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Invasive Plants: Changing the Landscape of America

Federal Interagency Committee for the Management of Noxious and Exotic Weeds

Randy G. Westbrooks

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INVASIVE PLANTS

Changing the Landscape of America



PB99-113524



FACT BOOK

Federal Interagency Committee for the
Management of Noxious and Exotic Weeds

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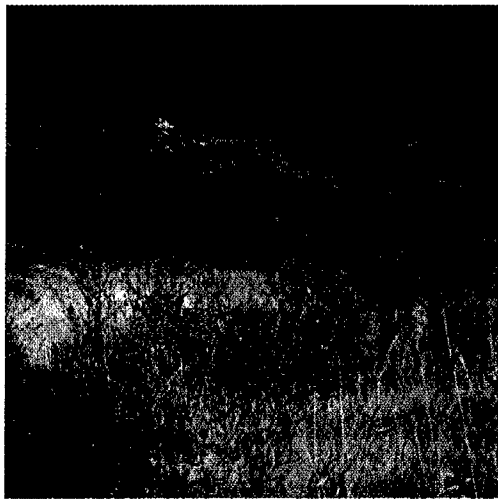
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INVASIVE PLANTS

Changing the Landscape of America



FACT BOOK

Federal Interagency Committee for the
Management of Noxious and Exotic Weeds

1998

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Cataloging-in-Publication Data

Westbrooks, Randy G., 1953-

Invasive plants: changing the landscape of America: fact book/ [senior author, Randy Westbrooks]. -- Washington, D.C.: Federal Interagency Committee for the Management of Noxious and Exotic Weeds, 1998.

[vi], 107 p.: col. Ill.; 28 cm.

Includes bibliographical references (p. 103-107) and index.

“Published with a grant from the National Wildlife Refuge System, U.S. Fish and Wildlife Service.”

1. Invasive plants--Control --United States. 2. Weeds--Control--United States. 3. Plant invasions--United States. I. United States. Federal Interagency Committee for the Management of Noxious and Exotic Weeds. II. National Wildlife Refuge System (U.S.) III. Title. SB613.5W47 1998 639.9/9--dc20

Suggested Citation:

Westbrooks, R. 1998. Invasive plants, changing the landscape of America: Fact book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), Washington, D.C. 109 pp.

Cover photo: C. DiSalvo, National Park Service

Author

Randy G. Westbrooks, Ph.D.
Noxious Weed Coordinator
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Whiteville, North Carolina

Project Director

Lee Otteni
District Manager
U.S. Department of the Interior
Bureau of Land Management
Farmington, New Mexico

Editors

Lissa Fox
Writer/Editor
U.S. Department of the Interior
National Park Service
Harpers Ferry, West Virginia

Beth Vairin
U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
Lafayette, Louisiana

Designer

Diane Baker
Lafayette, Louisiana

Publication Coordinator

Sue Lauritzen
U.S. Department of the Interior
U.S. Geological Survey
National Wetlands Research Center
Lafayette, Louisiana

Peer Reviewers

George K. Beck, Ph.D.
Weed Scientist
Colorado State University
Fort Collins, Colorado

Lloyd L. Loope, Ph.D.
Ecologist
U.S. Department of the Interior
U.S. Geological Survey
Biological Resources Division
Haleakala National Park, Hawaii

David T. Patterson, Ph.D.
Plant Physiologist
U.S. Department of Agriculture
Agriculture Research Service
Fort Pierce, Florida

Technical Reviewers

Robert E. Eplee, Ph.D.
Center Director
Oxford Plant Protection Center
U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Plant Protection and Quarantine
Oxford, North Carolina

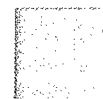
William P. Gregg, Ph.D.
International Affairs Officer
U.S. Department of the Interior
U.S. Geological Survey
Biological Resources Division
Reston, Virginia

Sean Furniss
Biologist
U.S. Department of the Interior
U. S. Fish and Wildlife Service
Arlington, Virginia

Deborah C. Hayes, Ph.D.
Noxious Weed Coordinator
U.S. Department of Agriculture
Forest Service
Washington, D.C.

Gary Johnston
Biologist
U.S. Department of the Interior
National Park Service
Washington, D.C.

*Publication made possible by a grant from the
National Wildlife Refuge System, U.S. Fish and
Wildlife Service.*



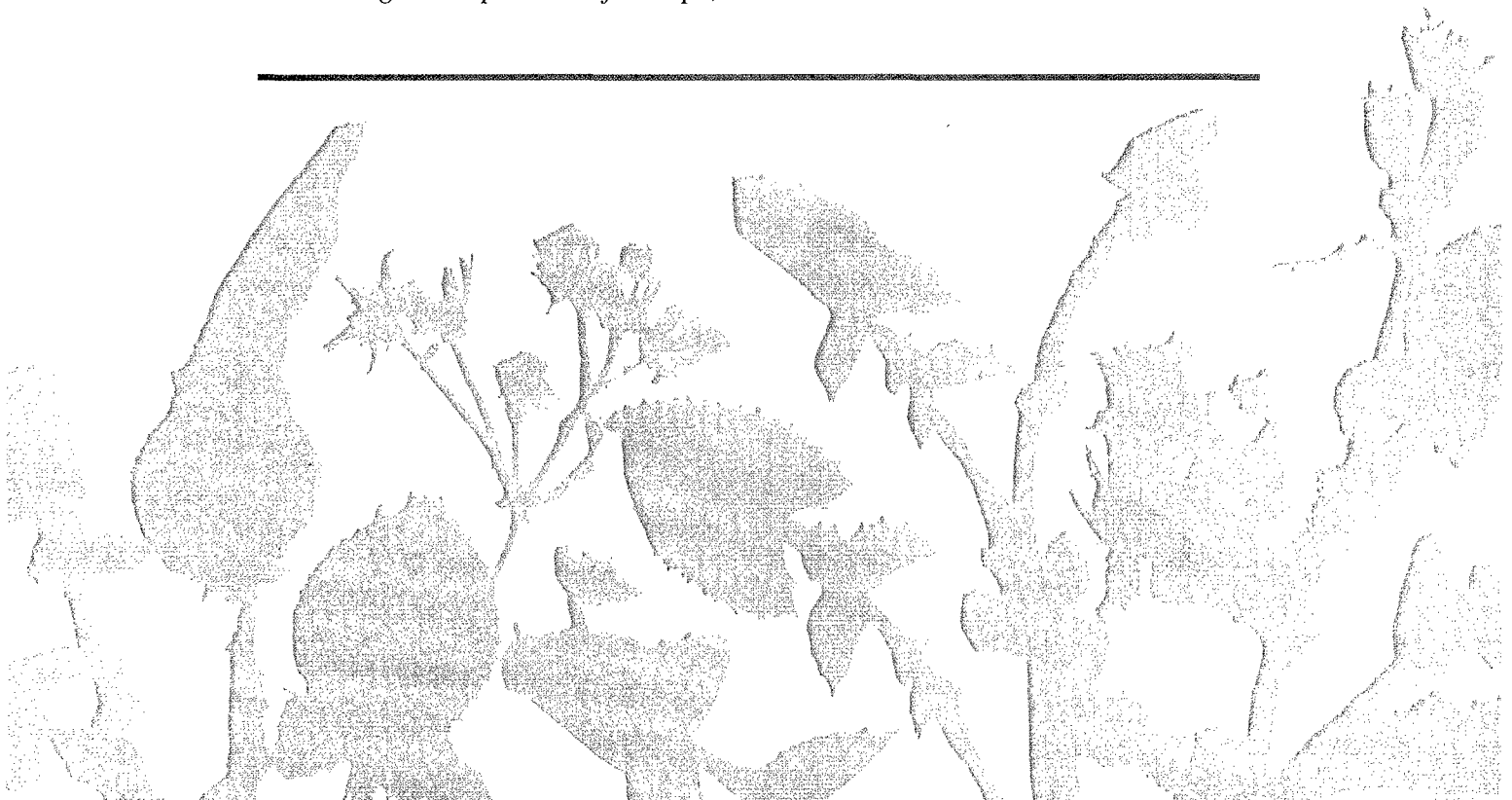
Project Staff

Weed sprout early and seize bare ground.
Direct sun, wind and rain do not discourage
them. They thrive in gravel beside railroad tracks,
and in niches between slabs of concrete. They grow fast,
seed early, and retaliate to injury with awesome power.
They will even take root in the cracks of an old shoe:
not much hope there, but perhaps the shoe will be
thrown into the midden out back, and then they can
burgeon and swallow the whole yard.

ALFRED W. CROSBY

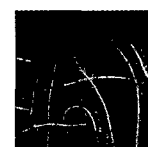
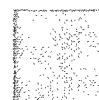
Ecological Imperialism

The Biological Expansion of Europe, 900-1900

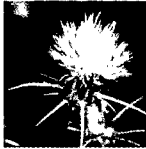


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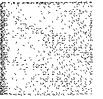


A biological wildfire is gradually consuming large areas of the American landscape. Nonnative plant invasions are sweeping across the nation into croplands, rangelands, pastures, forests, wetlands and waterways, wilderness areas, parks and refuges, and highway rights-of-way. These invaders are causing millions of dollars worth of damage to our natural, managed, and agricultural ecosystems.

Like a wildfire, invasive plants can seriously damage native plant and animal communities, increase soil erosion and sedimentation, and interfere with outdoor recreation. However, unlike wildfire damage, which soon heals, the effects of plant invasions can be long lasting. As biological pollutants, invasive plant populations can grow, adapt, multiply, and spread to unmanageable levels over time.

Developed by Dr. Randy Westbrook and the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), this fact book is intended to raise awareness of the destruction and economic losses caused by invasive plants in the United States. We hope this compilation of facts will encourage individual and collaborative efforts to respond to this threat to the integrity of the nation's ecosystems.

Mark Schaefer, Ph.D.
Deputy Assistant Secretary for Water and Science
U.S. Department of the Interior



Foreword

In the 1950s, the American public became aware that certain chemicals endanger human health and the environment. In response to this threat, new rules and regulations regarding chemical manufacture, use, and disposal were developed under state and federal law. Today, the public has a much better understanding of the chemical pollution problem and generally supports management efforts.

The 1990s have brought us face to face with another serious environmental threat: The invasion of the American landscape by aggressive nonnative plants. While farmers have always fought a battle with weeds in crops, invasion of these and other formerly weed-free lands has increased exponentially in recent decades. Because they often look no different than native plants and ani-

mals, nonnative plants can become established and cause serious economic and ecological damage before they are detected.

Since the 1960s, the United States has made dramatic strides in most areas of environmental protection. However, at the same time, biological invasions, which in part created the need for pesticides, continue in spite of federal efforts to exclude foreign pests from other countries. In recent years, this silent invasion has alarmed scientists worldwide and prompted federal officials in the United States to work together to address the problem.

Environmentally sound approaches and techniques for weed prevention and early control are necessary prerequisites in the battle against invasive plants.



Preface

INVASIVE PLANTS

Understanding the Problem

Invasive plants affect us all. Whether you live on a farm, in the suburbs, or in a city, invasive nonnative plants affect your life.

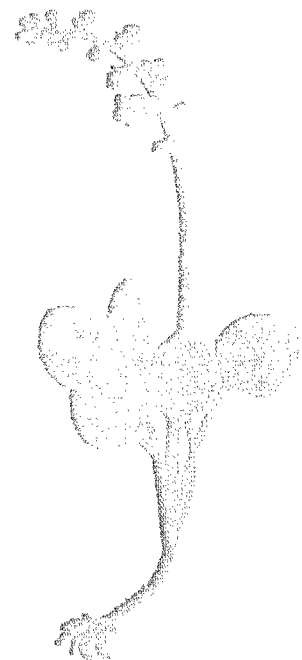
Farmers have always waged a war with invasive plants because they reduce crop yields and interfere with harvest operations. In recent years, the weed problem in crops has escalated. While consumers may not realize the impacts of this invasion, they are there; the costs of weed control are passed on through higher food costs and in reduced quality of merchandise.

Invasive plants interfere with recreational activities in parks, refuges, forests, grasslands, and other natural areas. Since such lands are usually maintained by public agencies, costs associated with invasive plant management in these areas are passed on to society in the form of higher taxes or fees.

Invasive plants also pose a serious threat to native species in natural areas. This is a long-term threat to biodiversity, ecosystem stability, and the balance of nature on which all species depend.

One year's seeding, seven years weeding.

OLD GARDENER'S ADAGE

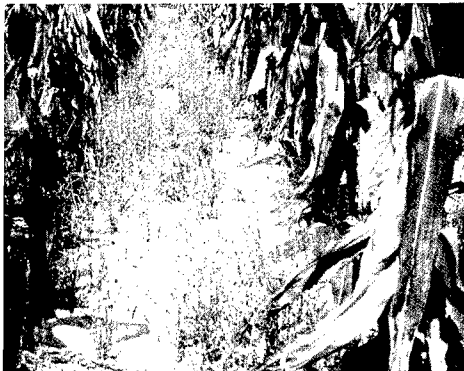


What Is an Invasive Plant?

Invasive plants have been called nonnatives, exotics, aliens, nonindigenous harmful species, weeds, and a host of other names. All of these definitions incorporate a basic concept: invasive plants are plants that have been introduced into an environment in which they did not evolve and thus usually have no natural enemies to limit their reproduction and spread. Whether plants are transported across an ocean to a new country or across a mountain range into a new valley or from an infested farm to a non-infested farm, the result is often the same—their fast growth characteristics and high reproductive rates allow them to “invade” the new habitats. (In this fact book, the terms “weed” and “invasive plant” are synonymous.)

On agricultural lands, weeds are defined by their effects on a human modified environment; that is, they generally interfere with crop production or other uses of the land. They are plants that grow out of place; plants that are competitive, persistent, and pernicious (James et al. 1991). Once introduced to a cropping situation, weeds are spread further as hitchhikers on equipment and vehicles and as contaminants of agricultural products.

In natural areas, the definition expands to include introduced aggressive plants that produce a significant change in terms of composition, structure, or ecosystem



Witchweed, a parasitic weed from Africa and Asia, infests corn fields in North and South Carolina. Through a cooperative federal/state program, the infestation has been reduced from 432,000 acres to less than 15,000 acres in the Carolinas. (R. Eplee, USDA Animal and Plant Health Inspection Service, Whiteville, North Carolina.)

function (Cronk and Fuller 1995).

About 8,000 species or 3% of all known plants are considered to be invasive plants in agriculture. Of these, about 200-250 species or less than 0.1% of the total, are



Melaleuca, a tree from northern Australia, was introduced into south Florida as a landscape plant around 1906. Since then, melaleuca has invaded the Florida Everglades and is expanding its range at a rate of 50 acres per day. (A. Fox, University of Florida, Gainesville.)

recognized as major problems in world agriculture. Holm (1978) estimated that about 200 species are involved in 95% of our agricultural weed problems on a worldwide basis. Of these, about 80 taxa are the primary and most troublesome species (Holm et al. 1977).

Invasive plants do not constitute a separate biological category. However, invasive plants do have characteristics that permit them to rapidly invade new areas and out-compete native plants for light, water, and nutrients. Some of these characteristics are included in the following list:

- Early maturation
- Profuse reproduction by seeds and/or vegetative structures
- Long life in the soil
- Seed dormancy ensures periodic germination and prevents seedlings from sprouting during unfavorable conditions
- Adaptations for spread with crop seeds, by natural agents, and by humans
- Production of biological toxins that suppress the growth of other plants
- Prickles, spines, or thorns that can cause physical injury and repel animals
- The ability to parasitize other plants
- Seeds that are the same size and shape as crop seeds, which makes cleaning difficult

- Roots or rhizomes with large food reserves
- Survival and seed production under adverse environmental conditions
- High photosynthetic rates

According to Rejmanek (1996), invasive woody plants tend to have small seed size, a short juvenile period, and a relatively short interval between seed crops that produce a high number of seeds.

How Did the Invasive Plant Problem Get So Bad?

Problems caused by invasive plants have increased dramatically in recent decades, due in part to an increasing human population. Population growth leads to greater disturbance of the land, increased demand for food and fiber, overuse of public land for recreation and commercial production, increased international travel, and globalization of world trade. All of these encourage the introduction, establishment, and spread of invasive plants.

Since the early days of European colonization, thousands of plants have been purposefully introduced into the United States. While most of these species benefit society (for example, corn, rice, wheat, and soybeans), several hundred of these nonnative plants have become invasive. Many introduced plants appear innocuous when first introduced; these plants then adapt and, in the absence of their co-evolved predators, explode in their new



According to Dr. Leroy Holm, University of Wisconsin, hand weeding of crops remains the number one work task of 80% of the world's population. (S. Dewey, Utah State University, Logan.)

environments. Many introduced plants that appear to pose no obvious threat to native ecosystems at this time could become invasive in years to come. Often by the time an invasive species is recognized as a major problem in a new area, it is well established and difficult or impossible to eliminate.

Currently, scientists are seeking to understand more about what makes a plant invasive in one habitat and benign in another. Until invasiveness can be predicted, plant introductions into the United States should be handled carefully. Many of the same traits that make a plant a highly desirable ornamental, such as prolific flowering and seeding or cold and heat tolerance, also may make them ideal weeds. Every new plant introduction is an experiment with an unknown outcome.

Invasive Plants Threaten Food and Fiber Production Worldwide

Nonnative invasive plants pose a serious threat to production of food and fiber for humans. Hand weeding of crops ranks as the number one work task of the world's human population. Weeds reduce the yield of rice, which provides 30% of all the food energy for human consumption, by an average of 30-35% in Southeast Asia (Holm et al. 1977). Surveys by the Food and Agriculture Organization of the United Nations showed that in the 1970s, insects, diseases, and weed infestations destroyed more than 33% of the potential annual world food harvest, an estimated \$75 billion loss. In 1975, weeds reduced global crop production by an estimated 11.5% (Parker and Fryer 1975).

Weed Control Costs in the United States

Weeds compete with crops and reduce the quality of food, feed, and fiber. During the 1950s, agricultural producers lost about \$5.1 billion per year to reduced crop yield and quality and to the cost of weed control (figure 1) (Agricultural Research Service 1965). In 1962, producers spent

Weed-Associated Losses and Costs in the United States

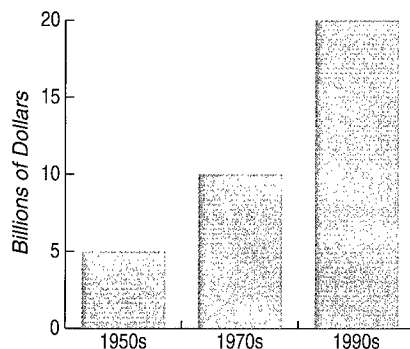


Figure 1.

\$200 million in the United States on herbicides alone for weed control (Montgomery 1964). In 1979, estimates indicate that 10-15% of the total market value of farm and forest products in the United States was lost to weeds, equivalent to about \$10 billion per year (Shaw 1979). During the 1980s, farmers spent over \$3 billion annually for chemical weed control and about \$2.6 billion for cultural, ecological, and biological methods of control (Ross and Lembi 1983). At that time, about 17% of crop value was being lost due to weed interference and money spent on weed control (figure 1) (Chandler 1985).

In 1994, the economic impact of weeds on the U.S. economy was estimated to be \$20 billion or more annually. In the agricultural sector, losses and control costs associated with weeds in 46 major crops, pasture, hay and range, and animal health were estimated to be more than \$15 billion per year. In non-crop sectors including golf, turf and ornamentals, highway rights-of-way, industrial sites, aquatic sites, forestry, and other sites, losses and control costs totaled about \$5 billion per year (figure 2). (Value of losses was not available for most non-crop sites, but estimates of control costs were determined.) The importance of herbicides in modern weed management is underscored by estimates that losses in the agricultural sector would increase about 500% from \$4.1 billion to \$20 billion per year without the use of herbicides (Bridges 1992; Bridges 1994). Since introduced species account for about 65% of the total weed flora in the United States, their total economic impact on the U.S. economy equals or exceeds \$13 billion per year.

Invasive Plants Threaten Biodiversity

Over the past several decades, there has been a heightened concern at the national and international levels about the impacts of habitat destruction and chemical pollution on biodiversity. In recent years, the impact of invasive species on biodiversity

has also become a major concern. These silent invaders constantly encroach into parks, preserves, wildlife refuges, and urban spaces. Nonnative species further threaten fully two-thirds of all endangered species. Nonnative species are now considered by some experts to be the second most important threat to biodiversity, after habitat destruction. (Randall 1996; Pimm and Gilpin 1989). Over the past decade, devastating impacts have been reported on every continent except Antarctica.

Homogenizing the World's Flora and Fauna

Although natural invasions of plants and animals have occurred in the past with serious consequences (e.g., when the Panama isthmus land bridge joined North and South America), there is no apparent corollary to the human-induced migration

Field bindweed causes more than \$40 million in crop losses annually in Kansas.

