Necessity for an invasive species management plan was identified by 97 parks, and it resides in the top 20 high priority planning needs identified in park foundation documents completed to date. Foundation documents also identified 88 parks that stated a need for invasive species surveys (107 surveys in total).

En masse, park foundation documents as well as PEPC and PMIS project tracking systems provide information that is helpful in gauging parks' concerns about and motivations to address invasive species. They also provide insights to NPS' response in assessing, prioritizing, and funding projects aimed at invasive species management.

6. Early Detection and Rapid Response

Prevention of arrival and subsequent establishment of invasive species remains the single most effective means of management. Once invasive species have arrived, early detection (e.g., surveys and monitoring activities) followed by rapid response becomes the best strategy to reduce the spread and establishment of invasive species. When invasive plant or animal species are not detected and removed early, expensive and long-term management may be unavoidable (Figure 7). Rapid response requires a coordinated set of actions to eradicate the founding population of invasive species before they establish, spread, and cause harm. There is recognized need across the federal government for national capacity to conduct early detection and rapid response (EDRR). This need culminated in development of the interagency report *Safeguarding America's Lands and Waters from Invasive Species: A National Framework for Early Detection and Rapid Response* (DOI 2016) which identified four general stages of the EDRR process (Figure 8). The NPS Invasive Animal Coordinator, NPS Invasive Plant Program Manager, and NPS Aquatic Invasive Species Coordinator served on the interagency work group that developed the report. Although there is little formally developed capacity at the NPS national, regional, or park level for EDRR of invasive animals, NPS has relatively well-developed capacity for invasive plant EDRR. The NPS EPMT program conducts the vast majority of invasive plant EDRR efforts and is described below for consideration as one example for developing and implementing NPS capacity for invasive animal EDRR.

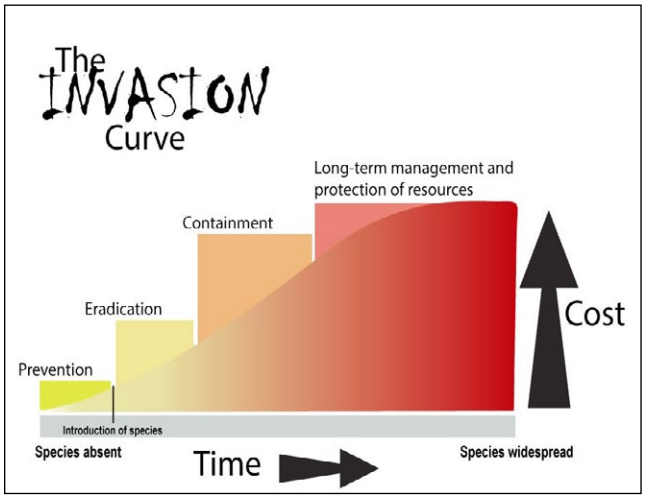


Figure 7. If an invasive plant or animal species is not detected and removed early, expensive and long-term management may be unavoidable.

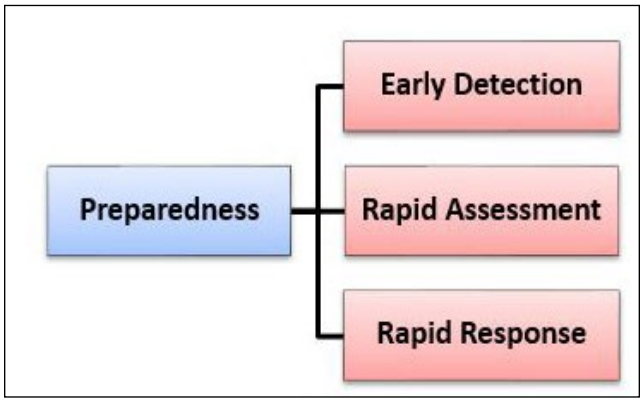


Figure 8. General stages of the EDRR process. Preparedness actions are necessary in advance of early detection and throughout each stage of the EDRR process (DOI 2016).

Preparedness and Early Detection

The NPS Invasive Plant Program Strategic Plan (BRD and Denver Service Center 2017) directs the invasive plant program to promote prevention and EDRR as the most effective and efficient means to address the threat posed by invasive plant species and to aid parks in their EDRR efforts. Currently, early detection programs and plans are implemented at the park unit, EPMT, and I&M Network levels with each having their own method for conducting early detection monitoring. The NPS Invasive Plant Program is building preparedness by developing a more cohesive early detection strategy that is outlined in its strategic plan.

Early Detection and Rapid Response efforts can be region-wide or park-specific. The Alaska region EPMT relies upon early detection since many invasive species have not yet penetrated the parks in this region or are generally discovered in manageable numbers. Nonetheless, many of Alaska's national parks border infested areas, so it is important to regularly monitor for new infestations. This has allowed the Alaska EPMT to catch infestations early when it is still possible to eradicate new invasive plant populations. Efforts by Yosemite National Park provide an example from a park unit.

Predictive tools and utilization of regional watch lists would aid early detection efforts given that NPS lacks the capacity to survey all land areas for new invasive plant or animal infestations. NPS is working with USGS to develop a predictive tool to assess the potential range for three invasive plant species. This pilot project could be extended to include Universities and expanded to include animal species. Regional watch lists are developed by state agriculture and natural resources departments, weed boards, and non-native pest and invasive plant councils. These lists, which include species that do not yet occur (but are likely to) within a specified area, would help focus early detection efforts where species are known to occur or are most likely to invade as opposed to attempting to survey all lands within park units. A potential invasive animal program could adapt this strategy to be applicable to strategies and methods for use on invasive animals.

The public can also assist the NPS in its early detection efforts through the use of citizen science. For example, the NPS has used its BioBlitzes to identify new species infestations at park units. EPMT-led BioBlitz citizen science efforts at two parks resulted in the discovery of a buffelgrass infestation, a new invasive plant species. While reduction in labor costs, inherent education and outreach opportunities, and more "eyes on the ground" make citizen science a useful tool for some EDRR applications and other invasive species management activities (Crall et al. 2010, Dickinson et al. 2012), it is not without its limitations. Analysis of information collected by citizen scientists related to Burmese pythons in south Florida provided little evidence that a citizen-science program would provide information helpful to estimate population size, delimit the geographic extent of the population, or answer questions essential to successful management (Falk et al. 2016).

Rapid Assessment and Rapid Response

Detecting invasive species early is required to eradicate the founding population before it establishes and /or spreads to the extent that eradication is no longer possible. Rapid assessment is the intermediary step that verifies species identification, determines the distribution and abundance of the species, if possible, and evaluates its potential risks and the potential options for response. These options are determined by a host of circumstantial factors such as the type of species, specific location, extent of spread, and relevant jurisdictions/authorities (DOI 2016). Rapid assessment and rapid response at the servicewide level is currently limited to invasive plants. A few of the larger park units have their own rapid response plans for invasive plants but most park units do not have the capacity to manage new infestations when they are found. For these parks, Invasive Plant Program and EPMT staffs provide crucial expertise on how to best manage new infestations.

Although EPMTs were created, in part, for rapid response to newly discovered infestations, there are impediments to implementation. These include the seasonal nature of their work which limits the amount of field time each year to conduct treatments. Annual travel ceilings also limit teams' ability to travel, and staffing limitations constrain the amount of work teams can conduct. Solutions to these limitations may include collaboration with partners to increase and leverage resources available for EDRR, increasing travel ceilings to facilitate travel beyond that identified within EPMTs' annual work plans, and increasing capacity within parks themselves through training and financial support.

Developing NPS Capacity for Invasive Animals EDRR

Early Detection and Rapid Response by the NPS Invasive Plant Program provides a good model that could be adapted to fit the challenges particular to monitoring for and eradicating founding populations of invasive animals. The multiple life forms that exist in the animal kingdom require a different and more broad set of management tools and control options. Early detection monitoring and rapid response options are, more often than not, extremely different for amphibians, birds, fishes, invertebrates, mammals, and reptiles; there can also be exceptional variation within these groups. Developing an EDRR capacity that can address invasive animals would thus need to account for the variability between and within animal taxonomic groups. Finally, invasive animal EDRR capacity should be developed within the context of existing (or developing) EDRR capacities at the local, state, and federal levels. The recent national framework (DOI 2016) provides a key step in proposing EDRR that includes 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.

Landscape Scale Coordination and Planning

Invasive species management requires active engagement with other federal, tribal, local, and state agencies as well as other interested groups. Without NPS coordination and cooperation beyond park boundaries, prevention or management efforts inside parks are most often ineffective and not a wise use of limited resources. The Consolidated Natural Resources Act of 2008 expands NPS ability to cooperate on natural resource activities by allowing NPS funds to be expended outside of park boundaries. It also authorizes the NPS to enter into cooperative agreements with state, local, or tribal governments, other federal agencies, other public entities, educational institutions, private nonprofit organizations, or participating private landowners for the purpose of protecting natural resources associated with a unit of the National Park System. There are examples from the EPMTs and parks where the NPS works with Public Land Corps partners through project funds to hire youth interns. These interns survey for new and existing infestations and conduct management actions when possible.

