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October 2005

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By Corry Westbrook and Kindra Ramos
with Monica La

Larry Schweiger, President and Chief Executive Officer
National Wildlife Federation

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**Cover Photos** (L-R/T-B): Tropical soda apple- Charles T. Bryson, USDA ARS, www.forestryimages.org; Parachuter- Art Hazebrook; Spotted knapweed- Jim Story, Montana State University, www.forestimages.org; 3rd Marine Light Armored Regiment navigating a Light Armored Vehicle through yellow star- thistle – Ken Spencer; Brown tree snake – Gordon H. Rodda-USFWS; Marine removing pickelweed- Diane Drigot; Musk thistle- USDA APHIS Archives, www.forestryimages.org; Soldiers training – Corry Westbrook, NWF; Kudzu covered trees- James H. Miller, USDA Forest Service, www.forestryimages.org .

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# Foreword

Growing up in Pennsylvania, I remember watching kudzu overtake everything in its path along highways and roadsides. In fact, kudzu was introduced to the United States in Pennsylvania at the 1876 Centennial Exposition in Philadelphia. I thought this prolific vine was kind of beautiful, with its dark green leaves wrapping around shrubs, trees, telephone poles and nearly anything that stood still long enough in the spring and summer.

As a kid, I never stopped to think that this plant was blocking native vegetation from the sun or that it was keeping native wildlife from its food sources and nesting locations.

I've since learned that invasive plants and wildlife are eating away at the heart of the nation's natural ecosystems. Combating them imposes significant costs on taxpayers. Overall, invasive species are second only to habitat loss as the leading cause of decline for wildlife populations. All across the nation, farmers, ranchers, hunters and anglers are feeling the impacts of invasive species.

And now, as this report documents, the toll extracted by invasive species extends all the way to our nation's armed forces.

Through 12 case studies from Army, Navy, Air Force and Marine Corps installations, this report focuses on the impacts of invasive species on the military. The National Wildlife Federation extends its appreciation to the Department of Defense for its support in conducting the research on which the report is based.

Our hope is that this report inspires the Department of Defense, military installation natural resource managers, legislators, scientists, industry leaders and the American public to work together to protect natural resources from the devastating effects of invasive species.

For its part, the National Wildlife Federation is committed to stopping the siege of invasive species on our natural resources. We are committed to protecting native wildlife and their habitats now and for generations to come.

Larry Schweiger
President and CEO
National Wildlife Federation

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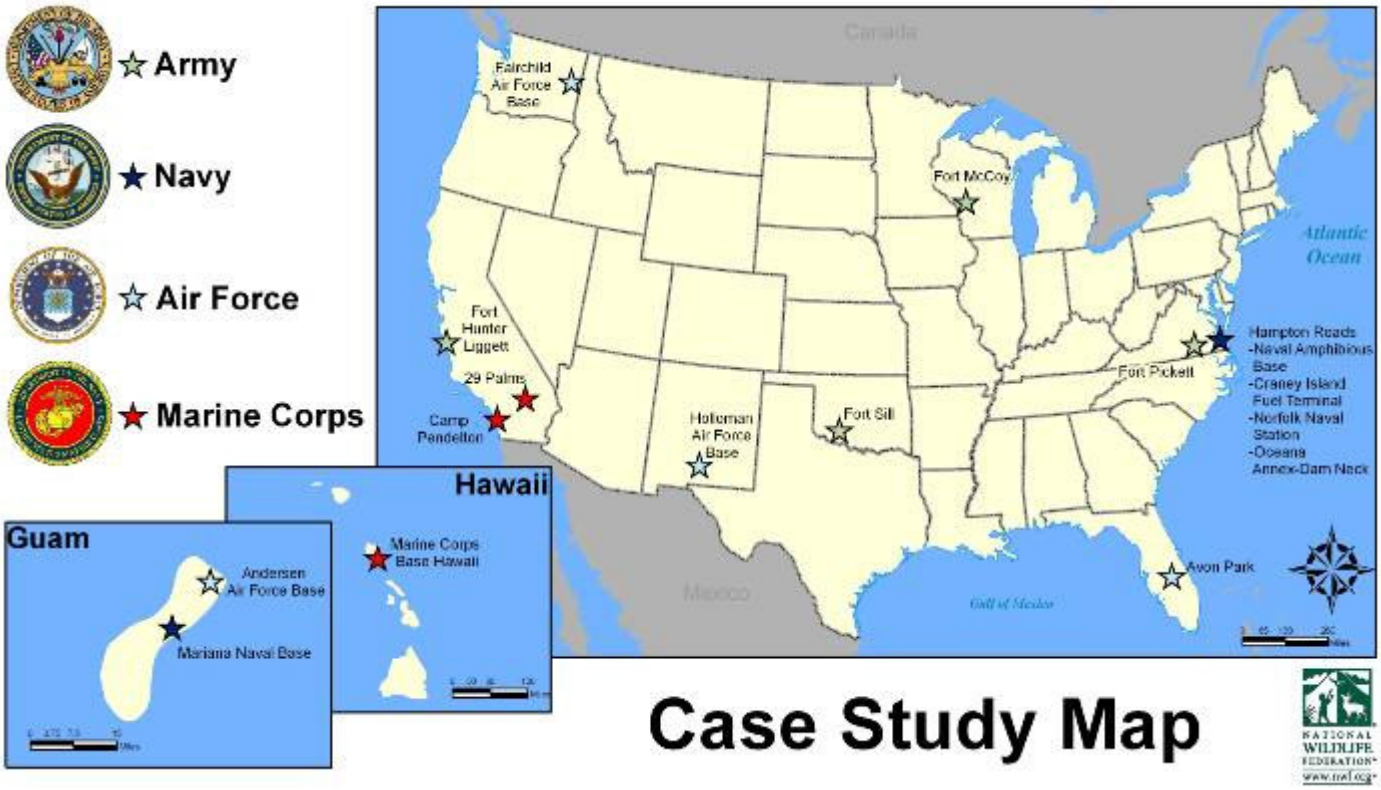


Map: Brad Nunie, NWF

# Executive Summary


## THE THREAT OF INVASIVE SPECIES

Invasive species affect many aspects of modern life. They are found in every nation of the world and have settled into all regions of the United States. Traveling by land, water and air, they bring with them an abundance of problems.

Society pays a great price for invasive species – costs measured not only in dollars, but also in unemployment, damaged goods and equipment, power failures, food and water shortages, environmental degradation, increased rates and severity of natural disasters, disease epidemics and even lost lives.

Invasive species are non-native species which when introduced cause, or are likely to cause, economic and environmental harm and/or harm to human health. Oftentimes these plants, animals and microorganisms are introduced into an environment with no natural predators. This can, and generally does, lead to rapid, unchecked reproduction.

The Ecological Society of America has found that invasive species contribute to the endangerment of 35 to 46 percent of all species protected by the Endangered Species Act, making them the second leading cause of species decline, after habitat loss.[1] In addition, controlling exotic species is one of the most significant land management issues facing national parks. Invasive plants infest some 2.6 million acres in the national parks and over 200 hundred parks have invasive animals in need of management.[2] Invasive species also threaten the health of lakes and rivers. In the Great Lakes, for example, the entire food web is being disrupted by aquatic invasive species.

Ignoring all borders and boundaries, invasive species have spread to every part of the United States, including military lands. This report illustrates the threats, costs and impacts of invasive species on the nation's military installations, as well as some of the innovative solutions being used to combat them on military facilities across the country. By focusing on this unique part of the nationwide problem, it becomes clear that solving this wide-spread and complex problem requires complex and comprehensive solutions.

## INVASIVE SPECIES AND THE MILITARY

The Department of Defense manages more than 400 major installations that encompass 25 million acres of land. Natural resource managers are challenged not only to be responsible stewards of these lands but to do so in a way that supports the mission of their installation. While the challenge for managing invasive species on military land falls to them, the impacts of the problem can be felt throughout the installation.

This report examines some of the costs and damages that invasive species have imposed on the Defense Department. It is not meant to be an inventory of the all the problems the Defense Department faces in association with invasive species. Rather, it presents a sampling of the problems, highlights areas of success and programs that are works in progress, and identifies significant gaps that need to be addressed.

## SUCCESSFUL COMBAT STRATEGIES FOR INVASIVE SPECIES

The problems caused by and solutions to invasive species are almost as varied as the plants and animals themselves. There is no cure-all. However, the installations that are successfully managing invasive species have three common traits.

1. Natural resource managers strive for rapid response and treatment as soon as the infestation is discovered.
2. Leadership of the installation is supportive of their natural resource managers and cooperates in the prevention and treatment activities for invasive species.
3. Natural resource managers implement solutions that are "outside the box" of traditional management methods.

## LOOKING TO THE FUTURE

In spite of the encouraging initiatives being implemented, more needs to be done. First and foremost, prevention must move to the forefront of invasive species management on both the national and installation levels.

On the ground, invasive species need to be addressed on a more ambitious scale by the Defense Department in order to protect ecosystem viability and ensure lands are available for continued military training and land use. Implementation of installation Integrated Natural Resources Plans should aggressively combat invasive species. Furthermore, if they are to be successful in stopping the spread of invasives on military lands, leaders of the installations must support natural resource managers' efforts in creating a comprehensive approach to prevention and control.

On the national level, Congress must enact broader prevention and control policies, and empower the Department of Defense, other Federal agencies and State and local governments to control movement of invasive species, conduct research, provide prevention technologies and educate the American public about the damages posed by invasive species and what they can do to stop the spread. The Department of Defense can only do so much alone. They rely on Congress to enact comprehensive legislation to address this growing problem not only on military lands but across the country. A comprehensive solution demands participation by all levels of government, all facets of society, and even foreign nations to stop the devastating impacts of invasive species.

Finally, with the support of the Departments of Defense, Commerce, Agriculture, Interior, Transportation, the Environmental Protection Agency, States and private industry, Congress and all affected stakeholders must make a monetary commitment to invasive species management.

## KEY FINDINGS

*Through 12 case studies, the impacts of invasive species on military land are examined for Army, Navy, Air Force and Marine Corps installations. The report finds that invasive species affect military lands in four primary ways:*

- **Invasive species negate realistic conditions for training or testing operations and/or directly limit training activities.** In nine of the 12 case studies, invasive species directly reduced available training land or the viability of training exercises.
- **Invasive species management escalates training and operations costs.** In eight of the 12 case studies, invasive species management took money away from other natural resource or operations funding.
- **As a leading cause of habitat destruction and biodiversity loss, invasive species can further reduce available training land.** Nine of the 12 installations had to treat invasive species to protect the habitat and biodiversity the military is charged with managing, including endangered species and their habitats.
- **In some cases, invasive species pose a security risk and/or create potentially life threatening situations.** At three of the 12 installations invasive species directly threatened the lines of sight of runways by pilots.

## NONHUMAN INVADERS

Snakes cut a base's electricity and sneak aboard military jets leaving the island; invasive vines seize large swathes of military training land making it unusable and undesirable for training or recreational purposes; feral pigs endanger the lives of pilots by charging onto a runway.

Human terrorists jump to mind when picturing threats to military readiness and homeland security. But few people realize that we face the threat of *nonhuman invaders*—harmful nonnative plant, pathogens and animal species that have become entrenched in our ecosystems.

While less dramatic and unnerving than human invaders, invasive species are infiltrating military lands across the country where they can severely impact the health and welfare of U.S. military forces, citizens and ecosystems. "The military recognizes this growing problem and understands that it must partner with other federal, state and county agencies, non-governmental organizations and the general public to effectively combat invasive species," says Peter Boice, Conservation Team Leader, Office of Secretary of Defense.

The case studies in this report provide examples of the battle currently being waged against invasive species on a variety of military installations. This report looks at successes and areas where more needs to be done with the hope of providing the military, Congress and the public a better understanding of invasive species and possible solutions to help combat this wide-reaching and escalating problem.

The recommendations section shows how members of Congress and the public can support the military installations in their effort to defeat these ecological invaders. Moreover, it can assist installations in learning from one another by providing specific examples of programs and treatment methods that have been successful.

Developing sound methods for detecting and preventing the introduction of invasive insects and diseases could better prepare the nation for defense against terrorist attacks using invasive species as biological weapons. Adversaries will not overlook the overwhelming impact that invasive species could have on the United States.[3] Introduction of an invasive species may be virtually undetectable until the costs are severe, widespread and irreversible. In a 2004 article in the U.S. Army's Senior Professional Journal, *Parameters*, Colonel Robert J. Pratt warns of the potential threat. "Today, the homeland is vulnerable to a different type of asymmetric attack, a biological attack from an invasive species. We should act now to strengthen our defenses to protect ourselves from such attacks. Our future and our children's future might depend on it." Colonel Pratt, commander of the 66th Infantry Brigade in the Illinois National Guard, further discusses in his article that such an attack could strain the economy, taint America's food supply or endanger human health. Tracing the perpetrator would also be extremely difficult or impossible.[4] The recent rapid expansion of West Nile virus across the United States after its introduction from unknown sources on the East Coast reveals the potential of invasive species to cause significant harm.