WILLIAM T. SCOTT
Kansas State Weed Specialist

Weed-Associated Losses and Control Costs in 1994

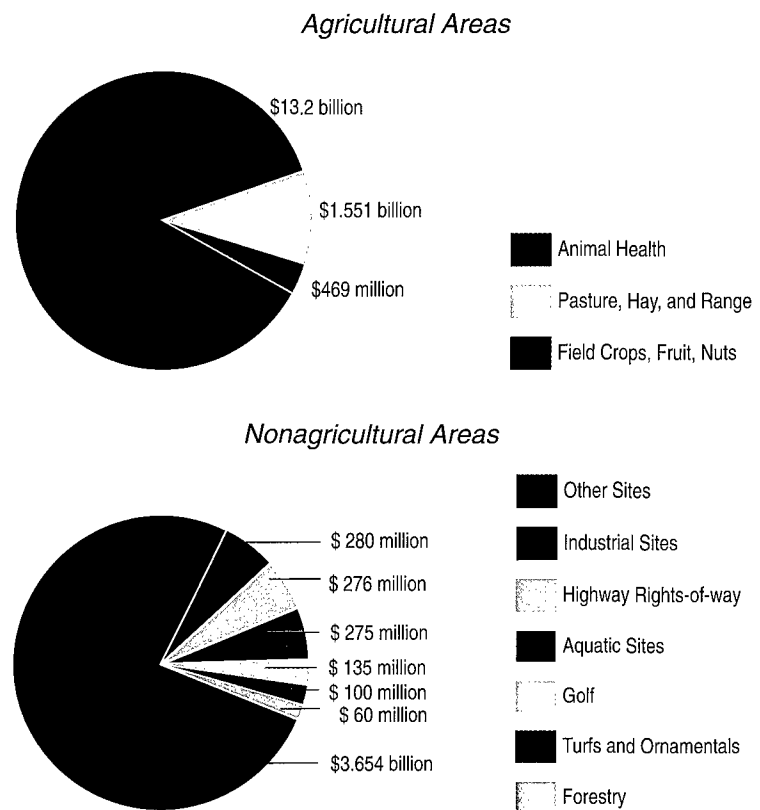


Figure 2. Adapted from Bridges 1994.

of species now underway around the world. Human induced biological invasions are occurring on a global scale and are beginning to blur the regional distinctiveness of the Earth's biota. That distinctiveness, which developed over the past 180 million years as a result of the isolation of the continents (termed evolution in isolation), maintains biodiversity. When considered as a single phenomenon, biological pollution probably has had greater impacts on the world's biota than more widely known aspects of global environmental change such as rising CO₂ concen-



trations, climate change, and decreasing stratospheric ozone levels (Vitousek et al. 1996). Unlike chemical pollutants that degrade over time, invasive organisms can become established and reproduce. Once established, they can spread from site to site, and region to region, often without further human assistance (Westbrooks 1991; Randall 1996). According to some

ecologists, if biological invasions continue as they have over the past 100 or so years, biological systems throughout the world will become homogenized and many native species will decline or disappear altogether (Elton 1958). The long-term impact of homogenizing the Earth's biogeographical realms will be a devastating decline in biodiversity and ever-increasing threats to food and fiber production.

The Silent Biological Invasion

According to the U.S. Congressional Office of Technology Assessment, there are at least 4,500 species of foreign plants and animals that have established free-living populations in the United States since the beginning of European colonization. Of that total, at least 675 species (15%) cause severe harm. In economic terms, 79 species, or 12% of total harmful species, caused documented losses of \$97 billion from 1906 to 1991 (Office of Technology Assessment 1993).

By 1950, the number of plant introductions into the United States was estimated to be at least 180,000 (Klose 1950). In 1975, it was estimated that at least 1,800 introduced plant species had escaped into the wild (Ripley 1975), with a large proportion establishing free-living populations (Austin 1978). Currently, the Weed Science Society of America recognizes about 2,100 plant species as weeds in the United States and Canada. Since about 65% of all weeds in the United States are nonnatives, approximately 1,365 of the weeds recognized by the Weed Science Society of America are of foreign origin (figure 3). This does not include most weeds of natural areas. Also, it does not include several hundred new species of nonnative plants that have become established in Florida in recent decades (David Hall, Forensic Botanist, Gainesville, Florida, personal communication, 1996).

Of the 6,741 plant species that are recognized as weeds somewhere in the world, only 2,063 species occur in the contiguous United States (Holm et al. 1979). This

Numbers of Native and Nonnative Weeds in the United States

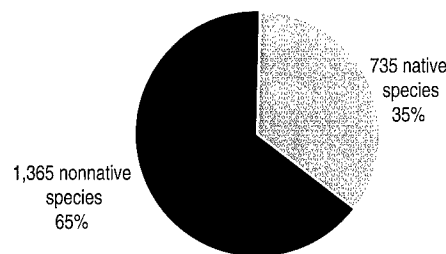


Figure 3.

leaves 4,678 species of invasive plants in other countries that could still be introduced into the United States (figure 4).

In the United States, introduced invasive plants comprise from 8-47% of the total flora of most states (Rejmanek and Randall 1996). Selected states with estimated native and introduced plants are shown in figure 5.

Role of the Federal Government

A number of U.S. federal agencies have weed management responsibilities, including weed regulation, research, and management. The U.S. Department of Agriculture’s Animal and Plant Health Inspection Service (APHIS) works to prevent the introduction of foreign weeds, as well as their establishment on private lands. APHIS cooperates with state and local agencies as well as private landowners and managers to eradicate newly introduced weeds on private lands, as well as regulating importation of biocontrol agents. The U.S. Department of Agriculture’s Agricultural Research Service conducts basic research on agricultural weeds. Weed research and manage-

Weeds in the United States and the World

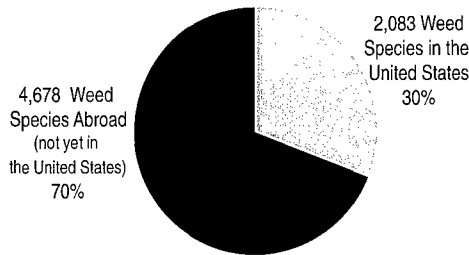


Figure 4.

ment on federal lands is conducted by a number of land management and scientific agencies, including the U.S. Forest Service, U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Bureau of Reclamation, U.S. Geological Survey, and Bureau of Indian Affairs. The departments of Defense, Energy, and Transportation are also involved in weed management.

In response to the economic and biological threat posed by invasive plants, 17 federal agencies have formed the Federal Interagency Committee for the

Native and Nonnative Plants in the United States

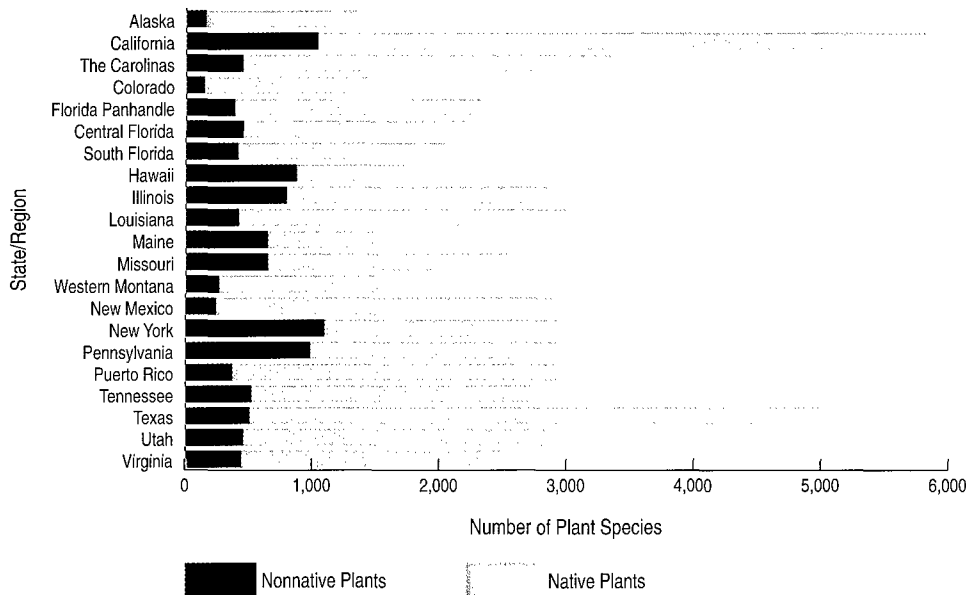


Figure 5.

Japanese dodder, a stem parasitic weed from Asia that parasitizes crops such as soybeans, is being eradicated from the South Carolina Botanical Garden at Clemson University. This quick action will keep the plant from spreading into the state from this source. The plant was probably introduced into the Garden as a contaminant of imported seeds or nursery stock.

RANDY WESTBROOKS, APHIS

Management of Noxious and Exotic Weeds (FICMNEW). The committee's goal is to facilitate the development of biologically sound techniques to manage invasive plants on federal and private lands. The committee promotes the weed programs of individual agencies as well as interagency projects that emphasize weed prevention, timely control, and restoration of degraded lands. The national program also includes research, monitoring, and public awareness elements. FICMNEW has published *Pulling Together: A National Strategy for Management of Invasive Plants* to delineate commonly held concerns and approaches to weed management in the United States. This weed fact book, *Invasive Plants: Changing the Landscape of America*, is one of the action items of the national strategy. Pulling Together Partnerships, a public/private challenge grant program for funding of local and

regional weed management projects, is another implementation action of the national strategy.

Another primary goal of the interagency committee is to form partnerships with state and local agencies and non-governmental organizations to identify new ways to deal with invasive plants. Such partnerships permit public agencies to increase their expertise and resources and ensure a voice for private industry, landowners, and others who are directly affected by invasive plants. Estimated expenditures for weed research and control by some federal agencies in FY 1997 are listed in figure 6.

Role of State and Local Agencies

Numerous state and local agencies have invasive plant management responsibilities, including state departments of agriculture, conservation, and transportation, state plant regulatory agencies,

Estimated Federal Agency Expenditures on Invasive Plants (FY 1997)

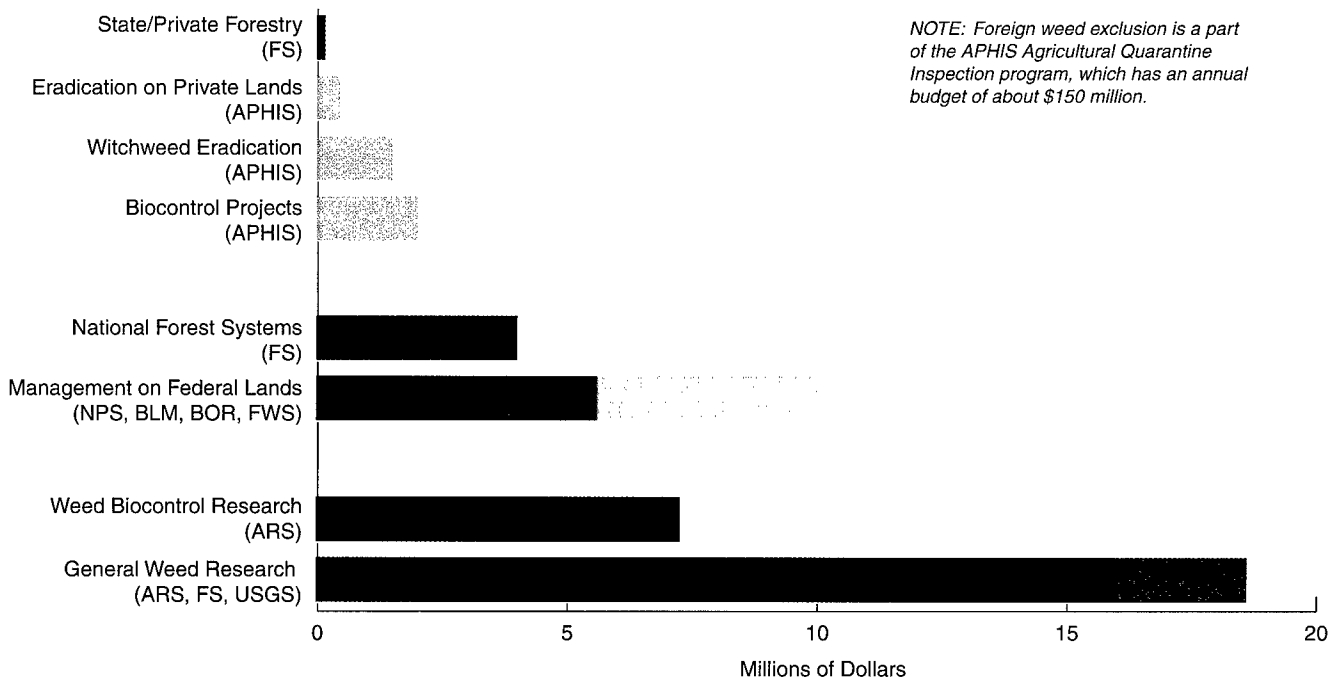


Figure 6.

universities, and county weeds districts. State plant regulatory agencies regulate the entry of invasive plants into their state by prohibiting the sale and movement of plants and by regulating high risk vectors such as potted nursery stock and seeds.

A number of western states have strict noxious weed laws and county weed supervisors to enforce them. In cases where an owner cannot or will not comply with the law, the county weed supervisor will control the infestation(s) and bill the owner for the work.

Increasing Public Awareness and Support

Preventing the spread of invasive plants in the United States is a monumental task that depends on public awareness, support, and participation. Volunteer programs have been very successful in promoting public awareness and concern about invasive plants. For example, Scotch Thistle Day in Millard County, Utah, and the Boy Scouts of America Woad Warriors Program in Cache County, Utah, use volunteers to manually remove scotch thistle and dyer's woad, respectively (Dewey et al. 1995).

Scotch Thistle Day in Millard County, Utah. Each spring for the past six years, organizers have held a community service field day for 300 middle and high school students in central Utah. On the morning of the event, participating students are bused to a remote scenic wildland location that is heavily infested with scotch thistle. Upon arrival, the students divide into small teams with adult leaders. During the morning session, the groups cut and dig out scotch thistle plants and discuss the spread and ecological impacts of the plants, as well as the need for early detection and control of all invasive plants. At lunch, volunteers feast on a dutch oven dinner and receive awards for their hard work. In recent years, the program has become very popular with science classes, with clubs from as far away as 150 miles asking to

participate. As a result of this six-year volunteer effort, scotch thistle has been significantly reduced in the target area.

The Woad Warrior Boy Scout Program in Cache County, Utah. Over the past 17 years, Boy Scouts from the area around Logan, Utah, have spent more than 4,000



Volunteer weed control programs such as the annual Scotch Thistle Day in Millard County, Utah, help teach young people about the impact of invasive plants on native ecosystems and agricultural production. (S. Dewey, Utah State University, Logan.)

hours manually removing dyer's woad from heavily infested non-crop sites and foothill rangelands in northern Utah. The project began in 1980 with one scout removing dyer's woad from 16 acres as an Eagle Scout Merit Badge service project. By 1994, it had expanded to include more than 200 boy scout volunteers working on 750 acres. Troops work each site an average of two times per season. Typically, labor requirements are reduced by 90-95% within eight years after a control effort begins.

■ Cost of Weed Control in Kentucky

In 1989-90, Kentucky farmers harvested about 5.7 million acres of field crops including tobacco, corn, soybeans, sorghum, small grains, and hay. In each of these crops, weeds reduced crop yield by competition and contamination. Each year, weed control in corn and soybeans alone costs Kentucky over \$50 million.

HARAGAN 1991



The Boy Scouts of America "Woad Warrior" Program in Cache County, Utah, is a volunteer weed program that is devoted to control of dyer's woad. Dyer's woad, a perennial plant from Eurasia, invades dry areas of the West. (S. Dewey, Utah State University, Logan.)

PLANT INVASIONS

Impacts, Status, and Trends

Invasive plants affect all types of environments in the United States. Overgrazing, land use changes, added fertilization, and use of agricultural chemicals are just some things that enhance the growth of invasive plants. Other human activities result in unstable or disturbed environments and encourage the establishment of invasive plants. Some of these include farming, highway and utility rights-of-way, clearing land for homes and recreation areas such as golf courses, and constructing ponds, reservoirs, and lakes. This section of the fact book covers impacts, status, and trends of plant invasions in croplands, yards and gardens, rights-of-way, rangelands and pastures, forests, deserts, islands, and natural areas. It also provides information on invasive plant impacts on native wildlife and plant communities, recreation, and human and animal health.

When chemical pollution or the exploitation of an ecosystem ceases, an ecosystem begins a recovery process. However, when invasive organisms (biological pollutants) are introduced into a new ecosystem, they can grow, adapt, proliferate and spread...indefinitely, causing ever increasing economic and environmental damage. Society always pays for invasive plants, either sooner or later.

ROBERT E. EPLEE
U.S. Department of Agriculture



Croplands

Since the beginning of agriculture more than 10,000 years ago, farmers have been confronted by invasive plants — as well as insects and diseases — that consume, contaminate, or compete with crops. In agricultural production, nonnative plants outcompete crops, limit choices of crop rotation sequences, reduce crop quality, act as vectors of other pests, interfere with harvesting operations, increase transportation costs, and reduce land values. Historically, invasive plants have been removed by hand weeding, hoeing, or plowing. This time consuming and labor intensive process has been somewhat alleviated since the mid-twentieth century in the industrialized world by the use of herbicides and growth regulators that interfere with the growth of weeds or kills them outright.

FACT: Weeds are superior competitors. Weeds interfere with crop growth through direct competition for light, water, and nutrients, and sometimes through production of toxins that inhibit the growth of nearby plants (allelopathy). Farmers in the Midwest have long recognized the difficulty of establishing crops in land previously infested with quackgrass because of the residual effects of plant toxins in the soil.

FACT: Weeds limit the choices of crop rotation sequences and cultural practices. A field seriously infested with a perennial weed such as johnsongrass cannot be economically planted in no-till corn or other row crops because of overwintering of rhizomes that make control difficult and expensive.

FACT: Weeds cause loss of crop quality. Weed contaminants in harvested crops can result in direct monetary loss to the farmer due to dockage (a reduction in value of the crop). Dockage can result from weeds that cause objectionable odors (e.g., wild garlic in wheat, mustards in milk), that stain a crop or edible seeds (e.g., nightshade berries in soybeans or dry beans), or that are toxic (e.g., jimsonweed and cotilaria seeds in soybeans). Fungal growth caused by excess moisture in contaminant plant parts can spoil crops. Wild sunflower heads can cause spoilage in harvested wheat (Ross and Lembi 1983). Weed seeds, as regulated contaminants, may prohibit the sale of crops in national and international trade.

Not all introduced plants are weedy. We depend on many introduced plants for food and fiber. For example, wheat, which was brought to America by English settlers in the early 17th century, is now used all over the globe. It has fed and employed billions of people for thousands of years and contributed greatly to agricultural diversity.

RICHARD ROMINGER
U.S. Department of Agriculture



Common cocklebur, a perennial plant from Europe, is a serious weed in row crops such as cotton, soybeans, and corn. Dr. John Byrd, a weed scientist at Mississippi State University, shows how cocklebur can outcompete cotton and interfere with harvesting operations. (J. Byrd, Mississippi State University, Mississippi State).

A study of commercially available clover seed in Nevada in 1900 found seeds of 68 "alien" weeds.

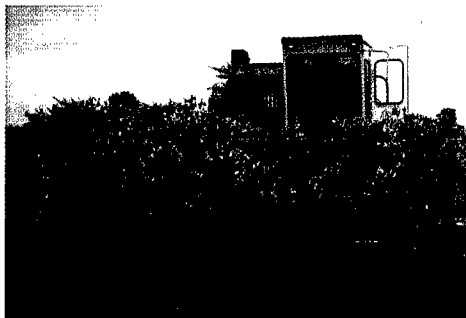
CHEATER 1992

FACT: Invasive plants act as vectors of other pests.

Weeds can harbor other crop pests such as plant pathogens, nematodes, and insects. Overwintering rhizomes of johnsongrass harbor viruses that are responsible for maize dwarf mosaic and maize chlorotic dwarf virus, which are devastating diseases of corn. During subsequent seasons, these diseases are transmitted to corn by insects. *Meloidogyne incognita* and *Hoplolaimus columbus*, two nematode pests of soybean and cotton, are harbored by henbit, johnsongrass, purple nutsedge, and yellow nutsedge (Zimdahl 1993).

FACT: Weeds interfere with crop harvesting.

Weeds directly interfere with hand and mechanical harvesting of vegetables. Grassy weeds and vines become wrapped around the rollers or cylinders of mechanical harvesters, necessitating frequent down time for cleaning. Harvesting of weeds along with the crop adds to the wear on expensive machinery and reduces the marketability and value of the crop.



Invasive plants and vines such as field bindweed interfere with harvesting and often clog equipment such as this combine. (J. Byrd, Mississippi State University, Mississippi State.)

FACT: Weeds and weed seeds in harvested crops necessitate extra cleaning and processing procedures.

Wheat harvested with wild garlic as a contaminant must be dried before the wild garlic bulbs can be removed from the grain by forced air separation. Then the cleaned wheat must be blended with non-infested lots to minimize the garlic flavor. Grass staining of cotton fibers is another problem resulting from weedy fields (Ross and Lembi 1983).

FACT: In 1995, U.S. farmers spent \$7.8 billion on pesticides.

Herbicides accounted for \$5 billion of the total (64%). That year, 90% of total U.S. herbicide sales was for crop market, with 34.7% of that amount designated for use on corn (American Crop Protection Association 1996).