Cooperative Invasive Species Management Areas (CISMAs) are partnerships of federal state, and local government agencies, tribes, individuals, and various interested groups that manage invasive species in a defined area. Everglades CISMA, created in 2008, is one of the most successful multi-stakeholder alliances in the country.

This North African python (*Python sebae*), measuring over 14 feet and 138 pounds, was captured near the border of Everglades National Park, Florida and is the largest male of this species ever recorded (Reed et al. 2011). The fact that this record-setting male was found outside its native range, and was in excellent body condition, is indicative of how this and other python species seriously impact the natural order of south Florida's ecological communities. South Florida Water Management District Photo.

A boat propeller engulfed in quagga mussels is intercepted at Glacier National Park, Montana. Native to waterbodies between Europe and Asia, quagga and zebra mussels have similar impacts in the United States. They rapidly colonize water supply pipes of utility plants and industrial facilities with serious economic consequences, and compromise integrity of navigational and recreational boating infrastructure. They also decrease the food source for zooplankton, thereby altering the food web. NPS Photo.

Some parks also participate in Cooperative Weed Management Areas or Cooperative Invasive Species Management Areas (CISMAs), the difference being the former addresses only plants while the latter typically addresses both plants and animals. Both are partnerships of federal, state, and local government agencies, tribes, individuals, and various interested groups that manage invasive species (or just weeds) within a defined area. Cuyahoga Valley National Park, by example, is part of the Crooked River Cooperative Weed Management Area. The highly successful Everglades CISMA[1] was created in 2008, is one of the most successful invasive species alliances in the country, and is often held as a model multi-stakeholder approach for addressing invasive species issues. Partners in the Everglades CISMA include the Florida Fish & Wildlife Conservation Commission, South Florida Water Management District, U.S. Army Corps of Engineers, FWS, NPS, and Miami-Dade County. Everglades and Biscayne national parks and Big Cypress National Preserve participate in this CISMA that address both invasive animals and invasive plants in south Florida.

For invasive animals, there is potential for landscape scale coordination with USDA-APHIS in control of feral swine. NPS was an active cooperating agency in the development of the APHIS (2015) programmatic EIS with the idea being to lay the groundwork for parks to collaborate and coordinate with APHIS-Wildlife Service state programs for feral swine control in or near parks.

1 www.evergladescisma.org

7. Information Management and Risk Assessments

Data and Information Systems

NPS collection and management of invasive animal data has been minimal to date. Some park-level information as to the presence of invasive species has been recorded in NPSpecies, the Service's web-based system of recording standardized information on species occurrence in parks. Park-level data is also reported annually to the national office as part of GPRA reporting (see Chapter 4). However, neither of these data sources are updated frequently enough or meet accepted data standards (such as those suggested by the North American Invasive Species Management Association (NAISMA) or the Global Invasive Species Information Network) for scientific applications. For these reasons, existing NPS data sources have limited utility for early detection monitoring, effectiveness monitoring, or risk assessment modelling of invasive animals.

For invasive plants, the Invasive Plant and EPMT programs have been managing some type of national invasive plant information system for many years. Prior to 2014, data were maintained in a central, Microsoft Access database called the Alien Plant Control and Monitoring database, which met NAISMA standards. In 2014, a new information system called the National Invasive Species Information Management System (NISIMS) was adopted from BLM and modified for use by NPS. This system includes a spatial component that also meets NAISMA standards. The purpose of NISIMS is to record inventory and monitoring results (both presences and absences), track treatment efforts, and maintain spatial information on infestations. NPS' decision to use NISMS for EPMTs ensures that data collected can be used for effectiveness monitoring or risk assessment modelling. A few parks are also starting to use it for invasive plants and parks may be required to in the future. It is possible to modify the existing NISIMS platform to maintain invasive animal data as well as invasive plant data. The BLM intentionally designed NISIMS with this in mind, though neither bureau is currently using it for this purpose.

Other information systems are being used to aid in early detection of invasive species. The Early Detection & Distribution Mapping System (EDDMapS) is a popular one that was designed for early detection of invasive species. Reports are uploaded by users (including members of the public); experts registered for particular counties, states, or regions are alerted to the report; experts identify the species reported based on photos and/or site visits; and once an identification has been verified by an expert, its report is made publicly available on the EDDMapS website. This real-time tracking of invasive species occurrences allows land managers to then conduct rapid assessment and rapid response. All NISIMS data collected by EPMTs is annually uploaded to EDDMapS by the NPS Invasive Plant Program. Some also upload their invasive plant data to EDDMapS on an annual basis. If similar data on invasive animals were collected by parks, it too could be uploaded to EDDMaps. Although the EDDMaps system is good in theory, it is important to note that it relies on the voluntary participation of "experts" to review and verify identifications. In Maryland, Virginia, and Washington, DC alone, there are hundreds of un-verified records waiting to be reviewed.

Whereas EDDMapS was designed for early detection of invasive species, uses experts to identify species, and is widely used in the invasive species community, there are other mobile software platforms that can provide early

The small Indian mongoose (*Herpestes javanicus*) was originally introduced to Hawai'i by the sugar industry to control rats in sugarcane fields. This resulted in only minor impacts on the invasive rat population but substantial negative impacts on insects and native, endangered ground-nesting birds and sea turtles. The mongoose pictured was captured during ongoing trapping efforts in Hawaii's national parks. NPS' Biological Resource Division provided funding in 2017 for a project at Haleakal National Park to evaluate trapping techniques for mongoose and feral cats that are impacting the endangered Nene (Hawaiian goose). NPS Photo.

detection information. iNaturalist, a software platform more focused on inventory and education, is used by many parks as a means to document natural resources (native or non-native) in parks. It is the platform used during park BioBlitzes, intensive efforts to conduct biological surveys within a designated area and time period, and is effective as citizen science tool for early detection. The process to verify species identifications differs from EDDMaps in that all observations are made public upon upload and any member can suggest the species' identification. If an identification has "community support"[1] it is considered a research-quality record.

EDDMapS and iNaturalist are both widely available to the public, can provide information as to the new location of an invasive species, and are tools for invasive species early detection. However, the use of multiple platforms to report information can be problematic. Several data aggregation tools have thus been developed to combine information from multiple sources for professionals to use. The National Capital Region EPMT recently started using a prototype of one such data aggregation service. Fresh Data[2] combines data from iNaturalist and EDDMaps as well as iDigBio (Integrated Digitized Biocollections), NEON (National Ecological Observatory Network), Reef Life Survey, USGS - Nonindigenous Aquatic Species program, Maryland Biodiversity Project (invasive species only), Maryland Department of Natural Resources fisheries data, eMammal, and BISON (Biodiversity Information Serving Our Nation). Despite different platforms being used to report invasive species occurrence information, FreshData allows the EPMT to source one system as a clearing house for invasive species identifications. BISON itself aggregates data across federal agencies (and is maintained by USGS), is the U.S. node of the Global Biodiversity Information Facility (GBIF).

Assessing Risks

Risk assessments may be utilized to identify a variety of different types of risk that are posed by invasive species. Some risk assessments are developed to identify the risk of a species invading a new location. Other risk assessments are created to determine the likelihood that a particular pathway (the mechanism by which invasive species are introduced) is to move an invasive species to a new location. Yet other risk assessments are trait-based and are used to rank species by the level of risk they pose to particular native species or ecosystems, resulting in lists of priority species that should be monitored. Some of these risk assessments may be combined to identify the overall risk of an invasive species. The type of risk assessment used will depend on the needs of the invasive species manager.

To date, NPS has not developed any risk assessments for use by park units or programs within NPS, nor is it known whether individual park units or programs are using risk assessments to manage invasive animals. There are a number of risk assessment tools available for use in invasive animal management that NPS could potentially adopt or modify. FWS recently developed the "Risk Assessment and Mapping

Invasive red imported fire ants (*Solenopsis invicta*) form a raft to survive flood waters in Congaree National Park, South Carolina. Native to South America, this species negatively affects wildlife and causes economic damage. Arriving to the U.S. by cargo ship, they have spread throughout the southern states and northern Mexico. NPS Photo.

The National Park Service should capitalize on software platforms already in use by parks and other state and federal agencies. The Early Detection & Distribution Mapping System (EDDMapS), iNaturalist, and the National Invasive Species Information Management System (NISMS) are examples of software platforms currently in use by parks and NPS' Exotic Plant Management Teams. A servicewide invasive animal program should consider using the same platforms. Ideally, federal agencies (at least all DOI bureaus) would be using standardized platforms.

1 https://www.inaturalist.org/pages/getting+started#how_ident_work
2 http://gimmefreshdata.github.io/about.html

Program" to provide efficient risk assessment of species potentially imported to the U.S. under current and potential future climatic conditions. This risk screening process was developed to inform both regulatory (such as evaluating species to list as injurious through the Lacey Act) and non-regulatory decisions. The U.S. Forest Service developed its own "Invasive Species Risk Assessment Program" for invasive forest insects and diseases. USGS conducts species-specific risk assessments, such as that conducted for nine large constrictor snakes (Reed and Rodda 2009).