West Nile virus first appeared in the Western hemisphere in 1999 and quickly spread through North America. It has been detected in at least 48 species of mosquitoes, over 250 species of birds, and at least 18 species of mammals, including humans. Since it was first identified in the United States, the virus has caused nearly 17,000 cases of human illness, including more than 650 deaths.[5] Furthermore, West Nile virus is responsible for the death of thousands of birds every year. It is difficult to know the actual number of bird deaths associated with this virus but 14,122 dead birds tested positive in 2002 and 12,066 did so in 2003.[6] While the total economic costs associated with West Nile virus have not been determined, one study found the cost of the 2002 Louisiana epidemic alone was approximately $20.1 million.[7]

## IMPACTS OF INVASIVE SPECIES

Over the past few centuries, several thousand foreign plant and animal species have become established in the United States. Only a small fraction of the nonindigenous species introduced in this country becomes invasive.[8] While it is difficult to know exactly how many invasive species have permeated the United States some studies estimate about 1 percent of introduced species become invasive and spread rampantly.[9] Invasive species are recognized as one of the leading threats to biodiversity. They impose enormous costs to agriculture, forestry, fisheries and other human enterprises, as well as to human health. Managing these species and their negative impacts in the United States costs more than $120 billion each year.[10] Every year this country loses more than a fourth of its agricultural gross national product to foreign pests and the costs associated with controlling them.[11]

### WHAT ARE INVASIVE SPECIES?

Invasive species are harmful, non-native, plants, animals or microorganisms that are introduced (either intentionally or unintentionally) into an environment in which they did not evolve. Without natural predators to limit their reproduction, invasive species spread and rapidly overrun native plants and wildlife. Not all non-native species are invasive.


*Musk thistle*

## INVASION OF U.S. MILITARY INSTALLATIONS

Invasive species impair military operations in four ways. These species can:

- Negate realistic conditions for training or testing operations and/or directly limit training activities
- Require the diversion of funding from other natural resource or operational priorities.
- Act as one of the leading causes of habitat destruction and biodiversity loss, which can further reduce available training land.
- Pose a security risk and/or create potentially life threatening situations.

Impacts of invasive species manifest on installations in

*We should act now to strengthen our defenses to protect ourselves from such attacks. Our future and our children's future might depend on it." ~ Colonel Robert J. Pratt*

various ways. For example, the spread of exotic plants that burn easily has increased the frequency and severity of fires, to the detriment of property, human safety and native plants and animals. On military installations, the frequent use of munitions for training greatly multiplies concerns about fire safety. Training areas covered by invasive plants that burn easily reduce training capability and increase operational costs. The spread of tall invasive plants can block vision and compromise security around sensitive military facilities. Some species, such as kudzu (*Pueraria montana*) or yellow star-thistle (*Centaurea solstitialis L.*), can render large areas that are required for training of troops useless. At Fort Hunter Liggett yellow star-thistle has shredded parachutes as jumpers descend into training areas filled with the thorny plant.

In an informal survey, conducted in 2001, by the National Military Fish and Wildlife Association's Invasive Species Working Group, out of 48 installation responses:

- 85 percent actively managed invasive species;
- 37 percent indicated disruption of training;
- 70 percent indicated that invasives had the potential to negatively impact training and/or listed species; and
- 19 percent were required to take action against invasives by the U.S. Fish and Wildlife Service.[12]

## MILITARY AS DEFENDERS AND STEWARDS OF PUBLIC LANDS

Invasive species can have a serious impact on the natural resources that provide the raw material for industry, agriculture and the aesthetic beauty of this nation. Large areas of undeveloped land managed by the U.S. military harbor significant biodiversity and natural resources due to large areas of undeveloped land. The Department of Defense manages approximately 25 million acres of land encompassing more than 400 major installations.[13] These critical federal lands harbor over 350 species protected by the Endangered Species Act in an abundance of intact ecosystems.[14]

Invasive species that gain a foothold on military installations can spread to surrounding areas, affecting private property and other public lands. Many installations are dealing with multiple invasive species, requiring them to prioritize their efforts. This means that there are often infestations of weeds and other pests on a base that go unchecked until significant

### Federal Controls for Invasive Species

Current federal mechanisms for addressing invasive species are spread across various agencies and organizations.

**Executive Order 13112**, signed on February 3, 1999, defines an invasive species as an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

This executive order also established the **National Invasive Species Council**, a collaboration of federal department and agency representatives to ensure complementary, cost-efficient and effective activities to combat invasive species. Among these council members, the Department of Agriculture's Animal and Plant Health Inspection Service and U.S. Fish and Wildlife Service have limited regulatory authority over movement of exotic species.

The **Nonindigenous Aquatic Nuisance Prevention and Control Act** of 1990 and its reauthorization in 1996, authorized the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Administration to address aquatic nuisance species.

## WHAT'S THE COST?

The Department of Defense must follow all federal and state laws and regulations to limit the spread of invasives, all of which cost money. For example, policies and procedures are in place at installations to ensure that tanks and other vehicles are properly washed, broken down, and/or fumigated before transport.[15] In some instances, tanks are disassembled—their engines removed and washed—in an expensive and laborious process to prevent the spread of invasive species. It has been estimated that the cost for vehicle washing over a nine-month period is approximately $9.6 million, with an additional $8.6 million spent on inspections.[16]

*The Department of Defense manages approximately 25 million acres of land encompassing more than 400 major installations. These critical federal lands harbor over 350 species protected by the Endangered Species Act in an abundance of intact ecosystems.*

These actions are necessary but can come with high costs. In the decade from 1991 to 2001, the Department of Defense spent more than $12 million on three invasive species management programs.[17] Additionally, every installation must create and fund any invasive species prevention, eradication or management programs needed. The actual costs associated with invasive species management are not well-documented throughout the military branches. However, the U.S. Marine Corps spent an average of $540,000 annually from 2002 to 2005 on invasive species management.[18] The actions of the various installations to prevent, detect and control invasive species also increase the burden on troops and divert resources that could be used for other programs. Current funding levels are not enough to control the existing problems or prevent a future explosion of invasive problems in the United States. Unless invasive species are more aggressively controlled now, the monetary and opportunity costs could become insurmountable.

## MILITARY TRANSPORT: A HISTORY OF SPREADING INVASIVE SPECIES

Military activities can be both casualties and carriers of invasive species. For hundreds of years, military actions by numerous countries have spread invasive species by plan and happenstance, often with unforeseen and unintended consequences.

Invasive species have been spread around the world through military troop movement, intentional placement of introduced species as food caches and as inadvertent stowaways, clinging to military equipment, supplies, clothing, and vehicles.[19] Some of the most extensive impacts have been on islands, where isolation has caused many species to lose their defense instincts in the absence of natural predators. Islands were a particularly important resource to colonial militaries as stations for stopovers to replenish food and water and for navigation during oceanic voyages.[20]

World War II accelerated the transport of invasive plants and animals. The most dramatic example is the brown tree snake (*Boiga irregularis)* brought to the island of Guam from the South Pacific and Australia. Snakes caused the extinction of some native species, loss of domestic birds and pets, and health problems to residents and visitors when these mildly venomous snakes infested the island. Approximately once a week there is a snake-caused power outage somewhere on Guam, causing localized or island-wide blackouts. Conservative estimates of costs due to direct damages and lost productivity range from $1 to 4 million per year; research and control costs of the brown tree snake total another $4 million.[21] Because Guam is a major transportation hub in the

*but we must also protect those valuable natural resources that make our country worth fighting for." Jim Bailey, President of the National Military Fish & Wildlife Association*

Pacific, accidental movement of the snake to other islands is a significant risk. It has been said that the ecological impact of the brown tree snake has been far more devastating to Guam's ecosystems than all of the heavy fighting and naval bombardment that leveled the island's forests during World War II. Although forests will grow back with time, recovery of species driven to extinction is not possible.[22]

Military activities have the potential to not only spread invasives, but sometimes also prepare the ground for establishment of these competitors. Human disturbance and habitat fragmentation associated with land use confer a competitive advantage for exotic species over their native counterparts. Ordnance practice, troop movement and maneuvers can create large areas of bare or disturbed ground, causing habitat fragmentation that is conducive to weedy invasions. Attempts to restore these areas quickly can also lead to more problems. Some invasive species, such as Bermuda grass (*Cynodon dactylon*), were deliberately introduced to revegetate islands denuded by military activity.

## WHAT'S AT STAKE?

As world travel becomes even more frequent and cargo is imported from parts of the world that have only recently become engaged in international trade, invasions are likely to increase dramatically. The subtropical states and territories of the United States, which rely on natural products, coastal development, tourism and international trade for revenue and economic growth, will continue to be particularly hard hit because the impacts of invasives are exacerbated by mild climates and geographic isolation. Hawaii, Guam and other areas with seaport cities not only meet these criteria, but also are major hubs for military traffic. Similarly, there is concern that the troops and equipment currently deployed in Iraq run the risk of transferring new invasive species back to the arid desert ecosystems of the American west.


*M1 Abrams tanks*

Military transport and land clearing is an integral part of training, readiness and operations and cannot be avoided. According to Jim Bailey, National Military Fish and Wildlife Association president, natural resources managers' have a dual responsibility **to ensure that our troops have the land they need for realistic training so they are prepared for their missions and to protect those valuable natural resources that make our country worth fighting for**.[24]

## CASE STUDIES

The following case studies describe how the military is meeting this challenge and what programs, policies and funding will be needed to continue to combat these nonhuman invaders. The case studies in this report were chosen to highlight some areas of success, some programs that are works in progress and some significant gaps that need to be addressed. It is hoped that these studies will help illustrate the growing threat of invasive species and provide the reader with a sampling of what is being done and what still needs to happen to better address this issue. The National Wildlife Federation does not necessarily endorse the treatment methods used in these case studies but is rather providing an explanation and overview of current practices and programs.

Photo: Gordon H. Rodda—USFWS

*Brown tree snake*

# INVASIVE SPECIES' IMPACTS ON THE ECOLOGY AND MILITARY OPERATIONS ON GUAM

The forests, wetlands and coastlines are eerily silent. The bright hues and twittering songs of birds should fill the air. Yet there's an odd vacancy. Nine of 12 native bird species and two of 11 native lizards are now extinct. Several other species' existences hang by a thread, their numbers so low that their future is uncertain.

The cause is an invasive species; the brown tree snake.

Andersen Air Force Base and Commander Naval Forces Marianna Naval Base Guam are constantly stressed to combat this alien invader in their midst. These bases must not only battle to protect the remaining species on the island, but work to ensure the constant flow of electricity to the installations. Brown tree snakes climb wires leading to poles supporting transformers, distribution lines, and high-voltage transmission lines. When the snakes simultaneously touch live and grounded conductors, they create faults and short circuits, resulting in losses of power to parts of the island and even island wide blackouts. Most importantly, the military must guard against this devastating invader spreading off the island.[25]

"If you want to understand how an invasive species can ravage an area almost beyond any chance of recovery, look no further than Guam," says Robert W. Wescom, Natural Resources Manager of the naval base. "The brown tree snake has touched all of Guam, including military operations, natural resources and how regular people live day-to-day. The major mission of Commander Naval Forces Marianna Naval Base Guam is to ensure the brown tree snake does not move to another island. If the brown tree snake moves to another island, Hawaii or the mainland, it will cause havoc."

## THE PROBLEM

The brown tree snake population in Guam is currently estimated at more than two million or approximately 12,000 per square mile. This slithering invasive is a notorious example of what occurs when a foreign species invades an island lacking natural defenses. Native to the South Pacific and Australia, the brown tree snake can grow up to eight feet and weigh five pounds. It is mildly venomous but not fatal to humans. It feeds on birds, lizards, small mammals, bird and reptile eggs and small household pets. The snake arrived in Guam after World War II, probably on a cargo ship. In less than 20 years, the snake established itself island-wide, and the damage was almost immediate, as birds and bats began to disappear. The military declared it a significant issue in the 1980s and started to receive funding to control and combat the snake in the early 1990s.[26]

The brown tree snake has impacted almost every aspect of daily life and military training at Andersen Air Force Base and Naval Base Guam. For example, snake-caused power outages happen at least once a week as snakes crawl on power lines and transformers. Until recently, up to $4 million a year was lost due to power outages, though more sophisticated trapping has reduced outages considerably in the past couple of years. In addition, the snakes bite hundreds of residents annually. Infants and small children are most susceptible to bites, though no human deaths are known.[27]


*A "Pinkie with a Parachute"*

In addition to being a day-to-day nuisance, the brown tree snake has driven most of Guam's native forest, shore and seabirds to extinction. It is also responsible for eliminating two types of bats (the only native mammals on Guam) and two lizard species. Because island species naturally evolved in the absence of most predators, plant and animal species have few defenses or instincts to avoid predation.

