DEPARTMENT OF DEFENSE:
INVASIVE SPECIES CHALLENGES AND SOLUTIONS

February 2017

Introduction

The U.S. Department of Defense (DoD) manages approximately 25 million acres of land across 525 installations, 344 of which have significant natural resources that require management through an Integrated Natural Resources Management Plan (INRMP). DoD's mission is to protect and defend our nation and its interests. Our installation natural resources managers work to ensure that our soldiers, sailors, and airmen have the land, air, and water resources they need to conduct crucial testing, training, and operational activities. DoD requires high quality testing and training landscapes to conduct mission activities and must balance mission needs and environmental stewardship responsibilities through implementation of our primary land management driver, the Sikes Act. Non-native and other invasive species commonly impact the military's testing and training mission, force health protection, security, global movement of personnel and equipment, installation infrastructure, and natural resources.

Defense lands encompass rare and sometimes unique habitats. Because many of our lands restrict access, they offer high biological diversity and host more sensitive species *per acre* than other federal lands (NatureServe, 2015). This means that, in addition to the direct mission impacts mentioned above, invasive species can have a significant detrimental effect on the threatened, endangered, and at-risk species managed by DoD. Ultimately, the introduction, establishment and spread of invasive species has both direct and indirect impacts to mission activities. These impacts affect sensitive species in ways that result in land use restrictions and added expenses to meet mission requirements.

Recognizing that partnering with other agencies and conservation organizations to achieve common goals results in better species and habitat management, DoD was among the first federal agencies to join The Pulling Together Initiative, the Interagency Invasive Terrestrial Animals and Pathogens, and the Federal Committee for the Management of Noxious and Exotic Weeds, which were the first technical and advocacy groups to manage invasive species across federal land management boundaries. Through DoD competitive funding programs discussed later, DoD supported participation in several initiatives including Weed Management Areas; demonstration of Early Detection and Rapid Response (EDRR) techniques; hyperspectral and remote sensing technologies; and other projects aimed at preventing, managing, and controlling the spread of invasive species. Funding these sorts of efforts is consistent with DoD policy to identify, prioritize, monitor, and control invasive and noxious species and feral animals on its installations (DoD NR Program, 2011).

Operational Impacts Due to Invasive Species

Impacts to Force Health Protection

Invasive species have broad and far-reaching impacts on the health and safety of military personnel and operations. Invasives cause injury, transmit disease-causing pathogens, and adversely impact safety and security by obscuring unexploded ordnance, serving as fuel for wildfires, and impeding line-of-site monitoring for security forces personnel. For injury examples, invasive feral swine on southeastern and increasingly northern military installations are known to attack military and civilian personnel and dogs. This is in addition to the adverse impacts on sensitive species, destruction of training areas due to foraging activity, aircraft and vehicle strike hazards, and danger to the health of wildlife and livestock

from the known reservoirs of more than 30 diseases and 37 parasites. Red imported fire ants (RIFA) also cause injury via mass bites/stings, and impact sensitive wildlife due to their aggressive predatory behavior. RIFA hinder personnel and equipment movement, and controlling them is often impractical due to the size of training areas or presence of endangered species (e.g., Camp Bullis, TX) which may preclude insecticidal treatment. Giant hogweed, an invasive plant present on several installations, has caused skin burns and temporary blindness to soldiers when they've come into contact with the plant during training operations.

Finally, personnel are understandably concerned about introducing disease pathogens and reservoirs, as well as arthropods that can serve as disease vectors. The Asian tiger mosquito (ATM), an aggressive day biting mosquito, continues to move north and west. ATM, along with the yellow fever mosquito (*Aedes aegypti*), are the primary vector species for the recent introduction of invasive arboviruses, Chikungunya and Zika. These introductions can impact local and deployed forces, and require significant surveillance, testing, and control measures for affected installations in the U.S. (DoD AFPMB, 2016). Additionally, the 2016 Zika outbreak in the New World resulted in mission hampering country clearance requirements (e.g., Italy) for personnel to disinsect military and commercial aircraft to eliminate mosquitoes potentially stowed away in aircraft and capable of transmitting the Zika virus. To meet this requirement, DoD had to work closely with the U.S. Environmental Protection Agency to obtain an emergency Section 18 registration to allow the use of insecticidal treatments in cabin areas of military aircraft.