While NPS has not developed its own risk assessment tools, the Invasive Plant Program and EPMTs have been using the results of others' risk assessment tools to inform management decisions for a number of years. USDA's Animal and Plant Health Inspection Service (APHIS) developed one of the best known risk assessment tools in the U.S., the Weed Risk Assessment, from the Australian Weed Risk Assessment. Over 100 species have already been assessed by APHIS, and several more are added every year. Some states also use risk assessments to provide ranked list of invasive plants. To help make management decisions, the Alaska EPMT uses a ranked list generated by the Alaska Center for Conservation Science risk assessment tool. California has also developed a weed risk assessment tool that has helped them identify 186 species with potential for invading the state. This information has been useful in helping EDRR efforts conducted by the California EPMT. The National Capital Region EPMT has ranked nearly 400 species using the Invasive Species Assessment Protocol developed by NatureServe and NPS in the early 2000s (Morse et al. 2004). The IUCN's EICAT system (discussed earlier in this report) may also be emerging as a global standard (Hawkins et al. 2015).

The Invasive Plant Program is currently developing a Management Prioritization Tool, which includes risk assessments, for the EPMTs. This tool is being designed to use habitat information, current infestation status, and vector data to identify locations most at risk for future invasion. The tool will also take into consideration those areas that are considered to be of special management interest to NPS, whether due to threatened or endangered species presence, wilderness or sensitive area status, or cultural resource presence. The result will be the identification of areas where invasive plant management efforts should be focused. There is potential for this tool to be modified for invasive animals modelling in the future. However, NPS will first need to establish a scientifically rigorous program to survey for and collect invasive animal data, whether using a system like NISIMS, EDDMapS, or iNaturalist. Systematic surveys for invasive plants in parks is not currently done but is similarly needed.

The NPS' efforts to manage invasive animals would greatly benefit from using risk assessments, as they increase the chances of deterring invasions through strategic early detection monitoring. They can also help park units and programs prioritize their prevention and control efforts to most efficiently and effectively manage invasive species. Regardless of which tools would be best to use, there are a number of options available to NPS. Other countries have developed their own risk assessment tools, two examples of which are Australia and the United Kingdom. Australia developed a trait-based risk assessment tool "Risk Assessment for the Import and Keeping of Exotic Vertebrates in Australia" to help identify the risk of importing new species. This tool could be modified to determine the risk of spread of species that have already been introduced to the U.S. The United Kingdom uses its own tool, the "Standard Methodology to Assess the Risks from Non-native Species Considered Possible Problems to the Environment") which could also be modified to identify species that could potentially become invasive in the U.S.

8. Summary

Burmese pythons are vying with American alligators (*Alligator mississippiensis*) for the spot at the top of the food chain in Florida's Everglades. In the photo at left, the python appears to be losing. In the photo at right, a python consumed an alligator but in the end they both lost. More than 2,000 pythons have been removed from Everglades National Park, Florida and surrounding areas since 2002, likely representing only a fraction of the total population. NPS Photo.

Invasive animals are a mission-critical issue for NPS. Among other things, they pose a grave threat to our nation's biodiversity and are a serious challenge to the conservation of native species within and beyond national parks. Loss of this biodiversity, in large part due to invasive non-native species, is ever-increasing. Detrimental impacts from invasive animals are wide-ranging: they displace native species, disrupt native ecosystems, interfere with ecological processes, damage cultural and historic resources, degrade the visitor experience, and threaten the integrity of sensitive and critical park infrastructure. In some cases, invasive animals have brought about drastic changes to entire ecosystems. The constant influx of new invasive animals has the capacity to completely reorganize more ecosystems into new states of equilibrium, or continuing disequilibrium. If prevention fails, these impacts can be irreversible if left unabated or are not addressed quickly enough.

Invasive animals plague every region of the NPS and the problems worsen every year as new invasions continue to occur and the ranges of invasive species that have already arrived continue to expand. Numerous factors contribute to the arrival spread of invasive animals such as increased park visitation, land-use change, the increasing ease and globalization of trade, a changing climate, and limited resources to manage invasions. Invasive animal threats occur across all major taxon and include feral animals, introduced animals, and the regional and continental dispersal of these animals. Unmanaged, these threats will exponentially increase over time and across park units, ultimately amplifying the resources needed to adequately prevent or address the invasions. Control costs climb as new invasive species establish and existing invaders spread and reproduce. Parks, for their part, are doing the best they can with the fiscal and operational resources, information, and leveraged partnerships available. But parks are losing the battle, and this ultimately erodes the NPS mission. It is time for a more organized, cohesive, and strategic approach to address these growing threats to the very natural and cultural resources, and the visitor experience, that we are mandated to conserve and protect "for the benefit and enjoyment of the people."

This state of the knowledge report assesses the current status of invasive animals and their management in NPS. It underscores the pivotal importance of developing a comprehensive strategy to guide and support park managers in facing this menacing issue. The NRSS Directorate has embarked on developing such a strategy, exploring the most effective and efficient ways to integrate information, resources, and funding to best address invasive animal management in parks. It is indeed time for the National Park Service to strategically address invasive animals on a servicewide level. If the NPS is to honor the letter and spirit of their mission, it is time to do more than just draw a new

line in the sand.

Below are important messages from this report:

- Two hundred forty-five parks (of 326 parks responding) reported 331 species of invasive animals occurring in 1,409 populations throughout NPS during 2016, of which only 150 (11%) populations were considered by parks as under control. Thus, at least 1,250 populations of invasive animals are not under control in the national parks.
- Records from the NPS Project Management Information System (PMIS) since 1998 indicate that over $65 million has been requested by parks for invasive species management. Approximately $12.5 million for invasive animal management projects at parks has been formulated (planned) for funding during 2000–2023. The NPS Planning, Environment, and Public Comment (PEPC) system indicates that since 2005, 139 parks have submitted close to 270 projects related to invasive animals.
- Consolidating around consistent terminology is needed to help NPS communicate internally to staff, and externally to other federal, state, and local agencies, partners, stakeholders and the general public. Understanding the difference between native, feral, non-native and non-native *invasive* species is important to translate science into policy and management.
- Invasive animals may require different approaches depending on the level of public (or political) interest in a particular species or management tool, degree of impact the species incurs on park resources, its extent of non-nativeness (e.g., from a different continent versus from a different area of the United States), and whether the invasive species are feral.
- Feral cats occur in at least 69 parks and feral swine occur in or adjacent to at least 49 parks. Feral cats in particular represent a problem where social science, commerce, economy, human dimensions, and ecology intersect with no easy roadmap to resolution. Feral and free roaming cats are one of the most serious threats to our nation's biodiversity. These type of complex situations are often times referred to as "wicked problems" by social scientists (Rittel and Webber 1973).
- No single law provides coordination among federal agencies and no comprehensive legislation on the treatment of invasive species has ever been enacted. NPS authorities and policies include expansive latitude for intensive lethal removal of invasive animals, yet the NPS identity (culture) generally orients towards non-lethal management whenever possible thus leading to slow or non-efficient responses.
- Clarification (interpretation) of existing authorities related to invasive animals for management and law enforcement activities may be needed.
- Controlling incipient invasions is the most effective means of controlling invasive species aside from preventing their invasion to begin with. Streamlined or fast-track environmental compliance processes are needed so quick management action is possible (particularly for Early Detection and Rapid Response (EDRR) efforts) while remaining in compliance with NEPA requirements to review and consider potential impacts on other park resources.
- Integrated Pest Management (IPM) and Exotic Plant Management Teams (EPMTs) are relatively tightly coupled across the NPS, yet conversely, NPS capacity to mitigate vertebrate invasive animal populations is widely and often loosely distributed across multiple organizational levels and offices.
- While EDRR may offer opportunities to address the "leading edge" and limit impacts from invasive plants, parks are increasingly engaging invasive animals at the "lagging end" where removal strategies and tactics are highly expensive to generate negative population growth, much less eradication. Invasive animal EDRR capacity could be developed within the context of existing (or developing) EDRR capacities at the local, state, and federal levels.
- Engagement with other federal, tribal, local, and state agencies as well as other interested groups. Without NPS coordination and cooperation beyond park boundaries, prevention or management efforts inside parks are most often ineffective.