## ACTIONS TAKEN

Andersen Air Force Base and Naval Base Guam expend substantial funds and energies to combat the snake and its possible spread to other Pacific islands, including Hawaii. Control and eradication are both extremely important, as are surveillance and monitoring. Dogs are used to identify snakes, especially at seaports and airports. Along with snake traps around the perimeter of the airfield and cargo yard at Andersen, the Department of Agriculture's Animal and Plant Health Inspection Service inspects all outbound cargo with highly trained terriers.[28]

Trapping and capture programs are used around power plant electricity lines, airports, sites supporting endangered species and other strategic locations, and is the primary suppression tool. A total of 295 snake traps are located throughout the flightline areas of Andersen to prevent snakes from entering the tarmac. In addition, a total of 957 snake traps are used on Andersen Air Force Base to control snakes in support of its endangered species recovery effort. Snake-proof barrier technology works, but has high initial cost, high maintenance and can be damaged by typhoons. New eradication techniques are also being developed, such as "pinkies with parachutes." A pinkie, or deceased newborn mouse, is filled with acetametaphine (the primary active ingredient in some pain


*Brown tree snake*

medications such as Tylenol) and dropped in strategic locations from the air. The pinkie is wearing a tiny parachute that allows it to drift down into trees and other locations where the snake is likely to come across it and ingest the poison bait.[29]

Naval Base Guam and Andersen Air Force Base work together to prevent snakes from stowing away on aircraft and vessels, train and outfit snake control teams, monitor training sites during military exercises and assist military inspectors searching outbound cargo from Guam. The Defense Department provides $1 million annually to the Animal and Plant Health Inspection Service Wildlife Services to ensure the brown tree snake is not inadvertently shipped off the island. The Navy has also allocated an additional $750,000 in 2005 to sustain this important fight. Similarly, the Air Force has provided $750,000 in funding this year for snake eradication interdiction and $200,000 for endangered species recovery on Guam.[30]

U.S. Naval Forces Marianas and 36th Air Expeditionary Wing provide in-kind support to the Department of Agriculture's Wildlife Services with office and kennel space on base, and Commissary and Exchange privileges valued at $300,000. The U.S. Dept. of the Interior provides $300,000, Guam Power Authority provides $50,000, U.S. Fish and Wildlife Service provides $40,000 and the State of Hawaii another $18,000 towards these important efforts.[31] These installations also partner with Guam's Department of Fish and Wildlife, other government agencies and the local Audubon society.

The work is comprehensive, expensive and tedious. According to a 2001 U.S. Geological Survey study, "[n]ormal military inspections involve passengers, accompanied luggage, personal property, Defense Department owned and leased ships, aircraft and crews, and Department of Defense cargo shipped from or transiting through Guam. Inspectors search for the snake while clearing outbound cargo containers, pallets, vehicles and aircraft. Particular emphasis is placed on inspection of confined spaces favored by the snake (e.g., aircraft wheel wells, undercarriages of vehicles and compartments)." Despite the comprehensive effort of the inspections, the work is not foolproof. The report notes that several brown tree snakes found in Oahu, Hawaii,

***According to a report co-authored by the Department of Agriculture, control programs can be made more effective by:***

1. Greater and more stable funding
2. Promoting legislation that requires action to prevent the spread of brown tree snake, including mandatory inspections
3. Clarification of leadership and program responsibilities
4. Development and implementation of comprehensive action plan with clearly defined milestones and
5. Progress on research and program integration.[32]


*The endangered Marianas fruit bat (Pteropus mariannus) is one of the many native wildlife species on Guam driven to the brink of extinction by the brown tree snake.*

were associated with military aircraft, adding that "one was found in the landing gear of a commercial airliner; another found in the customs area of Honolulu International Airport."[33]

The staff at Andersen Air Force base monitors training exercises closely to avoid spreading brown tree snakes outside of Guam, especially to the Commonwealth of Northern Mariana Islands (100 miles northeast of Guam). This monitoring covers virtually every type of air, land and water training exercise performed by the military.

Natural Resources staff at Naval Base Guam and Andersen work not only to control the invasives but also to protect the island's rare wildlife. The bases work with the Department of Agriculture's Animal and Plant Health Inspection Service, Wildlife Service to trap the snakes around caves and other locations. A wildlife enclosure at Andersen's Northwest Field has been constructed to exclude all snakes so that resource staff can raise endangered Guam rails in captivity. This bird is now reproducing within the enclosure. A trapping and perimeter barrier successfully excludes the invasive snakes. Wildlife biologists hope to use this technology to recover other wildlife lost to the brown tree snake, illustrating that adequate funding, determination and knowledge are vital and effective in the fight against invasive species.[34]

"It is unrealistic to think the brown tree snake will ever be fully eradicated from Guam. At this point working to reduce and stabilize the population is the main goal – as well as ensuring it does not spread to surrounding islands. The brown tree snake is the classic example of the devastation one invasive species can do to military installations – altering all aspects of military readiness and training and the very mission of the installations. This species could be the poster child of why comprehensive legislation addressing invasive species is needed," cautions Wescom.

Yet optimism remains. "Andersen Air Force Base is committed to the interdiction and eradication of the brown tree snake. We continuously work in cooperation with U.S. Navy, U.S. Department of Agriculture, the U.S. Fish and Wildlife Service and other federal agencies to conduct studies and determine possible methods for eradicating the brown tree snake," says Scott Whittaker, 36th Civil Engineer Squadron Environmental Flight Chief at Andersen Air Force Base.

## Installation Specifics

### Service Branches:

U.S. Air Force
U.S. Navy

### Locations:

Andersen Air Force Base, Guam
Commander Naval Forces Marianna Naval Base Guam

### Installations' Primary Mission(s):

**Andersen Air Force Base** is home to Pacific Air Forces' 13th Air Force and the 36th Air Base Wing, Air Mobility Command's 634th Air Mobility Support Squadron and several other tenant organizations. Andersen is one of four Bomber Forward Operating Locations in the Air Force. These locations provide forward support to bomber crews deploying overseas in Europe, Southwest Asia and in the Pacific. Andersen is one such base in the Asia-Pacific region.

**U.S. Naval Forces Marianas** mission is to provide the most effective and efficient operations, logistics and training to U.S. and Allied forces in support of Pacific theater strategy and objectives.

### Ecosystem(s):

Coastal cliffs, coastal plains, low-rising hills, mountains

# Hawaii

Photo: Tim Sutterfield

*Red-footed boobies*

## Marine Corps Base Hawaii: Leaders on Hawaii's Front Line

Hawaii is on the front line in the national war against invasive species. This remote island-state is among the most highly endemic and fragile habitats on earth with almost 10,000 species found here and nowhere else.[35] Hawaii is also the endangered species capital of the United States: home to 25 percent of the total 1,264 plant and animal species protected by the Endangered Species Act and 40 percent of the 286 candidate species nominated for the list. Hawaii's native species evolved in relative isolation, with few, if any, natural defense mechanisms, making them vulnerable to intruders. More than 5,000 invasive species have become established in Hawaii over the past 200 years, and more than 1,100 endemic species have become extinct during that time.[36]

The Aloha State has recently invested more than $8 million to control invasive species, staging interagency invasive species control committees on each island to enable rapid response to the problem.[37] A recognized leader in Hawaii's war on invasives is Marine Corps Base Hawaii. The base's natural resources program's persistence and ingenuity breed success and hope.

## THE PROBLEM

Mangrove (*Rhizophora mangle*) is one of the "most wanted" invasive species in Hawaii's coastal areas, including Marine Corps Base Hawaii. Introduced in the early 1900s, these trees form dense stands and literally crowd out native plant and animal life. Left unchecked, mangroves infest streams and wetlands and replace native marsh habitats critical for endangered Hawaiian waterbirds. Mangrove-choked waterways stagnate and foster mosquito breeding, helping to spread mosquito-borne diseases such as dengue fever. Furthermore, mangroves limit access to training areas by flooding them.

*Mangrove stand*

With Hawaii serving as a major staging ground for troops sent to Iraq and other theaters throughout Asia and the Pacific, mangroves are a serious threat to military readiness, says Diane Drigot, Ph.D., Senior Natural Resources Specialist at the base. Mangroves also conceal people intent on criminal behavior. According to Drigot, dense mangrove thickets near the base's borders along the Kaneohe Bay shoreline recently provided cover for a poacher of hundreds of pounds of illegally caught fish. "I'll bet few people think of invasive species as a security threat, but if we don't control mangroves, 'line of sight' security is breached for Marines protecting base borders," she says.

Other invasives disrupt training on the Marine Corps' upland training ranges. When dry land invasive plants, such as Guinea grass (*Panicum maximum*) ignite in such areas, the fires rage so fiercely that firefighters cannot bear the heat to control them. Fire-heated soil can trigger detonation of buried ordnance from past range uses, compounding perilous conditions. The peril is present not just for firefighters but for nearby sensitive species, ecosystems and human communities. For example, the base hosts a colony of more than 2,000 tree-nesting red-footed boobies (*Sula sula rubripes*) at the top of a crater firing range.[38] "Every time a fire occurs, the base has to immediately shut down training, fight the fire and prevent it from spreading into the booby colony or across the ridge into housing areas. This compels the military to be excellent environmental stewards and devise state-of-the art firefighting systems," says Drigot.

## ACTIONS TAKEN

Each invasive species requires different control methods. Notable at Marine Corps Base Hawaii are the integrated efforts to both support military training and combat invasive species, such as their "pickleweed patrols." Under a partnership between natural resources staff and the Third Marine Regiment's Combat Assault Company, Marines train in their 26-ton Amphibious Assault Vehicles over difficult terrain, while clearing mudflats of pickleweed (*Batis maritima*), an invasive ground cover from Argentina that unless removed would make wetland areas inaccessible to the endangered Hawaiian stilt (*Himantopus mexicanus knudseni*). Since this practice began, the number of stilt counted on the base's wetlands has nearly tripled, growing from 60 to 160 birds (10 percent of Hawaii's total stilt population).[39] The muddy terrain training is also valuable to the Marines, according to Marine Corps Captain Kleinpaste, who oversaw the assault vehicle "mud ops" with Drigot this year. The annual exercise is a definite boost to combat training. Recently in Iraq, he said there was a mechanized company that actually got mired down in mud

during an attack and had to extract themselves while under hostile fire. The training Marines get while combating pickleweed allows them to hone their skills to survive battle.

Mangrove infestation at Marine Corps Base Hawaii has been managed by an integrated team of natural resources staff, combat-ready Marines, contractors and community volunteers, who hacked, plowed, pulled and excavated their way to victory. "It took about $2.5 million over 20 years to finish the job of removing 20 acres of invasive mangroves from installation wetlands," says Drigot, "but it was worth it. Twenty acres of 'saved' native habitat offers a 'proving ground' of what can be done."

This is a notable accomplishment, yet mangroves are a continuing problem on the base due to reinvasion from the adjacent lands and waterways. In order for the Marine Corps base to have any sort of long-term success with mangrove removal, neighboring land owners, both public and private, must begin to manage the species on their property.


*Hawaiian Stilt nest on a mudflat created by the tracks of an Amphibious Assault Vehicles used to remove pickleweed during their annual "mud-ops".*

Military bases must engage in these kinds of integrated, interagency cooperative management efforts for controlling invasive species. "Marines are limited in funding and size," Drigot says, "but that leads to great motivation and creativity. We interact with neighbors and partners effectively. Through innovative teamwork, we will curb invasive species. We will do it because we have no other choice but to protect our military's ability to train, preserve Hawaii's ecosystems, and help sustain a healthy economy. We hope to inspire similar efforts elsewhere. Remember, however, it takes years of persistence to win this battle and the effort should be immune from partisan politics."

## Installation Specifics

### Service Branches:

U.S. Marine Corps

### Locations:

**Marine Corps Base Hawaii** manages the installations and natural resources located on a total of 4,500 acres on the island of Oahu, including Camp Smith, Kaneohe Bay, Marine Corps Training Area Bellows, Manana Family Housing Area, Pearl City Warehouse Annex and Puuloa Range Complex.

### Installation's Primary Mission(s):

Marine Corps Base Hawaii maintains key operations, training, and support facilities and provides services that are essential for the readiness and global projection of ground combat forces and aviation units, and the well-being, morale and safety of military personnel, their families and the civilian workforce. Marine Corps Base Hawaii Kaneohe Bay has a fuel pier and waterfront area, used for loading tank landing ships and small boats for transporting equipment off-island.

### Ecosystem(s):

watersheds, wetlands, mountains, grasslands, forests, reefs and tidal pools

Photo: Jim Story, Montana State University, www.forestimages.org

*Spotted knapweed*

# INNOVATORS IN INVASIVES: FAIRCHILD AIR FORCE BASE USES INSECTS TO KNOCK OUT INVASIVES

The answer arrived in the bottom of ice cream cups. That's what the containers, Dixie cups with wire mesh lids, looked like to Gerald Johnson anyway. Inside each cup were 100 tiny insects. Johnson, then natural resources manager at Washington's Fairchild Air Force Base, remembers standing with his staff in grasslands and setting their cargo free.

