Invasive Species Management on Military Lands

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Invasive species are a leading threat to our nation’s rich biodiversity, as well as to national security, the economy, and human health. Since colonial periods, thousands of non-native species have been introduced to the United States, some by accident and others quite deliberately. Based on the U.S. Department of Agriculture (USDA) Plants Database, currently 13 percent (5,303 of 40,140) of the vascular plant species in the nation are not native to North America. These would include most of Americans’ favorite foods and many ornamental plants. The majority of non-native plants and animals existing in the U.S. are not harmful, but some non-native species cause tremendous damage when released outside of their native habitats. As defined by Executive Order 13112, invasive species are those non-native species that “cause economic or environmental harm or harm to human health.” The Congressional Office of Technology Assessment reported in 1993 that 15 percent of invasive plants and animals cause severe economic and environmental harm.

Invasive species occur throughout the lands and waters of the United States, and military lands are no exception. These invaders are a major and growing problem on military lands, impacting the ability to train the nation’s armed forces, degrading ecosystem health of these public lands, endangering native biodiversity, and potentially causing harm to human health. The military faces some unique challenges in combating invasive species on their lands, challenges related to their primary goal of maintaining the quality of military lands for realistic training exercises, while also meeting their responsibility to safeguard the quality of natural resources and biodiversity on their lands.

Numerous military installations across the country have employed successful and innovative methods to control invasive species, examples of which will be referred to throughout this chapter and in the case studies. Given the vast amount of land that the military owns and manages in the United States, the military has a unique responsibility in managing invasive species and in helping to prevent new introductions. The Department of Defense (DoD), however, cannot stop the problem of invasive species on its own. Invasive species are a “beyond the fence-line” issue that must be addressed comprehensively, by Congress and other state and federal public land management agencies, as well as by private entities and individuals. Given the far-reaching nature of this problem, DoD has formed many diverse partnerships in battling invasive species, some of which are highlighted below.¹

Impacts on Military Operations

Invasive species affect the nation’s military installations and operations worldwide. The National Wildlife Federation’s recent report (Westbrook and Ramos 2005) on invasive species on military lands provides twelve cases outlining numerous threats and costs to military operations: from six-foot tall spiky yellow star-thistle shredding parachutes that average $4,000 apiece at Fort Hunter Liggett in California to Phragmites causing security concerns at Avon Park Air Force Range in Florida. Holloman AFB in New Mexico allocated over a half million dollars to remove invasive species from airstrips in order to protect the safety of Air Force pilots and prevent damage to aircraft worth tens of millions of dollars. And in Hawai‘i, dense non-native mangrove thickets can breach “line of sight” security for Marines assigned to protect base borders along the shoreline (Westbrook and Ramos 2005).
ECOLOGICAL IMPACTS

Many reports have documented the ecological impacts of these non-native invaders, including citing invasive species as one of the greatest threats to biodiversity (e.g. Stein et al. 2000). Worldwide, an estimated 80 percent of endangered species could suffer losses due to competition with or predation by invasive species (Pimentel et al. 2005). In addition to direct competitive impacts to native species, some of the worst invasive species are able to alter native habitats and ecosystems. Invasions by non-native species have been shown to modify ecosystem processes, like nutrient cycling, fire frequency, hydrologic cycles, sediment deposition, and erosion (Kelly 2007). On the Marine Corps Base Hawai‘i, non-native mangrove stands take over native marsh habitats, converting critical habitat for endangered Hawaiian waterbirds into mangrove thickets that are inhospitable to both native species and to realistic military training exercises on base. On Avon Park Air Force Range in Florida, invasive wild hogs compete with the endangered Florida scrub jay for food and destroy nesting habitat for many other endangered species (Westbrook and Ramos 2005). Such feral hogs are a growing menace at several other military installations. When invasive species cause habitat destruction and harm rare native species, the result can lead to reductions in available training lands on installations.
ECONOMIC IMPACTS

Invasive species impact the United States economy in many ways, negatively affecting economic sectors such as western ranching, Great Lakes shipping, southern forest plantations, and midwestern farming, just to name a few. Within the U.S., the estimated damage and management cost of invasive species is more than $138 billion annually, more than any other natural disaster (Pimentel et al. 2005). In addition to these costs, many economic losses from recreational and tourism revenues are difficult to calculate (Simberloff 2001); as a result, the $138 billion estimate may be low.

