

COMMANDER'S GUIDE ON INVASIVE SPECIES





ACKNOWLEDGEMENTS

The authors would like to thank everyone who provided input and reviewed this Guide.

Special thanks to Dr. Peter Egan, Armed Forces Pest Management Board, and Mr. Michael Lelmini, National Invasive Species Program Coordinator, U.S. Forest Service, for their subject matter expertise, as well as Kathryn Sabella, Booz Allen Hamilton, for her document coordination and edits.

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Booz Allen Hamilton. January 2011. Booz Allen wrote and produced this Commander's Guide on Invasive Species with funding awarded by the DoD Legacy Resource Management Program, under project #09-397 (Huntsville COE contract W912DY-09-2-0004) and project #10-397(AFCEE/ACX contract FA8903-05-D-8729, TO 0843).

This document is available in PDF format at <http://dodinvasives.org/Tools.html>.

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WHAT ARE INVASIVE SPECIES?

Invasive species are non-native plants or animals that out-compete native species in any given habitat. They cause significant harm to the economy and environment, and/or human health and wellbeing. These species can take over training lands, injure soldiers, damage equipment, overwhelm listed and at-risk species, and significantly erode natural resources and training budgets. For example, some invasive grasses can increase the risk of wildfire and rate of native species endangerment or extinction; others can cause loss of biological diversity, widespread tree death, species endangerment, and reduced water quality and quantity. Less directly, they can impact interstate trade and commerce, undermine border security operations, and decrease ecosystem services¹ vital to our nation's economy.

A 2005 study found that invasives cost the U.S. approximately \$138 billion every year² and more than \$1.4 trillion each year across the world.³ These costs would be several times higher if monetary values could be assigned to species extinction and losses in plant and animal diversity, ecosystem services, and aesthetics. On military lands, invasives can impair mission exercises, degrade training lands, and require costly work-arounds to meet mission objectives. For example, in Guam, the brown treesnake (a non-native species accidentally introduced to the island in the late 1940s) has eliminated nine of the island's 12 native forest bird species and most of the terrestrial vertebrates, killed many house pets, caused widespread power outages resulting in millions of dollars of damages, and bitten children – usually when they are sleeping.

The Department of Defense (DoD) faces a unique challenge in that military forces must maintain and support DoD's mission while simultaneously safeguarding the quality of natural resources and habitats on its lands. Invasive species know no boundaries and are spreading at alarming rates throughout the U.S. Installations across the country are threatened by these invasions, with areas overrun by a variety of aquatic and terrestrial invasive species. Invasives affect training capabilities, jeopardize military infrastructure, and hurt soldiers and native plants and animals. They do this by overtaking landscapes and transforming them to a point where they no longer resemble natural conditions that troops may face during combat.

Preventing and controlling each invasive species requires a unique approach that considers the environmental implications for both military installations and neighboring communities, and is most effective when done as early as possible and in collaboration with neighboring landowners. Military commanders must understand both the threats posed by invasives and the tools required to eradicate them, while ensuring those tools are used effectively and, when possible, proactively.

¹ Ecosystem services are the benefits all living organisms obtain from ecosystems. The four categories of ecosystem services are: provisioning services, including food, fresh water, fuel, fiber, and other goods; regulating services, such as climate, water, disease regulation, and pollination; supporting services, such as habitat, soil formation, and nutrient cycling; and cultural services, such as educational, aesthetic, cultural heritage values, recreation, and tourism.

² Pimentel, D., R. Zuniga and D., Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52: 273–288.

³ The Nature Conservancy. *Protecting Native Plants and Animals; Taking on the Invaders*. April 2010. www.nature.org/initiatives/invasivespecies.



Photo courtesy of the U.S Fish and Wildlife Service.

Brown tree snakes are venomous and harmful to humans, especially young children. They also are responsible for devastating the majority of the native bird population in Guam.



David Mitchell, "Brown-headed cowbird" May 29, 2008 via Flickr, Creative Commons Attribution.

The brown-headed cowbird is a parasitic nester. Females lay eggs in nests of other small birds. When the eggs hatch, the cowbird is fed by the host parents at the expense of their own young.



Photo courtesy of the Centers for Disease Control and Prevention.

The Asian tiger mosquito transmits diseases to humans and pets. Although native to tropical and subtropical regions, they are successfully adapting to cooler regions.