Jointed goatgrass, native to Asia, has seeds that are similar in size and shape to wheat. This makes contaminated shipments of wheat very difficult to clean. (P. Westra, Colorado State University, Fort Collins.)

FACT: Weeds interfere with water management in irrigated crops.

Water is consumed and flow is impeded by weeds growing in and along irrigation ditches. Weeds consume water intended for crops, cause water loss by seepage, use water for evapotranspiration, and reduce water flow, which leads to more evaporation from ditches (Zimdahl 1993).

FACT: Weeds increase transportation costs.

In 1969 and 1970, Canada delivered 16 million tons of grain by rail to west coast ports. These shipments included 487,000 tons of wild oat seeds or the equivalent of 33 train car loads per day for every day of the year. Excess transportation costs were estimated at \$2 million per year and the dockage loss (price reduction) for cleaning the grain was estimated to be \$8 million (Ross and Lembi 1983).

FACT: Weeds reduce land values.

Perennial weeds such as field bindweed, johnsongrass, quackgrass, dodder, knap-

weed, and leafy spurge can cause land purchasers to discount offers to buy or bankers to reduce the amount of a loan, because each recognizes a loss of productive potential on weed dominated land. They also recognize the costs required to restore otherwise valuable land to full productivity (Zimdahl 1993).

FACT: Some weed populations have become herbicide resistant.

Since the discovery of herbicide resistant weeds in the early 1970s, the number of occurrences of herbicide resistant weed populations has risen into the hundreds.

Herbicide resistance has evolved predominantly where producers repeatedly use herbicides or groups (families) of herbicides with the same mode of action. Certain populations of introduced weeds, including goosegrass and johnsongrass, are among the many nonnative and native weeds that have become resistant to herbicides. Herbicide resistant weeds usually do not differ in appearance from individuals of the same species that are susceptible to herbicides. Thus, as yet, there is no visual means to identify resistant populations before control becomes ineffective

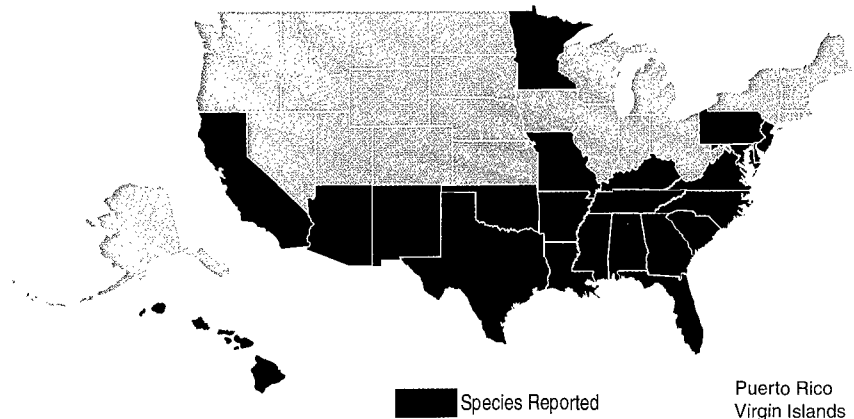
The first herbicide used in Montana was 2,4-D, in 1948. By 1952, nearly 85% of the wheat and barley acreage in the state was being sprayed annually with the new compound. That figure has not changed appreciably since that time.

FAY 1992

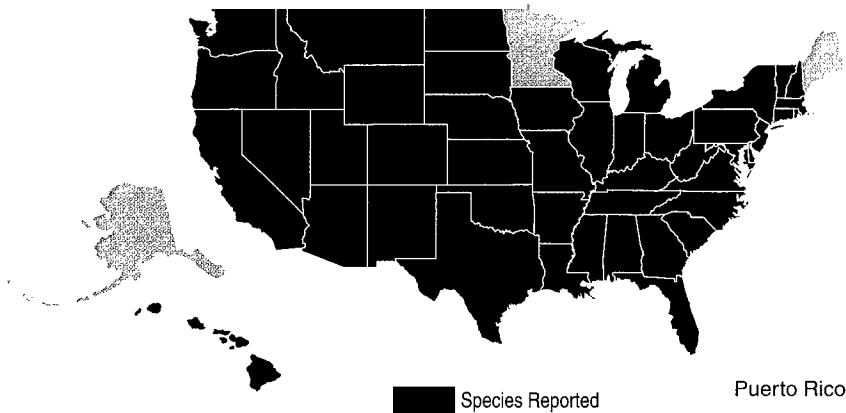
Invasive Plant Primer

Purple nutsedge *Cyperus rotundus* L.

Purple nutsedge is a perennial herb from India that occurs throughout the southern United States. It has fibrous roots, rhizomes, and underground tubers. According to Holm et al. (1977) purple nutsedge is the world's worst weed. It has been reported in most crops in most countries of the world. The rhizomes develop an extensive network that penetrates in and among vegetable crop roots. Underground tubers that can remain dormant through extreme environmental conditions such as heat, drought, and flooding increase the survivability of purple nutsedge. Seeds are dispersed by wind and water and soil-contaminated equipment, vehicles, and personal effects. The plant is also an alternate host for a number of insects, diseases, and viruses of crops.



Purple nutsedge, a native of India, has been called the world's worst weed. Purple nutsedge is shown here infesting cotton in Mississippi. (C. Bryson, USDA Agricultural Research Service, Stoneville, Mississippi.)

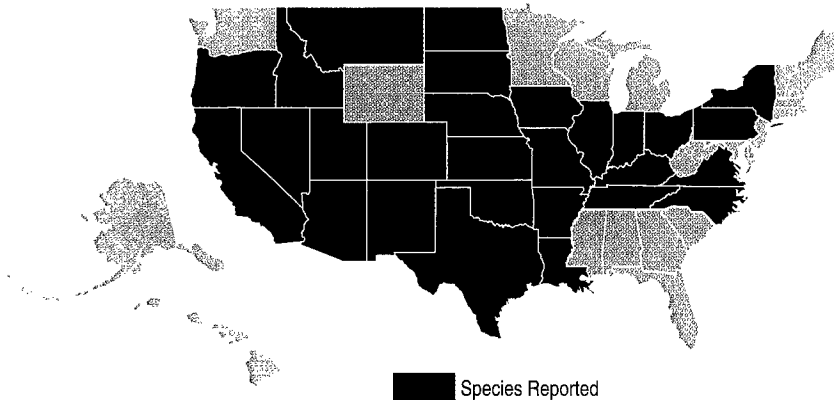


Johnsongrass

Sorghum halepense (L.) Pers.

A perennial grass, johnsongrass was originally introduced into the United States as a forage crop in the early 1800s. It is now a serious weed of numerous crops throughout the country. Johnsongrass freely hybridizes with grain sorghum under field conditions. The hybrids can be fertile and exhibit no apparent decrease in fitness. However, when the hybrid plant freezes, it develops a toxin that can be fatal to grazing cattle. Cut hay and silage from fields infested with johnsongrass must be cured for six weeks before being used to ensure the toxin has degraded (Haragan 1991).

Johnsongrass, which was introduced from eastern Europe into Alabama in the 1830s as a pasture forage, has become a serious weed of row crops such as cotton and corn throughout the United States. (C. Bryson, USDA Agricultural Research Service, Stoneville, Mississippi.)

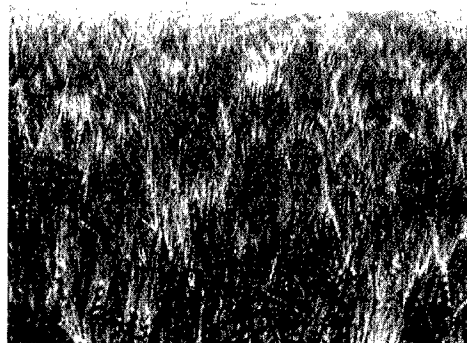


Jointed Goatgrass

Aegilops cylindrica Host

An introduced winter annual grass, jointed goatgrass now occurs in most of the lower 48 states. The weed is especially troublesome in Oklahoma, Colorado, Kansas, Nebraska, Wyoming, Utah, Idaho, Oregon, and Washington. Jointed goatgrass' close genetic relationship to wheat makes selective control impossible in wheat using current cultural, mechanical, and chemical methods. Jointed goatgrass seed can survive in the soil for up to 5 years. Over the past 20 years, jointed goatgrass populations have increased rapidly because of current farming practices such as the use of less competitive semi-dwarf wheats, shorter crop rotations, increased fertilizer use, and reduced frequency and depth of tillage. Once introduced into a region, jointed goatgrass spreads from field to field by planting contaminated wheat seed, hitchhiking seeds that blow off grain trucks, and seed transport on farm machinery such as combines.

Jointed goatgrass, a native to Asia, is a serious problem in wheat producing areas of the United States. It hybridizes with wheat and outcompetes the crop for nutrients and water. (P. Westra, Colorado State University, Fort Collins.)



Impact of Jointed Goatgrass. In the western United States, jointed goatgrass now infests 5 million acres of winter wheat, plus 2.5 million acres of fallow land. It is spreading unchecked at a rate of 50,000 acres or more per year. Because jointed goatgrass tillers profusely, as few as five jointed goatgrass plants per square foot can reduce wheat yields by 25%. In heavily infested fields, yield losses of 50% are common. Jointed goatgrass seed in harvested wheat reduces net grain weight, increases dockage costs, and can reduce grain value by as much as \$1 per bushel. The presence of a single jointed goatgrass plant in a field or a jointed goatgrass seed in a wheat seed lot will prevent certification of the field or the seed lot. Jointed goatgrass costs U.S. farmers \$45 million annually in direct yield losses and reduced

grain value. Furthermore, when jointed goatgrass infests wheat fields, it impedes the adoption of conservation farming practices, increases tillage and herbicide use, forces farmers to grow less profitable crops, reduces farmland values, and threatens the marketability of U.S. wheat for export and the long-term sustainability of agriculture in the western United States. These indirect costs of jointed goatgrass exceed \$90 million annually, and total losses exceed \$145 million annually (University of Nebraska 1997). Even though jointed goatgrass occurs throughout the Midwestern Corn Belt, it has not been reported as a commercial problem in winter wheat in that region. This may be due to widespread use of rotations of spring sown corn and soybean (Donald and Ogg 1991).

Yards & Gardens

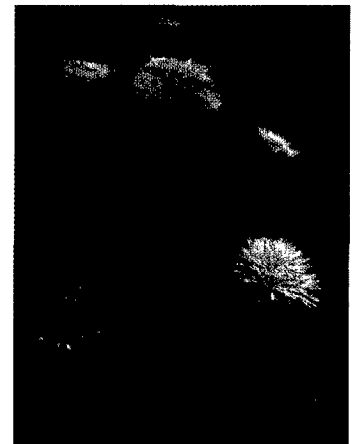
To many people, yards and gardens represent a personal connection with the earth and soil. In maintaining horticultural sites, homeowners constantly face weeds that seem to appear out of nowhere. A few examples of weedy grasses and sedges that invade turf include goosegrass, large crabgrass, foxtail, and nutsedge. Broadleaf turf weeds include dandelion, dichondra, chickweed, and knotweed. Fortunately, weed scientists have developed very effective methods for dealing with these and other invasive plants of the yard and garden.

A source of plant invasions. In the past, yards and gardens were tiny islands in the vast wilderness of the American continent. In such a setting, there was little need to worry about nature and our impacts upon it. Today, however, remaining natural areas in many parts of the United States have become islands in a sea of disturbance. In most cases, introduced ornamentals that are used in the yard and garden are poorly adapted for survival

without human care. However, some non-natives are very aggressive and have caused serious problems in natural areas. A few examples of imported ornamentals that have escaped in parts of the country include kudzu, bamboo, pampas grass, Japanese honeysuckle, Chinese wisteria, English and German ivy, and purple loosestrife. See the appendix “Ornamentals Invading Natural Areas in the Continental United States” (page 95)

As gardening brings pleasure to ever greater numbers of people, there will be many benefits from increased cooperation between ecologists and horticulturalists. Growers and gardeners need to be better informed about invasive plants so they can select plants that won't become weeds in the garden or spread to natural areas.

WILLIAM GREGG
U.S. Geological Survey



Dandelion, a serious weed of urban areas throughout the United States, was introduced into New England by European colonists in the 1600s as a salad green. (B. Harper-Lore, Federal Highway Administration, Minneapolis, Minnesota.)

Japanese honeysuckle, introduced into the United States as an ornamental vine more than 100 years ago, smothers native plants in woodlands throughout the eastern United States. (Left photo: J. Byrd, Mississippi State University, Mississippi State. Right photo: J. Randall, The Nature Conservancy, Davis, California.)

■ What can you do?

To help control the general spread of invasive plants, gardeners need to eradicate invasive weeds that appear on their property. This will help to prevent weeds from spreading to other properties.

In selecting new plants for the garden, gardeners need to consider if they have heavy seed production or other invasive characteristics. If a plant does pose a hazard, it should be avoided.

To prevent new infestations of weeds via nursery stock, gardeners should request sterile potting media whenever available.



Chinese wisteria, an ornamental vine from Asia, has become a serious problem in natural areas in parts of the United States. (J. Preacher, Army Corps of Engineers, Charleston, South Carolina.)

for a current list of introduced ornamentals that have escaped cultivation and become weeds.

FACT: Most introduced ornamental plants that adorn our yards and gardens cannot survive outside cultivation. Plants that do become established outside of cultivation often cause significant damage in natural areas.

FACT: Potted nursery stock is a source of weeds in the yard and garden. In the Southeast, *Phyllanthus sp.*, a small herb that is often spread in potted-nursery stock, is becoming a serious weed of gardens, landscape islands, and lawns.

FACT: According to a recent study, there are now over 300 species of introduced plants that are invading natural areas in the United States.

Of this total, more than half were introduced as ornamentals (Randall and Marinelli 1996).

FACT: Native plants are usually not invasive. Many plants that have escaped from cultivation and become invasive are much less common in their regions of origin. Co-evolved predators and parasites that keep plants in check in their native

ranges usually don't accompany them to new regions or countries where they are imported as ornamentals

FACT: Invasive plants in yards and gardens represent time and money. Time and effort spent in removing and controlling invasive plants in lawns and gardens worldwide require billions of hours that could be spent in other pursuits.

FACT: Sales in most known or potentially invasive species are generally unregulated. Many invasive plants of the yard and garden are widespread and are generally not regulated. One exception to this is the wetland invader purple loosestrife, which is prohibited in several states.

FACT: Wildflower seed mixtures often contain a percentage of weed seeds. Wildflower seed mixtures usually contain a certain percentage of weed seeds. In order to prevent their establishment and spread, consumers should buy only mixtures that are low in weed seed content and pull up weeds that germinate in plantings well before seed production and release.

Seven reasons to use native plants for landscaping

- Natives are adapted to regional conditions, may require less maintenance, and are cost-effective.
- Natives are hardy, withstand extreme winter cold, and do not suffer from die back.
- Natives are environmentally friendly and require fewer pesticides and fertilizers because of natural adaptations.
- Use of natives promotes biodiversity and land stewardship.
- Use of native plants provides food and shelter for native wildlife.
- Native plants can be used to restore regional landscapes.
- Use of natives ensures there will be less chance for introduced ornamentals to become invasive.

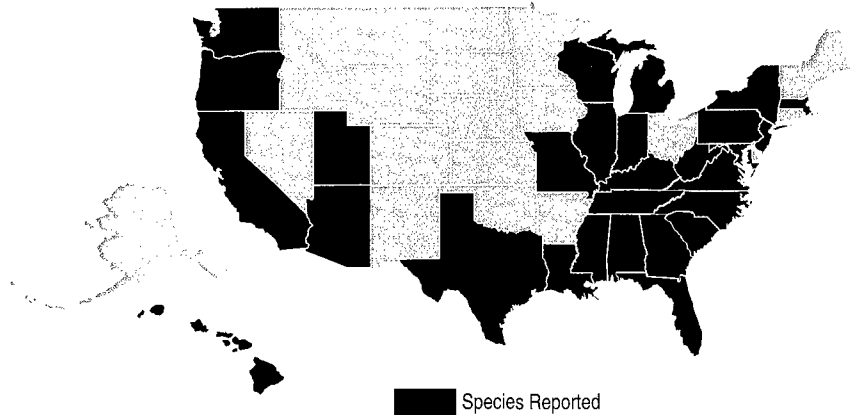
Tennessee Exotic Pest Plant Council 1997

Invasive Plant Primer

English ivy

Hedera helix L.

English ivy, a widely planted woody vine with dark green leaves, was introduced as an ornamental into North America from Eurasia during colonial times. English ivy easily escapes cultivation and grows in upland forests in the Mid-atlantic region, the Southeast, and on the west coast. In some areas, English ivy forms “ivy deserts” in forests that inhibit the growth and regeneration of native wildflowers, shrubs, and trees (S. Reichard, University of Washington, Seattle, Washington, personal communication, 1997). English ivy grows on trees and shrubs, adding weight to the canopy structure that ultimately increases storm damage. English ivy is especially invasive in western Oregon and Washington, where citizens groups spend weekends removing it and other invasive plants from natural areas (Randall and Marinelli 1996).



English ivy, introduced as an ornamental vine from Eurasia, has become a serious problem in woodlands in parts of the United States. (J. Randall, The Nature Conservancy, Davis, California.)

Rights-of-Way

Highway, railway, and utility rights-of-way serve as major corridors in the spread of invasive plants from place to place in the United States.

FACT: Invasive plants increase road maintenance costs. Invasive plants such as purple nutsedge grow up through cracks in asphalt and concrete, causing increased maintenance costs.

FACT: Invasive plants can obscure vision at intersections. One of the most serious problems associated with invasive plants is obscuring vision along transportation routes. Tall plants encroach on highway intersections, block the view of motorists, and can cause severe accidents.

FACT: Invasive plants are spread by mowing equipment. Mowing prevents reproduction of some weeds, but can accidentally spread the seeds of weeds like knapweed in the midwest and the dustlike seeds of parasitic weeds such as small broomrape in south Georgia.

FACT: State departments of transportation each spend at least \$1 million per year in vegetation management. Introduced weeds complicate and raise the cost of these programs. The use of weed-free hay as mulch in roadside planting projects minimizes introduction and spread of unwanted plants (Bonnie Harper-Lore, Federal Highway Administration, Washington, D.C., personal communication, 1997).

FACT: Invasive plants are spread along highways and railways. Weed seeds that become attached to vehicles, earth-moving equipment, and railway cars

can be spread for hundreds of miles. Itchgrass, a serious grass weed of sugarcane and other crops in the Gulf Coast states, has been spread by trains. Once established along a railway, weeds such as itchgrass then spread into adjacent fields (David Hall, Forensic Botanist, Gainesville, Florida, personal communication, 1997.)



Hay, spread as mulch in roadside planting projects, can enable invasive plants to spread into previously uninfested areas. Use of weed-free hay helps to prevent the spread of serious weeds. (C. Bryson, USDA Agricultural Research Service, Stoneville, Mississippi.)

FACT: Invasive plants can obstruct access to power and gas lines.

Utility rights-of-way are heavily disturbed but minimally maintained. Therefore, they serve as ideal sites for invasive plants to



become established and spread. Heavy weed populations can also obstruct access to power and gas lines.

Exotic weed control programs need to be part of every responsible highway system.

JOHN SCHWEGMAN
Illinois Department of Conservation

Invasive plants in roadside wildflower plots. In the past, some state beautification projects deliberately seeded plants such as



Itchgrass was introduced into Florida from the Philippines in the 1920s as a potential pasture grass. It is shown here beginning to infest a roadside wildflower plot in North Carolina. The contaminated seeds originated in Texas. (G. Cross, North Carolina Department of Agriculture, Raleigh, North Carolina)

purple loosestrife along selected roadsides. After becoming established, such plants may spread into adjacent crops and/or natural areas. However, in recent years, state highway agencies have become knowledgeable about the problem of invasive plants and how to deal with them. In 1994, the North Carolina Department of Transportation cooperated with the North Carolina Department of Agriculture to eradicate several small populations of itchgrass from roadside wildflower plots. In this case, itchgrass was found to be a contaminant of wildflower seeds that had been planted by the North Carolina Department of Transportation. The wildflower seeds originated in Texas (Gene Cross, North Carolina Department of Agriculture, Raleigh, North Carolina, personal communication, 1997).

Rangelands & Pastures

According to a recent survey by the U.S. Department of the Interior, noxious weeds have invaded over 17 million acres of public rangelands in the West, more than quadrupling their range from 1985-1995. At this rate of expansion, western wildlands are being lost at a rate of 4,600 acres per day to invasive plants such as leafy spurge and yellow starthistle. These estimates are considered conservative because careful inventories have not been carried out in many regions. However, taken at face value, they indicate a 14% annual increase in area infested. If weeds continue to spread at this rate it is predicted that about 33 million acres of western wildlands will be infested with weeds by the year 2000 (Bureau of Land Management 1996). Even now, there are 100 million acres of land that are moderately to heavily infested with non-native invasive grasses such as cheatgrass, red brome, and medusahead. On the positive side, effective and economical strategies are available to protect the portions of the remaining 95% of lands that are susceptible to noxious weeds if adequate resources are provided.