If monetary values could be assigned to the extinction of species, loss of biodiversity, and reduction of ecosystem services, costs from impacts of invasive species would drastically increase (Pimentel et al. 2005). For the military, the costs related to invasive species are significant and are increasing each year. To name one example, Camp Pendleton in southern California spent approximately $1.2 million over a five year period trying to control giant reed (Arundo donax) and tamarisk or salt cedar (Tamarix ramosissima) (Westbrook and Ramos 2005). While it also can be expensive to prevent invasive species on military lands—for example through programs to wash tanks and other military vehicles before and after transport—prevention is a critical first-line defense against new invaders on military lands. Once established, managing invaders such as the giant reed and tamarisk, mentioned above, can often be a multi-year and multi-million dollar effort.

RECREATIONAL IMPACTS

As many boaters and fishermen can attest, invasive species like water hyacinth (Eichhornia crassipes), hydrilla (Hydrilla verticillata), Eurasian milfoil (Myriophyllum spicatum), and water chestnut (Trapa natans) can reduce or prevent access to water bodies. In some cases, it is the recreational activities that have introduced or spread invasive species. So have people out for innocent walks;
**Miconia calvescens**, a broad-leaved plant introduced as a handsome ornamental in Hawai‘i in the 1960s, produces tiny seeds that must be removed from shoe soles by vigorous brushing, lest they plant themselves elsewhere. It and other invasives can limit hiking options or reduce the outdoor experience. Conservative estimates of the economic costs from invasive species impacts on wildlife-related recreation in Nevada alone range from $6 million to $12 million annually (Elswerth et al. 2005).

### Invasive Species Vectors

Invasive species have arrived in the United States through a multitude of means, including introductions by early human settlers who seek reminders of their homelands, to importation of ornamental plants, to introductions by government agencies to combat some other problem (often an agricultural one), to an expanding global trade enterprise that inadvertently allows the rapid spread of species. Modern trade has greatly increased the spread of a number of species. Asian tiger mosquitoes hitchhike into new areas in rainwater pools in discarded tires and even aboard water-filled depressions on ship structures. This mosquito is associated with the transmission of many human diseases, including dengue virus, West Nile virus, and Japanese encephalitis (Global Invasive Species Database 2006).

Ship ballast, typically water pumped into a ship’s tanks at one port and pumped out at another, is used to balance the weight and control the steerage of freight vessels and is a well-documented vector. The most noted species introduced by ballast is the zebra mussel. Zebra mussels (*Dreissena polymorpha*) are native to the Caspian Sea, but long ago began spreading throughout much of Europe. In 1988, they were detected in the Great Lakes where they had caused serious problems by out-competing native species for food and damaging harbors, boats, and power generation plants.

In some cases, the military itself unintentionally may have been responsible for the spread of invasive species. While it is difficult to pinpoint the precise time, location, and cause of introduction, there is speculation that the military introduced the brown tree snake to Guam, African iceplant to the San Francisco Bay area, black rats to the Midway Islands, and sakosisa shrubs (*Timonius timon*) to Palau. The military has taken a leadership role to reduce future unintentional introductions. The Armed Forces Ballast Water Management Program, which requires DOD vessels to twice flush ballast water at least twelve nautical miles from shore, should be used as an example to commercial vessels. Transportation policy and procedures rules already require the washing of vehicles after field operations. The primary purpose is to extend the life of field equipment, but it also has a secondary purpose of reducing hitchhiking foreign pests from entering U.S. borders.