Safety Impacts

Invasive species and wildlife management around the airfields is essential to safe military flight operations. For example, Holloman Air Force Base (AFB), NM, expended significant resources to remove invasive grasses from the airfield to protect aircrews and prevent damage to runways, ramp space, and aprons as well as the multi-million dollar aircraft and equipment used for operational activities. Many invasive grass species attract birds. To avoid bird/animal aircraft strike hazards, controllers divert, cancel, or delay flight operations when they see birds on or near the runway.

Another force protection concern is the common reed (*Phragmites spp.*), an aggressive 8' to 16' tall invasive wetland species increasingly present around the perimeters of several military installations along the Chesapeake Bay (e.g., Norfolk Naval Air Station, Langley AFB, Fort Eustis, VA). These plants and others, such as mangroves on military installations in Hawaii (see below), prevent clear line-of-sight around the installation perimeter threatening base security and negatively affect sensitive species. Norfolk and other adjacent natural resources staff are strategically controlling *Phragmites* using satellite mapping to identify problem areas, conduct targeted herbicide spraying, and then reseeding those areas with native plants to limit common reed growth and expansion (DoD, 2011).

Environmental Impacts

Threatened, Endangered, and At-Risk Species

DoD owns and operates some of the finest remaining examples of rare wildlife habitats, and has the highest density of federally listed threatened and endangered species of any federal land management agency, with 15 listed species and 85 species at-risk found only on DoD's lands. As more native species

become imperiled, DoD's burden to manage these species also increases. Because of the significant impact invasives have on sensitive species, DoD takes seriously its responsibility to prevent and control their introduction, spread, and establishment.

For example, feral swine destroy nesting habitats; eat or uproot endangered plants; disrupt food webs; and prey on endemic birds, herpetofauna, small mammals, and eggs of endangered species, such as sea turtles. DoD manages invasive feral swine by educating and communicating with stakeholders, as well as by hunting, trapping, and monitoring the species.

At Marine Corps Base Hawaii, DoD manages the endangered Hawaiian stilt, which resides on its lands. Each year, just before nesting season, marines drive Amphibious Assault Vehicles through nearly 200 acres of mud flats to break up non-native pickleweed and destroy invasive mangrove roots that the stilt uses for breeding. This activity provides essential training to our Marines, while directly helping to increase the Hawaiian stilt population on base from 60 birds in 1982 to nearly 150 individuals in 2017, which is approximately 10 percent of the bird's total population in Hawaii (U.S. Marine Corps, 2017).

Native Habitat

DoD maintains access to realistic testing and training areas by preserving biodiversity and fostering healthy ecosystems. Invasive species are the second-leading threat to biodiversity and species listings, behind habitat loss. Invasives can damage native landscapes and disrupt ecosystem processes such as nutrient cycling, sediment deposition, and erosion. It is DoD policy to use locally-adapted native plants (DoD NR Program, 2011).

Non-native mangrove stands have replaced native vegetation and are interfering with military readiness at Marine Corps Base Hawaii at Kaneohe. The mangroves can grow as tall as six-story buildings and obstruct lines of sight near installation borders. The mangroves take over native marsh habitats by converting them into thickets that are inhospitable to both military exercises and native species, increasing flood risks.

The invasive coconut rhinoceros beetle (CRB) was discovered for the first time in Hawaii at Joint Base Pearl Harbor-Hickam (JBPHH) in 2013. Since then, the CRB has become a threat to the quality and safety of training areas at JBPHH. The CRB bores holes into trunks of the iconic Hawaiian coconut and other types of palm trees, often leading to widespread tree mortality. This creates a safety hazard until dead trees can be cut down, and reduces training realism in areas of JBPHH where CRB densities are high. Because the CRB is still primarily found on JBPHH properties, the installation is working cooperatively with the U.S. Department of Agriculture, Animal and Plant Health Inspection Service (USDA APHIS), Plant Protection and Quarantine program; State of Hawaii Department of Agriculture, Plant Quarantine; and the University of Hawaii Department of Plant and Environmental Protection Sciences to eradicate CRB from Hawaii by monitoring its populations, surveying for and removing actual and potential breeding sites, and conducting public outreach and education (Campora, 2014). USDA APHIS and the University of Hawaii found that the overall presence of CRB on DoD lands decreased through 2016 while the overall presence of CRB on non-DoD lands on Oahu increased over the same time period. These findings illustrate the effectiveness of collaborative and coordinated efforts