FACT: Invasive plants can have a serious impact on grazing.

Spiny plants such as thistles and nightshades can be a serious problem in pastures and rangelands. Such plants can cause physical injuries to grazing animals and restrict their access to forage and water (Huenneke 1995).

FACT: Invasive plants can cause soil erosion. Invasions by introduced plants can alter vegetation in an area and

increase runoff and soil erosion. Such effects are particularly severe on slopes and in regions where climatic conditions favor runoff (e.g., semi-arid climates where a large proportion of precipitation comes in brief, intense storms). One example of this is where native grasses with shallow, fibrous roots that bind the soil in heavy rains are replaced by introduced broadleaved plants with deep, narrow taproots that are less effective in anchoring the surface soil (Huenneke 1995).

I understand they are strongly recommending now that all the old cemeteries be planted with multiflora rose. When Gabriel sounds his horn, I am afraid some will be stranded and won't be able to get through the roses. Please do not recommend the multiflora rose except for the bonfire.

CHARLIE DEAM, BOTANIST
Indiana, 1948

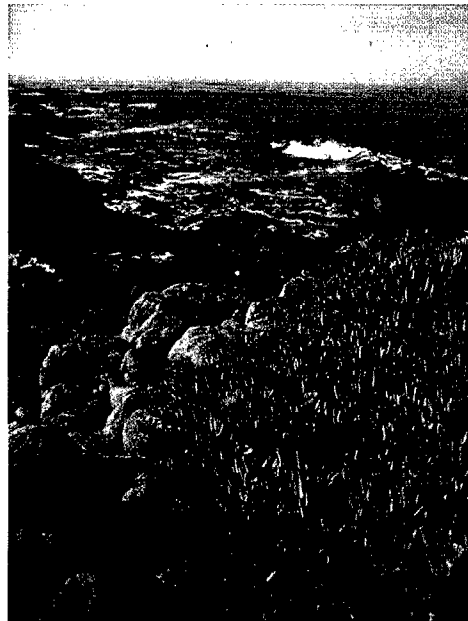


Musk thistle, which is native to Asia, can be a serious problem in pastures and rangelands in parts of the United States. (USDA Agricultural Research Service.)



Introduced invasive plants with taproots that outcompete fibrous rooted native vegetation can cause serious soil erosion problems. (J. Randall, The Nature Conservancy, Davis, California.)

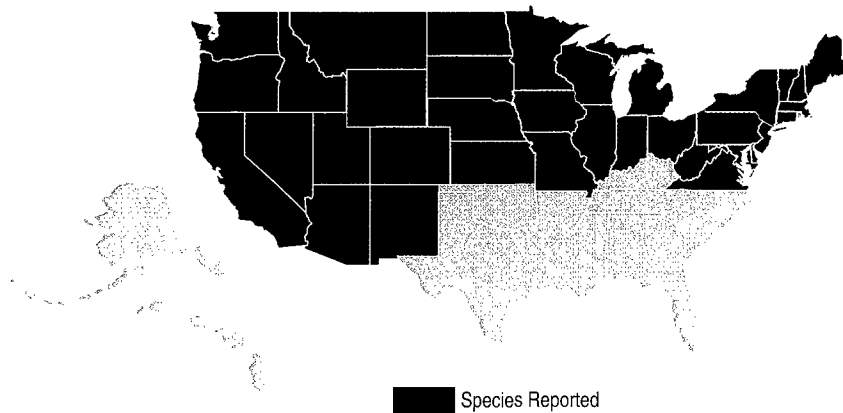
Iceplant, an introduced ornamental plant from South Africa, outcompetes native plants and impacts soil animals by increasing the salinity of the soil. (B. Harper-Lore, Federal Highway Administration, Minneapolis, Minnesota.)



FACT: Invasive plants can alter soil chemistry and nutrient cycling.

Some invasive plants alter soil chemistry substantially and thus have a negative impact on native biota. Two well-documented cases include the succulent iceplant, which is widely planted in coastal and arid landscapes and invasive in several areas of California and saltcedar, which invades riparian areas (streamsides). Both plants concentrate salt in their foliage and increase soil salinity drastically with negative effects on soil arthropods and other biota (Lovich 1996).

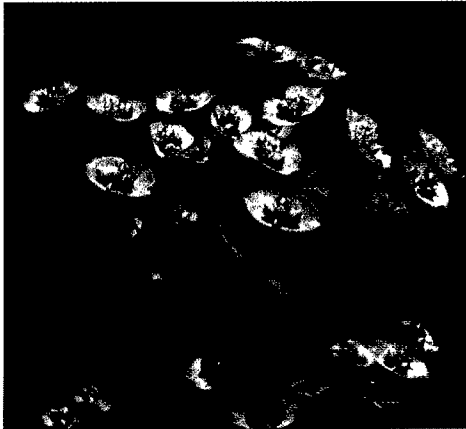
Invasive Plant Primer



Leafy Spurge

Euphorbia esula L.

Leafy spurge is a deep rooted, perennial herb, that grows up to 3 feet tall in dense patches. Native to Eurasia, leafy spurge was brought into the United States as a contaminant of seed in about 1827. Leafy spurge now infests about 2.7 million acres, mostly in Southern Canada and the Northern Great Plains of the United States (Lajeunesse et al. 1995; Lym 1991). In North America, the highly competitive leafy spurge often forms dense stands that crowd out most other vegetation. These infestations cause loss of plant diversity, loss of wildlife habitat, and reduction in land values. Cattle refuse to graze in areas with 10-20% leafy spurge cover. The milky sap is a digestive tract irritant to cattle and will also cause lesions around the eyes and mouth (Lajeunesse et al. 1995;



Leafy spurge, native to Eurasia, is one of the most serious weeds in the northern United States, causing millions of dollars in crop losses and control costs. (Top photo: George Markham, USDA Forest Service, Bozeman, Montana. Bottom photo: S. Dewey, Utah State University, Logan.)

Lym 1991). From a practical management standpoint, a leafy spurge infestation with 80% cover reduces the carrying capacity of a land area to zero. In the United States, direct livestock production losses together with indirect economic effects due to this species alone approached \$110 million in 1990 (Office of Technology Assessment 1993).

Biocontrol of Leafy Spurge. Biological control research has uncovered 13 insect species that suppress leafy spurge. One or more of these beneficial insects now attacks leafy spurge at multiple sites in the northern Great Plains (Neal Spencer, USDA Pest Management and Agricultural Systems Research Laboratory, Sidney, Montana, personal communication, 1997).

Economic Impact of Leafy Spurge

In 1991, researchers reported that because of reduced carrying capacity from leafy spurge infestation, ranchers and landowners lost \$2.2 million in Montana, \$1.4 million in South Dakota, and \$200,000 in Wyoming. Based on studies of direct and secondary impacts on grazing land, wildlife, and the state's economy, North Dakota was estimated to lose in excess of \$87 million annually because of leafy spurge infestations. The cattle industry in North Dakota loses over \$23 million per year, while ranchers lose \$8.5 million in reduced income (Goold 1994). Nearly 6% of the untilled land in North Dakota is infested with leafy spurge (Leistriz et al. 1995).

In 1994 grazing capacity lost to leafy spurge in Montana, North and South Dakota, and Wyoming would have supported a herd of about 90,000 cows generated about \$37.1 million in annual livestock sales. Direct and secondary economic impacts of leafy spurge infestations on grazing land and wild land in the four state area amount to approximately \$129 million and represent the potential loss of 1,433 jobs (Leitch et al. 1994).

Leafy Spurge in Ward County, North Dakota

1954. In 1954, Ben Barrett, the County Agent for Emmons County, North Dakota, took four young 4-H members to a livestock judging workout in Steele. Along the way, he stopped the car and showed the boys a small patch of leafy spurge located on an adjacent railroad right-of-way. He warned them to watch out for it in their



Leafy Spurge Depresses Land Values in Klamath County, Oregon

In the mid-1980s, the 1,360-acre Taylor Ranch in Klamath County, Oregon, was abandoned due to non-productivity caused by leafy spurge. In this area, at that time, the estimated value of similar clean land was \$125-\$150 per acre. Eventually, the ranch was sold for \$27,500 (\$22/acre) with the stipulation that spurge had to be controlled (Weiser 1995). At the time of purchase, the county estimated that it would cost \$65,000 to bring leafy spurge under control on the ranch. Since that time, the new owner has spent well over that amount and made practically no headway. The drop in sale price from \$170,000 to \$27,500 represented a loss of 83% in value for this ranch. The owner is now in the process of requesting an adjustment in the tax valuation of the property.

V. BALLECI
Klamath County Public Works Department,
Oregon, personal communication, 1996

The Taylor Ranch in Klamath County, Oregon, has been seriously affected by a heavy infestation of leafy spurge which is unpalatable to livestock. (J. Asher, Bureau of Land Management, Portland, Oregon.)

■ Land Values Crash on North Dakota Ranch

By the early 1970s, leafy spurge infested over 50% of the 3,200-acre Brooks Ranch in Ward County. In 1975, the ranch was sold at full market value to neighboring ranchers. In 1978, all of the pasture land on the Brooks ranch had become severely infested and was deeded back to Farm Credit Services, which finally sold the property in 1991 for \$40 per acre, a 60% drop from the full market price of \$100 to \$125 per acre. The drastic reduction in market value was directly attributed to the impact of leafy spurge on the carrying capacity of the land. By the time it was sold, most of the pastures had 100% coverage with leafy spurge.

The cost to control leafy spurge on the Brooks Ranch, with cost sharing, will be \$20-\$22 or more per acre. The landowner's cost will be \$7-\$8 per acre. This will be for maintenance control of leafy spurge only.

CHARLES WEISER
First American Bank, Minot, North Dakota,
personal communication, 1997

areas of the county.

1963. One of the young boys, Charles Weiser, became an assistant county agent in Ward County. By that time, leafy spurge had infested about 2,000 acres in the county in a seven township area centering on the Brooks Ranch (figure 7). In an effort to organize a county-wide effort to control leafy spurge, Ben Barrett and Charles Weiser set up demonstration control plots and encouraged landowners to control spurge on their property. However, they had very little success. Some of the excuses: "It's too expensive, the state should pay the bill." "It was brought in by the railroad, they should clean it up." "What's the problem? It's been here since the 1930s and hasn't spread very fast."

1972. The acreage had doubled to about 4,000 acres, in all 57 townships of Ward



The Brooks Ranch in Ward County, North Dakota, where the value of the land for livestock and wildlife has been seriously affected by leafy spurge. (C. Weiser, Minot, North Dakota.)

County. The County began a limited control program along county roads, but control on private land was limited due to the high cost per acre of chemical control.

1982. The acreage had doubled again to around 8,000 acres. About this time, the state noxious weed law changed to permit counties to levy three mills of property tax to be used for weed control. In 1983, the legislature appropriated state funds, which were divided among the counties that levied the tax. These funds were used in a

*Leafy Spurge in
Ward County, North Dakota*

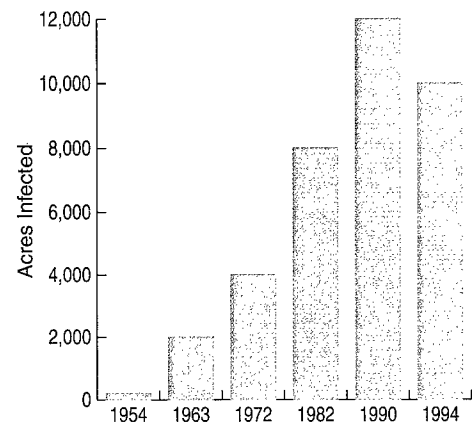


Figure 7.

cost-share approach to control leafy spurge on private lands. County and state funds cover 70% of the cost while the landowner pays 30%.

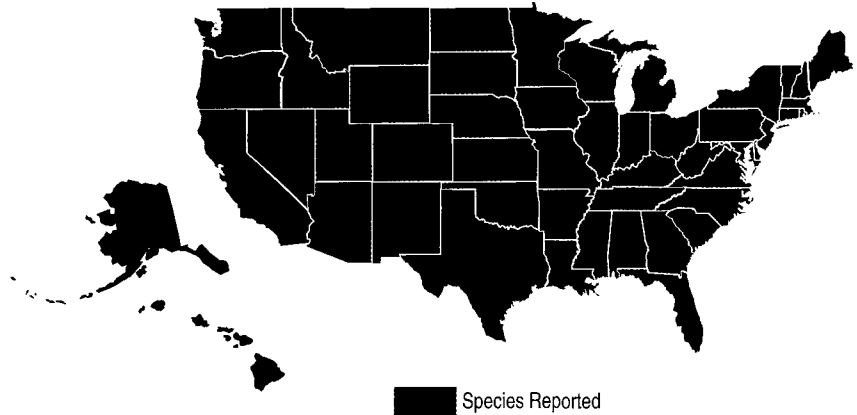
1990. Infested acreage had increased to about 12,000 acres. In 1994, as a result of the cost-share control program, estimated acreage in the county dropped to around 10,000 acres (Weiser 1995).

Cheatgrass

Bromus tectorum L

Cheatgrass is an annual grass that grows up to 30 inches tall and reproduces by seeds. Native to the Mediterranean region, cheatgrass was introduced into the United States with packing material. It was first found in the United States near Denver, Colorado, in the late 1800s. Since then, it has been spread far and wide by trains, livestock, and wildlife. Now widely distributed throughout North America (Whitson et al. 1991; Young 1991), cheatgrass commonly grows along roadsides, waste areas, pastures, rangelands, and croplands.

Cheatgrass is a major weed in winter wheat in the Pacific Northwest and on the Great Plains. In the Palouse wheat country of the Pacific Northwest, a population density of about 105 cheatgrass plants per square yard reduces wheat yields by an average of 27% (Young 1991). The highly flammable cheatgrass also alters the frequency and intensity of fires on western rangelands. Instead of major fires occurring every 60 years, they now occur every three to five years. The restoration and reconstruction of facilities lost in cheatgrass fires costs millions of dollars annual-



Cheatgrass, which is native to the Mediterranean region, is one of the most widespread weeds in the American West. (J. Randall, The Nature Conservancy, Davis, California.)

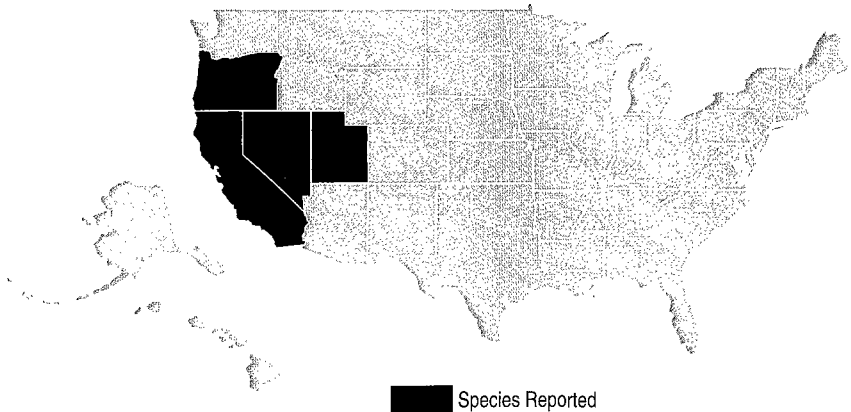
ly. The native sagebrush and grass communities are gone in many areas. Currently, almost 17.5 million acres in Idaho and Utah are almost totally infested by cheatgrass (Vitousek et al. 1996; Young 1991).

Squarrose Knapweed

Centaurea triumfettii All.

Squarrose knapweed, a long-lived perennial plant, comes from the eastern Mediterranean area. It has highly branched stems, deeply dissected lower leaves, and small rose or pink flowers. Squarrose knapweed has recurved or spreading bracts and seedheads that fall off soon after the seeds are mature.

Establishment and Spread of Squarrose Knapweed in Utah. In November 1954, a meeting of state and local officials was held to discuss concerns about squarrose





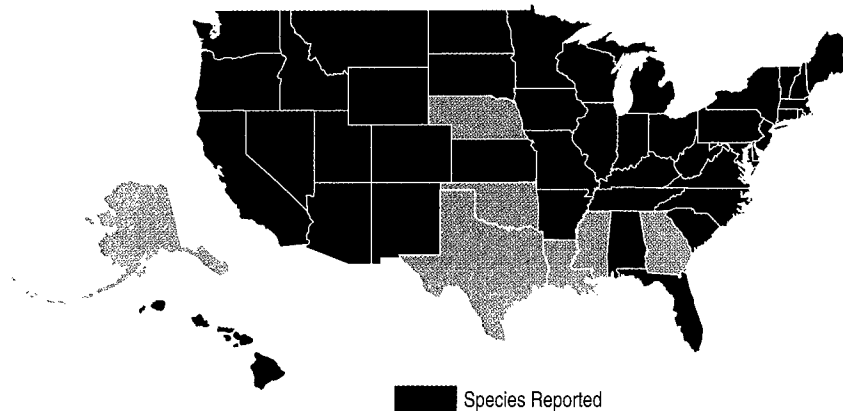
Squarrose knapweed from the eastern Mediterranean region is spreading on rangelands in the western United States. (S. Dewey, Utah State University, Logan.)

knapweed, which was beginning to spread in Utah. The infestation started at the Jesse Knight silo, about 3 miles west of Eureka, Utah. In 1954, the infestation covered a few hundred acres over a 5-square-mile area near Tintic Junction, Utah. Had officials acted at this point, squarrose knapweed could have been easily eradicated. However, no decision to act was made. As a result of inaction and uncertainty in 1954, squarrose knapweed now occurs widely in the western United States.

In 1954, officials discussed the dangers of squarrose knapweed infestation and the need for further research. The group decided to study the weed and follow a minimal management program. By the time the research was completed and published in 1960, the weed had spread north into Utah and Tooele counties, west along the livestock trails, south through the valley for about 30 miles, and east to the Starr Ranch in eastern Juab County, where about 400 to 500 acres were infested.

By 1983, the Juab County Weed Board minutes indicated that squarrose knapweed had spread to a few thousand acres and efforts to control it were being revitalized. In 1986, the Bureau of Land Management approved a Squarrose Knapweed Management Plan, which indicated that there were now thousands of acres of squarrose knapweed in Juab and Tooele counties. A working partnership was formed in 1993 to deal with this situation. By 1995, the partners were beginning to effectively manage the squarrose knapweed infestation using integrated weed management techniques. This strong and active partnership continues its work today.

Currently, about 150,000 acres of squarrose knapweed affect at least ten counties in Utah. Squarrose knapweed infestations have been documented as far south as Iron County, near Cedar City, and as far north and east as Salt Lake County and Wasatch County. (Pat Fosse, Bureau of Land Management, Richfield, Utah, personal communication, 1996).



Spotted Knapweed

Centaurea biebersteinii DC.

Spotted knapweed, a biennial or short-lived perennial with a stout taproot, has one or more stems, is branched, and grows up to 3 feet tall. The basal leaves of the plant grow up to 6 inches long and are entire to pinnately parted. Stem leaves are pinnately divided. Flowering heads are solitary at the ends of branches and contain pinkish-purple or cream-colored ray flowers. The involucre bracts are stiff and tipped with a dark fringe.

Introduction and Spread of Spotted Knapweed in the United States. Spotted knapweed, which was introduced from Eurasia as a contaminant of alfalfa and clover seed, is a very serious weed on rangelands in the western United States. Knapweeds establish themselves on all types of disturbed soil and early spring

growth gives them a head start over native species in competition for moisture and nutrients.

Successful Control of Spotted Knapweed in Sheridan County, Wyoming.

Sheridan County, Wyoming, which is located on the northern state line, encompasses about 1.6 million acres on the east slope of the Bighorn Mountains. Grasslands and open forests are highly susceptible to invasion by spotted knapweed. Interstate 25, which bisects the county, is a major corridor for movement of knapweed from Montana to Wyoming.

1982. In response to the threat of knapweed being spread south along the I-25 corridor from Montana into Sheridan County, the Sheridan County Weed and Pest District initiated a program to control knapweed in the county. Their objectives were to determine the size of the infestation in Sheridan County, control existing infestations, and educate landowners about problems caused by knapweeds.

1983. Surveys determined that 300 acres in Sheridan County were infested with spotted and Russian knapweed. Following this, a management and action plan was written that provided for public education and control efforts in all parts of the county. To encourage landowners with infestations to participate in the program, the Sheridan County Weed and Pest District offered cost sharing of herbicides and free application for knapweed control. After being treated,



each site was monitored annually to determine if additional treatments were needed.

1984. Since 1984, annual herbicide treatments for knapweed in Sheridan County have been reduced from 300 acres to less than 60 acres. This includes new infestations and new plants germinating from the seed bank within the old infestation.

1997. Sheridan County still offers cost share of herbicides and free application to landowners on sites where new infestations of knapweed are detected. In addition, the county monitors all knapweed infested sites annually to ensure they remain weed free.

If a knapweed control program had not been implemented in Sheridan County in 1983, it is estimated that about 2,440 acres would be currently infested, based on a spread rate of 15% per year (Duncan 1997).

Spotted knapweed, native to Eurasia, is a serious problem on rangelands in the western United States. It is a particular threat to pristine natural areas such as the Grand Teton National Park in Wyoming. (C. DiSalvo, National Park Service, Washington, D.C.)