"Talk about money flying through your fingers," Johnson says with a smile. At a cost of 10 cents each, more than $30,000 worth of gall flies and weevils flitted and crawled away, carrying hopes that they would curb the invasives problem that plagued the base near Spokane.[40]

In an innovative approach that has won national acclaim and environmental awards, base leaders and their partners used insects as part of a multi-pronged effort to knock out invasive plants that were taking over parts of the base. Fairchild implemented the largest successful biological weed control program in the state of Washington and became a Department of Defense leader in aggressive noxious plant control.

## THE PROBLEM

When the U.S. Air Force cracked down on herbicide use in 1995, Fairchild's leaders were left scratching their heads in concern. More than 16 species of invasive plants covered the undeveloped areas of the 4,500-acre base. Some of the most prevalent invaders include: Russian knapweed (*Acroptilon repens*), spotted knapweed (*Centaurea biebersteinii DC.*), Canada thistle (*Cirsium arvense*) and musk thistle (*Carduus nutans*). Herbicide was Fairchild's main method of control; the installation used 1,600 pounds of herbicide in 1993 alone.[41]

"The weeds have been here forever, longer than anyone can remember," says Johnson, now Chief, Environmental Flight at Fairchild. "We had to control the weeds, but we also had to cut our level of spraying by 50 percent." The directive was an environmental consideration. The Air Force wanted to reduce its use of toxic chemicals.

"In the end, the order was a blessing in disguise," Johnson notes. "We were charged with inventing a better solution. And we did!" Spraying alone was never a great option, Johnson admits. In spite of spraying, weeds continued to grow.

Today, Fairchild uses insects in addition to spraying and mowing. By 1997, a year after Fairchild instituted biological controls; they reduced herbicide use by 50 percent or 800 pounds. "It really worked," Johnson says. "So far, we've reduced our weed population by about 30 percent. But this is a forever project. The weeds will never be gone. But we've made a significant dent in what is out there."

Photo: Norman E. Rees, USDA ARS, www.forestryimages.org

*Canada thistle stem gall fly*

In all, Fairchild treated more than 710 acres of unimproved ground with insect controls. The base eliminated spraying near 200 acres of high quality wetlands. Approximately 1,200 acres of ground was eliminated from their spraying program.[42]

"Noxious plants don't impact our military readiness like they have at some installations," Johnson notes. "But we have a responsibility to manage our natural resources responsibly. We also must be sensitive to the surrounding community. It's important to maintain positive relationships with other landowners."

However, these invasive plants were pushing out many of the native species located on the base. State and county laws mandate landowners to control certain noxious plants to inhibit spread. To comply with these laws, Fairchild's 92nd Civil Engineer Squadron, responsible for maintenance of grounds and infrastructure, united experts inside and outside the base to attack the problem. "We were lucky to have the right people at the right time who were motivated to find an answer," Johnson says. They devised a plan.


*Broad-nosed knapweed seedhead weevils*

## ACTIONS TAKEN

Fairchild decided to employ biological control, the use of insects to damage weeds enough to curtail their growth, Johnson says. "A secret to controlling invasive weeds has been to go back to their native home and find their natural enemies."

Fairchild staff conducted an environmental assessment and made every effort to ensure that introduced insects were limited to specific weeds and did not threaten other native plants or wildlife. Working closely with Gary Piper, Ph.D., an entomologist at University of Washington, Fairchild's staff selected insects to work on the identified weeds. These controls included seed head gall flies (*Urophora affinis* & *quadrifasciata*), stem gall flies (*Urophora cardui*), seed eating weevils (*Rhinocyllus conicus*) and leaf and stem gall flies (*Cystiphora schmidti*).

The effects were dramatically apparent. Many thistles quickly developed stem galls; flowering seedheads teemed with larvae, and leaves showed evidence of insect damage. The base released 300,000 insects at a cost of $30,000, roughly the amount it would have cost to spray the area, except that insects reproduce naturally. They continue to attack the weeds and no spraying is needed. This cost savings is estimated to be in excess of $30,000 per year. The insects also spread to surrounding private lands, aiding in community pest-control efforts.[43]

"Use of biological agents is only one tool in the fight against noxious weeds," Johnson notes. "Multiple control methods, including spraying and mowing, are important when implementing any invasive weed control effort. Each installation needs to take an integrated approach when attacking noxious weeds and other pests."

As a result of Fairchild's efforts, Johnson has helped other installations nationwide achieve similar results.

"Biological controls and integrated plans are a lot to coordinate initially, but the outcome is worth it," he says. "It's been a win-win situation for everyone. We've made a big difference in the quality of our natural resources and grasslands, and we've maintained good relationships with our community."

### INSTALLATION SPECIFICS

**SERVICE BRANCH:**
U.S. Air Force

**LOCATION:**
Fairchild Air Force Base, near Spokane, Washington

**INSTALLATION'S PRIMARY MISSION:**
The Air Mobility Command base is home to the 92nd Air Refueling Wing, as well as the Air Force Survival School, 141st Air Refueling Wing and 2nd Support Squadron.

**ECOSYSTEM(S):**
Shrub-steppe


# Camp Pendleton: Mapping Out Success

The thick clouds of smoke that rose from the beach at Marine Corps Base Camp Pendleton weren't the results of any live-fire training happening nearby. Rather, the smoke was coming from enormous piles of giant reed (Arundo donax) burning along a stretch of beach.

The record-setting rains of the past winter in Southern California caused massive flooding, but it was the *Arundo* that the floods left littered all over the beach that became the most serious consequence. The Environmental Security Department, requested nearly $200,000 in emergency funds this year for *Arundo* removal on the beaches of Camp Pendleton. It is a lot of money, but when the mission at Camp Pendleton is to operate amphibious training for Marines, *Arundo* debris removal from the beach is a vital part of supporting that mission.[44]

## THE PROBLEM

Camp Pendleton has spent approximately $1.2 million over the last five years to treat more than 380 acres of primarily *Arundo* and *Tamarisk* (*Tamarix ramosissima* Deneb)—it generally takes five years of solid treatment in one area to get the infestation down to less than one percent cover. *Arundo* is like one of those alien monsters in the movies that just won't die. You can hack it up,

mow it, burn it, even mulch it to bits—but it will still come back. The secret is in its lifeline, the rhizome. A rhizome is an underground, horizontal stem with nodes where new leaves and roots can grow. *Arundo* is hardy because it only takes a piece of rhizome with a node to reproduce vegetatively. Additionally, *Arundo*'s rapid growth rate has been observed at up to 0.7 meters/week during certain months of ideal conditions.[45] And it is spreading along the costal areas and riversides of Camp Pendleton.

Riparian habitat is an important non-vehicular training area for the Marines: *Arundo* can impede exercises if it's not controlled. Deborah Bieber, head of the Land Management Branch at Camp Pendleton explains: "*Arundo* will form walls of impenetrable vegetation that Marines cannot train in."

Unfortunately, *Arundo* is only one on a lengthy list of invasive species that the Land Management Branch has been fighting. For example, fennel (*Foeniculum vulgare*), a perennial shrub, is literally pushing some training areas to the edge. In what is supposed to be uninterrupted open space for military operations, Marines have pitched tents in smaller open areas between large patches of fennel. A stand of mature fennel is a dense, impenetrable thicket that can grow taller than a Marine. The base is also working on controlling artichoke thistle (*Cynara carduncul*us *L.*), yellow star-thistle and other California Invasive Plant Council listed species. A long list of other invasive species, such as exotic bullfrogs and fish, are also controlled when encountered in management areas.

## ACTIONS TAKEN

Camp Pendleton has one of the most sophisticated and longest-running programs for managing invasive species. Pendleton occupies about 125,000 acres of coastal Southern California in one of the most biologically rich and diverse ecosystems in the United States. To help handle this complexity, the Land Management Branch has created area-specific weed control programs.


*Dense stands of fennel influence where tents and camps can be set-up at Camp Pendleton*

*Arundo* removal is covered under the Riparian Weed Control Program. Riparian weeds management was negotiated in a Biological Opinion, which details strategies to conserve listed species, such as the threatened southwestern willow flycatcher. The importance of invasive weed control and its connection to the Biological Opinion is why there is adequate and regular funding to deal with riparian weeds like *Arundo* and tamarisk.

The Upland Weed Control Program addresses many weeds, especially fennel. Todd Easley, Invasive Weed Specialist/ Ecologist for the Land Management Branch, describes the vastness of fennel: "It is so widespread throughout the base that it would literally take millions of dollars to get rid of it." There has been ongoing research to determine the best methods of invasive weed management for specific species such as fennel.

To help prioritize treatment, a geographic information system (GIS) is being used to map vegetation and training areas to help track areas of infestation for each control program. Historical data has been digitized and a "geo-database" has recently been produced for artichoke thistle, an invasive the base has been treating since 1984. Mapping and efficient survey methods have allowed for intensive and targeted control of this thistle, successfully bringing infestation down from 100 percent coverage in some areas to near eradication. Additionally, the upland and riparian programs have geo-databases near completion, which have already proved to be a powerful tool for invasive species management.[46]

Once a treatment project is identified it is matched with an appropriate funding opportunity. Funding for invasive species management operates on a project-by-project basis with proposals detailing control methods submitted years in advance. While money is available for invasive species, Bieber has to be creative in obtaining funding for weeds not tied to any regulatory driver. She has a contract she calls the "nip it in the bud" contract to immediately control emerging but potentially damaging weeds, such as yellow star-thistle, which is a big problem in other parts of California but not at Camp Pendleton. A greater challenge is funding the actual personnel to help handle the daunting workload.

Given all their success so far, Bieber believes the invasive species program is on the right track. However, she feels there is one gaping hole in all the invasives work that she would like to get addressed: "The most important thing you can do right now … is to work with the horticultural industry to tighten restrictions on the importing of invasives and avoiding their spread in the first place in ways such as breeding them to be infertile."


*Arundo removal*

## Installation Specifics

### Service Branch:
U.S. Marine Corps

### Location:
Northwest corner of San Diego County, California

### Installation's Primary Mission:
To operate an amphibious training base that promotes the combat readiness of operating forces by providing facilities, services, and support responsive to the needs of Marines, sailors and their families.

### Ecosystem(s):
coastal plains, valleys, mountain foothills, woodlands, chaparral and sage scrub, coastal bluff scrub, grasslands, coastal dunes, riparian communities, and wetlands

Photo: Steve Dewey, Utah State University, www.forestryimages.org

*Yellow star-thistle*

# Jumping into Invasive Species Treatment: Fort Hunter Liggett

The idea of trying to walk through a six-foot tall field of spiky yellow star-thistle is not an appealing one. Now imagine parachuting down into thickets of this prickly pest. This is what some of the brave men and women at Fort Hunter Liggett were facing. While the soldiers may have only ended up with some scratches, their parachutes were being torn to shreds. Averaging upwards of $4,000 apiece to replace, it was clear that something needed to be done.[47]

Training among the thistles is "pretty much like walking through concertina wire," says Marine 1st Lieutenant Timothy Brady. "Getting up and doing fire and movement or fire team rushes though the brush ... definitely causes irritation to the hands and face and could slow you down considerably."[48]

## THE PROBLEM

Estimated to cover 12 to15 million acres in California alone, yellow star-thistle is one of the most ruinous rangeland weeds in the western United States. Native to Eurasia, this invasive plant is highly competitive and typically develops dense, impenetrable

stands that displace desirable vegetation in natural areas, rangelands and along roads. Yellow star-thistle is able to out-compete native plants due to its deep root system and ability to introduce a mild toxin into the surrounding soil.[49]

Beginning in the early 1800s, yellow star-thistle started creeping its way across 22,000 acres of Fort Hunter Liggett. This plant, which grows in dense thickets sometimes higher than a soldier's head and contains "blossoms" covered with one to two inch spines, has rendered some areas of the installation unusable for many types of training. In addition, yellow star-thistle displaces native vegetation and threatens endangered species located on the installation. To make matters worse, when the large dense thickets of annual growth die off they become a serious fire hazard. Live ammunition training and the thorny tinder make for a combustible relationship and several uncontrolled burns occur annually as a result. These fires not only pose a risk to soldiers and base infrastructure, but combating these blazes is an additional expense. As the largest U.S. Army Reserve Command post with more than 165,000 acres (approximately 250 square miles), almost all of the installation is used for training activities; it quickly became obvious that it was time to wage war against this spiky yellow invader.[50]

## ACTIONS TAKEN

In 1998, Art Hazebrook, current Program Manager for Fort Hunter Liggett's Integrated Training Area Management program, pulled together a group to find a way to eliminate yellow star-thistle without causing new environmental problems. The project became a partnership of several state, federal and local agencies, including the University of California at Davis. These groups collaborated to develop an "Integrated Weed Management Plan for Control of Yellow Star-Thistle." The overall purpose of this project was to provide Fort Hunter Liggett with best management practices for dealing with this prickly invasive while sustaining