to eradicate CRB through monitoring, eliminating breeding sites, managing plant debris, and educating the public is effective (HDOA, 2016).

Wildfire

Invasive plants can overrun habitats, out-compete native species and weaken the health of forest trees and other native vegetation. This creates a change in species composition, which can make ecosystems more susceptible to wildfire. When invasives kill off native vegetation, the result is significant land areas with fuels that, when combined with lightning strikes, unattended campfires, military exercises, and other events can significantly increase the risk of wildfires. Uncontrolled fires threaten the safety of military personnel, dependents and, when fires cross military land borders, local communities. These fires also threaten infrastructure, and are often expensive to control and mitigate.

In addition, on affected military lands, wildfires degrade testing and training lands by creating smoke and fugitive dust that negatively affect air quality. This directly impacts the military's ability to conduct flight operations and training activities. The inability to conduct live fire exercises and the impediment of clean-up operations that obscures unexploded ordnance and increases wildland fire risk on affected military ranges has resulted in the use of C-130 aircraft to target heavily used training areas with various herbicides on Hill AFB (Utah Test and Training Range); Dugway Proving Ground, UT; Mountain Home AFB (Saylor Creek Range), ID, Barry M. Goldwater Range, AZ, and Smokey Hill Range, KS).

On military installations in the Pacific, non-native, invasive grasses have become the dominant ground cover, creating a fire risk from weapons firing training and endangering federally protected species. For example, fountain grass is a fire-promoting invasive species that has made its way into formerly forested landscapes on the island of Hawaii. U.S. Army Garrison Hawaii Pohakuloa Training Area, the Army's largest and most realistic training area in the Pacific, now has fountain grass cover. This invasive grass species has increased the frequency and size of wildfires on the training area; impacted important habitat for threatened, endangered, and at-risk species; and requires DoD natural resources managers to develop strategies to protect and restore the area to regain full mission capabilities for testing and training activities.

Invasives currently impact installations across the country, and many of these increase wildfire risk. For example, cheatgrass or other invasive plants/grasses dominate hundreds of thousands of hectares of western U.S military ranges dramatically altering species composition and creating conditions for wildfire on non-wildfire adapted ecosystems. Similarly, non-native forest pests such as bark beetles that have invaded Vandenberg AFB, the U.S. Air Force Academy, and other installations commonly kill or weaken trees which also exacerbates wildland fire risk (Vandenberg AFB, 2011).

In response, DoD's natural resources managers actively manage for both invasives and for fire. At Shaw Air Force Base, SC, installation staff implement a prescribed fire program that safely burned 1,568 acres at Shaw's Poinsett Range in 2013. Many of DoD's installations have similarly robust wildland fire programs. These programs reduce and clear excess vegetation, protecting sensitive resources, improving habitats, and directly supporting recovery efforts for fire-tolerant native species such as longleaf pines and the endangered red-cockaded woodpecker (Sustainable Fort Bragg, 2017).

Current target species include cheatgrass, halogeton, musk thistle, tamarisk, tumbleweed, Sahara mustard and others. As with all invasive species efforts, management is prescribed in the installation INRMP as well as applicable National Environmental Policy Act and Endangered Species Act documentation and consultations.

Economic Impact

Mitigation Cost

Tracking invasive species expenditures is difficult for DoD, as the Department doesn't have specific appropriations, separate budget line items, or a single dedicated program to manage invasive species. Rather, invasive species surveillance, prevention, management, and control are embedded in a myriad of programs including Operations, Training, Pest Management, Morale and Welfare, and Natural Resources. Collectively, DoD devotes significant resources to managing invasives and mitigating their negative impacts. For instance, Marine Corps Base Camp Pendleton in southern California spent roughly $1.2 million over a five-year period to control invasive fauna that would have caused severe infrastructure damage, devastated native ecosystems, and potentially halted training.