Forests

Currently, about one third of the nation's land area is forested. Forests provide us with numerous economic, social, and environmental benefits. While disturbance is a normal aspect of a functioning ecosystem, excessive disturbance caused by overuse and abuse can result in forest health problems, including invasion by nonnative pests such as insects, diseases, and invasive plants. In forests, invasive plants reduce habitat for native and endangered species, degrade riparian areas, create fire hazards, and interfere with recreational activities.

Forest communities may also be altered by weeds. For example, the invasion of St. John's wort into "partial cut" stands in the Umatilla National Forest near Looking Glass Fish Hatchery in Oregon has been observed. This weed is displacing native species that are important for soil nutrient development, soil microbial development, and water cycling. Mildly poisonous, St. John's wort may also affect certain species of wildlife (Harrod et al. 1996).



Cogongrass, a perennial grass introduced into Louisiana in the early 1900s from the Philippines as a potential cattle forage, is becoming a serious weed of row crops and pine plantations in the Gulf Coast Region. (C. Bryson, USDA Agricultural Research Service, Stoneville, Mississippi.)

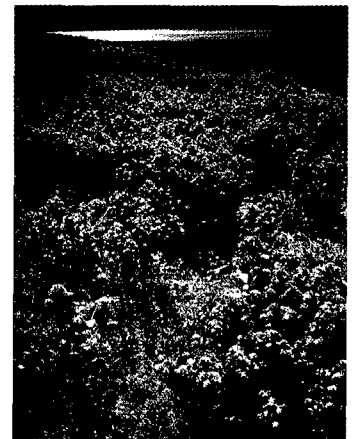
FACT: Invasive plants cause fire hazards. Weeds such as cheatgrass increase fuel loads and can create fire hazards around electrical substations and areas where flammable products such as lumber and oil products are stored.

FACT: Invasive plants are a serious problem in forest nurseries. In infested clearcut areas and forest nurseries, introduced vines such as kudzu and mile-a-minute quickly cover the ground and can prevent the growth of seedling trees.

FACT: Invasive plants affect young pine plantations. The importance of weed control in forestry enterprises is illustrated in young pine plantations. In studies conducted in Georgia and Louisiana, pine yields were 63% greater on sites where weeds were controlled than on sites where weeds were not controlled. Arkansas foresters have concluded that the cost of weed management in their pine plantations could exceed \$12 million annually (Yeiser 1988).

Noxious weeds are like a biological wildfire, raging beyond control.

MAX PETERSON
USDA Forest Service (formerly)

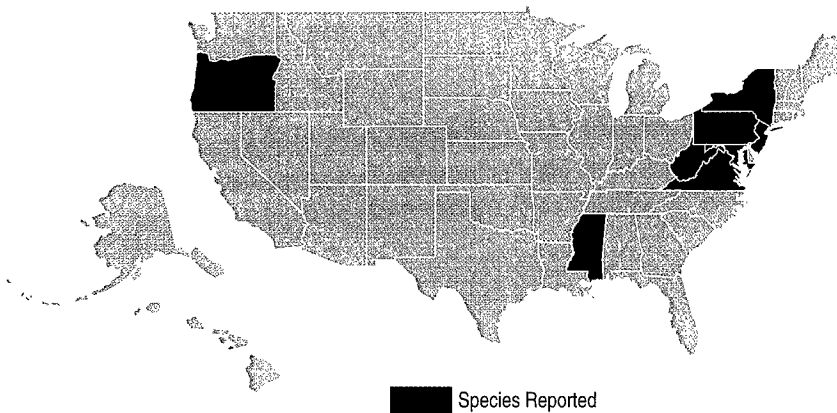


St. John's wort, native to Eurasia, is a serious problem in parts of the West where it displaces native plants that are important in maintaining soil nutrients, microbial activity, and water cycling. (C. DiSalvo, National Park Service, Washington, D.C.)

FACT: Invasive plants affect forest health. Healthy forests have a relatively open understory and permit sunlight to filter through the tree cover to the forest floor where resident animals and low lying plants can benefit from the heat and light. When invaded by an aggressive nonnative plant, the forest understory becomes a monoculture that crowds out the native

plants and animals. Once established in a forest, invasive plants also increase the effects of natural disturbances (e.g., fire, flooding, and drought) (Brian Bowen, Tennessee Exotic Pest Plant Council, personal communication, 1996).

Invasive Plant Primer



Mile-a-minute, a prickly vine from Asia that was accidentally introduced into York County, Pennsylvania, in the mid-1940s, is fast becoming the “kudzu” of the Northeastern United States. (R. Westbrook, USDA Animal and Plant Health Inspection Service, Whiteville, North Carolina).

Mile-a-minute *Polygonum perfoliatum* L.

A prickly annual vine from Asia, mile-a-minute grows up to 20 feet long. Mile-a-minute has pale green triangular shaped leaves and blue berrylike fruit. A population of the plant climbing over other plants and structures will appear to be light green compared to most surrounding vegetation. Dead plants turn reddish brown in winter. Typical habitats are roadsides (especially sites planted with crown vetch), forest and thicket margins, nurseries, reforestation clear-cuts, utility rights-of-way, low meadows and stream banks, orchards, and nurseries.

Introduction and Spread of Mile-a-minute. Mile-a-minute was first collected in the United States from ship ballast near Portland, Oregon, in the 1890s. The plant next appeared in rhododendron nurseries in York County, Pennsylvania, in 1946. Since that time, mile-a-minute has spread to New York, West Virginia, Maryland, Delaware, the District of Columbia, and Virginia. It has also been collected in Mississippi.

Since its first appearance in Pennsylvania in the 1940s, mile-a-minute

has been spread by birds and rodents and carried in rivers and streams. A very invasive plant, mile-a-minute outcompetes much of the native flora. Under favorable growing conditions, the plant will spread rapidly and reach high densities in locally

abundant populations. Mile-a-minute occupies a niche similar to Japanese honeysuckle. It is an excellent climber and can spread easily over shrubs and understory trees (Mountain 1989).

Kudzu

Pueraria montana var. *lobata*
(Willd.) Maesen & S. Almeida

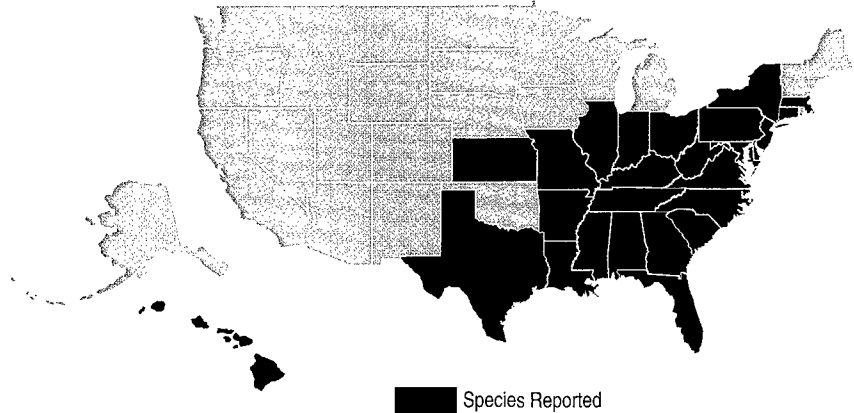
A high-climbing perennial vine from eastern Asia, kudzu has alternate leaves and deep purple, pealike flowers. The brown, fuzzy fruit pod is 1 to 2 inches long with small rounded seeds. Although the vines are killed each year by frost, the deep fleshy roots survive the mild winters of the South and resprout with vigor each spring. Kudzu is abundant throughout the southeastern United States from Texas to Virginia and southward. Kudzu grows on roadsides and railroad embankments, in vacant lots, in timberlands, and in fields.

Introduction and Spread of Kudzu

1876. The Japanese government first exhibited kudzu as an ornamental vine at the Philadelphia Centennial Exposition in 1876. Soon afterwards, kudzu became valued for the fragrant purple flowers and the large hairy leaves that provide dense shade for an arbor or a screen for a fence. Later, kudzu was grown in the southern United States as a forage crop, to reduce erosion, and to improve the soil.

1935. The Soil Conservation Service began using kudzu as a soil binder to prevent soil erosion on road cuts and farm-lands. At one time, the federal government paid as much as \$8 per acre for farmers to plant kudzu. Kudzu clubs were formed to promote its use, including the 20,000 member Kudzu Club of America.

Channing Cope, the founder of the club, christened kudzu the “miracle vine.” Soon communities were holding kudzu festivals and crowning kudzu queens.



Kudzu is a vine from Asia that was introduced into the United States at the Philadelphia Centennial Celebration in 1876 as an ornamental porch vine. It now infests at least 7 million acres in the Southeast. (Left Photo: J. Byrd, Mississippi State University, Mississippi State. Right Photo: J. Miller, USDA Forest Service, Auburn, Alabama.)



In the 1930s, kudzu was promoted by the Soil Conservation Service as a soil builder and erosion control aid. This picture shows kudzu being planted by the Civilian Conservation Corps in Alabama in 1935. (J. Miller, USDA Forest Service, Auburn, Alabama.)

■ Kudzu has invaded Florida!

Despite efforts by the state to block the spread of this fast growing species, it has been detected at seven sites in Dade and Broward Counties in south Florida. A kudzu explosion is the last thing that the Everglades needs.

Palm Beach Post, Palm Beach, Florida,
November 26, 1996



Kudzu will completely cover any object that remains still long enough, including stop signs and power poles. (J. Byrd, Mississippi State University, Mississippi State.)

1946. Kudzu had been established on 3,000,000 acres of highly erodible land across the South (Williams 1994; Bell and Wilson 1989).

1955. The plant had escaped its original plantings and covered power poles, trees, shrubs, gardens, fences, and anything else that stood in its path. Kudzu's ability to grow as much as a foot per day during the summer months eventually earned it the name "the vine that ate the South." Kudzu

was listed as a common weed by the U.S. Department of Agriculture in 1970 (Agricultural Research Service 1971).

1998. Today, kudzu is widespread throughout the Southeast and covers large areas with impenetrable thickets. The plant poses a serious threat to timberland, because the dense foliage totally blocks out sunlight. Over 7 million acres are estimated to be infested (Jim Miller, U.S. Forest Service, Auburn, Alabama, personal communication, 1996).



Kudzu covering an old house in the South (J. Asher, Bureau of Land Management, Portland, Oregon.)

Deserts

Deserts are dryland ecosystems with unique plants and animals that are adapted to extremes in temperature and moisture. Deserts and semi-arid areas comprise approximately 33% of the Earth's land surface, with about 5% categorized as extremely arid. In a desert climate, the mean annual precipitation is less than 10 inches. Until recent times, deserts were generally too harsh to support large-scale human use. However, with irrigation and modern modes of transportation, more and more desert areas are opening for use and development. Along with such development comes disturbance that encourages the growth and spread of invasive plants.

FACT: Invasive plants fuel desert fires. Currently, scientists with the Biological Resources Division of the U.S. Geological Survey are studying the impacts of fire and nonnative plants on the native plant and animal diversity of the Mohave Desert. In most cases, the presence of nonnative plants provides increased fuel for fires, which makes the fires potentially more devastating. In addition, nonnatives compete with native species for space and water and nutrients. Findings from the study will help land managers control the spread of nonnative plants to the benefit of native species (Todd Esque, U.S. Geological Survey, personal communication, 1996).

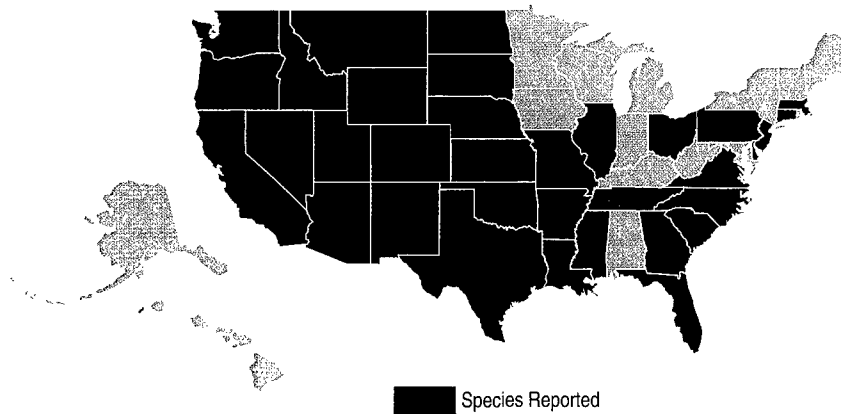


The challenge of controlling weeds may seem overwhelming, but through development of partnerships at all levels - local, regional, and national - the likelihood of reaching our collective weed management goals can be quite high.

MIKE DOMBECK
USDA Forest Service

Saltcedar, an invasive plant in the western United States. (Jerry Asher, Bureau of Land Management, Portland, Oregon.)

Invasive Plant Primer



Saltcedar, which was introduced as an ornamental from Asia, invades riparian (streamside) areas throughout the American West. It accumulates salt in its tissues, which is later released into the soil, making it unsuitable for many native species. (S. Dewey, Utah State University, Logan.)

Saltcedar

Tamarix chinensis Lour., *T. parviflora* DC., and *T. ramosissima* Ledeb.

Saltcedar is the common name for three introduced species of small deciduous trees or large shrubs that are causing serious problems in the desert southwest. Streambank (riparian) communities of the desert southwest have been reduced and altered so severely from saltcedar and other impacts that they may be one of the rarest habitats remaining in North America (Deuser 1996).

Growth Characteristics of Saltcedar.

Under good conditions, weedy saltcedars can grow 9 to 12 feet in a single season. Under drought conditions, saltcedar survives by dropping its leaves. Mature plants can survive immersion during flooding for up to 70 days (de Gouvenain 1996). After summer rains, saltcedar seedlings quickly colonize moist areas due to the constant availability of seeds. The plant's ability to exploit suitable germinating conditions over a long time period gives saltcedar a considerable advantage over native riparian species (Howe and Knopf 1991). Mature plants can resprout vegetatively after fire, flood, or treatment with herbicides and can adapt to wide variations in soil and mineral gradients (Brotherson and Field 1986). Saltcedar can grow at elevations up to 5,400 feet and prefer saline soils (Brotherson and Winkel 1986; Brotherson and Field 1987; DiTomaso 1996). They typically occupy sites with intermediate moisture, high water tables, and minimal erosion.

Introduction and Spread of Saltcedar

1800s. In the early 1800s, eight species of saltcedar were introduced into the United States from Asia as ornamentals for use as wind breaks or to stabilize eroding stream banks. Three of these species, including *T. chinensis*, *T. parviflora*, and *T. ramosissima*, have become invasive throughout their range in the southwestern United States.

1940s. These three species of saltcedar had spread extensively along the Gila, Salt, Pecos, Colorado, and Rio Grande rivers. The construction of dams and flood control structures along these rivers altered natural flooding regimes and provided ideal conditions for the establishment, reproduction, and growth of saltcedar.

1960s. By 1961, at least 1,400 square miles of floodplain in the western United States were infested by saltcedar. Since the 1960s, 70% of the original native vegetation in Afton Canyon, California, has been replaced by saltcedar. Reduced river flows, off-road vehicles, year-round grazing, and native tree cutting may have permitted the establishment and spread of saltcedar in such areas (Lovich et al. 1994).

1970s and 1980s. Saltcedar has moved into interior desert riparian habitats that are relatively undisturbed by human activities. In southern California, saltcedar now infests many of the springs, streams, and some of the more mesic desert washes (de Gouvenain 1996).

1998. The weedy saltcedars have successfully invaded nearly every drainage system in arid and semi-arid areas in the southwestern United States and occupy over 1 million acres (Randall and Marinelli 1996). Saltcedars now occupy most suitable habitat west of the Great Plains, north into Montana, and south into northwestern Mexico (de Gouvenain 1996).

Impacts of Saltcedar on Native Plants

and Animals. Saltcedar invasion is a severe threat to the structure and stability of native plant communities. Along the floodplain of the Rio Grande River in New Mexico, thick stands of saltcedar have severely limited the number of germination sites that are suitable to cottonwood and other riparian species. This has led to a precipitous decline in cottonwood populations (Howe and Knopf 1991).

Wetlands & Waterways

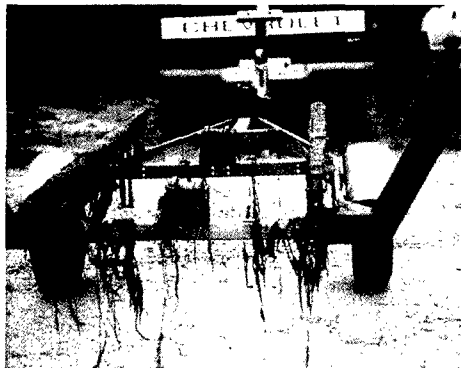
Invasive plants are a major problem in U.S. wetlands and waterways. In areas such as the Imperial Valley of southern California, aquatic invasive plants inhibit the flow of water in irrigation ditches and canals. In low-lying areas where drainage canals are needed to carry away excess storm water, aquatic weeds can inhibit the flow of water and cause flooding of homes and other property. In wetlands and waterways, aquatic weeds often outcompete or totally displace native species.

FACT: Aquatic invasive plants reduce water intended for crops, cause increased water loss by seepage, and slow water flow, which leads to more evaporation from ditches and canals.

FACT: Aquatic invasive plants can interfere with boat travel on waterways. In Florida, heavy infestations of aquatic weeds such as hydrilla and floating water hyacinth interfere with boating and other water sports.

FACT: Recreational boats and their trailers and motors are the most common methods for transporting major aquatic invasive plants such as hydrilla and Eurasian watermilfoil to new water bodies.

FACT: In Africa, Asia, and Central America, lakes built above dams across major rivers become so badly infested with invasive plants within 5-10 years after construction that their usefulness for power development, boat transportation,



Hydrilla, an aquatic weed from Africa, is often spread between water bodies in the United States on boats and boat trailers. (K. Langeland, University of Florida, Gainesville.)



Thick mats of introduced aquatic weeds such as hydrilla interfere with recreational activities such as sailing and swimming. (D. Hammerschlag, U.S. Geological Survey, Laurel, Maryland.)

Aquatic weeds like floating water hyacinth are as insidious as they are beautiful. Left to their own devices, they would continue to spread, eventually choking out waterways, making them unusable by people and uninhabitable to fish.

KEN LANGELAND
University of Florida



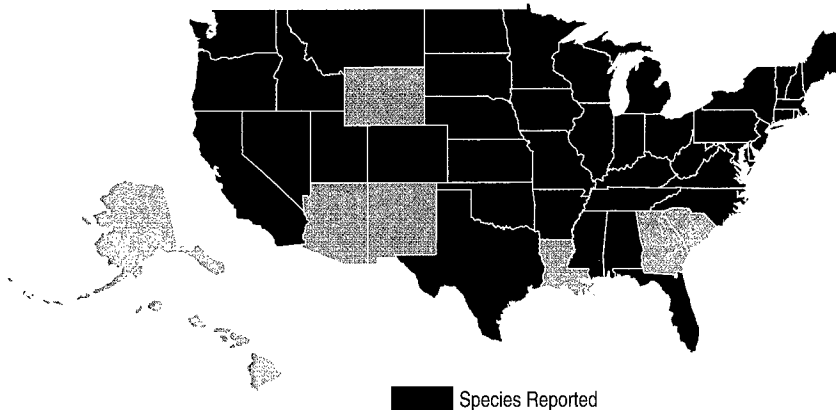
Water lettuce is an introduced floating weed from South America that clogs ditches and canals throughout the southern United States. (K. Langeland, University of Florida, Gainesville.)

and irrigation is greatly reduced (Zimdahl 1993).

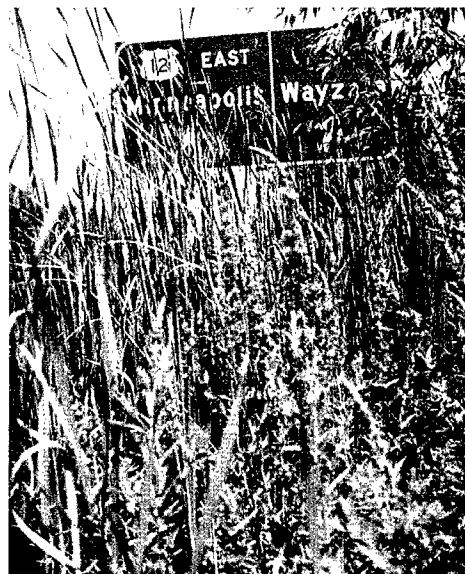
FACT: In wetlands, invasive plants crowd out native plants and animals and interfere with natural processes such as water flow and evapotranspiration.

FACT: In New England, the 10-foot tall species of reed phragmites has taken over thousands of acres of marshes, driving out rare native species like lady's slipper and spotted turtles.

Invasive Plant Primer



Purple loosestrife, introduced from Europe in the mid-1800s as an ornamental plant, has invaded wetlands in the eastern and north central states and is still being planted in roadside beautification projects in parts of the United States. (B. Harper-Lore, Federal Highway Administration, Minneapolis, Minnesota.)



Purple Loosestrife

Lythrum salicaria L.