- The NPS could critically examine new ways to utilize existing authorities to greatly expand skilled citizen engagement for invasive animal management.
- A better mechanism is needed for conducting the annual invasive animals data call and managing the information collected. This would increase the quality and integrity of the data, and allow it to be more useful to park, regional, and national staff. Additionally, an expanded data call conducted intermittently could be considered to acquire important information for developing, implementing, and sustaining a servicewide invasive animal program. Questions are recommended in the following topic areas: level of concern for species reported, effectiveness of prevention / control / eradication tools, management actions conducted and their success or failure, funding sources, and entities with which parks collaborate for invasive animal management. However, capacity is limted to conduct these queries.
- An internal NPS website could serve as an information resource, repository, and clearinghouse for parks on invasive animal management.
- As stated in Executive Order 13751, NPS should participate in technological innovation to control and prevent invasive species. NPS could partner with other government agencies, academic institutions, non-government organizations, and for-profit entities that are actively engaged in development of new technologies and approaches to invasive animal management.
- Responsibilities for invasive species are shared by four programs across three divisions in the NPS national office. Collaboration and cooperation is high within the NPS but efficiencies are likely being lost through a decentralized approach that does not fully build holistic capacity across plant, animal, aquatic (fresh and marine), terrestrial, vertebrate, and invertebrate life histories. An integrated invasive species management approach could be considered as a path forward.
- The NPS has not yet declared a servicewide mission-critical emergency, or declared any park "impaired" due to an invasive species. Such a declaration by a park may be perceived as indication that NPS has violated its statutory requirement to conserve the park's resources and values, and the park would be legally compelled to allocate whatever funds necessary to remove the impairment. In many cases, it is uncertain whether even unlimited resources would be able to remove an invasive species or its threat from a park.

Lionfish are prolific throughout the Southeastern United States, Gulf of Mexico, and Caribbean. NPS Photo, Cliff Mcreedy.

Next Steps

1. Work with servicewide "champions" to develop a national strategy for addressing invasive animals that can be applied to specific and prioritized geographical areas.
2. Frame management strategies using formal decision support to conduct risk assessments.
3. Sustain leadership in advancing the field of invasive animal management by becoming a leader in testing innovative resource management strategies.
4. Develop and share best management practices.
5. Drive action on challenges that transcend park boundaries.
6. Conduct a series of workshops that lead up to the development of a national strategy/implementation plan for addressing invasive animals servicewide. Two high priority areas for the Service to engage on include the Hawaiian Islands and the Greater Everglades Ecosystem.
    A. In FY 2018, BRD will work with the Pacific West Region and Hawaiian parks to prioritize invasive animal species to focus attention on strategies and approaches, innovative techniques, and pilot proof of concept projects for funding. In addition, BRD will work with USGS and Everglades National Park partners to ramp up efforts on invasive herpetofauna including new technologies and approaches, and increased public awareness.
    B. In FY 2019, BRD will host a servicewide community of practice "champions", to draft a Servicewide Invasive Animal Strategy and Implementation Plan.
7. Compare/contrast different organizational models for managing invasive animal species that NPS could adopt or use to inform development of its own organizational model(s). Focus will be on terrestrial vertebrates with the expectation that the model could be modified to apply to invasive invertebrate and some aquatic animal species.
8. Analyze a myriad of pertinent studies (attempts, failures, successes), world-wide, of different management and resource contexts in which invasive terrestrial or aquatic vertebrate issues manifest themselves and apply in context with appropriate NPS units.
9. Implement an interpretive educational and engagement component, inclusive of a national campaign-style message, that will increase park visitor awareness of invasive animal species impacts and improve NPS efforts to advocate "prevention" and "early detection" as the most effective means of invasive species management.
10. Develop and sustain a community of practice.
11. Initiate and implement proof of concept projects.
12. Present final draft strategy and innovative approaches to the NPS Natural Resources Advisory Group in late 2019.
13. Be prepared for opportunities to advance NPS management of invasive animals by continuing to refine budget strategies and approaches.

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Appendix A. FY2016 Invasive Animals Data Call Definitions

The following definitions were provided by the Department of the Interior's Strategic Plan Measure Template for use with the Invasive Animals GPRA Performance Measure during fiscal years 2014-2017. Updates to these definitions (provided in Appendix B) are being implemented with the FY2018 reporting cycle.

Invasive animal: As informed by EO 13751, an animal (amphibian, bird, invertebrate, fish, mammal, or reptile) that is 1) non-native to the ecosystem under management, and 2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal, or plant health.

Population: Individual animals found in parks are genetically parts of species populations that may extend across park and non-park lands. A "population" for GPRA reporting purposes is the group of individuals of a species that exist within park boundaries (even if they also spend time outside park boundaries.) In some cases, there may be discrete groups within a park that do not interact with other groups of the same species. For example, a park could report separately on two populations of rainbow trout located in two disconnected waters.

Management: Plans for and activities that conduct suppression, containment, eradication, or other activities that: 1) Reduce the number of individual invasive animals; 2) Prevent the spread of invasive animals beyond the infested area; or 3) Mitigate the effects/impacts of invasive animal presence.

Controlled: Suppressed, contained, or eradicated.

Suppressed: Reduced to a population level that achieves management goals for the park.

Contained: Confined to a geographic area within a park that achieves management goals for the park.

Eradicated: Eliminated from a localized area all of the individuals in an invasive animal population, as verified using monitoring and inventories. The population is considered suppressed until monitoring verifies that eradication has been successfully achieved.

Appendix B. Updated Department of the Interior Strategic Plan Measure Template for the Invasive Animals Performance Metric

The template below will be implemented with FY2018 Government Performance and Results Act (GPRA) reporting.

Measure ID:	1.1.2.4

Mission Area:	MISSION AREA #1: Conserving Our Land and Water
Goal:	GOAL #1: Utilize Science in land, water, species and habitat management for adaptation to environmental changes
Strategy:	STRATEGY # 2: Provide stewardship of land, surface water, streams and shorelines
Short Measure Name:	1.1.2.4 Percent of invasive animal populations under control
Full Measure Name:	Percent of invasive animal species populations that are under control

Beginning Year:	2004
End Year:	2022

Measure Scope:	This measure includes all of the known populations of invasive animal species that occur on DOI or tribal-managed lands and waters. It describes the percent of invasive species populations that are under control but does not capture management that is occurring for populations for which control has not yet been achieved.
Measurement Process:	Percent equals 100 times the number of populations of invasive animal species that are under control at the end of the reporting period, divided by the number of populations of invasive animal species that are known to occur on DOI or tribal lands and waterbodies.
Data Source(s):	BIA – tbd FWS - Performance Tracking and Reporting System (Ptrac) NPS - Google Sheets

Data Type:	Ratio
Data Aggregation:	Annual
Display Precision:	1
Reporting Frequency:	Annually
Exceeding Target Defined By:	Actual is greater than target

Data Point A (Numerator when applicable)	
Short Name:	Invasive animal populations under control
Definition:	The number of populations of invasive animal species that are known to be under control on DOI or tribal lands and waterbodies at the end of the reporting period
Unit of Measure:	Population

Data Point B (Denominator when applicable)	
Short Name:	Invasive animal populations
Definition:	The number of invasive animal species populations known to occur on DOI or tribal lands and waterbodies at the beginning of the reporting period.
Unit of Measure:	Population

Key Terms:	Definition:
Invasive animal	As defined in EO 13751, an animal species that, with regard to a particular ecosystem, is 1) a non-native organism and 2) whose introduction causes or is likely to cause economic or environmental harm, or harm to human, animal or plant health.
Population	A group of individuals of the same species (capable of breeding with each other) which live on/in a particular DOI or tribal-managed land unit or waterbody. More than one population could occur if there are groups of the same species within the same DOI or tribal-managed land unit or waterbody that do not interact with each other.
Under Control	Reduced to a maintenance level or eradicated. A maintenance level has been achieved when a population within the DOI or tribal-managed land unit is suppressed. Notes: Suppressed means a population is reduced within the unit in abundance, distribution, and/or reproductive output below the threshold needed to maintain a desirable species population, ecological process, or other resource objective. When actions are taken to maintain the suppressed status, continue reporting that population as under control. If a population is eradicated, report this only for the year that eradication is verified. When actions are taken to maintain the eradicated status, continue reporting that population as eradicated. To evaluate a management action, monitoring often is performed one or more years after the management action was initiated. Therefore a population under control often is not reported in the same year that the management action was conducted. Management actions and monitoring effort are not reported explicitly in this metric. If management actions or monitoring have been carried out for a population but the population is not suppressed or eradicated, then it is not reported as under control. Bureaus may choose to report management actions and monitoring effort in a separate sub metric.
Eradicate	Eliminate from a localized area all of the individuals in an invasive animal population, as verified using monitoring and inventories.

Bureaus Reporting:	1	2	3
	BIA	FWS	NPS

Finalized Date:	11/20/2013
Last Updated Date:	12/21/2017

Appendix C. Additional Summary Tables for FY2016 Servicewide Data

Invasive Animals Present in Parks

Table C.1 Number of invasive animal species and populations by taxonomic group reported by parks through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

	Taxonomic Group	NPS	AKR	IMR	MWR	NCR	NER	PWR	SER
Species by Taxonomic Group*	**Amphibian**	8	0	4	0	0	0	4	4
	Bird	36	2	8	8	3	5	31	9
	Fish	103	0	49	23	4	12	33	25
	Invertebrate	130	1	23	14	7	42	51	29
	Mammal	37	2	20	7	4	9	25	18
	Reptile	17	0	3	1	1	2	7	9
Populations by Taxonomic Group	**Amphibian**	30	0	11	0	0	0	12	7
	Bird	271	3	66	48	6	37	88	23
	Fish	350	0	139	56	10	24	73	48
	Invertebrate	379	1	56	35	29	100	68	90
	Mammal	340	2	77	21	11	39	88	102
	Reptile	39	0	6	1	3	2	8	19

* The Servicewide (NPS) statistic for Species by Taxonomic Group reflects the total number of unique species within each taxonomic group reported by NPS units. Therefore, as some of the species were reported by multiple regions, the number of Species by Taxonomic Group for 'NPS' is smaller than the sum of numbers reported for each region.