KEY ISSUES TO CONSIDER

- Installation Commanders may want to consider the following questions when they encounter a new or already established invasive species population on their installation:
- How will this species impact training?
- Does this species pose a health risk to installation personnel?
- Will this species cause federal endangered species listings, and consequently halt or limit training?
- Can we engage in partnerships to minimize this species?
- How did this species reach the installation?
- How can we better monitor the installation to prevent future invasive species introductions?
- What are the fastest, safest, and most practical ways to manage this species on my installation?
- Which invasive species are the most important to eliminate from my installation?
- Does the budget proactively plan for early detection and rapid removal, as well as long-term monitoring to prevent reinvasions?

EXECUTIVE ORDER 13112

Thousands of invasive species have been introduced throughout the U.S., both accidentally and deliberately. Executive Order (E.O.) 13112 created the National Invasive Species Council which is composed of 13 federal departments and agencies, including DoD. E.O. 13112 reinforces existing DoD policy by requiring that DoD monitor invasive species populations, prevent additional invasive species introductions, promote native species restoration, and endorse invasive species education to the public. DoD works in partnership with other groups to more effectively combat invasives and to educate installation personnel and other stakeholders about invasive species impacts and actions that can be taken to contain them.



National Public Lands Day volunteers clear invasive species and debris from a natural area at Navy Information Operations Command Sugar Grove, West Virginia.

WHY PREVENTING AND ERADICATING INVASIVE SPECIES IS IMPORTANT TO THE MILITARY'S MISSION

Holloman Air Force Base in New Mexico allocated over a half million dollars to remove invasive species from its airstrips to protect pilots and prevent damage to aircraft worth tens of millions of dollars. Invasive grasses on the airstrips attracted birds, which created a bird-airstrike hazard that, if not addressed, could ground aircraft. Invasive grasses also can attract mammals, potentially deteriorate airstrip infrastructure, damage equipment, and create a wildfire hazard. Moreover, invasive grasses can permanently alter

entire landscapes, as can pests and pathogens associated with the invasives. On military installations in the Pacific, non-native, invasive grasses have become the dominant ground cover, aggravating fire risk to weapons firing training, endangering federally protected species, damaging archaeological resources, and costing millions of dollars to control. In January 2011, the Army ended its live-fire training at Makua in large part due to fire events resulting from widespread guinea grass infestations.

RELEVANT POLICIES

DODI 4715.03, NATURAL RESOURCES CONSERVATION PROGRAM (2011).

This Instruction directs installations to ensure invasive species management measures are included in their Integrated Natural Resources Management Plans (INRMPs), and provides guidance on developing an Invasive Species Management Plan and the elements it must contain.

SIKES ACT, AS AMENDED. This Act (16 USC 670a-670o, 74 Stat. 1052), was enacted on September 15, 1960. It provides for cooperation by the Department of the Interior and DoD with state agencies in planning, development, and maintenance of fish and wildlife resources on military reservations throughout the United States.

ARMED FORCES PEST MANAGEMENT BOARD. The Army Surgeon General established the Army Committee for Insect and Rodent Control in November, 1944. The U.S. Navy had a liaison representative to that committee. Out of this beginning grew the Armed Forces Pest Management Board, established in 1956 with all three military services equally represented. The mission of the Board is to develop and recommend policy for the DoD pest management program to the Assistant Secretary of Defense, and to serve as a scientific advisory body to DoD.

E.O. 13112, INVASIVE SPECIES (1999). This E.O. created the National Invasive Species Council to prevent invasive species introductions, monitor invasive populations, promote native species restoration, and endorse invasive species education to the public.

NATIONAL INVASIVE SPECIES ACT (1996). This Act amends the Nonindigenous U.S. Aquatic Nuisance Prevention and Control Act of 1990 to implement a ballast water management program, state invasive species management plans, research studies, and demonstration projects.

NONINDIGENOUS U.S. AQUATIC NUISANCE PREVENTION AND CONTROL ACT (1990). This Act authorizes the National Oceanic and Atmospheric Administration's National Marine Fisheries Service and the U.S. Fish and Wildlife Service to prevent the introduction and control the spread of aquatic invasive species.

ENDANGERED SPECIES ACT (1973). This Act provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend.

CLEAN WATER ACT (1972). This Act establishes the basic structure for regulating pollutant discharges into United States waters as well as surface water quality standards. The April 2011 amendment regulating aquatic pesticide applications further complicates invasive species management and control.⁴

MEMORANDUM OF UNDERSTANDING FOR FEDERAL NATIVE PLANT CONSERVATION (2006). This MOU declares that conserving native plants cannot take place without also managing invasive species.



Photo courtesy of the Agricultural Research Service.