An erect, perennial herb that grows up to 8 feet tall, purple loosestrife was introduced to the United States from Europe in the early 1800s in ship ballast and as a medicinal herb and ornamental plant. The magenta flowers have five to seven petals and are arranged in long racemes. Since 1880, the distribution of purple loosestrife in the United States has been increasing rapidly (Thompson et al. 1987). From 1940 to 1980, the rate of spread was approximately 1.5 latitude-longitude blocks per year. The plant now grows wild in at least 42 of the 50 states, with greatest concentrations in New England, Mid-atlantic, and Great Lakes states. In the eastern and central United States, purple loosestrife grows best in freshwater marshes, open stream margins, and alluvial floodplains. Loosestrife often grows in association with cattails, reed canarygrass, and other moist-soil plants.

Impacts of Purple Loosestrife on Wetlands. Wetlands infested with purple loosestrife often lose 50% of native plant biomass. It is not uncommon to find

affected wetlands that have been 100% infested. In such densely infested areas, predator/prey relationships change due to changes in food and cover, resulting in a reduction of vertebrate and invertebrate populations. This highly competitive plant especially threatens endangered, threatened, or declining plant and animal species (Thompson et al. 1987).

Commercial Sale and Regulation of Purple Loosestrife. Nurseries across the country still sell purple loosestrife as an ornamental despite its well-known impacts on wetlands. Loosestrife is promoted for use as a landscape plant and as a nectar plant in honey production. About 24 states have listed purple loosestrife as a noxious weed and prohibit its sale and distribution. Since purple loosestrife is very difficult to control once established, the best defense is to prevent its spread and to eradicate new populations as soon as possible (Stein and Flack 1996).



Purple loosestrife has spread from cultivation into wetlands where it often totally replaces communities of native plants. (R. Westbrook, USDA Animal and Plant Health Inspection Service, Whiteville, North Carolina.)

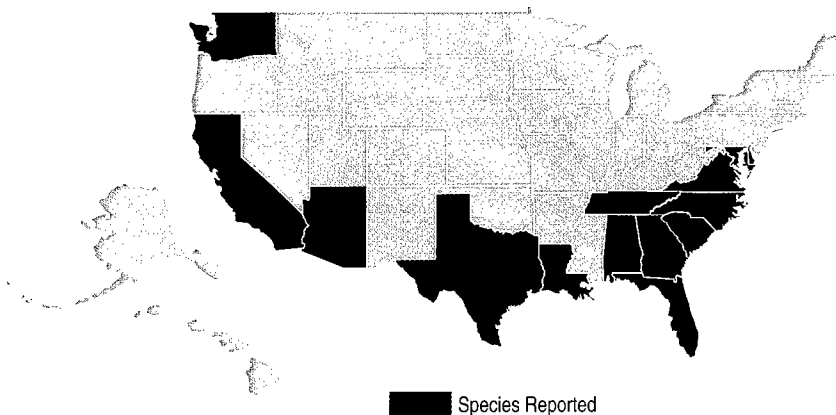


Despite its reputation as a wetland invader, purple loosestrife is still being sold as a flowering plant in some states. (B. Harper-Lore, Federal Highway Administration, Minneapolis, Minnesota.)

Hydrilla

Hydrilla verticillata (L.f.) Royle

Hydrilla, a submerged, perennial herb, normally roots in the hydrosol, but often breaks free and forms free-floating mats. It grows in freshwater lakes, streams, and rivers. Hydrilla is native to Asia, but has spread into Europe, Asia, Australia, New Zealand, the Pacific Islands, Africa, South America, and North America. In the United States, hydrilla now occurs in all of the Gulf and Atlantic coast states as far north as Maryland, in Connecticut, and on the west coast in California and Washington. Arizona eradicated hydrilla from the state in the 1980s (Langeland 1990).



■ Hydrilla takes over Lake Martin

Hydrilla was first detected in Lake Martin, an 80-acre oxbow lake in southern Louisiana, in the fall of 1992. By late summer 1994, about 50% of the lake surface was covered with hydrilla. Late summer coverage reached nearly 100% in 1995. Fish kills occurred by late summer 1995. In June of 1996, surface oxygen concentrations were less than 1 mg per liter in much of the lake, and never above 3.3 mg per liter, even in the few areas of open water. As a result, fish restricted to open surface waters were subject to intense predation by wading birds perching on the hydrilla mats.

U.S. Geological Survey,
Lafayette, Louisiana



Hydrilla now infests about 4,000 acres of the Potomac River near Washington, D.C. (C. DiSalvo, National Park Service, Washington, D.C.)



Hydrilla was discovered in the Crystal River in south Florida in 1960. (R. Charudattan, University of Florida, Gainesville.)

Hydrilla in Florida

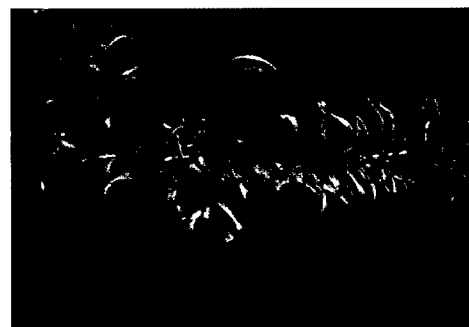
1947. An aquatic plant dealer in St. Louis, Missouri, imported hydrilla from Ceylon (Sri Lanka) (Don Schmitz, Florida Department of Environmental Protection, Tallahassee, Florida, personal communication, 1996).

1950s. Hydrilla was brought into the Tampa, Florida, area in the early 1950s for possible use as an aquatic ornamental.

1960s. Hydrilla was discovered in the Crystal River in south Florida. After this, it spread rapidly throughout the state.

1970s. Hydrilla had become established in most major water bodies of all drainage basins in Florida. After first being found in Orange Lake, Florida, in 1972, hydrilla rapidly expanded into waters four to eight feet deep, and eventually covered over 90% of the lake surface by 1976 (Schmitz and Brown 1994). The impact of hydrilla on real estate values, tourism, and user groups can be staggering. One economic study on Orange Lake indicated that the economic activity attributed to the lake was almost \$11 million per year. During years that hydrilla covers the lake, such benefits are all but lost (Langeland 1990).

1980s. The Florida Department of Natural Resources estimated that hydrilla infested over 50,000 acres in the state by the late 1980s, not including an estimated 20,000 infested acres that were being managed (Langeland 1990).



1990s. In 1994, it was estimated that hydrilla was established in 42% of Florida's public waters, infesting some 75,000 acres.

Funds Spent to Control Hydrilla in Florida. During the period from 1980-1993, hydrilla management in public lakes and rivers in Florida cost \$38.5 million. During FY 1995, hydrilla management cost \$3 million. Estimates indicate that \$10 million is actually needed for adequate annual control of hydrilla on a statewide basis (Schmitz and Brown 1994).

Impacts of Hydrilla in the United States.

In several areas of the United States, hydrilla has become a severe problem. Hydrilla clogs drainage and irrigation canals, prevents boating access for fishing and other water recreation, impedes commercial navigation, shades out beneficial native plants, degrades water quality, restricts water movement, and interferes with hydroelectric plants and urban water supplies (Langeland 1990).

Hydrilla in the Potomac River. The spread of hydrilla can be quite rapid. For example, in little more than a year a small colony found in the Potomac River near Alexandria, Virginia, in 1982 expanded to 12 acres and established a satellite colony about 28 miles downstream (Parsons and Cuthbertson 1992).

Eurasian Watermilfoil

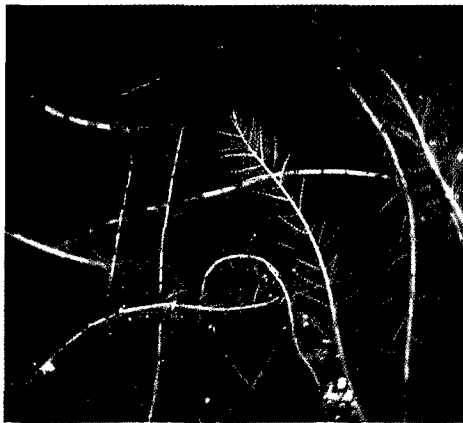
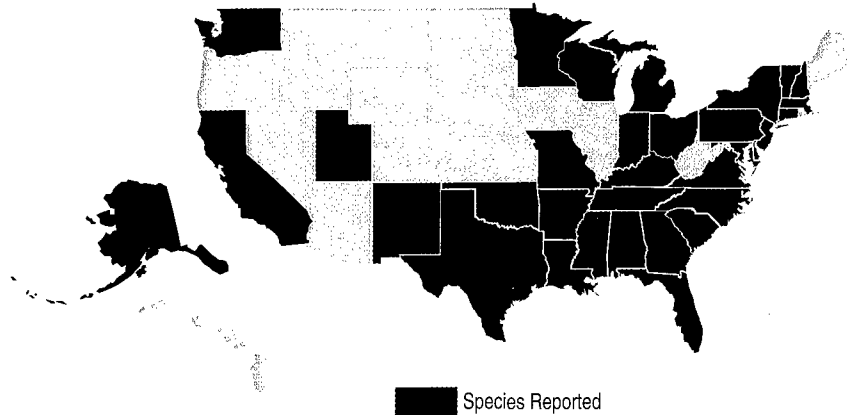
Myriophyllum spicatum L.

Eurasian watermilfoil, a submerged aquatic weed from Europe, Asia, and northern Africa, is spreading rapidly throughout the United States. Watermilfoil invades lakes, ponds, and reservoirs and is especially troublesome in nutrient rich waters with high motorboat use. Most populations of Eurasian watermilfoil cause problems in water bodies that have been invaded (Couch and Nelson 1985).

Introduction and Spread of Eurasian Watermilfoil in the United States. Since it was observed in a pond in Washington, D.C., in 1942, watermilfoil has been spread throughout the country by aquarium dealers and fishermen. The plant disperses primarily by vegetative propagation through stem fragmentation. Boat propellers and trailers play an important role in long-distance spread of the plant.

Competitive Nature of Eurasian Watermilfoil. Due to its unique growth habits, Eurasian watermilfoil competes aggressively with native aquatic plants. Soon after becoming established in a new site, watermilfoil quickly forms an extensive root system. In the early spring, watermilfoil begins growth well before native species. Later in the season, watermilfoil forms a dense canopy that overtops and shades out existing vegetation. The plant's ability to grow in eutrophic conditions and over a broad temperature range also contributes to its competitive edge over native plants (Smith and Barko 1990). In the Mobile Delta of Alabama, watermilfoil has displaced populations of native eelgrass and southern naiad (Bates and Smith 1994).

Impacts of Eurasian Watermilfoil. As a food source for waterfowl, Eurasian watermilfoil has less nutrient value than the native plant species it replaces (Aiken et



Eurasian watermilfoil, which is native to Africa, Asia, and Europe, invades lakes, ponds, and other water bodies throughout the United States. (A. Fox, University of Florida, Gainesville.)

al. 1979). Watermilfoil's dense beds support a lower abundance of invertebrates, an important fish food, than do native aquatic plants (Keast 1994). The dense beds also restrict natural water flow and encroach on fish swimming and foraging (Engel 1995). Dense populations also clog water intakes and create a favorable habitat for mosquitoes (Smith and Barko 1990). Decaying mats of dead plants foul lakeside beaches (C. Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996.)

Florida

Currently, more than 900 nonnative plant species have become established in Florida and constitute at least 27% of the total flora of the state. In some cases, nonnative plants seem to cause little or no obvious damage, appearing only as minor weeds in Florida gardens, urban landscapes, or along roadsides. In other cases, invaders such as melaleuca or Brazilian pepper crowd out native plants and animals, reduce biodiversity, destroy ecosystems, and reduce available water supplies. Invasive nonnative plants cause economic as well as ecological concern. At least 1.5 million acres of Florida's natural areas have become infested with nonindigenous plant species (Schmitz and Brown 1994).

Florida's abundance of lakes, streams, and other wetland habitats predisposes the state to invasion by nonnative species. For example, about 7,800 lakes comprise about 6% of the land area of the state, and 1,700 rivers dissect Florida. These watery habitats are invaded by nonnative plants and animals introduced by pet, fishing, and ornamental horticultural enthusiasts.

Modification of Florida waterways for irrigation, water supplies, flood control, and recreation has facilitated the spread of introduced species and worked to the disadvantage of several key native species (Office of Technology Assessment 1993). Pollution of Florida waterways by various human activities also favors growth of several nonnative plant species over that of natives. Extensive disturbance of soils through rock plowing, diking, strip mining, and bedding have created new habitats, which tend to be dominated by nonnative species (Schmitz and Brown 1994).



The state of Florida spends at least \$14 million per year to control aquatic weeds such as water lettuce and hydrilla. Large mats of floating aquatic weeds such as this floating water hyacinth impede water flow, interfere with water use, and become jammed up against bridges. (K. Langeland, University of Florida, Gainesville.)

In 1988, over 1.2 million acres of freshwater lakes, rivers, and canal systems were surveyed in Florida to determine the extent of aquatic weed infestations. The survey detected 137 aquatic plant species covering 348,344 acres. Of this total, 22 species (26%) were nonnative and covered nearly

An army of invasive plant and animal species is over-running the United States, causing incalculable economic and ecological costs. Florida is a beach head for the invasion.

DON SCHMITZ
Florida Department of Environmental
Protection

91,427 acres. The submerged aquatic weed hydrilla comprised 16% of total area

Old world climbing fern, which was introduced from the old world tropics as a potted plant, has spread throughout south Florida where it smothers native trees, shrubs, and herbs. The plant is spread by spores which are carried about by wind, animals, and water. (K. Langeland, University of Florida, Gainesville.)



infested, and 62% of the area infested by nonnative species.

These biological pollutants have caused extensive ecological and resource management problems in Florida's waterways. Their introduction and spread have hindered navigation, flood control, and recreational activities such as fishing and water sports, and their expansive growth has displaced native wildlife habitat. From 1980-1990, public agencies and private individuals in Florida spent approximately \$90



Floating water hyacinth was introduced from South America at the U.S. Cotton Exposition in New Orleans, Louisiana, in 1884. By the 1890s, this floating aquatic plant had become a serious problem on the St. John's River in Jacksonville, Florida, where it interfered with commercial shipping and recreational use of the river. (M. Worley, Florida Department of Environmental Protection, Tallahassee.)

million on aquatic plant management programs (Schmitz 1990).

Although some introduced plant species can provide a limited new habitat for native species, the most widespread nonna-

tive plant species in Florida (Australian pine, old world climbing fern, hydrilla, melaleuca, torpedo grass, and water hyacinth) have low use and feeding levels by native insects. In addition, Australian pine, melaleuca, torpedo grass, and floating water hyacinth are rarely grazed upon by larger herbivores (insects and animals that feed on plants). Without the herbivores, the carnivores disappear and the subsequent displacement of native keystone species may result in serious disruption of an ecosystem's natural food web. Also, many of these widespread introduced species are modifying Florida's natural areas in ways that make them inhospitable for native plant survival (e.g., alteration of fire regimes, changes in soil structure and hydrology, decreased light, etc.). Consequently, without native keystone plant species that supply critical support (food and habitat), Florida's native amphibians, reptiles, birds, and mammals are forced to seek areas that have not been as impacted.

With the expected continued expansion of introduced plant populations and a continued loss of natural habitats to agricultural development, human population growth, and urban sprawl, there is a real threat of an increased rate of extinction of native plant and animals species in Florida's future. Invasions by nonindigenous plants in natural areas and the resultant loss of Florida's biological heritage also cause great economic concern. Such an event would have repercussions on Florida's economy in terms of water availability and use (fishing, potable water, etc.), hunting, and a reduction in tourist dollars because of degraded, unattractive natural areas that are devoid of wildlife (Schmitz and Brown 1994).

Invasive Plant Primer

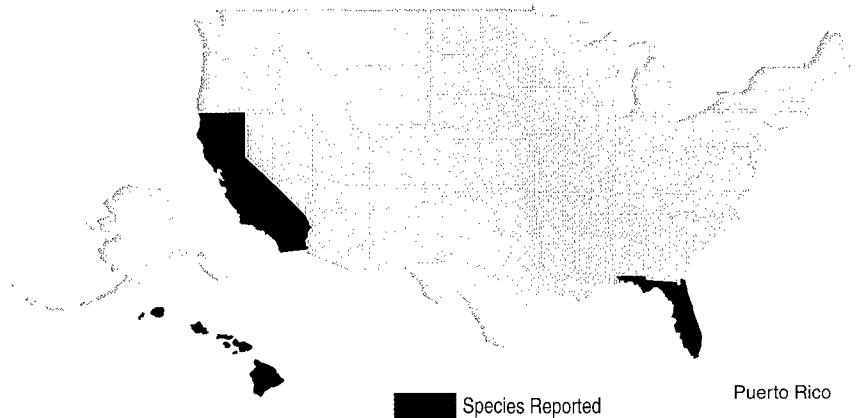
Melaleuca

Melaleuca quinquenervia (Cav.) T. Blake

Melaleuca, a tree in the myrtle family, grows to 50 feet or more. Melaleuca has thick, spongy, papery bark and lance-shaped leaves that smell like camphor when crushed. Melaleuca's small white flowers are arranged in bottlebrush spikes near the end of the stems. The flowers mature into tightly packed clusters of woody capsules with small amber seeds. In its native range in northern Australia and Papua New Guinea, melaleuca grows in coastal wetlands.

Introduction and Spread of Melaleuca in Florida. Melaleuca was first introduced as an ornamental in Florida, California, and Hawaii. In 1906, a forester at the University of Miami planted two specimens of melaleuca along the Atlantic coast. Subsequently, it was planted as an agricultural windbreak, soil stabilizer, and landscape ornamental around Miami, where it quickly escaped into wetlands and marshes. In 1936, melaleuca seeds were broadcast by airplane over south Florida in a private campaign to forest and drain the Everglades. As a result of these introductions, melaleuca is now a major threat to the Everglades in south Florida (Dan Austin, Florida State University, Tallahassee, Florida, personal communication, 1996).

Impacts of Melaleuca on Wetlands in South Florida. Over the past 40 years, melaleuca has undergone an explosive invasion of wetlands similar to the



Everglades in south Florida. This is attributed to its prolific seed production, adaptation to fire, tolerance of flooding, and lack of competitors and predators. In freshwater wetlands, melaleuca almost completely displaces native vegetation and degrades wildlife habitat. Its flowers and new foliage produce volatile emanations that cause serious asthma-like symptoms or a fine burning rash coupled with headache and nausea in sensitive people. State officials now estimate that melaleuca infests about 500,000 acres of native wetlands in south Florida and is expanding at a rate of 50 acres per day across the state. A melaleuca control project is now underway in the Arthur C. Marshall Loxahatchie Wildlife Refuge (U.S. Fish and Wildlife Service) in south Florida. However at current funding levels, the project is able to remove only one acre of this invasive plant per day (S. Jewel, Fish and Wildlife Service, Palm Beach, Florida, personal communication, 1996).

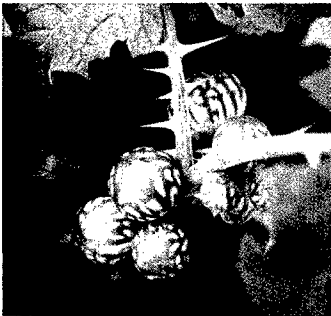


Melaleuca, a tree from northern Australia, was introduced into south Florida in the early 1900s as a landscape ornamental and to dry up the Everglades and for use as a timber crop. (A. Fox, University of Florida, Gainesville.)

Tropical Soda Apple

Solanum viarum Dunal

Tropical soda apple, a thorny shrublike herb native to Argentina, grows up to 6 feet tall. The plant produces mottled whitish and green immature fruits that look like watermelons. The mature fruits are yellow. Tropical soda apple grows in pastures, bahiagrass fields, vegetable crops, and natural areas.



Tropical soda apple, a thorny nightshade from Argentina, first appeared in the United States in pastures and rangelands in Glades County, Florida, in 1988. Mottled green fruits that look like small watermelons are a distinguishing feature of the plant. (Top photo: A. Miller, USDA Animal and Plant Health Inspection Service, Conyers, Georgia. Bottom photo: J. Mullahey, University of Florida, Immokalee.)

Tropical Soda Apple Spread in Florida.

Tropical soda apple was first collected in the United States in Glades County, Florida, in 1988. In 1990, estimates indicated soda apple occurrence on 25,000 acres on several ranches in south Florida. By 1993, that estimate increased to 150,000 acres in Florida. Tropical soda apple now infests close to 1,000,000 acres and occurs in most counties of the state (figure 8).

Damage Caused by Tropical Soda Apple in Florida.

In Florida, tropical soda apple has become a serious threat to the cattle industry. Since it grows well in either full sun or shade, soda apple crowds out available forage in open pastures and prevents cattle from seeking shelter from the sun in tree hammocks. In 1994, control costs and losses attributed to tropical soda apple were estimated to be over \$11 million. Tropical soda apple also threatens the vegetable crop industry as a competitive weed and acts as an alternate host for numerous pathogens that are diseases of eggplant, peppers, and potatoes (Westbrooks and Eplee 1995).

Interstate Spread of Tropical Soda Apple.