Table C.2 Top 25 invasive animal species* reported by parks through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
69	*Felis catus*	feral cat	Mammal
66	*Sturnus vulgaris*	European starling	Bird
47	*Columba livia*	rock pigeon	Bird
40	*Passer domesticus*	house sparrow	Bird
40	*Solenopsis invicta*	red imported fire ant	Invertebrate
38	*Sus scrofa*	reral hog	Mammal
36	*Oncorhynchus mykiss*	rainbow trout	Fish
31	*Agrilus planipennis*	emerald ash borer	Invertebrate
31	*Mus musculus*	house mouse	Mammal
28	*Rattus norvegicus*	Norway rat	Mammal
28	*Streptopelia decaocto*	Eurasian collard dove	Bird
27	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
26	*Salmo trutta*	brown trout	Fish
25	*Corbicula fluminea*	Asian clam	Invertebrate
22	*Cyprinus carpio*	common carp	Fish
22	*Lymantria dispar*	gypsy moth	Invertebrate
21	*Rattus rattus*	black rat	Mammal
20	*Canis lupus familiaris*	domestic dog	Mammal
18	*Salvelinus fontinalis*	brook trout	Fish
16	*Bos Taurus*	cattle	Mammal
15	*Apis mellifera*	Africanized bees	Invertebrate
13	*Dasypus novemcinctus*	nine-banded armadillo	Mammal
13	*Lithobates catesbeianus*	American bullfrog	Amphibian
12	*Alectoris chukar*	chukar partridge	Bird
11	*Equus caballus*	feral horse	Mammal

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Invasive Animals Adjacent to Parks

Table C.3 Top 25 invasive animal species[A] reported by parks through the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
15	*Agrilus planipennis*	emerald ash borer	Invertebrate
12	*Lymantria dispar*	gypsy moth	Invertebrate
11	*Sus scrofa*	feral hog	Mammal
6	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
6	*Anoplophora glabripennis*	Asian longhorned beetle	Invertebrate
6	*Botrylloides violaceus*	golden chain tunicate	Invertebrate
6	*Dreissena bugensis*	quagga mussel	Invertebrate
5	*Dreissena polymorpha*	zebra mussel	Invertebrate
5	*Felis catus*	feral cat	Mammal
5	*Lithobates catesbeianus*	American bullfrog	Amphibian
5	*Streptopelia decaocto*	Eurasian collard dove	Bird
3	*Columba livia*	rock pigeon	Bird
3	*Orconectes rusticus*	rusty crayfish	Invertebrate
3	*Rattus norvegicus*	Norway rat	Mammal
3	*Solenopsis invicta*	red imported fire ant	Invertebrate
2	*Carcinus maenas*	European green crab	Invertebrate
2	*Cyprinus carpio*	common carp	Fish
2	*Didemnum vexillum*	carpet sea squirt	Invertebrate
2	*Oreamnos americanus*	mountain goat	Mammal
2	*Ovis aries orientalis*	European mouflon sheep	Mammal
2	*Pityophthorus juglandis*	walnut twig beetle	Invertebrate
2	*Sturnus vulgaris*	European starling	Bird
2	*Varanus niloticus*	Nile monitor	Reptile
2	*Wasmannia auropunctata*	little fire ant	Invertebrate
1	*Aedes albopictus*	Asian tiger mosquito	Invertebrate

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion

Invasive Animals Eradicated from Parks

Table C.4 Invasive animal species populations* reported by parks through the annual NPS invasive animals data call as eradicated from a park during 2016 or a previous year.

Parks	Scientific Name	Common Name	Taxonomic Group
2	*Capra hircus*	feral goat	Mammal
2	*Lymantria dispar*	gypsy moth	Invertebrate
2	*Sus scrofa*	feral swine	Mammal
1	*Axis axis*	axis deer	Mammal
1	*Bos taurus*	cattle	Mammal
1	*Crocodylus niloticus*	Nile crocodile	Reptile
1	*Eleutherodactylus coqui*	coqui frog	Amphibian
1	*Felis catus*	feral cat	Mammal
1	*Herpestes javanicus*	Indian mongoose	Mammal
1	*Iguana iguana*	green iguana	Reptile
1	*Myocastor coypus*	nutria	Mammal
1	*Odocoileus hemionus*	mule deer	Mammal
1	*Oncorhynchus mykiss*	golden trout	Fish
1	*Oryctolagus cuniculus*	European rabbit	Mammal
1	*Pavo cristatus*	Indian peafowl	Bird
1	*Rattus rattus*	black rat	Mammal
1	*Threskiornis aethiopicus*	sacred ibis	Bird
1	*Xylosandrus crassiusculus*	granulate ambrosia beetle	Invertebrate

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Invasive Animals Management Plans and Expenditures for Control

Table C.5 Top 25 invasive animal species[A] for which parks reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
25	*Sus scrofa*	feral swine	Mammal
23	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
20	*Felis catus*	feral cat	Mammal
18	*Agrilus planipennis*	emerald ash borer	Invertebrate
15	*Oncorhynchus mykiss*	rainbow trout	Fish
13	*Rattus norvegicus*	Norway rat	Mammal
12	*Bos taurus*	cattle	Mammal
11	*Mus musculus*	house mouse	Mammal
10	*Salmo trutta*	brown trout	Fish
10	*Salvelinus fontinalis*	brook trout	Fish
10	*Solenopsis invicta*	red imported fire ant	Invertebrate
8	*Lymantria dispar*	gypsy moth	Invertebrate
7	*Equus asinus*	feral burro	Mammal
6	*Equus caballus*	feral horse	Mammal
6	*Lithobates catesbeianus*	American bullfrog	Amphibian
6	*Pterois volitans*	lionfish	Fish
6	*Rattus rattus*	black rat	Mammal
5	*Capra hircus*	feral goat	Mammal
5	*Columba livia*	rock pigeon	Bird
4	*Ammotragus lervia*	Barbary sheep	Mammal
4	*Apis mellifera*	Africanized bees	Invertebrate
4	*Axis axis*	axis deer	Mammal
4	*Canis lupus familiaris*	feral dog	Mammal
4	*Herpestes javanicus*	Indian mongoose	Mammal
4	*Oreamnos americanus*	mountain goat	Mammal
4	*Sturnus vulgaris*	European starling	Bird
4	*Vulpes vulpes*	red fox	Mammal

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park.

Table C.6 Top 25 invasive animal species* for which parks reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
32	*Felis catus*	feral cat	Mammal
28	*Solenopsis invicta*	red imported fire ant	Invertebrate
27	*Sus scrofa*	feral swine	Mammal
26	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
21	*Rattus norvegicus*	Norway rat	Mammal
18	*Agrilus planipennis*	emerald ash borer	Invertebrate
18	*Mus musculus*	house mouse	Mammal
11	*Bos taurus*	cattle	Mammal
11	*Oncorhynchus mykiss*	rainbow trout	Fish
11	*Rattus rattus*	black rat	Mammal
10	*Salvelinus fontinalis*	brook trout	Fish
8	*Canis lupus familiaris*	feral dog	Mammal
8	*Lymantria dispar*	gypsy moth	Invertebrate
7	*Apis mellifera*	Africanized bees	Invertebrate
7	*Columba livia*	rock pigeon	Bird
7	*Equus caballus*	feral horse	Mammal
7	*Salmo trutta*	brown trout	Fish
6	*Dreissena bugensis*	quagga mussel	Invertebrate
6	*Dreissena polymorpha*	zebra mussel	Invertebrate
6	*Pterois volitans*	lion fish	Fish
5	*Capra hircus*	feral goat	Mammal
5	*Herpestes javanicus*	Indian mongoose	Mammal
4	*Equus asinus*	feral burro	Mammal
4	*Orconectes rusticus*	rusty crayfish	Crustacean
4	*Oreamnos americanus*	mountain goat	Mammal
32	*Felis catus*	feral cat	Mammal
28	*Solenopsis invicta*	red imported fire ant	Invertebrate

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Appendix D. Tables of "Top 10" Summaries for FY2016 Invasive Animal Data Reported by NPS Regions

Regional data summaries provide a source of information about the invasive animal management needs and concerns of each region. These "Top 10" summaries augment information summarized by region in tables 2–5 (Chapter 3) of this report.

Alaska Region

No invasive animals have been reported as eradicated from parks in the Alaska region. No invasive animals were reported by parks in the Alaska region as having an existing management plan (or one in progress).