Fire ants are aggressive and swarm over anyone or anything that disturbs their nest. They sting people and pets, short out electrical equipment, and kill and eat ground- and tree-nesting birds and mammals. Left uncontrolled, fire ants can eradicate native species and upset the ecological balance of nature.



Photo courtesy of the New York State Department of Environmental Conservation.

The snakehead fish is a voracious predator of native fish, freshwater crustaceans, frogs, small reptiles, and occasionally birds and mammals. Their predation can alter the balance of aquatic ecosystems. They have no natural enemies in the U.S., and can migrate by "walking" over land.



Christian Fischer, "The Chinese mitten crab, Eriocheir sinensis" October 6, 2007 via Wikimedia Commons, Creative Commons Attribution.

The Chinese mitten crab's burrowing nature damages embankments and clogs drainage systems. The crabs also compete with native species in the waters they inhabit.

⁴ Effective April 2011, the Environmental Protection Agency requires a National Pollutant Discharge Elimination System permit for pesticide applications that discharge into U.S. waters. Given the proliferation of invasive species, there will likely be a need to use more pesticides. Additional pesticide usage will complicate environmental planning and increase costs to installations. Further, installations may now find themselves having to reevaluate implications for Clean Water Act regulatory compliance.



A previously sandy beach is now invaded by common reed.

Janke, "Reedbeach" November 8, 2006 via Wikipedia, Creative Commons Attribution-ShareAlike 2.5 License.

IMPACTS TO THE DEPARTMENT OF DEFENSE

MISSION IMPACTS

Increased fire frequency, electrical malfunctions, and obstructed lines of sight are all serious risks posed by invasive species on an installation. Fire ants can short out electrical equipment by chewing through cables and wiring; cheatgrass can quickly dry out and become highly flammable (thus limiting the use of tracer rounds, smoke grenades, and vehicles); and dense, intrusive flora such as kudzu or mile-a-minute vine can grow uncontrollably to block areas that need to remain clear, visible, and secure.

Invasive species can eliminate and reduce the quality and quantity of suitable, available training locations. It is crucial to act as quickly as possible to control invasives. It is equally important to maintain native flora and fauna, since robust native plant and animal populations can act as a deterrent against future invasive species introductions.

ECOLOGICAL IMPACTS

Invasives are one of the largest threats to species health and diversity. Once established, invasives can alter native habitats and ecosystem processes such as nutrient cycling, fire frequency, sediment deposition, and erosion. DoD lands serve as habitats to hundreds of species protected under the Endangered Species Act, more than 40 of which exist only on military lands. It is therefore crucial that DoD maintain high quality lands and waters. Invasives commonly destroy landscapes, leaving them unlivable for endangered and at-risk species. Impacts from invasive species could result in a decline of roughly 80% in worldwide endangered species populations due to competition or predation.⁵ In addition to increased species endangerment, invasives also can decrease biological diversity and degrade air and water quality.

HEALTH/SAFETY IMPACTS

At Avon Park Air Force Range, Florida, and other Southeastern ranges and installations, feral hogs dig up the soil along runways, exposing insects that attract large birds, thereby creating bird-airstrike hazards for pilots. The sighting of even one crane, vulture, or wild hog on or near the runway may restrict flight operations to ensure the safety of the pilot, passengers, and equipment.

Safety is also an issue at Fort Indiantown Gap, Pennsylvania, where soldiers must avoid giant hogweed, a toxic plant that causes severe skin rashes, burning blisters that leave long-lasting scars, and even blindness. In areas with large quantities of dead grasses or trees, lightning strikes, unattended campfires, military exercises, and other events can significantly increase wildfire events that can jeopardize military personnel, training exercises, and base infrastructure. Wildfires also can endanger aircrews by severely impeding their vision, as well as create respiratory problems resulting from smoke inhalation.

⁵ Pimentel, D., R. Zuniga and D., Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52: 273–288.



Cheatgrass depletes available water early in the season, preventing native grass seedlings from reproducing and, as a result, overtakes the landscape. Cheatgrass dries up early in the year, increasing the risk of wildfire and degrading habitat health.

ECONOMIC IMPACTS

As previously stated, invasive species cause more than \$138 billion in annual damage and management costs in the U.S. alone.⁶ Worldwide, the cost is equivalent to five percent of the global economy.⁷ Each Military Service, along with installations of all sizes, is affected by these financial impacts. For example, 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 Virginia, Naval Station Norfolk can afford to treat just 200 of 1,000 acres of a noxious weed called common reed that takes over habitats along the shoreline, eliminates native species, and degrades training areas.