Since 1994, tropical soda apple has been documented in Mississippi (29 sites in 13 counties), Tennessee (1 site), Alabama (13 sites in seven counties), Georgia (11 sites in seven counties), South Carolina (3 sites in two counties), North Carolina (1 site), and Pennsylvania (1

Explosion of Tropical Soda Apple

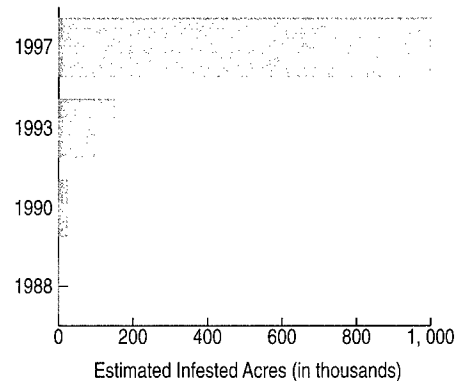
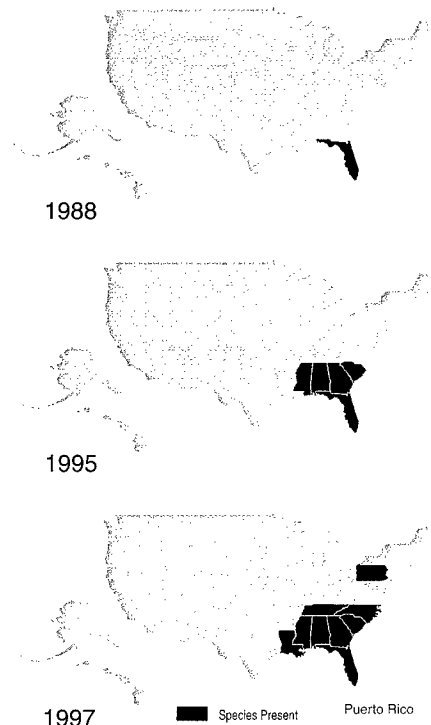


Figure 8.

Spread of Tropical Soda Apple in the United States



(Pennsylvania population has been eradicated)

Figure 9.

site). All of these infestations have been linked to interstate movement of cattle, bahiagrass, and composted manure from infested areas in Florida (figure 9).



Tropical soda apple grows well in sun and shade and is invading tree hammocks where it prevents cattle from seeking refuge from the sun in southern pastures. (J. Mullahey, University of Florida, Immokalee.)

Florida Tropical Soda Apple Task Force.

In 1994, Florida Governor Lawton Chiles established a Florida Tropical Soda Apple Task Force composed of industry, state, and federal personnel, in order to develop strategies for dealing with this pest plant. By 1995, the Florida Tropical Soda Apple Task Force had developed best management practices that included methods for control and ways to minimize its spread. In 1996, the Florida Cattlemen's Association adopted the Task Force's best management practices that included a recommendation to hold cattle on a fruit-free area for at least six days prior to shipment to noninfested areas. This averted the immediate need for an official quarantine and certification program to prevent interstate spread of tropical soda apple. Other states have formed similar groups to deal with tropical soda apple as well.

■ Composted Cow Manure as a Vector of Tropical Soda Apple

In 1994, composted cow manure was confirmed as a vector in the interstate movement of tropical soda apple from Florida, when a "county fair" blue ribbon specimen was observed growing directly from a bag of cow manure at a residence in Vidalia, Georgia.

Hawaii

Oceanic islands throughout the world are very vulnerable to biological invasions. Island species have evolved in isolation from forces faced routinely by plants and animals on continents, such as browsing and trampling by herbivorous mammals, predation by ants, virulent diseases, and frequent and intense fires. This has resulted in a lack of mechanisms for protection from predators and reduced competitiveness against introduced species (Jacobi and Scott 1985).

Human impacts have also clearly made the situation worse on most islands. According to scientists, the native biota of the Hawaiian Islands can be accounted for by one successful immigrant species every 35,000 years over 70 million years. Upon the arrival of the Polynesians in the 4th century A.D., this rate of immigration increased to about three to four species per century for about 1,400 years. Since European contact in the 18th century, the rate of insect immigration has increased to 15 to 20 species per year. Presently, the Hawaiian archipelago has more than 8,000 introduced plant species or cultivars. This represents an average of 40 introductions per year over the past 200 years. Currently 861 (11%) of these introduced plants now grow wild and have reproducing populations (Loope 1997).

FACT: At least 86 introduced plants threaten Hawaiian ecosystems.

According to Smith (1985), there are at least 86 nonnative plants present in Hawaii that pose a threat to native Hawaiian ecosystems. However, this number needs to be revised upward, since new invaders

Just how big is the noxious weed problem? In 1995, for every acre of federal land lost to forest fires, we lost two acres to noxious weeds. This problem affects all 50 states, but nowhere is it more serious than in Hawaii. Because of our climate, Hawaii is heaven-on-earth, for weeds. This year for the first time, foreign introduced plants outnumber Hawaii's rich heritage of native species. Hawaii is the Aloha State, but we have no aloha for alien weeds. We need to start thinking of noxious weeds as biological pollution.

U.S. SENATOR DANIEL AKAKA
Hawaii



Banana poka, also known as passion-flower vine, was introduced from the Andes to the Hawaiian Islands as an ornamental about 1900. It is now smothering more than 200 square miles of native forest on the islands of Hawaii and Kauai. Seeds are spread by feral pigs, birds, and humans. (Top photo: J. Randall, The Nature Conservancy, Davis, California. Bottom photo: F. Campbell, Exotic Pest Plant Councils, Springfield, Virginia.)



Kahili ginger, one of the worst rain-forest invaders in Hawaii, is rampant in Hawaii Volcanoes National Park. Native to the Himalayas, it is also a serious forest invader in the Azores, Madeira, New Zealand, Reunion, and South Africa. (J. Avaiza, National Park Service, Hawaii.)



Koster's curse, native to the Neotropics, is an aggressive invader of moist forests of many Pacific Islands. Introduced to the Hawaiian Islands in 1940, it covered 90,000 acres on Oahu by the late-1970s and has spread to Hawaii (by 1972), Molokai (1973), Maui (1976), Kauai (1982), and Lanai (1988). The primary mode of inter-island dispersal is believed to be in mud on boots. Several biological control agents show promise of limiting the further invasion on islands other than Oahu. (The Nature Conservancy, Hawaii.)

and trends have become apparent during the past decade.

FACT: Some of the most destructive invading plants in native ecosystems of Hawaii include beardgrass, broomsedge, buffelgrass, fountain grass, molassesgrass, banana poka, strawberry guava, firetree, kahili ginger, Australian tree fern, and Koster's curse (Loope 1997).

FACT: Some introduced plants alter ecosystem processes. Native plants that grow in natural ecosystems have co-evolved within plant and animal communities. Within these established ecosystems, plant and animal populations oscillate according to changes in the environment and the availability of resources. However, introduced invasive plants do not necessarily play by these rules. In some cases, they totally change the rules of the game. This is done by altering ecosystem processes such as primary productivity, decomposition, hydrology, geomorphology, nutrient cycling, or natural disturbance regimes.

FACT: Nonnative grasses have altered the natural fire cycle in Hawaii. In contrast to many other terrestrial environments of the world, fire does not seem to have played an important evolutionary role in most native ecosystems of the Hawaiian islands, and relatively few Hawaiian endemic plant species possess adaptations to fire. Since lightning is uncommon on oceanic islands, humans cause most fires in Hawaii. Nonnative grasses primarily fuel these fires, which are generally highly destructive to native plants.

The major grasses that fuel fires in Hawaii are beardgrass, broomsedge, buffel grass, fountain grass, and molassesgrass. Invasion by these grasses into otherwise undisturbed native ecosystems adds enough fine fuel to carry fire into previously fire-free sites. Most native species are elim-

inated sooner or later by fire, while invasive grasses recover rapidly after fire. This increases the flammability of the site and the dominance of invasive grasses.



Feral pigs are currently the primary modifier of Hawaii's forests, directly through destruction of native plant species and indirectly through creating perfect seedbeds (by soil disturbance) and dispersing weed seeds. (The Nature Conservancy, Hawaii.)

FACT: Feral pigs open areas to invasions by nonnative plants. The long-term outlook for maintaining the ecological integrity of Hawaii's rain forests is not promising, given the recent invasion of feral pigs. Pigs churn up the forest floor, causing massive erosion of soil and organic matter. Pigs also break the trunks of tree ferns. Such disturbance provides an ideal habitat for invasion of invasive plants such as kahili ginger, banana poka, and strawberry guava.

FACT: So far, about 10% of Hawaii's remaining rain forests are receiving protection from feral pigs and the invasive plants that follow them.



Disturbed areas in Hawaiian rain forests are being invaded by banana poka, Koster's curse, kahili ginger, and other nonnative ornamental plants. (The Nature Conservancy, Hawaii.)

To prevent further degradation, certain areas within Haleakala and Volcanoes national parks and other conservation lands in Hawaii have been fenced to keep pigs out. While pig exclusion will allow such areas to begin to recover, invasive plants that are established in such areas must be actively controlled to prevent further spread (Loope 1997).

Firetree in Hawaii Volcanoes

National Park. The nitrogen-fixing fire-tree is invading Hawaii Volcanoes National Park, seriously damaging the native ecosystem. Dispersed by birds, the firetree spreads to new sites created by volcanic eruptions. Normally, the low nitrogen content of young volcanic soils limits plant growth. However, firetree increases the amount of biologically available nitrogen on

these sites by four times. This extra nitrogen changes the succession of plants and soil organisms in newly created volcanic habitats, favoring nonnative species. In essence, the invasion of one species—fire-tree—changes the composition and the dynamics of an entire ecosystem (Vitousek et al. 1996).



Firetree is native to the Canary Islands, Madeira, and the Azores. It was introduced to Hawaii as an ornamental, probably by Portuguese laborers, who made wine from the fruit. It was first recorded in Hawaii in 1900. Firetree increases available nitrogen on new volcanic sites. This allows nonnative plants to invade before native species have a chance to become established. (U.S. Geological Survey.)

Invasive Plant Primer

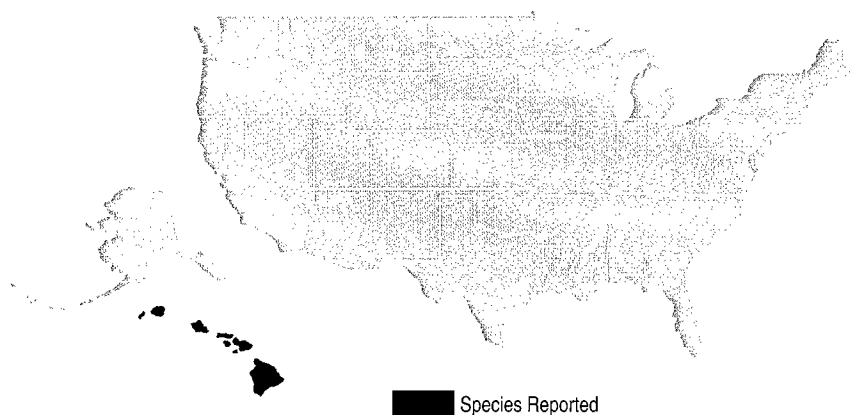
Miconia

Miconia calvescens DC.

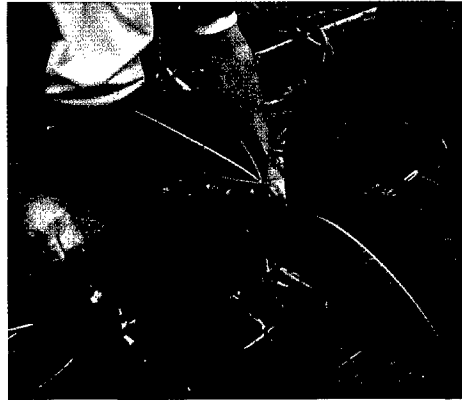
The Brown Tree Snake of the Plant World

Native to tropical forests in Central America, miconia begins life as a shrub, but can reach 50 feet at maturity. Miconia has large, velvety, dark-green leaves that grow 3 feet long and have purple undersides. Miconia has invaded moist island habitats with rainfall greater than 80 inches per year in Tahiti, the Hawaiian Islands, and other Pacific islands.

Introduction and Spread of Miconia in Tahiti and Hawaii. Introduced to Tahiti in 1937 as a botanical curiosity, miconia was spread into the wild by birds. By the



Miconia, called the “green cancer” in Tahiti, has replaced over 70% of the native forest on that Pacific island. (The Nature Conservancy, Hawaii.)



1980s, dense thickets of this seemingly innocent ornamental plant had replaced over 70% of the native forest of the island. Tahitians call miconia the “green cancer.” Miconia has already caused substantial losses of native plants and animals. French Polynesian scientists estimate that one-fourth of Tahiti’s indigenous species are threatened with extinction as a result of habitat loss due to miconia. Over the past 60 years, miconia has been introduced to other islands and is now recognized as one of the most invasive and damaging nonnative plant species in rain forests of the Pacific islands.

Miconia was introduced to the island of Hawaii as an ornamental in the 1960s. Miconia was discovered in the wild on east Maui in 1990, about 20 years after its apparent introduction at a botanical garden near Hana. Since then, Miconia has been found in nine east Maui locations. It has also been found on Oahu, Manoa, Nuuanu, Kalihi, and Wahiawa. Miconia has not yet been found on Molokai or Lanai.

Impacts of Miconia on Island

Ecosystems. Where a miconia forest proliferates, almost all other plant life ends. Miconia forms dense thickets that block sunlight from reaching the forest floor so that few plants beneath its canopy survive. As miconia grows, it destroys natural habitat, depriving native plants of sunlight and nutrients from the soil and depriving native birds of the plants they need to survive. Without soil-stabilizing, native ground

cover, infested sites begin to wash away because miconia has shallow roots that cannot hold the soil in place.

Organized Efforts to Control Miconia in Hawaii. Miconia was recognized as invasive in Hawaii the 1980s. From 1991-93, federal, state, and private volunteers removed about 20,000 individual trees from private lands on the island of Maui. For a while, this appeared to make a substantial dent in the miconia population. However, in September 1993 an aerial survey discovered a previously undetected 250-acre infestation on state land. This was far larger than all previously known populations on the island. In response, an interagency working group developed and implemented a strategy for containment and control that began in January 1994. The initial control phase involved aerial application of Garlon 4 and subsequent monitoring of treated trees via helicopter. Efforts to mobilize long-term control programs on infested islands are gaining momentum (Loope 1997).



Miconia on a mountainside in Tahiti. (The Nature Conservancy, Hawaii.)

Natural Areas

Originally, the wilderness of the North American continent held a great diversity of plants and animals. Today, the natural areas that have survived are small islands in a sea of developed land. As a result, natural areas are vital to the preservation of the native plants and animals that make up the biological heritage and diversity of the United States.

In new ecosystems, invasive plants out-compete native species because the new ecosystem lacks the natural enemies that kept these plants in biological balance in their native habitats. Invasive plants that produce large numbers of seeds and have mechanisms for rapid seed dispersal have more pronounced impacts on an ecosystem and require more complicated management strategies than native plants (Bryson 1996).

Scientists are becoming increasingly aware of invasive plants as they observe native vegetation succumbing to the effects of aggressive nonnatives. Heywood (1989) remarked that "invasion of natural communities, in many parts of the world, by introduced plants, especially woody species, constitutes one of the most serious threats to their survival, although it is one that is not fully acknowledged by conservationists."

Invasive plants modify natural and semi-natural habitats by replacing a diverse system with single species stands, altering the water or fire regime, changing the nutrient status of the soil and humus, removing a food source (for wildlife), introducing a food source where none existed before, or altering sedimentation processes. Such alterations may have profound effects on the composition of both the flora and



fauna of the region and on the landscape as a whole (Cronk and Fuller 1995).

FACT: In some areas, solid stands of invasive plants are replacing diverse natural ecosystems.

In Hawaii, strawberry guava has spread widely, dominating large tracts of wet evergreen forest, and has replaced much of the native vegetation. Another tree that is invading upland forests in Hawaii is miconia (Cronk and Fuller 1995). Melaleuca, a wetland tree native to Australia, invades the Florida Everglades at a rate of 50 acres per day. Melaleuca's dense stands crowd out all native vegetation.

FACT: Invasive plants pose a direct threat to native fauna. Australian pine has spread to such an extent in coastal areas of Florida that it is interfering with

Invasive alien plants pose a significant threat to the biodiversity of natural areas, to life on the planet.

MICHAEL SOULE
University of California

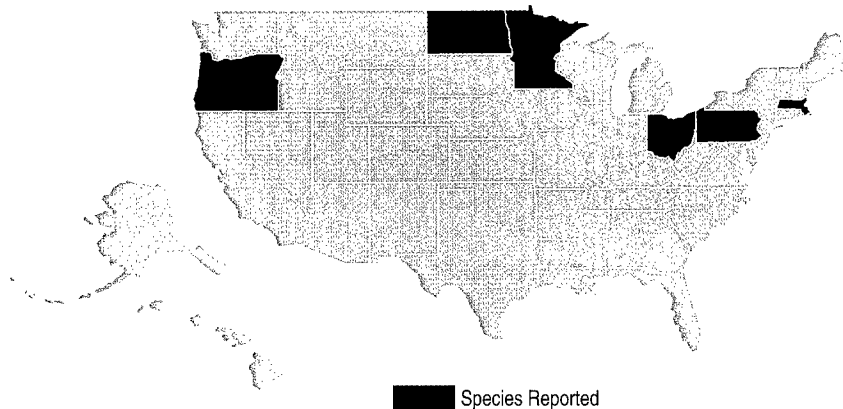
nesting sea turtles and American crocodiles (Cronk and Fuller 1995).

FACT: Plant invasions can lead to plant extinction. On the continents, many factors contribute to species extinction, including invasions by aggressive non-native plants. However, on oceanic islands, some extinctions can be attributed almost entirely to plant invasions. In Hawaii, fountain grass threatens several species listed as endangered by the U.S. Fish and Wildlife Service, and banana poka threatens Hawaiian rainforests, home to many native species (Cronk and Fuller 1995).

FACT: Invasive plants alter the natural fire regime. In Florida, the introduction of melaleuca, which is almost perfectly adapted to fire, has increased the intensity of fires across the sawgrass prairies of the Everglades. Melaleuca seeds have a delayed seed dispersal, called serotiny, that enhances their survival.

FACT: Some introduced plants hybridize with native species and could, in time, effectively eliminate native genotypes. Nonnative white mulberry, which is now widespread in eastern North America, hybridizes with the native red mulberry, a threatened species in Canada (Randall 1996).

Invasive Plant Primer



Dalmatian toadflax, which was introduced from southeastern Europe as an ornamental, outcompetes native plant species in the western United States. (George Markham, Bozeman, Montana.)



Dalmatian Toadflax *Linaria genistifolia* (L.) Miller

Dalmatian toadflax, a perennial plant from southeastern Europe, grows up to 3 feet tall. Toadflax has an extensive and deep root system along with waxy leaves that make control extremely difficult. It outcompetes desirable native plant species and decreases plant species diversity. It has limited forage value for livestock and wildlife.

Introduction and Spread of Dalmatian Toadflax at Raymond Mountain, Wyoming. Over the past 15 years, Dalmatian toadflax has begun to spread throughout the Raymond Mountain Wilderness Study Area near Border Junction, Wyoming.

1970s. The source of the present infestation of Dalmatian toadflax in the Wilderness Study Area is thought to be a phosphate mine that was operated for three years in the 1970s on private land at the base of Raymond Mountain just outside of the Wilderness Study Area. During the time the mine operated, trucks and heavy equipment transported seeds of Dalmatian toadflax to the mine site area.

1980s. During the 1980s, toadflax thrived in this area and began to spread from the mine site to adjacent private and public land.

1990s. By 1991, toadflax had infested about 63 acres within the Wilderness Study Area and 148 acres of adjacent private land.

Today, toadflax continues to spread in the Wilderness Study Area and surrounding areas. According to Dee Wilde with the Lincoln County Weed and Pest District, the infestation of Dalmatian toadflax has more than quadrupled since 1991. It has now spread out in a 10-mile radius around the original mine site. Elk act as a prime vector for movement of the plant to uninfested areas, as indicated by the plant's

appearance in elk bed grounds. As toadflax increases and crowds out more desirable plant species, the aesthetic values in the Wilderness Study Area are being diminished. In addition, forage for wildlife and livestock is being lost.

Control Efforts. In the summer of 1991, an attempt was made to control Dalmatian toadflax in the Wilderness Study Area by aerial application of Tordon 22K. While this was somewhat effective, the steep terrain made application by helicopter difficult and hazardous.

Currently, Bureau of Land Management and county personnel are using herbicides and biological agents in an attempt to control Dalmatian toadflax in and around the Wilderness Study Area. A flower-feeding beetle has provided the best results so far. However, the beetles cannot overwinter in the area and have to be replaced each year. During 1997, Bureau of Land Management and the Lincoln County Weed and Pest District plan to release more of the beetles in hopes of slowing the spread of toadflax in the area (Carl Bezanson, Bureau of Land Management, Kemmerer, Wyoming, personal communication, 1996).