In another example, the International Maritime Organization's Marine Environmental Protection Committee developed guidelines to control ship ballast water and prevent the introduction of unwanted aquatic organisms and pathogens. The U.S. Coast Guard initially published these guidelines for adoption as voluntary standards to decrease the possibility of introducing cholera and other pathogens into U.S. waters, and converted them to mandatory regulations in 2004. While the standards do not apply directly to Navy ships, the Navy has adopted the U.S. Coast Guard standards to prevent costly remedies that would be necessary to control the invasive pathogens.

Likewise, the fee-for-service military agricultural pre-clearance inspection program, covered under the Defense Transportation Regulations (DTR) Chapter 505-506 (*Agricultural Cleaning and Inspection Requirements* and *DoD Preclearance Program Customs and Agriculture Inspections* respectively), helps to avoid expensive mitigation expenses associated with the accidental introduction of invasives. The DTR also expedites the return of military personnel, vehicles, equipment, and cargo from forward operating locations around the world.

Inter- and intra-theater and state movement of equipment, vehicles, and supplies, as well as allied-nation humanitarian relief efforts can also result in the inadvertent introduction of invasive species. To prevent this from happening, DoD implements management practices that include cleaning facilities that meet appropriate U.S. Environmental Protection Agency, state, and host nation standards; customs inspections of equipment and personnel; equipment washdowns; and military cooperator plant and pest quarantine officer inspections (Medina, 2016). Inspections and cleanup operations are performed via a long-standing Memorandum of Understanding and partnership with USDA APHIS that is intended to prevent the entry of foreign animal and plant pests, diseases, and invasive species into the U.S.. DoD also has phytosanitary regulations (e.g., DoD 4149.01-M-1) for non-manufactured wood packing materials (WPM) aimed at preventing the introduction of pests through transport of uninspected WPMs used in global shipping and cargo transport.

Lost Capability Costs

Adverse mission impacts from invasives include limiting field maneuvers, live fire training, and parachute exercises, as exemplified by the invasion of yellow star thistle (YST) at Fort Hunter Liggett, CA. Fort Hunter Liggett mission activities require parachute training. When ground-truthing a drop zone prior to an exercise, staff found a 5,000-acre thicket of YST, the thorns of which were ½" long. Dropping soldiers into such an environment would have injured them, snagged and torn their parachutes, and clogged vehicle air filters. Additionally, dried YST thickets are highly flammable, increasing wildfire risk that could have jeopardized military families and base infrastructure. To combat this issue, Fort Hunter Liggett established an integrated pest management (IPM) approach involving hand pulling, mowing, herbicide applications, and biological controls. Natural resources managers also used satellite mapping to identify areas of greatest overlap between training lands and YST habitat. Ultimately, staff removed about 10,000 acres of YST. The costs for control and for the workarounds necessary to continue mission activities, though not specifically tracked, was significant (DoD, 2011). Any time DoD is unable to perform testing, training, or operational activities due to invasive species, installations must implement often costly workarounds to ensure that our military personnel are properly trained. As with other invasive species issues, funds spent battling invasives are funds that could otherwise be spent on readiness requirements.

DoD Invasive Species Management

Policy and Guidance

Policy and guidance related to invasive species management is divided among DoD's Pest Management, Operations and Maintenance, and Natural Resources programs. Per DoD Instruction 4150.07, *DoD Pest Management Program*, DoD's Armed Forces Pest Management Board (AFPMB) provides policy and guidance stating that the Military Services shall, subject to availability of appropriations, comply with regulations, including Executive Order 13112 (now Executive Order 13751), and (1) prevent the introduction of invasive species; (2) detect and respond rapidly to, and control populations of, such species using IPM techniques; (3) monitor invasive species populations accurately and reliably; (4) restore native species and habitat conditions in ecosystems that have been invaded; (5) conduct research on invasive species, develop technologies to prevent introduction, and provide the latest IPM techniques for their control; and (6) promote public education on invasive species. The DoD Pest Management regulation also states that the Military Services shall comply with regulations the National Invasive Species Management Plan developed by the National Invasive Species Council (NISC).