Table D.1 Invasive animal species* reported by parks in the Alaska Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
2	*Streptopelia decaocto*	Eurasian collared dove	Bird
1	*Bison bison bison*	plains bison	Mammal
1	*Felis catus*	feral cat	Mammal
1	*Sturnus vulgaris*	European starling	Bird
1	*Trichoides canis*	dog lice	Invertebrate

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Table D.2 Invasive animal species[A] reported by parks in the Alaska Regionthrough the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
6	*Botrylloides violaceus*	golden chain tunicate	Invertebrate
2	*Carcinus maenas*	European green crab	Invertebrate
2	*Didemnum vexillum*	marine tunicate	Invertebrate
2	*Salmo salar*	Atlantic salmon	Fish
1	*Arion ater*	European black slug	Invertebrate
1	*Streptopelia decaocto*	Eurasian collared dove	Bird
1	*Sturnus vulgaris*	European starling	Bird

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

Table D.3 Invasive animal species* for which parks in the Alaska Regionreported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
1	*Bison bison bison*	plains bison	Mammal

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Intermountain Region

Table D.4 Top 10 invasive animal species* reported by parks in the Intermountain Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
17	*Sturnus vulgaris*	European starling	Bird
15	*Oncorhynchus mykiss*	rainbow trout	Fish
14	*Streptopelia decaocto*	Eurasian collared dove	Bird
13	*Bos Taurus*	feral cattle	Mammal
12	*Salmo trutta*	brown trout	Fish
10	*Apis mellifera*	European honey bee	Invertebrate
10	*Felis catus*	feral cat	Mammal
10	*Sus scrofa*	feral swine	Mammal
9	*Columba livia*	rock pigeon	Bird
9	*Passer domesticus*	house sparrow	Bird

* Some populations are non-native and invasive, while other populations may only be considered non-native

Table D.5 Top 10 invasive animal species[A] reported by parks in the Intermountain Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
4	*Dreissena bugensis*	quagga mussel	Invertebrate
4	*Dreissena polymorpha*	zebra mussel	Invertebrate
2	*Oreamnos americanus*	mountain goat	Mammal
2	*Streptopelia decaocto*	Eurasian collared dove	Bird
1	*52 species were reported once[C]:*	41 invertebrates, 6 fishes, 3 mammals, 1 bird, and 1 amphibian	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

[C] Fifty-two is too many species to be listed in a table footnote; a species list can be provided upon request.

Table D.6 Invasive animal species[A] populations reported through the annual NPS invasive animals data call by parks in the Intermountain Region as eradicated from within park boundaries during 2016 or a previous year.

Parks	Scientific Name	Common Name	Taxonomic Group
1[B]	*Oreamnos americanus*	mountain goat	Mammal

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] Bryce Canyon National Park

Intermountain Region Continued

Table D.7 Top 10 invasive animal species[A] for which parks in the Intermountain Region reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
8	*Bos Taurus*	feral cattle	Mammal
6	*Felis catus*	feral cat	Mammal
5	*Apis mellifera*	European honey bee	Invertebrate
4	*Canis lupus familiaris*	feral dog	Mammal
4	*Dreissena bugensis*	quagga mussel	Invertebrate
4	*Sus scrofa*	feral swine	Mammal
3	*Dreissena polymorpha*	zebra mussel	Invertebrate
3	*Oreamnos americanus*	mountain goat	Mammal
3	*Solenopsis invicta*	red imported fire ant	Invertebrate
2	*6 species were reported twice[B]:*	2 invertebrates, 2 mammals, and 2 fishes	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Apis mellifera scutellata*** (Africanized European honey bee), ***Equus caballus*** (feral horse), ***Melanoides tuberculata*** (Malaysian trumpet snail), ***Mus musculus*** (house mouse), ***Salvelinus fontinalis*** (brook trout), and ***Salvelinus namaycush*** (lake trout)

Table D.8 Top 10 invasive animal species[A] for which parks in the Intermountain Region reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
9	*Bos Taurus*	feral cattle	Mammal
5	*Felis catus*	feral cat	Mammal
4	*Ammotragus lervia*	Barbary sheep	Mammal
4	*Oncorhynchus mykiss*	rainbow trout	Fish
4	*Sus scrofa*	feral swine	Mammal
3	*Lithobates catesbeianus*	American bullfrog	Amphibian
3	*Oreamnos americanus*	mountain goat	Mammal
3	*Salvelinus fontinalis*	brook trout	Fish
2	*10 species were reported twice[C]:*	4 invertebrates, 3 fishes, 2 mammals, and 1 bird	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park.

[C] ***Apis mellifera scutellata*** (European honey bee), ***Dreissena bugensis*** (quagga mussel), ***Equus asinus*** (feral burro), ***Equus caballus*** (feral horse), ***Lepomis cyanellus*** (green sunfish), ***Melanoides tuberculate*** (Malaysian trumpet snail), ***Pasianus colchicus*** (ring-necked pheasant), ***Salmo trutta*** (brown trout), ***Salvelinus namaycush*** (lake trout), and ***Solenopsis invicta*** (red imported fire ant)

Midwest Region

No invasive animals have been reported as eradicated from parks in the Midwest region.

Table D.9 Top 10 invasive animal species[A] reported by parks in the Midwest Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
12	*Passer domesticus*	house sparrow	Bird
12	*Sturnus vulgaris*	European starling	Bird
11	*Columba livia*	rock pigeon	Bird
7	*Cyprinus carpio*	common carp	Fish
7	*Felis catus*	feral cat	Mammal
6	*Corbicula fluminea*	Asian clam	Invertebrate
5	*Agrilus planipennis*	emerald ash borer	Invertebrate
5	*Dreissena polymorpha*	zebra mussel	Invertebrate
5	*Mus musculus*	house mouse	Mammal
4	5 species were reported four times[B]:	3 fishes, 1 bird, and 1 invertebrate	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Hypopthalmichthys molitrix*** (silver carp), ***Hypopthalmichthys nobilis*** (bighead carp), ***Lymantria dispar*** (gypsy moth), ***Osmerus mordax*** (rainbow smelt), and ***Streptopelia decaocto*** (Eurasian collared dove)

Table D.10 Invasive animal species[A] reported by parks in the Midwest Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
1	*Agrilus planipennis*	emerald ash borer	Invertebrate
1	*Cyprinus carpio*	common carp	Fish
1	*Dreissena bugensis*	quagga mussel	Invertebrate
1	*Lithobates catesbeianus*	American bullfrog	Amphibian
1	*Lymantria dispar*	gypsy moth	Invertebrate
1	*Misgurnus anguillicaudatus*	Oriental weatherfish	Fish
1	*Orconectes rusticus*	rusty crayfish	Invertebrate
1	*Rattus norvegicus*	Norway rat	Mammal
1	*Scardinius erythrophthalmus*	rudd	Fish
1	*Sus scrofa*	feral swine	Mammal

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

Table D.11 Invasive animal species[A] for which parks in the Midwest Region reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
4	*Sus scrofa*	feral swine	Mammal
3	*Dreissena polymorpha*	zebra mussel	Invertebrate
3	*Felis catus*	feral cat	Mammal
2	*Agrilus planipennis*	emerald ash borer	Invertebrate
2	*Hypopthalmichthys molitrix*	silver carp	Fish
2	*Hypopthalmichthys nobilis*	bighead carp	Fish
2	*Mus musculus*	house mouse	Mammal
1	*9 species were reported once[B]:*	5 invertebrates, 3 mammals, and 1 fish	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Bythotrephes cederstroemii*** (spiny water flea), ***Cercopagis pengoi*** (fish-hook water flea), ***Ctenopharyngodon idella*** (grass carp), ***Dreissena bugensis*** (quagga mussel), ***Equus caballus*** (feral horse), ***Odocoileus virginianus*** (white-tailed deer), ***Orconectes rusticus*** (rusty crayfish), ***Rattus norvegicus*** (Norway rat), and ***Solenopsis spp.*** (fire ant)

Table D.12 Invasive animal species[A] for which parks in the Midwest Region reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
4	*Sus scrofa*	feral swine	Mammal
3	*Agrilus planipennis*	emerald ash borer	Invertebrate
2	*Ctenopharyngodon idella*	grass carp	Fish
2	*Hypopthalmichthys molitrix*	silver carp	Fish
2	*Hypopthalmichthys nobilis*	bighead carp	Fish
2	*Lymantria dispar*	gypsy moth	Invertebrate
1	*Dreissena polymorpha*	zebra mussel	Invertebrate
1	*Equus caballus*	feral horse	Mammal
1	*Mus musculus*	house mouse	Mammal
1	*Solenopsis spp.*	fire ant	Invertebrate

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park

National Capital Region

Table D.13 Top 10 invasive animal species[A] reported by parks in the National Capital Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
9	*Agrilus planipennis*	emerald ash borer	Invertebrate
8	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
7	*Lymantria dispar*	gypsy moth	Invertebrate
5	*Channa argus*	northern snakehead	Fish
4	*Rattus norvegicus*	Norway rat	Mammal
3	*Felis catus*	feral cat	Mammal
3	*Mus musculus*	house mouse	Mammal
3	*Trachemys scripta*	red-eared slider	Reptile
2	6 species were reported once[B]:	3 birds, 2 fishes, and 1 invertebrate	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Columba livia*** (rock pigeon), ***Ictalurus furcatus*** (blue catfish), ***Passer domesticus*** (house sparrow), ***Pylodictis olivaris*** (flathead catfish), ***Sturnus vulgaris*** (European starling), and ***Vespa crabo*** (European hornet)

Table D.14 Invasive animal species reported by parks in the National Capital Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)* park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
1	*Agrilus planipennis*	emerald ash borer	Invertebrate
1	*Lymantria dispar*	gypsy moth	Invertebrate

* This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

Table D.15 Invasive animal species populations reported through the annual NPS invasive animals data call by parks in the National Capital Region as eradicated from within park boundaries during 2016 or a previous year.