### Federal Guidelines for Invasive Species

The United States has several legal guidelines that are intended to prevent and combat invasive species. Chief among them is the National Invasive Species Act of 1996. This act is a reauthorization and amendment to the 1990 Nonindigenous U.S. Aquatic Nuisance Prevention and Control Act of 1990 (P.L. 101-646), which authorized the National Oceanic and Atmospheric Administration and the U.S. Fish and Wildlife Service to address aquatic invaders. Section 1103 of the
The 1996 act states that the “Secretary of Defense shall implement a ballast water management program for seagoing vessels of the Department of Defense and Coast Guard (see http://www.nemw.org/nisa_summary.htm). The act also calls for the creation of state invasive species management plans, development of ballast water guidelines for commercial vessels, research studies, and demonstration projects. Advocates of the ballast program argue that the act needs reauthorization that includes the program’s expansion to cover all commercial vessels similar to that of the armed services program. The Aquatic Nuisance Species Task Force (http://www.anstaskforce.gov/default.php) is an intergovernmental group that helps to implement the act. There is also a hotline to report sightings of aquatic nuisance species (ANS) in the U.S. (telephone 877-STOP-ANS; http://cars.er.usgs.gov/Nonindigenous_Species/Stop_ANS/stop_ans.html).

**EXECUTIVE ORDER 13112, INVASIVE SPECIES.** Executive Order 13112, which was signed in 1999, created the National Invasive Species Council (NISC) that is composed of 13 federal departments and agencies, including the Department of Defense. The council’s principal objectives are to prevent the introduction of invasive species, monitor invasives’ populations, promote restoration of native species, and promote public education on invasive species (http://www.invasivespeciesinfo.gov/laws/execorder.shtml). A five-year review of the NISC was recently completed (see http://www.invasivespeciesinfo.gov/docs/council/fiveyearreview.pdf). This document highlights the accomplishments to date and the NISC’s future plans.

**ARMED FORCES PEST MANAGEMENT BOARD.** This board (http://www.afpmb.org) provides numerous resources regarding invasive species and other pests impacting military lands and operations. The AFPMB has developed best management practices, standard pesticide use guidelines, resources for identifying invasive species, and links to research activities. The AFPMB publishes technical guidance for installation personnel who are responsible for pest management plans (see http://www.afpmb.org/pubs/tims/TG18/tg18.htm). The DOD website lists a number of “Technical and Informational Resources Regarding Invasive Species” notices. They may be found at https://www.denix.osd.mil. Another useful document on the site is “Predicting the Spread of Non-Indigenous Invasive Species: Can It Be Done?” at https://www.denix.osd.mil.
Combating Invasive Species

The most cost-effective means to control invasive species is to prevent their initial arrival. The impacts of many of these species, however, are not understood until they are well established. For those species where environmental and economic impacts are known, measures need to be taken to reduce the risk of introduction, including surveys for these species at ports of entry and military bases where equipment and materials are imported or returned from foreign soils. Military vessels and equipment used in foreign lands and waters where potential invasive species are suspected should be thoroughly cleaned before leaving those foreign lands. If any invasive species are found at our first lines of defense (i.e. shipping ports), then immediate eradication should occur. As noted previously, preventing the discharge of foreign ballast water by military vessels in U.S. ports will reduce the introduction of invasive aquatic species.

On military lands where invasive species are already present, management activities should include restoration actions. The removal of invasive species without restoration can lead to the reestablishment of the same or new invasive species. Furthermore, on many installations, there is a chance that invasives species can reinvade from lands outside the installation boundaries. On Avon Park Air Force Range in Florida, the highly invasive and problematic climbing ferns and tropical soda apple occur in public and private lands nearby. It is important for military natural resources managers at all installations to think beyond the fenceline and cultivate public and private partnerships to keep invasive species under control.