Photo: Jan Spooner, Photo Journalist, 369th

*Sergeant First Class Richard Amiot wading through a field of yellow star-thistle.*

training and readiness on the installation. This project was also to be used as a template for habitat-specific management practices for other land managers facing yellow star-thistle infestations. The project's final product, a "users guide" to help design and administer cost-effective programs to manage yellow star-thistle and related invasive weed species on military installations, is due out this year.[51]

After testing a variety of treatment methods on different ecosystems the group discovered that the answer was a multi-tiered approach. The solution utilizes a combination of conventional control methods, such as burning, mowing or application of herbicides, followed by biological control to delay resurgence of the weed, thereby decreasing long-term costs and potential environmental damage. Due to the high cost of treatment, the base uses satellite mapping to see what areas have the greatest amount of overlap between training and yellow star-thistle infestation. Then in the late summer or early fall the Integrated Training Area Management program coordinates with the fire department to execute controlled burns of the areas selected for treatment. These burns are often set in conjunction with the other preventative burns done each year on the installation. In the following spring the same area is then treated with an aerial application of clopyralid (the active ingredient in Transline), which costs approximately $50,000 per 1,000 acres. Finally, biocontrol insects, like the hairy weevil (*Eustenopus villosus*) and the false peacock fly (*Chaetorellia succinea*), are released to help stand guard against re-invasion. According to Hazebrook, the cost of treating invasive species takes about a quarter of his program's budget, money that could otherwise be spent on improving overall training conditions.[52]

While Fort Hunter Liggett has made significant progress in its battle against yellow star-thistle and reopened a number of heavily infested training areas, the war is not over. The fort's Training Area Management program has treated only about 5,000 of the 22,000 infested acres and this persistent invader continues to find its way onto new areas of the installation. Getting ahead of the curve is the challenge according to Environmental Chief Gary Houston: "From a natural resources perspective it is about actually getting star-thistle into a manageable state where it's not having as much of an impact on training activities. We need some money, quite a lot of it, over a relatively short time period . . . It's feasible with this controlled burning and herbicide program but it requires money." According to the Army's current budget policy, treatment of invasive species is not considered a priority; thus, funding is limited to treatment of training lands rather than natural resource management.

*Yellow star-thistle threatens to tear parachutes*

## Installation Specifics

### Service Branch:
U.S. Army

### Location:
The central coast of California, 150 miles south of San Francisco and 250 miles north of Los Angeles.

### Installation's Primary Mission:
To maintain and allocate training areas, airspace, facilities and ranges in order to support reserve and active components field maneuvers, live fire exercises, testing, and institutional training.

### Ecosystem(s):
Primarily grass and oak woodlands

Photo: Laura Busch

Saltcedar

# Tamarisk No More: Marine Corps Air Ground Combat Center

Clad in protective body suits, contracted workers canvassed the vast desert home of the Marine Corps Air Ground Combat Center in search of tamarisk, a shrub-like, small tree also known as saltcedar. Careful to avoid unexploded ordnance, they would spray each plant they came across. Today, years of treatment have yielded successful results—tamarisk plants are few and far between on the installation, and the sprayers are only needed every other year for maintenance.

Located in the southern Mojave Desert, one of the hottest and driest places in North America, it's obvious why the Combat Center took an aggressive approach to controlling the spread of tamarisk. "We don't want tamarisk sucking up our water," says Natural Resources Specialist Laura Busch. Busch is referring to the Combat Center's Surprise Spring aquifer, the sole supply of potable water for the installation.

The Natural Resources and Environmental Affairs Division recognized early on the potential ecological and economic impacts of this invasive and about six years ago established an invasive species management program with a primary focus on tamarisk.

## THE PROBLEM

Tamarisk was introduced into the United States in the early 1800s from Central Asia and the Middle East as an ornamental plant and for erosion control.[53] It adapted easily to the western United States' riparian areas where it quickly spread and is now crowding out native species such as cottonwood and willow. Tamarisk's extensive root system allows it to out-compete native plants for resources, especially water. Furthermore, this invasive increases the salinity of surrounding soil surfaces, making it inhospitable to native plants. Scientists at the Department of Agriculture have described the tamarisk invasion as "arguably one of the worst ecological disasters ever to befall western riparian ecosystems of the United States."[54]


*A "fighting hole".*

### *The Latest Threat*

*Although a classic symbol of the American west, Russian thistle, also known as tumbleweed, is an invasive species that is posing the latest threat to training at the Combat Center. Since 1999, Russian thistle has increasingly spread throughout the installation. Russian thistle can become a fire hazard if it gets into live-fire training areas. The bulky weed has also become entangled in moving target tracks, obstructed the target mechanism and adversely affected the ability of Marines to use target arrays for training. At Range 113, concrete pits in the ground known as "fighting holes" are checked for thistle, so that Marines don't jump onto the thorny bush.*

In a vast desert usually devoid of a lot of vegetation, tamarisk plants are fairly easy to spot. To some Marines and nearby residents of Twentynine Palms, tamarisk provides precious shade. Busch explains the conflict: "We're trying to fight back, but how can you deny people their shade when it's 110 degrees?" Unfortunately, the cost of shade, possible reduced water supplies and native plant life, is not well-known. This misunderstanding of tamarisk, and invasive species in general, demonstrates how more education about the tamarisk's significant consequences is needed. Often the public does not know what an invasive species is nor do they recognize the potential harm of planting or improperly discarding non-native organisms.

In the western United States, where water is already scarce, the share that tamarisk population uses is astounding. Rough estimates range from 2.0 to 4.5 million acre-feet of water per year. This amount could supply enough water for upwards of 20 million people or irrigate more than one million acres of land.[55]

Given all this, the base's decision to react before tamarisk becomes an immediate thirsty threat to their water supply shows the needed foresight to protect their ecological and economic resources.

## ACTIONS TAKEN

Natural Resources and Environmental Affairs Division's invasive species program has been funded every year for mostly on-the-ground weed control. Sprayers are contracted to individually treat tamarisk plants with a glyphosate (the active ingredient in Roundup) mixture. If Busch could request any additional resources for invasive species work, she would ask for manual labor to help pull weeds—not more money. How does she establish such strong financial support for their invasive species program?

The key is in policy: "You need a reason as to why you want to do this? Well, we're doing it because our Wildfire Management Plan says we need to, and our Invasive Species Management Plan says we need to … Nothing in nature is a vacuum, it all feeds off each other. If you can show that by taking care of invasives, you're going to get double benefit out of the treatment efforts, it really helps in trying to get those dollars," Busch says.

It also helps that the head of the division, Major Jon Aytes, understands the importance of both training and environmental protection and has the leverage to influence policy decisions. "We are attempting to solve the problem with a look at the overall ecosystem, and invasive species are part of the problem. By managing invasive species, we can provide habitat, conserve water and still meet our mission obligations," Aytes says.

Even with the tamarisk being effectively kept under control, the installation's natural resource managers continue to work on preventing and responding to other potentially damaging invasive species that are spreading throughout the Mojave Desert, such as Russian thistle (*Salsola tragus.*), Sahara mustard (*Brassica tournefortii*) and Mediterranean grass (*Schismus barbatus (L.) Thellung*). The capacity of its invasive species program to sustain what is essentially a long-term commitment to controlling invasives is not only a testament to top-level support, but is ultimately required in a number of the Combat Center's policies that tie invasive species management to the protection of the installation's assets.[56]

## Installation Specifics

### Service Branch:
U.S. Marine Corps

### Location:
Twentynine Palms, California

### Installation's Primary Mission:
Marine Corps Air Ground Combat Center runs the premier Combined Arms Training Program, where thousands of Marines practice essential live-fire and maneuver skills in brigade and battalion sized exercises.

### Ecosystem(s):
high desert, mountains and hills, broad alluvial plains and valleys, dry washes and dry lakes


*A Russian thistle stand*


Photo: Steve Dewey, Utah State University, www.forestryimages.org

# Why Tamarisk it?
# Staying Ahead of Invasives at Fort Sill

Glen Wampler, Natural Resources Administrator at Fort Sill, says if he did not control tamarisk and red cedar they would take over base landscapes and make them unusable for military training. Wampler has worked at Fort Sill as a biologist for 16 years and has seen the damage invasive species cause to the native ecosystem.

## THE PROBLEM

Tamarisk is currently scattered over 20 percent of the 94,000 acres that make up Fort Sill. It has been spreading across the base since the 1980s and in recent years it has begun to noticeably damage recreational ponds in the area. These ponds are important

for fish and wildlife habitat, and for hunting and fishing opportunities for soldiers, an important quality of life amenity. Fort Sill sells over 2,100 restricted hunting and fishing permits per year: if invasive species reduce the habitat or numbers of game animals the fort would be forced to decrease the number of permits issued.[57]

## ACTIONS TAKEN

Tamarisk is not killed by fire but will burn intensely, which is not a good quality on a live-fire artillery training base. For control, Wampler uses an herbicide combination of imazapyr and glyphosate, which provides 90-99 percent control at a cost of as little as $60/acre. In the future, Wampler hopes to use biological controls. A leaf-eating beetle is currently being tested as a biocontrol and if the tests are successful, and it is cost-effective, Wampler is eager to try it. Fort Sill also uses satellite mapping to locate new infestations. They are currently combining the Integrated Training Area Management database with the natural resource records, so that training and invasive species control activities appear on the same maps to highlight overlap.[58]

So far Wampler has been successful at holding back a complete invasion. However, he says that may not always be the case due to a lack of consistent funding for invasive species control. This is a matter of concern because if invasives are not treated in a timely manner, they can quickly become a bigger, more expensive problem.

### ANOTHER INVASIVE THREAT: DOUBLE CEDAR TROUBLE

In addition to wrestling with tamarisk, Wampler must deal with the noxious red cedar (*Juniperus virginia*). While native to the Eastern United States red cedar is rapidly invading the Southwest, bringing with it all the problems of an invasive species. Due in large part to fire suppression, red cedar has invaded more than 6 million acres across Oklahoma. Currently, the Oklahoma Natural Resources Conservation Service estimates that Oklahoma is losing 762 acres of rangeland per day.[59] Red cedar is scattered over 70 percent of Fort Sills' 94,000 acres.[60] Red cedar infestations cause a loss of biodiversity to native plant communities and change habitat composition and dynamics that many songbirds and other fauna such as deer and turkey depend on for survival.

According to the 2002 Red Cedar Task Force estimates, the annual economic loss from catastrophic wildfire, loss of cattle forage, loss of wildlife habitat, recreation and water yield is $218 million. If no preventive steps are taken to control red cedar, this number is estimated to rise to $447 million by 2013. The task force estimates do not include other potential economic losses such as loss of endangered species, poor water quality and degraded air quality. A mature red cedar can use more than 30 gallons of water per day, and its leaves can intercept up to 25 percent of rainfall where it can evaporate before reaching the ground.[61]

To control red cedar, fire is the answer, according to Wampler. Controlled burns help manage this noxious plant while enhancing the prairie ecosystem. Unfortunately, because red cedar takes over land area, making it unappealing for native vegetation, there is often not enough understory fuel around the base of the red cedar. When there is not sufficient fuel for fire, Wampler pays a contractor to mechanically clip the red cedar at a cost of $80,000 per year.[62]

## INSTALLATION SPECIFICS

**SERVICE BRANCH:**
U.S. Army

**LOCATION:**
Fort Sill, Oklahoma

**INSTALLATION'S PRIMARY MISSION:**
**The United States Army Field Artillery Center and Fort Sill** trains soldiers and Marines: develops Field Artillery leaders; designs and develops fire support for the force; supports unit training and readiness; mobilizes and deploys operating forces; and maintains installation infrastructure and services.

**ECOSYSTEM(S):**
High, short-grass plains

Photo: U.S. Air Force

*F-117A Nighthawk*

# Invasives Impact the Air Force's Expensive Technology

Every day, hundreds of millions of dollars take to the skies above Holloman Air Force Base in the Chihuahuan Desert near Alamogordo, New Mexico. Home of the 49th Fighter Wing, Holloman supports pilot training and operations for the F-117A Nighthawk, the world's first operational stealth fighter. The 49th Fighter Wing is the Air Force's only Nighthawk fighter unit, with 51 aircraft.

As Jeanne Dye watches those $45 million jets zoom from the runways, she can't help but reflect that invasive species tamarisk and African rue (*Peganum harmala*) could cause untold damage on some of the Air Force's most amazing technology, as well as threaten pilots' lives. "Sure, there's a price tag on these fighter jets, but the truth is they are irreplaceable," says the Natural Resources Manager at Holloman. "They've made all the F-117A's that are going to be made. Of course, when you consider the pilots, there's no price tag on human life."

## THE PROBLEM

More than 3,500 acres at Holloman suffer from invasive species, and Dye scrambles to keep their spread in check. Her main focus is tamarisk and African rue, which could impede security efforts and degrade airstrips.

Tamarisk grows across entire airfields at Holloman. These thirsty invaders grow thick along runways and roadsides where they soak up runoff. The water tables of the base's rivers and streams have dropped noticeably due to this invasive. "Tamarisk forces native plants out of its path," Dye says. "If we don't step in and stop it, tamarisk could take over everything. It's an ongoing concern, but with proper support, we can bring it to a manageable level."