Parks	Scientific Name	Common Name	Taxonomic Group
1*	*Lymantria dispar*	gypsy moth	Invertebrate

* Rock Creek Park

Table D.16 Invasive animal species* for which parks in the National Capital Regionreported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
5	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
4	*Agrilus planipennis*	emerald ash borer	Invertebrate
3	*Lymantria dispar*	gypsy moth	Invertebrate
3	*Mus musculus*	house mouse	Mammal
3	*Rattus norvegicus*	Norway rat	Mammal
1	*Corbicula fluminea*	Asian clam	Invertebrate
1	*Felis catus*	feral cat	Mammal
1	*Passer domesticus*	house sparrow	Bird
1	*Sturnus vulgaris*	European starling	Bird

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Table D.17 Top 10 invasive animal species[A] for which parks in the National Capital Regionreported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
3	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
3	*Agrilus planipennis*	emerald ash borer	Invertebrate
1	9 species were reported once[C]:	3 birds, 3 mammals, 2 invertebrates, and 1 fish	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park.

[C] ***Channa argus*** (northern snakehead), ***Columba livia*** (rock pigeon), ***Felis catus*** (feral cat), ***Lymantria dispar*** (gypsy moth), ***Mus musculus*** (house mouse), ***Passer domesticus*** (house sparrow), ***Rattus norvegicus*** (Norway rat), ***Sturnus vulgaris*** (European starling), and ***Vespa crabo*** (European hornet)

Northeast Region

Table D.18 Top 10 invasive animal species* reported by parks in the Northeast Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
14	*Felis catus*	feral cat	Mammal
14	*Sturnus vulgaris*	European starling	Bird
11	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
11	*Agrilus planipennis*	emerald ash borer	Invertebrate
10	*Rattus norvegicus*	Norway rat	Mammal
9	*Lymantria dispar*	gypsy moth	Invertebrate
8	*Columba livia*	rock pigeon	Bird
7	*Carcinus maenas*	European green crab	Invertebrate
6	*Mus musculus*	house mouse	Mammal
6	*Passer domesticus*	house sparrow	Bird

* Some populations are non-native and invasive, while other populations may only be considered non-native.

Table D.19 Top 10 invasive animal species reported by parks in the Northeast Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)[A] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
8	*Agrilus planipennis*	emerald ash borer	Invertebrate
6	*Lymantria dispar*	gypsy moth	Invertebrate
5	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
4	*Anoplophora glabripennis*	Asian longhorned beetle	Invertebrate
4	*Sus scrofa*	feral swine	Mammal
2	*Pityophthorus juglandis*	walnut twig beetle	Invertebrate
2	*Rattus norvegicus*	Norway rat	Mammal
1	12 species were reported once[B]:	9 invertebrates, 2 mammals, and 1bird	–

[A] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

[B] ***Aedes albopictus*** (Asian tiger mosquito), ***Aedes japonicas*** (Asian rock pool mosquito), ***Agrilus bilineatus*** (oak-decline insect), ***Anaphalodes rufulus*** (red oak boarer), ***Cygnus olor*** (mute swan), ***Eriocheir sinensis*** (Chinese mitten crab), ***Felis catus*** (feral cat), ***Fiorinia externa*** (elongate hemlock scale), ***Lycorma delicatula*** (spotted lanternfly), ***Malacosoma disstria*** (forest tent caterpillar moth), ***Operophtera brumata*** (winter moth), and ***Rattus rattus*** (black rat)

Table D.20 Invasive animal species populations reported through the annual NPS invasive animals data call by parks in the Northeast Region as eradicated from within park boundaries during 2016 or a previous year.

Parks	Scientific Name	Common Name	Taxonomic Group
1*	*Felis catus*	feral cat	Mammal
1*	*Myocastor coypus*	nutria	Mammal

* Assateague Island National Seashore (both species)

Table D.21 Top 10 invasive animal species[A] for which parks in the Northeast Region reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
13	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
9	*Rattus norvegicus*	Norway rat	Mammal
6	*Agrilus planipennis*	emerald ash borer	Invertebrate
6	*Felis catus*	feral cat	Mammal
4	*Mus musculus*	house mouse	Mammal
3	*Columba livia*	rock pigeon	Bird
2	Five species were reported twice[B]:	3 invertebrates, 1 bird, and 1 mammal	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Cygnus olor*** (mute swan), ***Fiorinia externa*** (elongate hemlock scale), ***Halyomorpha halys*** (brown marmorated stink bug), ***Orconectes rusticus*** (rusty crayfish), and ***Vulpes vulpes*** (red fox)

Northeast Region Continued

Table D.22 Top 10 invasive animal species[A] for which parks in the Northeast Region reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
12	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
10	*Rattus norvegicus*	Norway rat	Mammal
7	*Agrilus planipennis*	emerald ash borer	Invertebrate
4	*Mus musculus*	house mouse	Mammal
3	*Felis catus*	feral cat	Mammal
2	6 species were reported twice[C]:	2 birds, 2 invertebrates, and 2 mammals	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park.

[C] ***Canis lupus familiaris*** (feral dog), ***Corbicula fluminea*** (Asian clam), ***Cygnus olor*** (mute swan), ***Lymantria dispar*** (gypsy moth), ***Sturnus vulgaris*** (European starling), and ***Vulpes vulpes*** (red fox)

Table D.23 Top 10 invasive animal species[A] reported by parks in the Pacific West Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
14	*Felis catus*	feral cat	Mammal
12	*Oncorhynchus mykiss*	rainbow trout	Fish
12	*Sturnus vulgaris*	European starling	Bird
11	*Columba livia*	rock pigeon	Bird
10	*Salvelinus fontinalis*	brook trout	Fish
10	*Sus scrofa*	feral swine	Mammal
9	*Rattus rattus*	black rat	Mammal
8	4 species were reported once[B]:	2 birds, 1 amphibian, and 1 fish	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Lithobates catesbeianus*** (American bullfrog), ***Passer domesticus*** (house sparrow), ***Salmo trutta*** (brown trout), and ***Streptopelia decaocto*** (Eurasian collared dove)

Table D.24 Invasive animal species[A] reported by parks in the Pacific West Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
3	*Lithobates catesbeianus*	American bullfrog	Amphibian
2	*Ovis aries orientalis*	European mouflon sheep	Mammal
2	*Wasmannia auropunctata*	little fire ant	Invertebrate
1	8 species were reported once[C]:	3 birds, 2 invertebrates, 2 mammals, and 1 amphibian	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

[C] ***Axis axis*** (axis deer), ***Eleutherodactylus coqui*** (coqui frog), ***Meleagris gallopavo*** (feral turkey), ***Orconectes rusticus*** (rusty crayfish), ***Streptopelia decaocto*** (Eurasian collared dove), ***Strix varia*** (barred owl), ***Vespa tropica*** (Asian wasp), and ***Vulpes vulpes*** (red fox)

Pacific West Region

Table D.25 Invasive animal species[A] populations reported through the annual NPS invasive animals data call by parks in the Pacific West Region as eradicated from within park boundaries during 2016 or a previous year.

Parks[B]	Scientific Name	Common Name	Taxonomic Group
1	*Axis axis*	axis deer	Mammal
1	*Bos taurus*	feral cattle	Mammal
1	*Capra hircus*	feral goat	Mammal
1	*Eleutherodactylus coqui*	coqui frog	Amphibian
1	*Odocoileus hemionus*	mule deer	Mammal
1	*Oncorhynchus mykiss aquabonita*	California golden trout	Fish
1	*Oryctolagus cuniculus*	European rabbit	Mammal
1	*Pavo cristatus*	Indian peafowl	Bird
1	*Sus scrofa*	feral swine	Mammal

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] Species were eradicated from: Channel Islands National Park (mule deer), Haleakala National Park (European rabbit), Hawai'i Volcanoes National Park (feral cattle, feral goat, coqui frog), North Cascades National Park (California golden trout), Olympic National Park (feral swine), and Point Reyes National Seashore (axis deer, Indian peafowl).