EARLY DETECTION/RAPID RESPONSE. The idea of early detection/rapid response is a two-part component: first, surveys to identify newly-established invasive species, and second, an effort to eradicate newly detected infestations. There are many cases where early detection has identified newly established pests, but managers have proven less adept at following up with eradication programs. Many scientists want to study the problem more, but agencies are bogged down in red tape that prevents immediate eradication. Given the potential environmental and economic impacts, a suggested strategy of “yank it now, ask questions later” may prove most cost effective. This is particularly important for species that are known to cause harm.
MECHANICAL CONTROL. The use of mechanical control is often effective for dealing with small, newly established populations or as part of a large scale restoration program. Mechanical control may simply include hand pulling or the use of large equipment. No matter what control feature is employed, follow-up monitoring is necessary to ensure eradication.

PESTICIDES. Many modern pesticides have been vastly improved over earlier controls, such as DDT, with its notorious residual environmental impacts. Methodologies for applying pesticides have also improved. Cut-stump treatments (i.e. painting herbicides directly onto a cut surface), wet wicking (hand applying herbicides to individual target plants), and stem injections (the use of needles to inject herbicides directly into a target plant or impacted plant) allow applicators to directly apply chemicals to the target species with little or no non-target impacts. In extreme cases, broadcast spraying of herbicides may be viewed as the only option, in which case more care and review are needed. Drawbacks to chemical treatment include its cost and potential negative impact to the environment and to the applicators’ health.

BIOLOGICAL CONTROLS. Biological controls are growing in use as non-chemical opponents of harmful invasive species and diseases. Biocontrols can be defined as the use of natural enemies, usually from a pest’s native lands, to reduce the impact of problematic insects, diseases, and plants. There are many examples of successful use of biocontrols in the place of chemical poisons; a tiny parasitic wasp, part of a large group of parasitoids, controls many agricultural pests and diseases, for example. The Texas Agricultural Experiment Station has collaborated with the DoD to remove noxious weeds on military lands. The weeds include leafy spurge, field bindweed, spotted knapweed, Canada thistle, and St. John’s wort; participating installations include Fort Carson, the Air Force Academy, Rocky Flats Environmental Technology Site, Buckley AFB, all in Colorado, and F.E. Warren AFB, Wyoming, (see http://amarillo.tamu.edu/programs/entotaes/CNWB.htm; http://amarillo.tamu.edu/programs/entotaes/Biological_Noxious_Weed_Control.pdf).

As with any effort to tinker with nature, biocontrol can have unintended, negative results. One danger is that the biological control agent—parasitoid, fungus, nematode, bacterium, competing organism, growth regulator—can gobble up or
infect not only its intended target but also beneficial organisms. In the 1970s, for example, biologists released the Asian ladybug in an effort to control aphids that were attacking pecan trees in the southeastern U.S. These ladybugs were successful at eradicating these aphids, but they also had appetites for other insects. The result has been a biocontrol that eats so many aphids and other native ladybugs that many native ladybugs became threatened or extinct. Even New York’s official state insect, the nine-spotted ladybug (*Coccinella novemnotata*), is now extinct from New York State as a result of competition with the Asian ladybug.

These and other examples should be viewed as cautionary tales. When biocontrols are thought to be the only solution, detailed research and extensive testing must be done. Researchers and land managers need to learn from the biocontrol failures. They need to ensure that biocontrols do not become the next wave of invasive species, potentially worse than the species they were meant to control. But if carefully evaluated before introduction, biological controls can be highly effective, as Jerry Johnson at Fairchild AFB, Washington, can attest (see case study). Biocontrol agents are tightly controlled by the U.S. Department of Agriculture.