African rue has an aggressive, woody root system and grows about 18 inches tall. Its root system is extremely deep, extending more than 16 feet. "It's very tough, and it is toxic, so nothing will eat it," Dye says. It becomes established in disturbed areas, especially along roadsides. Each plant produces more than 300 flowers with numerous large seeds per pod. It can put out large numbers of lateral shoots which can generate vegetatively. Introduced in New Mexico in 1928 to produce a vegetable dye known as Turkish red, it has spread throughout the Southwest, infesting areas and making them inhospitable for wildlife and plants.

The areas most impacted by invasive species at Holloman are the airfields. Tamarisk obstructs line-of-sight visibility at runway and taxiway intersections, and increases bird-aircraft strike hazards, as birds roost in these nonnative shrubs. African rue also impacts the airfield by causing premature degradation of roadside/runway shoulders, as well as increasing the potential of foreign object damage to aircraft by punching through asphalt on runways.[63]

So far, no one has been seriously hurt. However, Dye says, "Pilots shouldn't have to struggle to see around the corner of a taxiway. If they overshoot runways, they shouldn't have to

Photo: National Park Service

*African Rue*

> *"The Air Force has powerful jets; they train talented pilots. But the bottom line is a safe and secure Air Force base depends, in part, on how well we control invasive weeds and trees."*
>
> *~ Jeanne Dye*
> *Holloman Natural Resources Manager*

worry about running into tamarisk, which could cause significant damage. They shouldn't have to fret about colliding with birds or landing on runways broken up by African rue."

Tamarisk also affects boundary fencelines, which require line-of-sight clearance for security, as well as anti-terrorism/force protection. "Stands grow tall and dense in exactly the wrong areas to maintain a secure base," Dye says. "Controlling tamarisk can be a huge priority from a security standpoint."

## ACTIONS TAKEN

Dye worked to control tamarisk along boundary fences in 2002 for antiterrorism/force protection. She identified areas to be cleared and partnered with a plant removal expert to identify control methods. "We cut the tamarisk at the stump then applied herbicide," Dye says. "When you must treat dense stands by hand, it is a very costly and labor intensive effort." Up to 98 percent of treated plants were killed during the 2002 effort, and Dye continues to monitor areas. Also in 2002, staff treated African rue along a base bypass road where approximately 90 percent were killed, but she says the plants are reinvading.

Through an integrated pest management process, Holloman staff use all the tools in their kit, including aerial and tanker truck spraying, hand pulling and stump cutting. Prevention and control costs are funded through the base's operations and maintenance budget, environmental conservation funds and grants. In the last several years, Holloman Air Force Base has spent $60,000 annually for invasive species controls. In 2005, the base is spending $160,000 on invasives management on the airfields.[64] Additional control efforts are slated for 2006, including: $200,000 to treat 900 acres of tamarisk by helicopter and $360,000 has been set aside for a focused effort to treat invasives within the airfield. "It adds up quickly. Clearing a stand of tamarisk can cost thousands of dollars per acre," notes Dye.

"The world we knew ended on 9-11," Dye says. "The military's eyes opened that the war on terrorism also means a battle with invasive species. But we lack adequate funding. We can't put more than a Band-Aid on the problem. The Air Force has powerful jets; they train talented pilots. But the bottom line is a safe and secure Air Force base depends, in part, on how well we control invasive weeds and trees."

## INSTALLATION SPECIFICS

### SERVICE BRANCH:
U.S. Air Force

### LOCATION:
Holloman is located in New Mexico's Tularosa Basin between the Sacramento and San Andreas mountain ranges, about 10 miles west of Alamogordo, New Mexico.

### INSTALLATION'S PRIMARY MISSION:
Home of the 49th Fighting Wing, which supports national security objectives with mission-ready F-117A stealth fighters, Air Transportable Medical Clinic, and the Basic Expeditionary Airfield Resources Base. It deploys combat-ready and mission-support forces supporting Air Expeditionary Force operations, Global War on Terrorism and peacetime contingencies. It trains pilots in the F-117A and the T-38A aircraft.

### ECOSYSTEM(S):
Chihuahuan Desert


Kudzu

# It is Not Easy Getting Out from Under Kudzu— But Fort Pickett Just Might

Fort Pickett is an Army National Guard maneuver training center and has 42,000 acres of land. It also hosts training for Air Force, Marine Corps and Navy activities. Training exercises include armor, hell-fire missiles and cannon cockers, with both live and inert ammunition. With all the fire power located at Fort Pickett one would think there was little to fear on the installation: well, except for invasive species.

"Defense of our natural resources and defense of the United States are related to one another. Protecting our native flora and fauna from any type of invasive species is good for our installation and good for southern Virginia," says Lt. Colonel David B Weisnicht, Director of Lands, Training, Mobilization and Security at Fort Pickett.

## THE PROBLEM

Over the past 100 years, kudzu has spread throughout the southeast, replacing native plants and disrupting ecosystems as it smothers anything in its path. Bob Wheeler, Natural Resource Administrator at Fort Pickett, says kudzu has overrun training lands rendering them useless to the mission of the base. Kudzu makes training lands useless because it can tangle around tanks and soldiers, and conceal what lies beneath, such as poisonous snakes, roads and dangerous ditches. Even Humvees and M-1 Abrams tanks have to avoid kudzu.

Kudzu is native to Asia and is flourishing in the United States. Originally brought to the United States as an ornamental plant, in the 1930s the Department of Agriculture decided kudzu could be used for erosion control and distributed millions of seedlings throughout the south. It was later determined that kudzu's erocion control properties were limited. In 1970 it was declared a

weed. Kudzu is now established throughout the southeast and ranges as far wast as Oklahoma and as far north as Connecticut.

At one point kudzu had consumed over 200 acres of military training land at Fort Pickett. This invasive vine spreads exponentially when left to grow unchecked. In the summer it can grow one foot per day. Kudzu's stems grow to 95 feet and its roots down to 9 feet. One of the sites rendered useless by kudzu infestation included an 80 acre assault airfield used for heavy drops and tank company maneuvers. However, after a lot of work, the area has been reclaimed. One helicopter landing zone is currently closed due to kudzu and is targeted for reclamation this year.[65]

Not only does kudzu eliminate use of training lands, it impacts native ecosystems. The natural resources staff at Fort Pickett work to ensure neither kudzu nor its removal negatively impacts the fort's resident endangered species, including false poison sumac (*Rhus micheauxii*) and Roanoke logperch (*Percina rex*), or the base's nesting bald eagles (*Haliaeetus leucocephalus*). Wheeler also works to protect the native natural resources on the base to ensure quality of life for soldiers training there and the local people living near the installation. People hunt deer, turkey, quail, rabbit, dove and squirrel on and around Fort Pickett. More than 2,500 hunting and fishing permits are sold each year to the public. If kudzu reduces access to hunting and fishing, this will reduce recreation opportunities.

## ACTIONS TAKEN

Wheeler has worked at Fort Pickett for 27 years and says kudzu has been living on the base for decades, but only became a problem seven or eight years ago. Fort Pickett uses controlled burning to benefit the native flora and fauna and to reduce the risk of wildfires caused by use of live ordnance. In fact, before Fort Pickett implemented a controlled-burn program they experienced over 100 wildfires a year but now have as few as 40 to 50 wildfires. It was hoped that these controlled burns would prove effective against kudzu; unfortunately, though fire stresses this invasive, it does not stop its spread. Wheeler also tried bushhog mowers, but the vines only ruined the machines.

Wheeler now uses herbicides to control kudzu. He uses the chemical DuPont Escort XP at a rate of 3-4 oz. per acre per year and applied with high-volume sprayers. If the kudzu is too close to streamside management zones a foliar or cut stump method is utilized with an aquatic-sensitive glyphosate product such as Razor.

Currently, kudzu occupies over 120 acres at approximately 18 sites, down from a high of 200 acres.

Wheeler had been spending $85,000 a year to properly control kudzu but some of those funds dried up. He currently tries to budget around $45,000 per year but even that money is unreliable and inconsistent. Wheeler says kudzu is not a problem you can neglect because it will only grow bigger.

If Wheeler and the rest of the staff at Fort Pickett stay on top of the kudzu problem, it will probably remain under control. However, kudzu spreads so easily that constant diligence is needed. Unfortunately, Fort Pickett also faces problems with spotted knapweed and grasses that are also detrimental to training. These additional invaders my stress their invasive species control programs to the point that they may not be able to keep their gains.

### INSTALLATION SPECIFICS

**SERVICE BRANCH:**
U.S. Army National Guard

**LOCATION:**
Fort Pickett, Virginia

**INSTALLATION'S PRIMARY MISSION:**
Fort Pickett's primary mission is to support the training of Active, Reserve and National Guard combat and combat support units in successful techniques of organization, deployment and combat operations under as wide a variety of conditions as possible.

**ECOSYSTEM(S):**
Upland pine and oak-hickory savannas, wetlands

# Avon Park


*Wild hog*

## Hog Wild Invasives at Avon Park Air Force Base

A rare Florida scrub jay sits atop a missile-like target in the middle of an active bombing site at Avon Park Air Force Range. However, this beautiful bird is threatened more by the invasive species invading its natural habitat than by the daily bombing practices.[66] Avon Park Air Force Range is a 106,000-acre bombing and gunnery range located in central Florida. Despite heavy live fire, the range is home to 11 species protected by the Endangered Species Act. At any given time more than 1,000 soldiers are training on this installation, coexisting with the wildlife. But invasive species threaten them both.

Avon Park provides access to extensive, diversified and convenient training airspace, as well as ranges with unique training capabilities for military ground training. This installation is also used by the National Guard to train infantry and the Navy to practice bombing exercises. The base has daily bombings using both live and inert ordnance. Avon Park provides a variety of air-to-ground targets in support of air and ground operations, while supporting a large natural resources program, including fish, wildlife and grazing programs within the range complex. Approximately 82,000 acres of the range may be open to public access - as military activities allow - for hiking, hunting, fishing, camping, and other related activities. The bulk of the installation is classified as a Wildlife Management Area through a cooperative agreement with the Florida Fish and Wildlife Conservation Commission. The installation sells over 3,000 permits a year for hunting, fishing and other recreational activities.[67]

## THE PROBLEM

"What can cause the immediate halt of training soldiers at Avon Park? Invasive vines, weeds, and feral hogs that can put troops' lives at risk and impede military readiness and training," says Paul Ebersbach, retired Lieutenant Colonel and current Natural Resources Manager at Avon Park.

Avon Park has several invasive species causing problems: Japanese climbing fern (*Lygodium japonicum)*, Old World climbing fern *(Lygodium microphyllum)*, tropical soda apple (*Solanum viarum Dunal)* and wild hogs.

Japanese climbing fern was most likely introduced into Florida as an ornamental plant in 1932.[68] Old World climbing fern is native to Africa, Asia and Australia and was first brought to the United States in 1958.[69] The climbing ferns can devastate native plant communities by smothering understory and canopy trees and creating thick mats of highly flammable plant material on the ground. The climbing ferns burn intensely, altering the dynamics of controlled burns. While controlled burns benefit Avon Park's forests by reducing understory, invasive ferns grow to the top of trees causing the fires to move up, completely destroying the trees and devastating the forest ecosystem. Fires involving climbing ferns are difficult to control and can pose a safety risk for military personnel working on the installation. On a bombing range it is very important to be able to use controlled fires to minimize understory and thereby reduce the chances of wildfires caused by ordnance. The removal or control of climbing ferns and other vegetation that promotes intense fire is vital to ensuring the reduction of uncontrolled fires that could shut down training activity.[70]

As Avon Park Rangeland Management Specialist Scott Penfield explains, "At the border between Bravo and Foxtrot training ranges, in one of Avon Park's most important bombing areas, is a cypress swamp. The swamp is large, about 300 acres, and is being taken over by Old World climbing fern." Penfield has a serious dilemma on his hands: continue training with the realization that a difficult-to-control fire inevitably will occur, killing native trees and wildlife and possibly shutting down the training in this portion of the range or close the range while he and his staff try to control the fern. Making the situation worse is the presence of unexploded ordnance in the area which prohibit staff and contractors from walking in and treating the infestation without the area first being declared safe by explosive ordnance personnel. Another option would be to use aerial spraying, which is less targeted, however, and


*Old World climbing fern*

would therefore have a big impact on the native plant community and would still require shutting down the range for a period of time.