Table D.26 Top 10 invasive animal species[A] for which parks in the Pacific West Region reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
8	*Felis catus*	feral cat	Mammal
8	*Oncorhynchus mykiss*	rainbow trout	Fish
8	*Salvelinus fontinalis*	brook trout	Fish
5	*Salmo trutta*	brown trout	Fish
5	*Sus scrofa*	feral swine	Mammal
4	*Capra hircus*	feral goat	Mammal
4	*Herpestes javanicus*	small Asian mongoose	Mammal
4	*Rattus norvegicus*	Norway rat	Mammal
4	*Rattus rattus*	black rat	Mammal
3	6 species were reported three times[B]:	4 mammals, 1 bird, and 1 invertebrate	

A Some populations are non-native and invasive, while other populations may only be considered non-native.

B ***Axis axis*** (axis deer), ***Bos taurus*** (feral cattle), ***Equus asinus*** (feral burro), ***Linepithema humile*** (Argentine ant), ***Meleagris gallopavo*** (feral turkey), and ***Rattus exulans*** (Polynesian rat)

Table D.27 Top 10 invasive animal species[A] for which parks in the Pacific West Region reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
8	*Oncorhynchus mykiss*	rainbow trout	Fish
7	*Salvelinus fontinalis*	brook trout	Fish
7	*Sus scrofa*	feral swine	Mammal
5	*Felis catus*	feral cat	Mammal
5	*Salmo trutta*	brown trout	Fish
4	*Capra hircus*	feral goat	Mammal
4	*Equus asinus*	feral burro	Mammal
3	*Axis axis*	axis deer	Mammal
3	*Bos Taurus*	feral cattle	Mammal
3	*Lithobates catesbeianus*	American bullfrog	Amphibian

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park

Southeast Region

Table D.28 Top 10 invasive animal species[A] reported by parks in the Southeast Region through the annual NPS invasive animals data call as occurring within park boundaries during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
34	*Solenopsis invicta*	red imported fire ant	Invertebrate
20	*Felis catus*	feral cat	Mammal
16	*Sus scrofa*	feral swine	Mammal
12	*Dasypus novemcinctus*	nine-banded armadillo	Mammal
9	*Rattus rattus*	black rat	Mammal
8	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
8	*Canis lupus familiaris*	feral dog	Mammal
8	*Pterois volitans*	lionfish	Fish
8	*Sturnus vulgaris*	European starling	Bird
7	Two species were reported seven times[B]:	–	2 mammals

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Canis latrans*** (coyote) and ***Mus musculus*** (house mouse)

Table D.29 Top 10 invasive animal species[A] reported by parks in the Southeast Region through the annual NPS invasive animals data call as occurring adjacent to (but not within)[B] park boundaries in 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
6	*Sus scrofa*	feral swine	Mammal
5	*Agrilus planipennis*	emerald ash borer	Invertebrate
4	*Felis catus*	feral cat	Mammal
4	*Lymantria dispar*	gypsy moth	Invertebrate
3	*Columba livia*	rock pigeon	Bird
3	*Solenopsis invicta*	red imported fire ant	Invertebrate
2	*Anoplophora glabripennis*	Asian long-horned beetle	Invertebrate
2	*Varanus niloticus*	Nile monitor	Reptile
1	26 species were reported once[C]:	8 invertebrates, 7 reptiles, 6 birds, 4 mammals, and 1 amphibian	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] This may include species further distant than "adjacent" to a park (e.g., zebra and quagga mussels) and for which the park spends money to prevent invasion.

[C] Twenty-six is too many species to list in a table footnote; a species list can be provided upon request.

Table D.30 Invasive animal species populations reported through the annual NPS invasive animals data call by parks in the Southeast Region as eradicated from within park boundaries during 2016 or a previous year.

Parks	Scientific Name	Common Name	Taxonomic Group
1	*Crocodylus niloticus*	Nile crocodile	Reptile
1	*Herpestes javanicus*	small Asian mongoose	Mammal
1	*Iguana iguana*	green iguana	Reptile
1	*Lymantria dispar*	gypsy moth	Invertebrate
1	*Rattus rattus*	black rat	Mammal
1	*Sus scrofa*	feral swine	Mammal
1	*Threskiornis aethiopicus*	African sacred ibis	Bird
1	*Xylosandrus crassiusculus*	granulate ambrosia beetle	Invertebrate

* Species were eradicated from: Big South Fork National River & Recreation Area (gypsy moth), Buck Island Reef National Monument (small Asian mongoose, black rat), Cape Hatteras National Seashore (feral swine), Carl Sandburg Home National Historic Site (granulate ambrosia beetle), and Dry Tortugas National Park (green iguana), and Everglades National Park (Nile crocodile, African sacred ibis).

Table D.31 Top 10 invasive animal species[A] for which parks in the Southeast Region reported through the annual NPS invasive animals data call related management or control expenditures during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
25	*Solenopsis invicta*	red imported fire ant	Invertebrate
14	*Sus scrofa*	feral swine	Mammal
8	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
8	*Felis catus*	feral cat	Mammal
6	*Agrilus planipennis*	emerald ash borer	Invertebrate
6	*Pterois volitans*	lionfish	Fish
6	*Rattus rattus*	black rat	Mammal
5	*Mus musculus*	house mouse	Mammal
4	*Lymantria dispar*	gypsy moth	Invertebrate
3	2 species were reported three times[B]:	–	–

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] ***Canis lupus familiaris*** (feral dog) and ***Rattus norvegicus*** (Norway rat).

Table D.32 Top 10 invasive animal species[A] for which parks in the Southeast Region reported through the annual NPS invasive animals data call having a management plan[B] existing or in progress during 2016.

Parks	Scientific Name	Common Name	Taxonomic Group
10	*Sus scrofa*	feral swine	Mammal
8	*Adelges tsugae*	hemlock woolly adelgid	Invertebrate
8	*Solenopsis invicta*	red imported fire ant	Invertebrate
6	*Felis catus*	feral cat	Mammal
6	*Pterois volitans*	lionfish	Fish
5	*Agrilus planipennis*	emerald ash borer	Invertebrate
4	*Rattus rattus*	black rat	Mammal
3	*Canis latrans*	coyote	Mammal
3	*Lymantria dispar*	gypsy moth	Invertebrate
3	*Mus musculus*	house mouse	Mammal

[A] Some populations are non-native and invasive, while other populations may only be considered non-native.

[B] A management plan could be for a single species or multiple species in a park.

Appendix E. Interviews with Regional Representatives

Interview Questions

Informing Decisions

- What types and sources of information, particularly as relates to science, do park managers use in making decisions about invasive animal management?
- Are there types of information you think should be used but aren't being used?
- What are park managers' perceptions of the usability and accessibility of invasive animal science?
- What are park managers' perceptions of the need for decision support tools for managing invasive animals?
- If they are perceived as needed, what would make decision support tools useful?

Factors in Making Decisions

- Social Factors: What factors do park managers currently consider when making management decisions about invasive animals?
- Non-social factors: What factors (other than social) contribute to decisions about managing invasive animals?
- External entity factors: What types of cross-boundary problems exist? What if any challenges are there with inter-agency (local, state, or federal) coordination and cooperation?

Invasive Animal Control/Management (i.e. taking action)

- What challenges and constraints do park managers face in implementing invasive animal control measures?
- What do park managers perceive as barriers to successful management?
- Are management decisions at the park level focused on prevention, early detection/rapid response, or controlling things only once they cause substantial damage? Why?
- What types of funding sources are being used for invasive animal management? Which types of funding sources are used most and why?

Regional Office Activities

- How are invasive animal issues/expertise/responsibilities (including aquatic) distributed in your regional office? In other words, who handles what issues?
- Does your regional office have any initiatives, priorities, or projects currently underway regarding invasive animals?
- What do parks reach out to the regional office for help with in regards to invasive animals?
- What does your regional office need help with in regards to invasive animals?
- In your opinion, what kind of national NPS institutional structure/strategy/framework do you think would benefit parks in your region?
- Do you have any other ideas or comments you want to share before closing the interview?

Table E.1 Region Representatives Participating in Interviews

Region	Name	Title
Alaska	Tahzay Jones	Regional Oceans & Coastal Programs Coordinator
Intermountain	Myron Chase	Regional IPM Coordinator (retired)
	John Nelson	Regional IPM Coordinator (current)
	Mike Wrigley	Regional Wildlife Biologist
Midwest	Dan Licht	Regional Wildlife Biologist
National Capital	Jil Swearingen	Regional IPM Coordinator
	Scott Bates	Regional Wildlife Biologist
Northeast	Casey Reese	Regional IPM Coordinator
	Sheila Colwell	Regional Wildlife Biologist
Pacific West	Erv Gasser	Regional IPM Coordinator
	Mietek Kolipinski	Regional Endangered Species and Water Resources Coordinator
Southeast	Chris Furqueron	Regional IPM Coordinator (retired)
	Tim Pinion	Regional Wildlife Biologist

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National Park Service
U.S. Department of the Interior

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