Furthermore, vast areas of yellow star thistle once flourished in the parachute drop zone at Fort Hunter Liggett in California. The long, sharp thorns on this plant pose a serious injury hazard to soldiers and can easily shred parachutes that cost thousands of dollars each. While this invasive is still a problem, installation personnel have successfully reduced the extent of the plant's coverage.

Additional economic impacts caused by invasive species include damaged infrastructure, reduced property value, and diverted funds to control pests. Implementing a strategy of early detection and rapid response, tackling problems when they're small and still manageable, is optimal – especially when natural resources management budgets are already underfunded.

RECREATIONAL IMPACTS

Aquatic invasive species, such as water hyacinth, hydrilla, and other plants can be highly obstructive and reduce or even prevent access to bodies of water. These species also can severely restrict the use and enjoyment of lakes and rivers, which are important for both military training and recreational activities. Some terrestrial invasive plants are intrusive enough that they can limit hiking and hunting options for installation personnel and visitors. Not only do invasives prevent certain activities, they also reduce the overall outdoor experience that people strive to enjoy. In Nevada, estimates range from \$6 million to \$12 million annually for impacts from invasive species on wildlife related recreation alone.⁸

⁶ Pimentel, D., R. Zuniga and D., Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52: 273–288.

⁷ The Nature Conservancy. *Protecting Native Plants and Animals; Taking on the Invaders*. April 2010. www.nature.org/initiatives/invasivespecies/

⁸ Elswerth, Mark E., Tim D. Darden, Wayne S. Johnson, Jean-Marie Agapoff, and Thomas R. Harris. Input-output modeling, outdoor recreation, and the economic impact of weeds. *Weed Science* 53(1): 130–137.



LIVE FIRE TRAINING CANNOT BE DONE IN FIELDS OF HIGHLY FLAMMABLE INVASIVE GRASSES

Photo courtesy of the National Park Service.

INVASIVE SPECIES MANAGEMENT IN ACTION

ARMY TRAINING FACILITY FORT HUNTER LIGGETT, CA FUNDING

Fort Hunter Liggett in California is an Army training facility that conducts field maneuvers, live fire training, and parachute exercises. The invasive yellow star thistle severely impacts these exercises when the plant's spiky thorns snag and tear parachutes, clog vehicle air filters, and injure soldiers. Dried thickets of yellow star thistle also are highly flammable; the ensuing wildfires decrease air quality and jeopardize both military personnel and base infrastructure. Fort Hunter Liggett established an integrated pest management approach that includes hand pulling, mowing, and applying pesticides, herbicides, and biological controls. Satellite mapping enhances this approach by identifying areas of greatest overlap between training lands and yellow star thistle invasion. From the time Fort Hunter Liggett personnel first detected a small patch of yellow star thistle on the installation, the plant spread to approximately 20,000 acres in only five years.⁹ To date, workers have cleared yellow star thistle from about 10,000 acres of land, but high costs have prevented additional treatment. Adequate, stable, and consistent funding can greatly accelerate the yellow star thistle detection and removal process, restoring access to once-usable training lands.

MARINE CORPS BASE HAWAII, KANEOHE, HI COMMUNITY INVOLVEMENT

The Marine Corps Base (MCB) Hawaii at Kaneohe trains deploying warfighters for combat in Iraq and other theaters throughout Asia and the Pacific. Non-native mangrove stands, which can grow as tall as six-story buildings, interfere with military readiness by allowing training areas to be flooded and by impeding lines of sight security near installation borders. The mangroves also take over native marsh habitats by converting them into thickets that are inhospitable to both native species and military exercises. MCB Hawaii has spent millions of dollars to clear three acres of invasive mangroves from installation wetlands by physically removing them with shovels and chainsaws. Although reinvasion is still a risk, the teamwork of installation natural resources staff, soldier Marines, contractors, groups such as a local chapter of the Sierra Club, and volunteers demonstrated that continued cooperation can deliver effective, long-term mangrove control across the Island.

⁹ DiTomaso, Joe. Fort Hunter Liggett Grasslands Restoration. *Cooperative Conservation America*. January 2011. www.cooperativeconservation.org/viewproject.asp?pid=418.