Natural resources managers plan, budget, and execute invasives control through two types of plans:

- Integrated Pest Management Plans, which focus on identifying pests, pathogens, and insects, monitoring those pests, setting action thresholds, and preventing and controlling pests, and
- Integrated Natural Resources Management Plans, which are planning documents required by the Sikes Act that outline how each military installation with significant natural resources will manage those resources.

DoD's Natural Resources Instruction (DoDI 4715.03) states that invasive species management must comply with DoDI 4150.07, and be addressed in the installation's INRMP. Specifically, DoDI 4715.03 requires that installations identify, prioritize, monitor, and control invasive and noxious species and feral animals on its installations whenever feasible.

In addition, DoD requires that native species be used, where feasible, to restore any habitats from which native species are removed or controlled (see *DoD Policy to Use Pollinator-Friendly Management Prescription*, September 5, 2014), and that landscaping practices shall be consistent with the Presidential Memorandum *Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds* (April 26, 1994). Accordingly, each installation shall, to the extent practicable, conserve and protect water resources, use locally adapted native plants, avoid using invasive species, and minimize the use of pesticides and supplemental watering. Each of the Military Services has more detailed pest management and natural resources conservation regulations associated with unique mission-relevant requirements.

DoD Natural Resources Competitive Funding Programs

Through several competitive funding programs, DoD supports priority invasive species research, demonstration, and pilot projects through the DoD Legacy Resource Management Program (Legacy Program), Strategic Environmental Research and Development Program (SERDP), and Environmental Security Technology Certification Program (ESTCP). This section also includes information on the Secretary of Defense Environmental Awards.

- The DoD Legacy Program provides funding for natural and cultural resources projects that support military readiness and enhance conservation objectives. The Legacy Program has funded 145 invasive species-related projects totaling approximately $19.3 million from Fiscal Year 1991 to 2016. These projects go beyond federal regulatory and statutory compliance requirements to protect and manage resources to ensure continued access to realistic habitat conditions and support combat readiness needs, while fulfilling stewardship responsibilities. For example, the Legacy Program funded an early detection/rapid response (EDRR) invasive species strike team demonstration project (14-622) to illustrate EDRR invasive plant control and native species restoration. Personnel treated 23 invasive plants on nearly 400 acres at Naval Air Station Patuxent River, MD, Fort Detrick, MD, Naval Air Station Cherry Point, NC, and other installations, then surveyed those sites to determine regeneration and the need for reestablishing native plants. Through this project, installation personnel also developed partnerships with local stakeholders through Cooperative Invasive Species Management Areas, and updated and refined an online tracking/reporting tool and the manual for DoD EDRR strike teams.

- SERDP funds basic and applied research to address DoD's environmental challenges and sustain the military mission. One SERDP project, *Application of Hyperspectral Techniques to Monitoring and Management of Invasive Weed Infestation* (RC-1143), funded personnel to develop new remote sensing methodology using hyperspectral imaging (HSI) to test the detectability of plants that grow over a wide range of environmental and climatic conditions. This generated a predictive model of potential plant invasion that integrated HSI information

with a geographic information system, resulting in improved understanding of key non-native invasive plant distribution on military installations, and the environmental conditions associated with their distribution and spread. Remote sensing surveys can dramatically increase survey area while reducing associated costs by more than 90 percent (SERDP, 2017).