**Partnerships.** As a member of the National Invasive Species Council ([http://www.invasivespeciesinfo.gov/council/main.shtml](http://www.invasivespeciesinfo.gov/council/main.shtml)), the Armed Forces Pest Management Board ([http://www.afpmb.org/](http://www.afpmb.org/)) works with multiple agencies to combat invasive species. Throughout the country, Cooperative Weed Management Areas (CWMAS) or similar partnerships are forming to address invasive species problems across multi-jurisdictions (see [http://www.weedcenter.org/weed_mgmt_areas/wma_overview.html](http://www.weedcenter.org/weed_mgmt_areas/wma_overview.html)). These partnerships may allow the DoD, along with other federal agencies, state agencies, NGOs, and local land managers, to share resources and experiences to better manage invasive species.

**Conclusions**

As with any land manager today, the military’s first line of defense against invasive species must be prevention of new invasions and preventing expansion of existing invaders. The military already has many policies in place to aid in prevention, such as DoD’s Customs and Border Clearance Program Regulations ([http://www.dtic.mil/whs/directives/corres/pdf/503049p.pdf](http://www.dtic.mil/whs/directives/corres/pdf/503049p.pdf)), but consistent funding is needed in order for prevention programs to be successful. Since funding is often linked to an installation’s Integrated Natural Resources Management Plan (INRMP), prevention of invasive species should always be considered in the INRMP, along with early detection, rapid response, and long-term management of invasives.

Perhaps the most important weapon in the fight against invasive species on any installation is outreach and partnerships. Installations such as Fort McCoy, Wisconsin, have enlisted the help of citizen volunteers in controlling numerous invasive plants, such as garlic mustard and leafy spurge. Staff at the Wisconsin fort have reached out to local stakeholders and developed partnerships to educate the community about the harmful impacts of invasive species on and off base. These partnerships have even aided Fort McCoy with bringing in funding for their efforts, through the National Fish and Wildlife Foundation’s “Pulling Together Initiative” (see [http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs](http://www.nfwf.org/AM/Template.cfm?Section=Browse_All_Programs)) which provides grants for public and private partnerships to combat invasive species (Westbrook and Ramos 2005). The military can also form very beneficial
partnerships with conservation organizations and invasive species researchers, to share resources, information, and best practices in the battle against invasives (see https://www.denix.osd.mil). The military has teamed with nongovernmental organizations, such as The Nature Conservancy, to combat some of the nation’s worst invaders, such as tamarisk or salt cedar.

Not only do installation natural resources managers need to look outside their borders to form partnerships, but they also should look to their own operational forces as partners in controlling invasive species. In some cases, management of invasive species can be aided by training activities, such as on the Marine Corps Base Hawai‘i, where Marines help clear out invasive pickleweed by running their amphibious assault vehicles over the invaded mudflats, helping to improve the habitat for native species such as the endangered Hawaiian stilt while simultaneously improving the training ranges for military maneuvers (Westbrook and Ramos 2005).

Managers of lands invaded by undesirable species also must consider native biodiversity and the entire ecosystem. When addressing the problem of invasive species in an INRMP, natural resources managers should always consider what they are managing for, not only what they are managing against. For example, in some cases, restoration efforts are necessary after invasive species have been removed from an area. Moreover, when managers think holistically, they are more likely to minimize any harmful environmental impacts of invasive species control efforts. Herbicides and biocontrols can be very useful management tools in some situations, but any potentially harmful side effects also must be examined, and the benefits weighed against the possible long-term costs. Partnering with other public and private land managers and with researchers in universities who have expertise in invasive species control can be critical for military natural resources managers seeking and testing the most cost effective and least environmentally harmful invasive species control methods.

Through sharing knowledge and expertise about invasive species prevention and management within the military, and among the military and various public and private partners, the battle against invasive species must continue in order to protect training lands from degradation and to safeguard the rich native biodiversity that occurs on military lands across the country.

NOTES
1. Some general sources of information about invasive species can be found at the National Invasive Species Information Center (http://www.invasivespeciesinfo.gov/); the National Fish and Wildlife Foundation (http://www.nfwf.org/), and http://tnckweeds.ucdavis.edu/ or http://www.invasiveplants.net/.
3. For more on beyond-the-fenceline thinking, see chapter 10.

Literature Cited


Other Resources