ANDERSEN AIR FORCE BASE & MARIANAS NAVAL BASE, GUAM COOPERATIVE PLANNING

Andersen Air Force Base and Commander Naval Forces Marianas in Guam oversee various Air Force and Navy exercises and training procedures. The bases are surrounded by a rich diversity of plants and animals, but many of these have been ravaged by brown treesnakes that also slither in and around electrical equipment causing frequent power outages. In the 1980s and 1990s, brown treesnakes caused an average of one power outage every three days.¹⁰ According to the Brown Treesnake Containment Plan for Guam, the snake causes hundreds of power outages annually, disrupting lives, reducing productivity, and requiring millions in repair costs.¹¹ Additionally, the brown treesnake is a formidable predator that is driving Guam's forest birds and amphibians to extinction. In response to this threat, the bases developed and launched a cooperative plan, which includes a comprehensive control and eradication approach coupled with surveillance and monitoring. Extensive trap and capture programs are in place, as are canine inspections of outbound cargo and snake-proof barriers around base perimeters. Recently, an effort to remove brown treesnakes through the use of strategically distributed baits also has been implemented. Substantial DoD funding allows installation personnel to implement the comprehensive action plans. Comprehensive and cooperative planning at all levels is necessary to best leverage all available resources to reduce invasive species populations.

RANGE SUPPORT IS CRUCIAL TO A SUCCESSFUL PREVENTION EFFORT

FAIRCHILD AIR FORCE BASE, WA CHEMICAL AND BIOLOGICAL CONTROL

Fairchild Air Force Base in Spokane County, Washington, previously relied on herbicides to control numerous invasive plant species. In response to a federal mandate and an Armed Forces Pest Management Board goal for DoD to reduce toxic chemical usage by 50%,¹² Fairchild successfully developed the largest biological weed control program in the State. The program features a biological control method that introduces insects that attack invasive weeds. The insects reproduce naturally, thus eliminating the need to use toxic chemical herbicides. Introducing the insects was just as effective as herbicide application for controlling the weeds, and it saved the Air Force over \$30,000 per year. However, although biological control methods can be highly effective, they must be coupled with an integrated pest management plan. Rigorous testing by the U.S. Department of Agriculture must determine that introduced biological agents are limited to specific hosts and will not threaten other plants. Fairchild's biological control program serves as an exceptional model in controlling invasive species while responsibly preserving natural resources by avoiding expensive and dangerous chemicals.

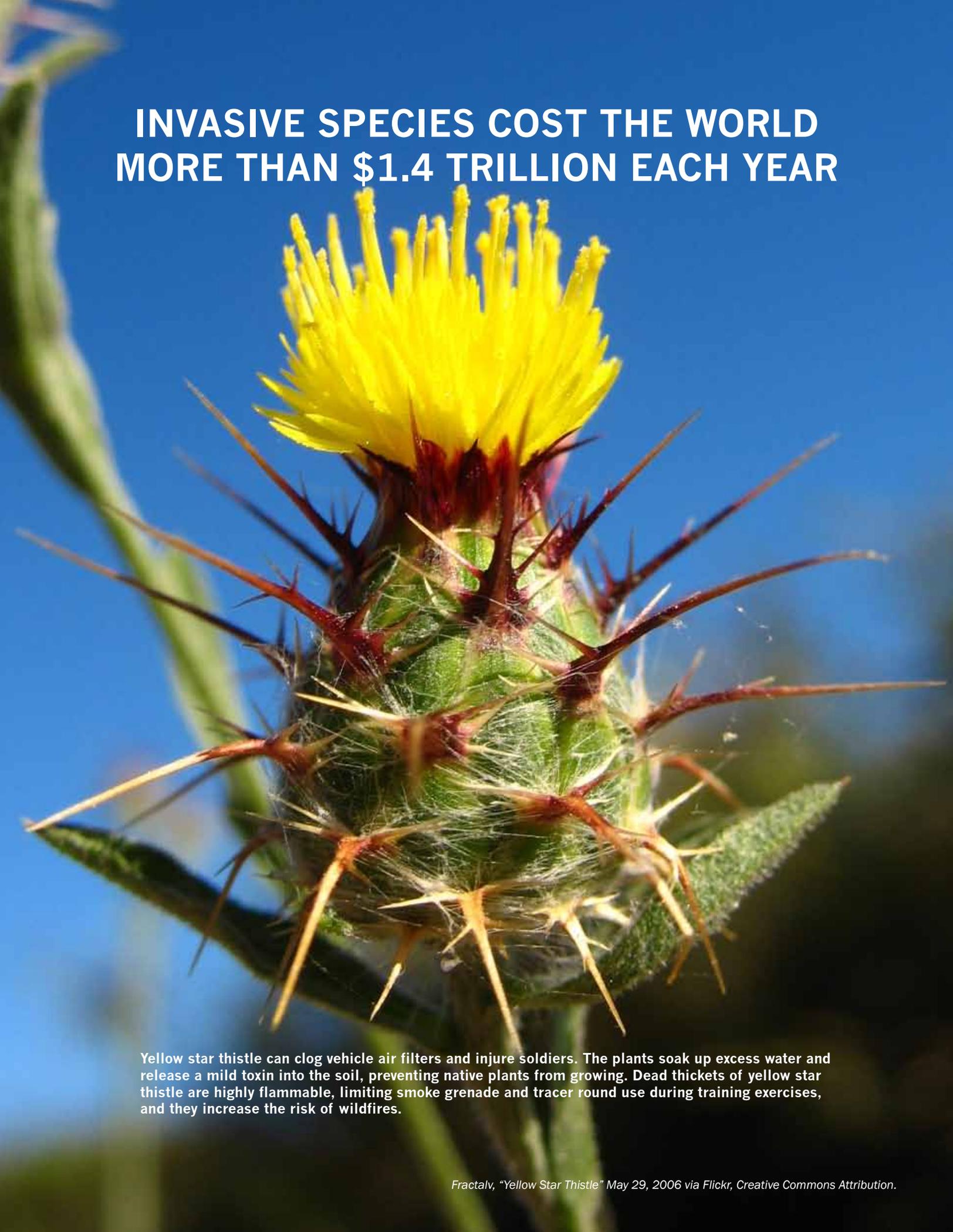
Programs such as Fairchild's will become increasingly important as new regulations emerge. For example, effective April 2011, the Environmental Protection Agency requires a National Pollutant Discharge Elimination System permit for pesticide applications that discharge into U.S. waters. Given the proliferation of invasive species on installation lands and the resulting need for more control work, there will likely be a need to use more pesticides. Additional pesticide usage will complicate environmental planning and increase costs to installations. Further, installations may now find themselves having to reevaluate implications for Clean Water Act regulatory compliance.