- ESTCP funds demonstration projects. A series of ESTCP projects (ESTCP, 2013) focused on one of DoD's most important invasive species: the brown treesnakes (BTS, *Boiga irregularis*). The BTS infestation on Guam has led to the extinction and/or extirpation of all but two of Guam's 12 native forest birds, has caused power outages and other impacts, and has resulted in significant mitigation expenses for military operations. One recent high visibility effort, *A Novel Tool for Controlling Brown Treesnakes* (RC-200925), was a multi-agency cooperative proof-of-concept project using aerial application of acetaminophen-treated baits to control BTS. The USDA's National Wildlife Research Center and collaborators demonstrated the effectiveness of applying baits aerially to reduce BTS populations in forested sites on Guam. The success of the aerial application proof-of-concept project has resulted in the continued development of aerial application technology and long-term planning for large-scale application BTS control. Aerial application is an additional tool to supplement other operational BTS control methods, such as trapping, bait stations, hand capture, and canine inspection of outbound cargo.

- The annual Secretary of Defense Environmental Awards encourage individuals, teams, and installations to demonstrate dedication and thought-leadership to develop and implement effective environmental practices, conservation efforts, and protect human health without compromising mission success. Through this awards program, the Office of the Secretary of Defense has recognized several invasive species efforts in recent years. For example, Camp Dawson Army Training Site, WV, received a 2016 Secretary of Defense Environmental Award for plotting the location of invasive autumn olive, multiflora rose, Japanese knotweed, and tree of heaven on the Camp's training sites, and incorporating the data into the installation's integrated invasive species eradication plan. In 2015, Camp Blanding Joint Training Center, FL, won the Secretary of Defense Environmental Award for using prescribed burns and herbicide treatments to manage the spread of cogon grass, Chinese tallow, Japanese climbing fern, and torpedo grass that degrade native habitats on important military training areas (DENIX website, 2017). These and other efforts like it, illustrate how DoD comprehensively manages ecosystems in ways that directly and indirectly support both natural resource program and military mission goals.

Managing Invasive Species through Biosecurity Plans

In some situations, DoD must develop coordinated plans to counteract significant invasive species risks that can impact mission requirements. In support of the relocation of U.S. Marine Corps personnel to Guam (frequently called the "Guam Military Relocation"), the Department of Navy (DON) has invested nearly $4 million to proactively address regional concerns about terrestrial, freshwater, and marine invasive species risks and develop a regionally-vetted framework that will guide implementation efforts

across the region. Working with the U.S. Geological Survey, Smithsonian Environmental Research Center, National Invasive Species Counsel, University of Guam, and USDA APHIS, DON produced the Regional Biosecurity Plan for Micronesia and Hawaii (RBP) – the most comprehensive plan of its type ever produced. The Plan assesses risk pathways through which invasive species travel, with a focus on current threats from the CRB and BTS (University of Guam and the Secretariat of the Pacific Community, 2014). DON also has, and is implementing, an invasive species focused biosecurity plan for Navel assets on San Clemente Island in CA.

Conclusion

A key theme that runs throughout many military invasive species management and control efforts is that prevention and partnerships provide the foundation for success. This approach is exemplified by the Cooperative Invasive Species Management Areas Program, which promotes public-private partnerships to manage invasive species at Eglin AFB, Avon Park Air Force Range, Camp Blanding Joint Training Center, and Key West Naval Air Station, FL, as well as the lands surrounding these installations.

DoD leverages environmental stewardship responsibilities with military readiness requirements. Invasive species pose numerous site-specific challenges, many of which significantly impact mission critical activities. Since no single approach is guaranteed to work in every situation, DoD regularly implements a wide array of approaches to combat the spread of, and threats from, invasive species. Unlike other federal agencies, invasive species management in DoD is largely decentralized and managed locally at the installation level via INRMP implementation. Funding is ultimately dependent on operational needs and regulatory drivers such as the Sikes Act and Endangered Species Act.

While this chapter covers only a portion of the invasive species challenges important to DoD, preventing the spread of invasive species, monitoring them, and controlling new species introductions will continue to be a Department priority. Funding for natural resource management within DoD is limited, so our installations and our leadership works collaboratively with partners at all levels. In partnership with federal, state, local, academic, and industry partners, DoD will continue to address a range of invasive species issues to sustain and ensure maximum flexibility for vital testing, training, and operational activities needed for our national defense.

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Acknowledgements

The authors would like to thank everyone who provided input and reviewed this chapter. Special thanks to Valerie Leone and Kimberly Alles, Booz Allen Hamilton, for their document coordination and edits.