Tropical soda apple, a thorny, shrub-like herb native to Argentina that can grow up to six feet tall, is also causing problems on the installation. Tropical soda apple will grow in open fields or shaded areas. Cattle are permitted to graze on the installation and tropical soda apple initially arrived at Avon Park via hay brought in from off the Range. These initial introductions were controlled, but the plant still shows up periodically because adjacent landowners have not controlled this invasive plant. When soda apple grows in large clumps around shade trees in Florida, the ¾-inch long thorns keep cattle away from the shade. The same thorns that can cause enough pain and discomfort to keep cattle away can also injure a soldier conducting training or shred an expensive parachute. If tropical soda apple continues to spread across the installation, it could impede military training and readiness by reducing the availability of viable training lands.[71]

Wild hogs, descendants from European wild boars and escaped farm pigs, are not native to the United States. Wild hogs are often managed by agencies as game species and are a popular food item, which makes them sound rather harmless – but they are capable of severely altering native ecosystems and preventing soldiers from training. Wild hogs compete with native wildlife for food and alter habitats. For example, at Avon Park, wild hogs compete with the endangered Florida scrub jay for acorns and can destroy ground nests of the endangered Florida grasshopper sparrow (*Ammodramus savannarum floridanus*).

John Bridges, Avon Park's lead Wildlife Biologist, works hard to ensure that grasses along runways are kept at the optimal height and are managed so they do not attract birds. However, wild hogs frequently dig up the soil along the runways, which causes more insects and other appealing treats to be revealed that draw sandhill cranes, vultures and other large birds. "The sighting of even one crane, vulture or wild hog, on or near the runway may restrict flight operations


***Florida scrub jay***

to ensure the safety of the pilot, passengers and equipment" says Bridges. Wild hogs are responsible for disrupting flight operations several times a year due both to increasing bird strikes and hog presence on the tarmac.

"One of the biggest problems with the invasive species on the installation is that even if the installation manages to control its invasive species and reduces impacts to training, the invasives spread back on the installation from surrounding lands," says Scott Penfield. Florida has in place a program to address invasive plants on all conservation lands throughout the state; however, this program does not include any private lands. Without effective control of these invasive plants from a geographic perspective, irrespective of who owns the land, huge infestations of climbing ferns or tropical soda apple will grow out of control. "Unfortunately, without a new innovative holistic control program re-infestation is inevitable," says Penfield. "We all need to work together, federal, state, and local governments, conservation groups

and regular citizens if we are going to stop new invasions and control those already here. For example, the State of Florida needs to work to prevent Japanese climbing fern from going south and Old World climbing fern from moving north."

## ACTIONS TAKEN

Avon Park deals with its invasive species problem through several different mechanisms. It uses base management operation and maintenance money to survey and purchase herbicides to control for tropical soda apple. Penfield sprays individual plants with glyphosate (the active ingredient in Roundup and Rodeo) and triclopyr (the active ingredient in Remedy). This invasive seems to be spreading at Avon Park primarily from introductions from adjacent landowners, though this increase may also be a result of better monitoring and awareness by Avon Park natural resource managers.

The most common method of controlling climbing fern is to cut and spray. Penfield uses glyphosate, which has been approved for use over water. Treated populations must be monitored for regrowth and re-treated as necessary. Spot treatments are usually made with a backpack sprayer or other hand-held sprayer. The treatment has been successful: climbing fern populations have been in decline since 2003. Avon Park allots $50,000 from the conservation program budget; $20,000 is used for survey work and $30,000 for spraying. The base also partners with the State of Florida's invasive species program, which provides $50,000 per year for spraying to control the climbing ferns.

As Penfield explains, "This money is crucial for keeping invasive species under control. If funding is cut for even one year, the growth of these weeds will be exponential, so consistent maintenance is crucial. With invasive weeds, neglect of the problem will let not only the weeds grow out of control, but also the costs."

Avon Park addresses the wild hog problem with annual hunting that collects 150-200 hogs. They also work with local volunteers to trap wild hogs. Volunteers trap around 50 wild hogs near the air field each year to ensure the area is less attractive to birds.


*Tropical soda apple*

Avon Park is also fortunate to have satellite mapping to manage all wildlife resources by tracking the locations of threatened and endangered wildlife, grazing and timber activities, controlled burns and invasive species. The staff hopes to incorporate this information with training activities. By having this information at their fingertips, range managers can make the best decisions to ensure the health of both ecosystems and soldiers.

Avon Park has done a remarkable job of balancing military training, natural resource management and public access. With the proper funding and technology they will be equally successful in their fight against invasive species. However, this optimism must be balanced with a reminder that treating invasives is a constant battle requiring both vigilance and adequate funding that can only come from state and federal support of invasive species prevention and management.

## INSTALLATION SPECIFICS

### SERVICE BRANCH:
U.S. Air Force

### LOCATION:
Avon Park, Florida

### INSTALLATION'S PRIMARY MISSION:
To manage special-use airspace and scheduling assets; provide access to extensive, diversified and convenient training airspace and ranges with unique training capabilities for military ground training.

### ECOSYSTEM(S):
Dry prairie, oak and sand pine scrubs, pine flatwoods, and freshwater marshes.

Photo: Nathan Tucker

*High School volunteers pulling garlic mustard on Fort McCoy*

# Cooperation is Standard Operation at Fort McCoy

Invasive species do not recognize ecological and political boundaries. For this reason, partnerships are absolutely essential for the management of invasive species. The people at Fort McCoy understand this and have been working with a variety of organizations on invasive species removal for years. Kim Mello, Wildlife Biologist at Fort McCoy, has been combating invasive species for almost two decades and believes it is vital to get the public involved. "State and federal agencies only have so many resources to go around. Too often we take for granted that people know about invasives. The truth is they don't know. We need to inform and educate them about the damage caused by invasive species."

Fort McCoy's primary mission is to provide for the training and readiness of America's reserve and active-component armed forces. It also serves as a Power Projection Platform by processing and preparing soldiers for duty in the global war on terrorism. In addition to its primary mission, Fort McCoy's command imperatives promote partnerships. Employees are encouraged to seek opportunities, both internally and externally, to work together with key stakeholders to achieve common goals. Fort McCoy's invasive species management program exemplifies this commitment and the positive outcomes that can result from a cooperative approach.

## THE PROBLEM

According to Mello, "invasive species out-compete native plants and affect the quality of training lands and the unique flora and fauna at Fort McCoy." With approximately 30 to 50 exotic plant species on the 60,000 acre installation there is no shortage of plant problems. Some of these exotic plants that are very invasive and of special concern to installation include: leafy spurge (*Euphorbia esula* L.), spotted knapweed, garlic mustard (*Alliaria petiolata Cavara*), and wild parsnip (*Pastinaca sativa* L.).

Leafy spurge is a perennial weed with roots often exceeding 20 feet in depth. Its leaves are narrow and up to four inches long. These plants can grow up to three feet high and its leaves exude milky latex when broken, which can produce blisters and dermatitis in humans, cattle, and horses and may cause permanent blindness if rubbed into the eye. This plant can present serious health concerns to troops conducting on-the-ground training.


Photo: Nathan Tucker

*Garlic Mustard Removal*

Spotted knapweed was introduced from Eurasia in contaminated alfalfa, or soil used as ship's ballast. It grows three to five feet tall and forms dense stands. This invasive plant poses a very serious threat to local ecosystems because it releases chemicals into the soil that affect other plant species' growth, resulting in a monoculture of spotted knapweed. Knapweed also captures moisture and nutrients from a deep taproot and spreads rapidly by seed, which stays viable for up to eight years. Loss of native vegetation is a serious concern at Fort McCoy who are charged with protecting the endangered Karner Blue butterfly (*Lycaeides melissa samuelis*). The only known food source for the larvae of these federally protected butterflies is the native wild lupine, which is now being threatened by invasive plants.[72]

Garlic mustard poses a similar threat to native vegetation. This non-native, biennial herb grows five to 46 inches tall. The crushed leaves emit a garlic-like odor. In addition to the concerns of out-competing native plants, garlic mustard has been credited with the decline of the West Virginia White butterfly (*Artogeia virginiensis Edwards*) because chemicals in the plant appear to be toxic to the butterfly's eggs.[73] If the Karner Blue butterfly has a similar response the results could be devastating.

Wild parsnip is both an ecological problem and a health risk at Fort McCoy. This flowering plant, with a thick stem holding hundreds of yellow flowers, can grow over four feet tall. Not only does the plant threaten the biodiversity of native plants but if wild parsnip juices come in contact with skin in the presence of sunlight, severe blistering can occur and the associated skin discoloration can last several months. Wild parsnip poses a serious health risk for soldiers training around this irritating invasive.

## ACTIONS TAKEN

Fort McCoy is developing an integrated weed management plan to address these prevalent invasive plants, using a

combination of prescribed burning, mowing, herbicides, manual removal and biocontrols (insects). What makes Fort McCoy's story unique is the level of partnership, outreach and volunteer opportunities the base has developed. Cooperative ventures offer several advantages to military installations including additional funding opportunities, extra manual labor and further community involvement.

The philanthropic world looks very favorably on both partnership projects and on-the-ground restoration work. A collaborative program, focused on reducing invasive species on the base and surrounding public and private lands, can provide military installations with additional resources, knowledge and manpower. For example, Fort McCoy has received several grants totaling over $112,000 under the National Fish and Wildlife Foundation's "Pulling Together Initiative." These grants influenced Mello to help found the Monroe County Invasive Plant Species Working Group and to work with the group to create a series of informational brochures on invasive plants found in Monroe County.

This working group is made up of a number of state, federal, academic, local and private groups. It has done invasive species surveys and control work on and around Fort McCoy. The working group also allows its members to share knowledge of treatment options and activities. For instance, the base has been able to collaborate with the state Department of Transportation to ensure that when Fort McCoy removes spotted knapweed from its property, the department performs a corresponding treatment of the plant along its roads near the installation.

Mello has also instigated community outreach and education programs on invasive species. For instance, he, along with other members of the county working group, hosted workshops on invasives for local teachers that included lectures, sample exercises that can be used in classrooms and a hands-on demonstration of invasive species removal at Fort McCoy. The goal of the teacher workshops, according to Mello, is to encourage "teachers to bring the information back to their students "future generations," who will continue the effort to control invasives." In fact, the success has been even greater. After taking this workshop, several local teachers have made arrangements to bring their classes to Fort McCoy, where they, too, can learn first-hand about the installation's efforts to combat invasive plant species. Volunteers have also been a large help to Fort McCoy's manual removal of invasive plants, removing over 800 pounds of invasive plants in 2004. From soldiers to local biology students, these volunteers contributed over 1,900 hours of manual labor to the fort's invasive species project, saving almost $50,000 in a single year.[74]

The outreach programs and volunteer participation at Fort McCoy bring about measurable results and substantial savings. These are great successes but they reach even further: the motto of the natural resource folks at Fort McCoy is "seeing is believing." When people visit the installation, they see the invasives problem, the effort and the successes at controlling them, says Mello. "This understanding is vital to getting the financial and community support necessary for a successful invasive species management program both on and off military installations."

## Installation Specifics

### Service Branch:
U.S. Army

### Location:
Monroe County, Wisconsin between the cities of Tomah and Sparta.

### Installation's Primary Mission:
To provide quality training facilities for reserve- and active-component military forces. Fort McCoy is also one of 15 Army Power-Projection Platforms. Fort McCoy is a ready and capable mobilization site, equipped to prepare and deploy U.S. Army Reserve and Army National Guard units for any contingency.

### Ecosystem(s):
Primarily grass and woodlands

Photo: Patsy Kerr

*Phragmites lined airstrip*

# World's Largest Naval Complex Fights to Keep "Sleeping Giant" at Bay

For military leaders at the world's largest naval station, the world's largest amphibious naval base and the nation's largest naval fueling terminal in southeastern Virginia, weeds should rank low on the list of concerns. Yet the invasive species known as the common reed (*Phragmites australis*) is a "sleeping giant," according to Patsy Kerr, Natural Resources Manager at Naval Station-Norfolk, Naval Amphibious Base-Little Creek, Craney Island Fuel Terminal and Oceana Annex-Dam Neck. More than 1,000 acres of the reed impact the installations' security, its ability to fly planes and the safety of ordnance depots. *Phragmites* also affects natural resources and the well being of people who live and work nearby.[75]

"We've long had an Executive Order to direct us to control invasive species like *Phragmites*," Kerr notes. "Since 9-11, the military looks at invasives with a totally different view." She describes how the tall-growing, dense reeds could spell big trouble. "We have operational areas where fields of *Phragmites* grow too close for comfort. Incidental, fast fires and poor visibility are two paramount concerns. And that is just the start of the *Phragmites* problem.