¹⁰ Department of Land and Natural Resources, State of Hawaii. Alien Species. 31 Aug. 2010. www.state.hi.us/dlnr/Snake.html.

¹¹ U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services. *Brown Treesnake Containment Plan for Guam*. April 2010. Legacy Resource Management Program project #05-238. www.dodlegacy.org.

¹² Armed Forces Pest Management Board. *Technical Information Memorandum No. 39*. February 1997. www.afpmb.org/pubs/tims/tim39.htm.

INVASIVE SPECIES COST THE WORLD MORE THAN \$1.4 TRILLION EACH YEAR



Yellow star thistle can clog vehicle air filters and injure soldiers. The plants soak up excess water and release a mild toxin into the soil, preventing native plants from growing. Dead thickets of yellow star thistle are highly flammable, limiting smoke grenade and tracer round use during training exercises, and they increase the risk of wildfires.

U.S. ARMY POST FORT BENNING, GA MECHANICAL CONTROL

Fort Benning is the primary training installation for all U.S. Army infantry enlistees. Maintaining high quality natural training conditions at this location is essential. Feral hog rooting severely damages infrastructure and property in housing areas and ranges across Benning. The hogs' activities also can detrimentally impact keystone species, such as the gopher tortoise, and those already listed, including the endangered red-cockaded woodpecker. These impacts can lead to increased mission restrictions. To address these threats, the Army is applying technological advancements in thermal imaging equipment to help control feral hogs. They use long range thermal spotting scopes to locate hogs during their nocturnal feeding activities. The Army then builds corral traps stocked with automatic feeders, captures the hogs, and removes them. While the trapping program is currently the most successful technique in use, feral hogs remain a problem due to their prolific breeding habits and aggressive nature.

NAVAL STATION NORFOLK, VA STRATEGIC MANAGEMENT

Naval Station Norfolk in Virginia is the world's largest naval complex, and it has a substantial invasive species problem. The common reed, an aggressive and coarse 8 to 16 foot tall plant, thrives in moist environments such as tidal and non-tidal wetlands. The common reed plagues the installation by obstructing line of sight security and threatening the safety of base perimeters and gates. It also increases the risk of airfield accidents and impedes water flow, which, consequently, allows mosquito populations to multiply. Heavily disturbed soil from maneuvering and development provides the perfect conditions for common reed to get established. Norfolk's multi-faceted strategic management approach to control the reed includes satellite mapping to identify problem areas, extensive targeted herbicide spraying, and reintroducing native plant seeds to limit common reed growth and expansion. Strategically attacking this invasive species using multiple approaches has proven the best way to minimize its damage.

ROUGHLY 80% OF THE WORLD'S ENDANGERED SPECIES POPULATIONS COULD DECLINE BECAUSE OF SPREADING INVASIVE SPECIES



Photo courtesy of the New York State Department of Transportation.



Photo courtesy of King County, Washington.

Giant hogweed is a dangerous invasive plant that can grow more than twelve feet high. Contact with its watery sap can result in long-lasting skin damage from inflammation and blisters that are exacerbated when exposed to sunlight. In severe cases, hogweed can cause permanent blindness.

Feral cats can cause harm to the environment by preying on native species. They are responsible for killing endangered birds and small mammals, reptiles, and amphibians. Feral cat predation in the U.S. on birds alone leads to billions of dollars in economic loss each year.



dr_relling, "Domestic cat eating bird on lawn." April 30, 2009 via Wikimedia Commons, Creative Commons Attribution-Share Alike 2.0 Generic license.

Photo courtesy of the Agricultural Research Service.

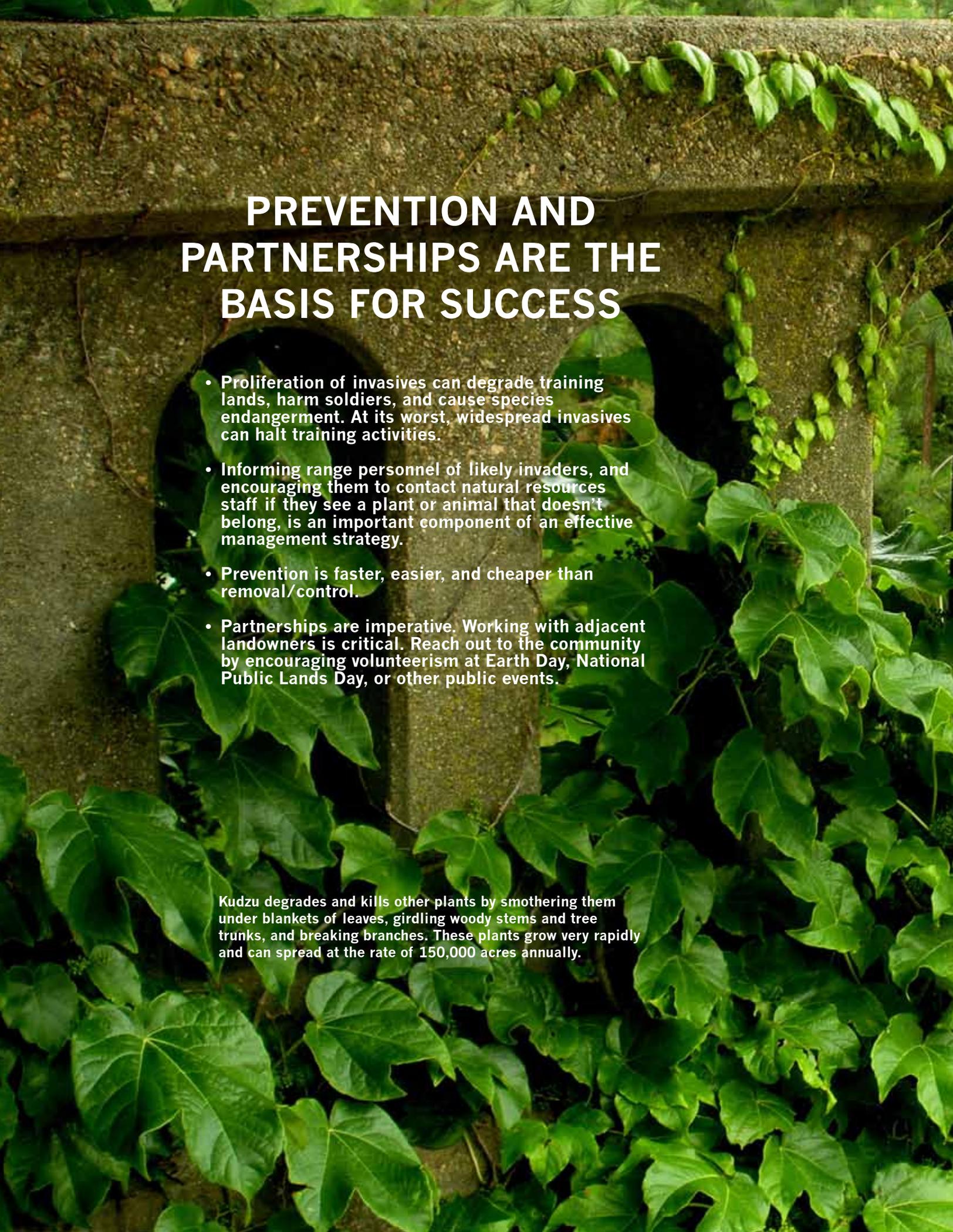


Formosan termites live in large colonies and consume wood at a rapid rate; a single colony can consume as much as 13 ounces of wood a day. They are especially problematic in southern military installations.