## THE PROBLEM

*Phragmites australis* is an aggressive eight to 16-foot-tall, coarse grass that grows in moist soils of tidal and nontidal wetlands as well as upland soils. While *Phragmites* is native to the United States, the introduction of a nonnative genetic strain of this reed causes it to act like an invasive species, invading wetlands, displacing native vegetation and forming dense stands.[76] In his handbook, *Phragmites australis (Common Reed) Control on Department of Defense Installations*, M. Stephen Ailstock, PhD., describes how the reed "has invaded many marshes throughout the Chesapeake Bay region by forming dense stands which crowd out other native marsh plants." Ailstock is an environmental scientist at Anne Arundel Community College in Maryland and a contractor to control *Phragmites* at Hampton Roads' installations. He adds that *Phragmites* invades disturbed soils easily. Naval installations, with heavy development that disturbs the soil, are perfect places for *Phragmites* to grow out of control.[77]

The impacts of *Phragmites* are felt throughout these four naval installations. *Phragmites* is a big issue for forces who guard these naval installations because the reed grows so tall and thick, often edging close to secure areas such as base perimeters and gates. "Security has not been breached because of *Phragmites*," Kerr says, "but we need to control it to prevent the possibility." Furthermore, the growth of this reed around airfields can have serious consequences. Hundreds of flocking birds roost in *Phragmites*. Deer hide and bed in the reed thickets as well. When startled by aircraft, birds take to air; deer can scuttle across runways. Birds and planes frequently collide, Kerr notes. So far, pilots have been lucky and no serious injuries have occurred. However, a collision with birds or deer can be life threatening for pilots. Secondly, aircraft that overshoot the runway can ignite fields. "*Phragmites* would cause a hot, fast-burning fire. If an aircraft left the runway, the results could be catastrophic," Kerr says. The tall reed also affects visual clearance for pilots and airfield personnel.


*Common reed*

At Craney Island Fuel Terminal and the nearby community of Portsmouth, the mosquitoes are rampant. *Phragmites* impedes water flow, making a perfect environment for mosquitoes to lay eggs in stagnant waters. "You can barely stand to be outside, the mosquitoes are so prolific," Kerr says. "Residential housing surrounds Craney Island; it is extremely difficult for people to be outside." Workers at Craney Island wear a coating of bug spray and heavy-duty clothes, but to little effect. Partnerships with the local community to control mosquitoes are imperative. Kerr notes, "we get a lot of pressure from Portsmouth leaders to fix the mosquito problem. It's important that the community knows we're trying to do our part to help."

*Phragmites* also threatens the natural resources that Kerr is responsible for. It quickly consumes marshy, moist environments, pushing out native plants and creating a monoculture, hurting the ability of certain animal species to thrive. "*Phragmites* messes up biodiversity," explains Kerr. "It displaces native tidal systems that can tolerate hurricanes and heavy storms. It is a sink for trash and mosquitoes. When storms strike, the weeds simply flop over, trapping anything and everything with them. It's impossible to chemically treat *Phragmites* when the plants are mashed to the ground."

## ACTIONS TAKEN

"If we didn't take steps to control *Phragmites*, it would be everywhere," Kerr says. While reedy patches total 1,000 acres, the installation can afford only to control 200 of the most critical acres near runways, base perimeters and gates, fueling and ammunition depots and residential areas. These installations depend on Anne Arundel Community College and Professor Ailstock, who trains military staff in invasive species controls and has compiled massive research on *Phragmites* at military installations.

Kerr follows a plan for *Phragmites* that includes identifying all infested sites on a satellite map and determining which areas can be sprayed by air or on the ground. Spraying herbicide aerially from helicopters is the best way to knock out *Phragmites*; however, ground application is necessary to control hard to reach places. After an area is treated, Kerr replants using native seeds. Typically, native vegetation exists in the Phragmites' understory; these species thrive once the invasive is eliminated. Kerr explains the real key is to give native vegetation the chance to become healthy enough and thick enough to discourage invasive species growth.

Another key to this treatment plan is community relations. The base has an active public relations campaign that informs residents and Naval staff about control efforts. "If people saw helicopters spraying a mysterious substance, we'd get a lot of community backlash," Kerr notes. "We do our best to keep folks informed. They just want to know what we're doing and why."

*Phragmites* doesn't impact on-the-ground training, Kerr notes. "It impacts the tools of training, the ability to fly aircraft, the ability of munitions and refueling sites to function safely and efficiently. Growth of invasive species like *Phragmites* challenge Defense Department's natural resources staff to look at creative funding and new control alternatives. We are constantly testing new methods."

## Installation Specifics

### Service Branch:

U.S. Navy

### Locations:

Naval Amphibious Base-Little Creek;
Craney Island Fuel Terminal;
Naval Station Norfolk;
Oceana Annex-Dam Neck,
are all part of Hampton Roads, the world's largest naval complex; totaling 36,000 acres in southeast Virginia.

### Installations' Primary Mission(s):

**Naval Amphibious Base-Little Creek:** The largest base of its kind in the world, it is the major operating station for the amphibious forces of the U.S. Atlantic Fleet. Its mission is to provide continuously improving support and services for operating forces and shore commands.

**Craney Island Fuel Terminal:** Craney Island is the Navy's largest fuel facility in the United States and possesses 1100 acres of above- and below-ground fuel storage tanks.

**Naval Station Norfolk:** To support and improve the personnel and logistics readiness of the U.S. Atlantic Fleet. Naval Station Norfolk provides seaport, airport and squadron facilities, quality of life and personnel management services.

**Oceana Annex-Dam Neck:** Strategically located within 30 minutes of 50 percent of the U.S. Fleet, joint forces and the North Atlantic Treaty Organization Commands, as well as in close proximity to NAS Oceana and major Army and Air Force Commands, Dam Neck has a distinct advantage in providing training and testing services to the U.S. Fleet. Dam Neck is part of Naval Air Station-Oceana and is home to the Fleet Combat Training Center-Atlantic.

### Ecosystem(s):

Natural tidal basin.

# Recommendations for Action

Map: John and Karen Hollingsworth, USFWS

## "A country worth defending is a country worth preserving."

~Brigadier General Mike Lehnert, Commanding General of Marine Corps Base Camp Pendleton.

Much can and should be done to stop the spread of invasive species on military lands and across the country. Prevention must be at the forefront of any invasive species management plans or policies. Unlike traditional pollutants, invasive species will not dissipate when new species stop being introduced so stopping additional introductions is not enough. Existing populations must also be controlled or eradicated. New management tools must address entire ecosystems, not just individual species or pathways of introduction. It is vital that the environmental impacts of treatment techniques be considered and minimized to the greatest extent possible. Action must be taken on several levels, including the Defense Department, other Federal agencies, Congress, state and local governments and private citizens. To accomplish these important objectives this problem must be addressed on multiple fronts: management plans, education and outreach, funding, research, and sound policy at all levels of government.

### Recommendations from the Natural Resource Managers Interviewed:

- Ensure adequate and consistent funding for invasive species prevention and management
- Create working partnerships with neighboring landowners and jurisdictions
- Enact comprehensive legislation addressing prevention, rapid response and education.

## Recommendations for the Defense Department

### Management Plans

Like most military operations, the key to preventing and combating invasive species is good intelligence, a solid plan of attack, teamwork and the ability to respond quickly. While some bases have taken it upon themselves to create detailed invasive species plans, many still deal with invasives in a reactive manner. Military installations need to incorporate invasive species management into their Integrated Natural Resource Management Plans. These plans should emphasize prevention, rapid response, identify problem species or infested areas, and outline a plan of attack to help the natural resource managers reduce future invasions, prioritize treatment and look for overlap with training opportunities. Cross-check and coordination with operational forces should be standard, in order to integrate situational awareness and inspection and cleaning of military materials to prevent transport of invasives, as referenced in the Defense


*Leafy Spurge*

Department's Customs and Border Clearance Program Regulations.[78]

### Education and Outreach

Joining an invasive species coalition can provide the military with several advantages in terms of funding opportunities, knowledge, manpower, research opportunities and community relations. Similarly, using a network of natural resources managers and contractors can prove invaluable when looking for treatment options or trying to find out about a new species discovered in the area.

### Funding

The Defense Department needs to fund for invasive species control, preparing budget requests that provide adequate funds for invasives management. Furthermore, the amount spent on invasive species prevention and management should be clearly documented by each branch of the military, like the Marine Corps currently does, in order to better track the costs associated with this problem. Invasive species will continue to encroach upon important training land and habitat, and the longer that management programs go under-funded, the more expensive and difficult it will become to get ahead of this problem.

### Research

The Department of Defense should encourage military installations to partner with local colleges and universities to develop and test new prevention techniques and treatment methods for invasive species. Case studies demonstrate that new techniques, such as Fairchild Air Force Base's introduction of insects as biocontrols, can be more effective than traditional methods and greatly reduce the amount of herbicide needed. The National Wildlife Federation hopes that as prevention techniques and treatment methods improve there will be a gradual but determined effort to implement non-chemical, environmentally sound alternatives for the control and eradication of invasive species.

As new prevention and treatment technologies are introduced all federal agencies, including the military services, should be required to use best available technologies. For example, predictive modeling efforts provide a means by which environmental decision makers and managers can identify potential geographic distributions of invasive species, allowing for focused, proactive prevention strategies. One promising example of a predictive model is the machine-learning algorithm, the Genetic Algorithm for Rule-set Prediction. This is a superset of modeling algorithms that searches for nonrandom associations between species occurrence data and the ecological conditions at those sites and constructs a set of rules that describes the species' ecological niche.[79]

## RECOMMENDATIONS THAT LOOK BEYOND THE MILITARY

Invasive species are not just a problem on military lands; they spread across local parks, roadsides, backyards, and other public and private lands. The Department of Defense will not be able to successfully eradicate or control invasive species on their own; other federal, state and local agencies, along with Congress and the general public, must work to prevent new introductions and eradicate infestations of invasive species across the country.

## Management Plans

At the state and local levels government agencies need to be aware that their actions and policies can lead to the spread of invasive species. These government organizations should prohibit the use of invasive species in restoration, landscaping, recreational activities and other government funded projects. Furthermore, state and local governments should develop and adopt management plans to combat invasive species regionally.

## Education and Outreach

Policymakers, the public and military leadership have heard about toxic pollution and habitat destruction for years so there is a relatively high level of general understanding on these issues. On the other hand, though growing in notoriety, the devastation caused by invasive species is still not widely recognized. Considering that invasive species are the second greatest threat to native species survival, and cost the United States approximately $120 billion annually, it is vital to increase awareness of these damaging invaders. A number of mechanisms are available to bring about this change. A few include:

- Organized public hearings, in Washington, D.C., and across the country, to explore and highlight the problem.
- Public education workshops teaching people how to look for invasive species in their own backyards and communities, creating volunteer monitoring programs across the country.
- Start national, local and on-the-base education and training projects so people become aware of local plant and animal invasions and what they can do to help stop the spread of invasive species.

## Funding

- The Administration and Congress should create a military line item for invasive species management, education and personnel.
- The Administration and Congress should support adequate funding so that federal agencies have the resources to address invasive species problems promptly and comprehensively over the long-term.

## Research

- The National Invasive Species Council with input from the States should create a public database listing known and potential invasive species, current locations, and probable paths of entry and/or spread. This information would help with public education, rapid response efforts and development of state and local invasive species management plans.

## Sound Policy

Two bills are currently before Congress that would be great steps forward in addressing invasive species:

- **National Aquatic Invasive Species Act**
  This comprehensive aquatic legislation, introduced by Rep Wayne Gilchrest (R-MD) (H.R. 1591 / 1592) and Senators Carl Levin (D- MI) and Susan Collins (R-ME) (S. 770), would substantially increase the ability to prevent and control damaging aquatic introductions of invasive species. It would create new mechanisms and strengthen existing ones to treat and minimize the effects from invasives on our waters. The bill would also implement a framework establishing a coordinated effort among all levels of government and the private sector addressing prevention, early detection, rapid response, long-term management and control, research, risk analysis and public education and outreach.

- **Public Land Protection and Conservation Act (S. 1541)** This bill, introduced by Senator Daniel Akaka (D-HI), addresses the protection, conservation and restoration of native fish, wildlife, and their habitats on federal, state, tribal and private lands through cooperative, incentive-based grants. These grants would encourage efforts to control and eradicate harmful nonnative species. This funding would benefit the military by assisting with forming working partnerships with neighboring landowners. This bill would also establish a rapid-response program to combat budding invasive species invasions.

### Other Policies that Would Make Federal Agencies More Effective

- Congress needs to enact a legal directive requiring the Department of Defense, and other federal agencies, to prevent and combat the spread of invasive species. This is a necessary step in increasing the stature of invasive species management and its budgetary authority.
- The President should require all federal agencies, including the Department of Defense, to annually report their progress in implementing Executive Order 13112 by identifying those actions and their costs that reduce the introductions or spread of invasive species in the United States or elsewhere.
- The Administration and Congress should strengthen support for the National Invasive Species Council to enable the Departments of Defense, Interior, Commerce, Agriculture, Transportation, State, and the Environmental Protection Agency to more aggressively implement its National Management Plan. This implementation must include measurable results and a timeline for completion.

## CONCLUSION

As one of the largest land owners in the country, the Department of Defense understands the threat that invasive species pose: they alter the function of the land and eliminate native plants and wildlife. The on-the-ground natural resource managers are in a daily battle to control these nonnative invaders, but they cannot do it alone. The nation will only get ahead of this invasion if the military installations, all branches and levels of government and the public are supportive of invasive species prevention and management efforts.

It is hoped that this report inspires the Department of Defense, legislators, scientists, industry leaders and private citizens to work together to control invasive species on military, public and private lands, preserving the native ecosystems of the United States for future generations.


*Musk thistle*

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