Feral hogs destroy native habitats with their hoofs and tusks. They prevent trees from growing, damage vegetation, and dig up soil, causing erosion and poor stream quality. By foraging and grubbing, feral hogs also make it easier for non-native weeds to invade. They also can transmit diseases to wildlife and humans.



Photo courtesy of the Northern Territory Government.



PREVENTION AND PARTNERSHIPS ARE THE BASIS FOR SUCCESS

- Proliferation of invasives can degrade training lands, harm soldiers, and cause species endangerment. At its worst, widespread invasives can halt training activities.
- Informing range personnel of likely invaders, and encouraging them to contact natural resources staff if they see a plant or animal that doesn't belong, is an important component of an effective management strategy.
- Prevention is faster, easier, and cheaper than removal/control.
- Partnerships are imperative. Working with adjacent landowners is critical. Reach out to the community by encouraging volunteerism at Earth Day, National Public Lands Day, or other public events.

Kudzu degrades and kills other plants by smothering them under blankets of leaves, girdling woody stems and tree trunks, and breaking branches. These plants grow very rapidly and can spread at the rate of 150,000 acres annually.

THE BOTTOM LINE

Invasive species pose numerous challenges that vary from site to site. Installations across the country and across the Military Services are implementing creative and innovative approaches to combat the spread of, and threats posed by, invasive species. The cases described in this Guide provide a small set of examples describing how different military installations are combating invasive species. No single approach is guaranteed to work in every situation, but successful experiences can be used as guiding principles for effective invasive species management.

A key theme that runs throughout all invasive species management and control efforts is that prevention and partnerships are the basis for success. This approach was exemplified by the creation of the Cooperative Invasive Species Management Areas Program that worked through public-private partnerships to reduce invasive species at Eglin Air Force Base, Avon Park Air Force Range, Camp Blanding Joint Training Center, and Key West Naval Air Station, as well as the lands surrounding these installations.¹³

As an installation Commander, it is important that your natural resources personnel consider the following points when managing for invasive species:

- ***Prevent new invasions and stop the expansion of established invaders.*** Prevention programs are the first line of defense against invasive species. Early detection and rapid response helps maintain healthy systems, prevents loss of training areas, and is significantly more cost effective. By working cooperatively, installation natural resources managers can provide range personnel with information critical to their situational awareness. Range support is crucial to a successful prevention effort.
- ***Focus on the military mission.*** Natural landscapes provide more realistic training conditions than those infested by invasives. Therefore, preventing the spread of invasive species facilitates mission activities while helping preserve natural areas.
- ***Minimize harmful environmental impacts.*** All installations must consider potentially damaging side effects when using any eradication procedure, such as pesticides or biocontrols. Understanding the benefits and disadvantages of each technique will help ensure a positive outcome for both the species and the military personnel training on that land or in those waters. Sometimes, effects may not at first be transparent.
- ***Engage in partnerships.*** Establishing strong partnerships at all levels with a wide variety of stakeholders can multiply the benefits of any treatment method, and can reduce costs by leveraging non-DoD resources. For example, conservation organizations can share costs of regional treatment approaches, researchers can provide information about treatment effectiveness, and local citizens can volunteer to pull weeds on Earth Day or National Public Lands Day. In short, individuals from different sectors can contribute unique experiences and expertise, and can help installation personnel combat invasive species.
- ***Conduct long-term monitoring.*** It does not take long for native landscapes to become overrun with invasives. While it is important for installations to closely monitor their lands and waters to prevent invasive species from arriving and dominating the landscape, it is equally important to regularly monitor treated areas to ensure that reinvasions do not occur, and that recurring treatments can be applied in a timely and effective way. The intelligence that range personnel can provide can be a key factor in the success of any effective natural resources monitoring program.

¹³ U.S. Air Force. *Creating Cooperative Invasive Species Management Areas to Effectively Reduce Re-infestation on Four Military Bases and Surrounding Lands in Florida*. August 2010. Legacy Resource Management Program project #09-437. www.dodlegacy.org.