Parks & Refuges

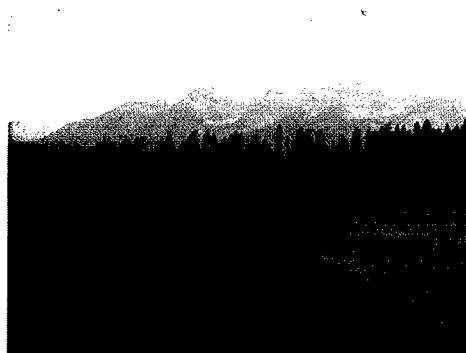
Our national parks and wildlife refuges represent a small fraction of the rich biological heritage of the United States. At least 194 federal units have identified invasive plants as a resource management problem. Since these sanctuaries represent a small fraction of the total land mass of the United States, their biodiversity must be protected from further encroachment by nonnative invasive species. Invasive plants can interfere with use of campgrounds, hiking trails, and with activities such as birdwatching, photography, and hunting. Aquatic weeds interfere with fishing, swimming, and other water-based recreational activities.

FACT: In a recent survey of national park superintendents, 150 of the 246 respondents (61%) indicated that nonnative plants were a moderate or major problem. National parks with severe invasive plant problems include Great Smoky Mountains, Zion, Channel Islands, Hawaii Volcanoes, and Haleakala (Randall 1996).

FACT: Currently, it is estimated that invasive plants occur in 7 million acres of National Park Service land. This is equal to 31% of National Park Service acreage in the lower 48 states plus Hawaii. At least 1.5 million acres of NPS lands are severely infested and need immediate treatment.

FACT: A recent study of 22 national parks in the Midwestern United States revealed an average of 529 total plant species per park and 95 non-native species (18%) (Bennett 1996).

FACT: Currently, about 448 control projects have been deemed necessary to meet the challenge on severely infested lands of the National Park Service.



FACT: Since 1988, the National Park Service has treated 4.3 million stems of melaleuca on 77,500 acres in south Florida at a cost of \$2.4 million. Currently, all funding for this program comes from a wetland development mitigation fund that was established by the state of Florida.

The ecological integrity of our nation's parks and refuges is threatened by invasive plants and animals. It is our responsibility to protect the tremendous biodiversity of these unique places for recreational, cultural, and scientific purposes for ourselves and future generations.

MARK SCHAEFER
U.S. Department of the Interior

Leafy spurge in Glacier National Park. (Dan Taylor, National Park Service.)

FACT: Control of invasive plants in Yellowstone National Park focuses on 24 of 164 nonnative species that are present in the park. Weed control in Yellowstone has benefited greatly from support from volunteer crews and increased emphasis on early detection and treatment in recent years (Randall 1996).

Invasive Plant Management in Glacier National Park, Montana.

Not only are nonnative species, by definition, unnatural members of Glacier's communities, they may also contribute to the decline of native species and the deterioration of natural habitats. Like most aggressive nonnatives, spotted knapweed rapidly invades disturbed areas. In addition,



Control of introduced invasive plants in Glacier National Park gives native plants a chance to become re-established. (Glacier National Park, Montana.)



Fire is sometimes used to "spot treat" small infestations of leafy spurge in Glacier National Park. (Glacier National Park, Montana.)

tion, knapweed invades undisturbed sites, where it displaces native vegetation. Furthermore, some nonnatives like knapweed also invade agricultural lands outside of the park and their eradication is of economic importance to the region's farmers and ranchers. Other particularly aggressive nonnative plants in Glacier are leafy spurge, St. John's wort, and oxeye daisy.

Management actions in the park to control the spread of aggressive nonnative plant species include: mechanical removal of plants (pulling, cutting, mowing), cultural methods (revegetation, burning), biological controls (e.g., introducing insects that feed on nonnatives), and chemical treatments (herbicides). The park uses a combination of these methods that will be the most effective in controlling the nonnatives while minimizing alteration of native communities, an approach known as integrated pest management. Other components of Glacier's nonnative plant management policy include prevention of nonnative plant dispersal (e.g., requiring the use of certified weed-free hay for pack animals and horses in backcountry areas) and public education. Interpreters have, for example, engaged visitors in pulling nonnative plants like spotted knapweed and butter-and-eggs during interpretive programs designed to provide information on the impacts of nonnative species on biodiversity. Perhaps the single most important component of Glacier's nonnative plant management program is minimizing human-caused vegetation and soil disturbances and thereby minimizing the size and number of optimal invasion sites.

Private Preserves

In 1993, Dr. John Randall, Invasive Weed Specialist for The Nature Conservancy, surveyed 97 land managers in 46 states to determine the extent of invasive nonnative plant problems on Conservancy land. The managers reported the presence of 197 nonnative plant species on the more than 1 million acres that are owned or managed by the Conservancy. Problems occurred from all 46 states, but managers from California, Florida, and Hawaii reported the greatest number of nonnative invasive plants. Nearly 60% of land managers reported that spread of nonindigenous plants were among their top 10 management concerns. A total of 13% rated it as their number one problem (Schmitz and Brown 1994).

According to survey respondents, The Nature Conservancy personnel and volunteers devoted more than 21,000 hours to weed control in 1991. Fifty survey respondents spent more than \$170,000 on weed control. In 1990, the totals were about 16,000 hours and nearly \$110,000. The increasing amount of time and money spent on weed control can be attributed to new invasions, expansion of old infestations, increased awareness of threats posed by weeds, and expansion of management programs (Randall 1996).

Restoration of the Nature Conservancy Blowing Rocks Preserve in South Florida.

Restoration efforts in Blowing Rocks Preserve in south Florida provide a good example of the Florida Chapter of The Nature Conservancy's commitment to control invasive plants. Blowing Rocks Preserve is a 73-acre site on a barrier island in southeast Florida. The preserve

provides an important nesting site for the federally endangered leatherback sea turtle, the federally threatened loggerhead, and the green sea turtle.

When The Nature Conservancy acquired Blowing Rocks Preserve in 1968, it was dominated by nonnative plant species that threatened to destroy the ability of the site to support native plants and animals. In particular, an infestation of Australian pine had severely altered the dynamic dune ecosystem of the beach. Major degradation of the beach began as dense shade and leaf litter from Australian pines shaded out native vegetation such as sea oats and other herbaceous plants that require full sun. Without native plants to stabilize the front dunes, the beach has become more susceptible to erosion and collapse during major storm events. Exposed roots of Australian pines also trap and entangle adult sea turtles when they come to shore to nest.

There's no question that a surgeon does grievous damage in the course of removing a cancer. But if he didn't do it, the person might die. In the same way, there are some cases where what a weed will do is far worse than what an herbicide might do.

JOHN RANDALL
The Nature Conservancy

Australian pine, which was introduced into Florida as a landscape ornamental in the early 1900s, is changing the ecology of Florida beaches by displacing native plants that normally stabilize the dunes. (R. Scherbaum, National Park Service, Florida.)



In 1985, The Nature Conservancy staff, contractors, and volunteers began a restoration program on the preserve. When completed, 14 acres of Australian pine and Brazilian pepper trees had been cleared, leaving 35 additional acres on the western half of the island to be cleared and restored at a later time. In 1987, The Nature Conservancy initiated the restoration process, planting more than 50,000 native plants on the cleared 14-acre site.

From 1985-88 the restoration cost about \$250,000, which included clearing, removal, plantings, and irrigation. These figures do not include staff time, operating expenses, or the value of volunteer labor.

From 1990-94, 1,810 volunteers worked over 8,000 hours on the project. The hours contributed to this project by volunteers are valued at \$114,700 (\$14.30/hour based on information from the Thousand Points of Light Foundation). In addition, the preserve added a volunteer coordinator, restoration coordinator, and a native plant nursery in 1991 for an additional \$111,360 (Schmitz and Brown 1994).

The Blowing Rocks example illustrates the intensive effort and significant financial resources that can be required to restore an area besieged by invasive plants. Although most sites do not require this level of involvement, it demonstrates the real need for weed prevention, early detection, and removal of invasive plants from sensitive sites such as the Blowing Rocks Preserve. In putting this example in perspective, the value of staff and volunteer labor and other expenses must be multiplied thousands of times to reach the level of resources necessary to curb this problem across the United States.

Wildlife, Plant Communities, & Biodiversity

Habitat destruction through excessive use and pollution poses one of the main threats to the biodiversity of natural ecosystems. Humans use about 40% of the total productivity of land ecosystems, crowding out other species. As a result, biodiversity declines as many species are lost each year. Although a natural process, the current rate of extinction is now about 400 times that recorded in recent geological times. This threat to biodiversity is largely attributed to the growth of the world human population to more than 5 billion and the dramatically increased demands for food and fiber products (Erlich 1990).

Biological invasions pose another serious and usually underestimated problem. Unlike chemical pollutants that tend to degrade over time and permit an ecosystem to recover, biological invasions tend to multiply and spread, causing ever-worsening problems. Thus, biological invasions pose long-term threats that are usually not associated with chemical pollution. Insidious effects of invasive nonnative species include displacement or replacement of native plants and animals, disruptions in nutrient and fire cycles, and changes in the pattern of plant succession (Lovich 1996). Adequate surveys and reliable monitoring data are not available for many of these invaders.

FACT: Invasive plants damage soil and water resources. The displacement of native bunchgrasses by spotted knapweed substantially increases surface water run-off and sediment yield (soil loss). An

additional 18 tons of soil would be lost from a 500-acre rangeland infested with spotted knapweed in western Montana during an average 30-minute rainfall event, compared to a similar site occupied by native bunchgrasses (Duncan 1997).

FACT: Invasive plants can reduce the presence of important cryptogamic ground crust. Cryptogamic ground crust, which is composed of small lichens and mosses, is important for soil stabilization, moisture retention, and nitrogen fixation. One native fescue grassland site in Glacier National Park that is infested with spotted knapweed was found to have 96% less ground crust than an uninfested grassland site (Anderson et al. 1982; Tyser 1992).

FACT: Invasive plants can ruin fish spawning habitat by causing soil erosion. In the Selway-Bitterroot

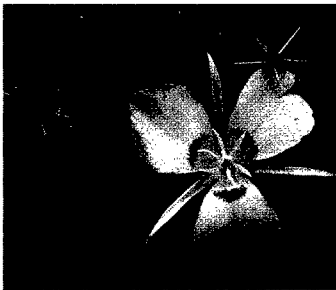
Biological invasions represent a human-caused breakdown of the regional distinctiveness of Earth's flora and fauna - a substantial global change in and of itself.

PETER VITOUSEK
Stanford University

■ **Tree Tobacco Threatens Sensitive Birds In California**

In Laguna Beach, California, scientists are worried that the rapid spread of nonnative plants such as the tree tobacco could slow the revival of the California gnatcatcher and the cactus wren. Experts believe the birds were displaced from their habitat during a series of wildfires in 1993 and are now in danger of losing their habitat altogether to the nonnative plants.

Los Angeles Times, December 4, 1996



Yellow starthistle, a native of the Mediterranean region, is crowding out cattle forage as well as rare species such as this mariposa lily in Hells Canyon, Idaho. (J.Asher, Bureau of Land Management, Portland, Oregon.)

Wilderness of Idaho, spotted knapweed has replaced normally dense vegetation along stream banks, increasing soil erosion that can ruin spawning habitat for salmon (Washington Post, November 6, 1995).

FACT: Invasive nonnative plants crowd out native species. In the western United States, invasive nonnative plants can grow very densely and compete with or completely exclude native plants. In rangelands of the the western United States, nonnative grasses such as cheatgrass and Lehmann lovegrass can totally outcompete native grasses and forbs. (Lee Otteni, Bureau of Land Management, Farmington, New Mexico, personal communication, 1996)

FACT: Invasive plants are having an impact on endangered species. Rare species appear to be particularly vulnerable to the environmental changes that are brought about by nonnative species. In California, it has been estimated that 30 of the state's endangered plant species are threatened by nonnative invaders (Randall 1996). In Florida, Australian pine has spread to such an extent in coastal areas that it is interfering with nesting sea turtles and crocodiles (Austin 1978).

FACT: Invasive plants degrade wildlife habitat. Reductions of native plants have a direct impact on the presence, abundance, and activities of native vertebrates and invertebrates since they are dependent on vegetation for shelter and food. In Arizona, Lehmann lovegrass stands support fewer small mammals, seed harvesting ants, and quail than noninfested areas. (Lee Otteni, Bureau of Land Management, Farmington, New Mexico, personal communication, 1996).

FACT: Invasive plants affect big game species by crowding out native forage. Although it is difficult to quantify the effects on wildlife, nonnative plants replace native plants that are pre-

ferred as forage by big game species and as habitat by smaller wildlife species. In northwestern Montana, reduced forage production on big game winter ranges because of noxious weeds could result in a loss of 220 elk annually by 1998. In the Disappointment Creek area north of Delores, Colorado, the invasion of Russian knapweed has drastically reduced the availability of key winter range for wildlife. The Rocky Mountain Elk Foundation and the USDA Forest Service have joined together to control the weed (Goold 1994).



Spotted knapweed, an invader from Europe, crowds out native forage used by big game animals. (F. Moss, Logan, Utah.)

FACT: Invasive plants reduce available winter forage for wildlife.

Spotted knapweed invasion of bunchgrass sites in western Montana reduces available winter forage for elk as much as 50%-90%. Since a highly productive foothills site in western Montana can produce an average of 1,800 pounds of forage grass per acre, forage loss from spotted knapweed can be as high as 1,620 pounds per acre (Duncan 1997).

FACT: Control of invasive plants increases forage for wildlife species. The use of herbicides to remove spotted knapweed from an elk winter range in Montana resulted in a 266% increase in the use of the area by elk. This reduced grazing pressure on adjoining private lands (Duncan 1997).

Recreational Areas

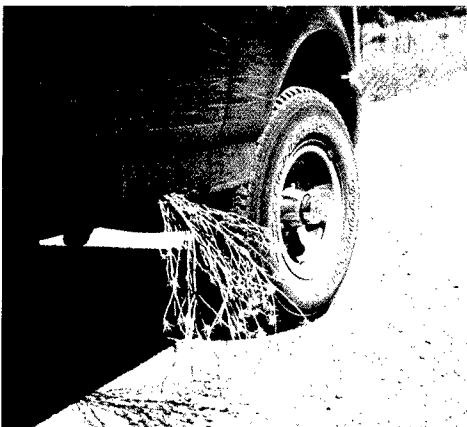
Today, people in the United States are spending more and more time outdoors. Hiking, camping, backpacking, walking, rafting, snow sports, birding, climbing, horseback riding, hunting, biking, and ecotourism are just some of the activities that draw people back to nature. With large numbers of people comes disturbance of recreational areas. This disturbance encourages the growth and spread of invasive plants.

FACT: Invasive plants can reduce revenues from hunting and fishing.

According to a Colorado Division of Wildlife study, elk hunters spent over \$2.6 million in La Plata County in 1989. During that same year, big game hunting produced \$187.2 million in revenues. Therefore, if elk and other wildlife are displaced or populations are reduced, hunting revenues will decrease as well (Goold 1994).

FACT: Invasive plants have a negative impact on tourism.

According to the U.S. Fish and Wildlife Service, five times as many people watch and photo-



Invasive plants can be spread far and wide by people and as hitchhikers on vehicles. (J. Asher, Bureau of Land Management, Portland, Oregon.)

graph wildlife than hunt wildlife. It has been estimated that North Dakota loses over \$3.5 million annually in revenues from wildlife-related recreation due to nonnative plant infestations. In Colorado, leafy spurge, musk thistle, and other noxious weeds are outcompeting the beautiful blend of native wildflowers and grasses that tourists come to see and photograph (Goold 1994).

FACT: Invasive plants can be a special nuisance to rafters and boaters.

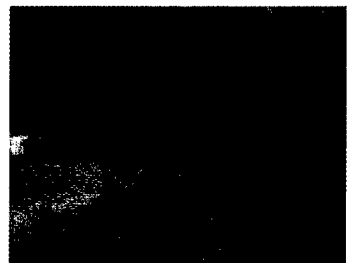
Along the Pine River, below Ignacio, Colorado, fishing from the bank is almost impossible because of musk thistle infestations that limit access to the river. The shoreline of McPhee Reservoir in Colorado is severely infested with musk thistle due to seeds that collect in the water and germinate as the reservoir level drops during dry periods and when irrigation increases. This makes it difficult for rafters and boaters to find a place to tie up their boats along the shore (Goold 1994).

FACT: Invasive plants can be spread by vehicles.

The source of many weed infestations has been traced to roads, trails, railroads, and other travel corridors. When driven through a weed-infested area,

Outdoor enthusiasts need to take special precautions against accidentally moving weed seeds on their equipment, vehicles, and clothing. Without their cooperation, public recreation areas will be overrun by invasive plants.

JERRY ASHER
Bureau of Land Management



Musk thistle, which was introduced from Eurasia in the mid-1800s, is shown here along the Pine River in Colorado, where it prevents access to the river for recreation and crowds out native forage for wildlife. (G. Beck, Colorado State University, Fort Collins.)

weed seeds may become lodged between the tire treads, in a winch, and in other cracks and crevices on the chassis of a vehicle. Such seeds may become dis-

lodged hundreds of miles away, infesting new areas.

FACT: Invasive plants can be spread by pack animals. Many weed seeds can pass through an animal's digestive tract and still grow. Pack animals that have eaten contaminated feed can deposit weed seeds throughout backcountry areas.

FACT: Invasive plants can be spread by camping gear. Weed seeds that cling to camping gear can be spread to the next camp site.

FACT: Many invasive plants have pretty flowers and are often picked for floral arrangements. New weed infestations can be established when seeds fall off transported flowers. Some weeds can develop roots and produce new plants directly from plant parts, even after weeks of use as decorations.

Invasive plants often have beautiful flowers that encourage the unwary to spread them to new places. (S. Dewey, Utah State University, Logan.)



What Can You do to Prevent the Spread of Invasive Plants?

- ☒ Use only feed that is certified weed free for pack animals.
- ☒ Begin to feed pack animals food that is certified weed free at least 96 hours before entering backcountry areas.
- ☒ Remove weed seeds from pack animals by brushing them thoroughly and cleaning their hooves before transporting them.
- ☒ If you find a weed-infested area, let the landowner or land managing agency know so they can take steps to control the weeds.
- ☒ Don't pick wildflowers and noxious weeds and take them home.
- ☒ Don't camp or drive in weed-infested areas.

Bureau of Land Management; USDA Forest Service; National Park Service

Invasive Plant Primer

Yellow Starthistle

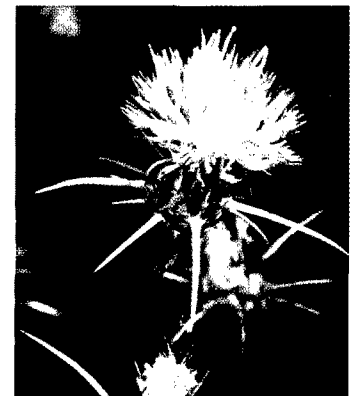
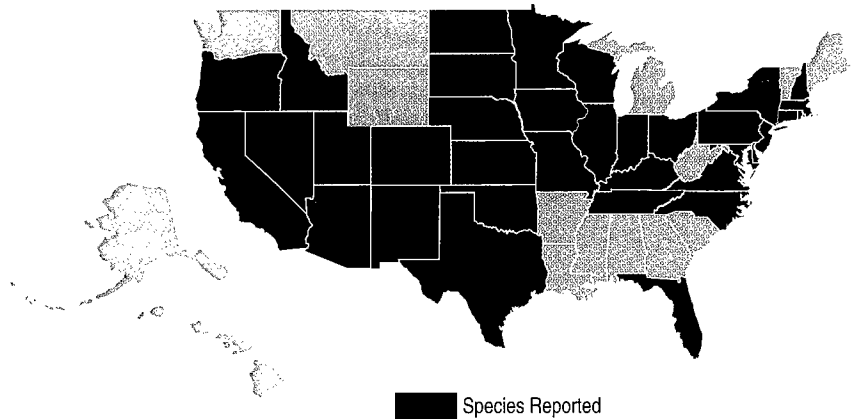
Centaurea solstitialis L.

Yellow starthistle, an annual herb up to 3 feet tall, has yellow flowers and thorn-like straw-colored bracts. Native to dry open habitats in southern Europe and the Mediterranean region, starthistle was first introduced into southeastern Washington in the early 1900s as a contaminant of alfalfa seed. Alfalfa and clover seed continue to be important vectors of spread even though it is regulated as a noxious weed in some states (Roche and Roche 1991).

Currently, it is estimated that yellow starthistle infests 9.25 million acres of rangeland in the western United States. This includes 8 million acres in California, 1.1 million acres in Idaho, 10,000 acres in Oregon, and 135,000 acres in Washington. In California, starthistle has expanded its range at a very rapid rate, increasing from 1.25 million acres to 8 million acres between 1958 and 1991 (Randall 1996).

Prevention of Yellow Starthistle in

Montana. To date, all known infestations of yellow starthistle have been eradicated in Montana. Small infestations have been associated with contaminated seed and movement of recreational vehicles (Barbra Mullin, Montana Department of Agriculture, Helena, Montana, personal communication, 1997).



Yellow starthistle, introduced from southern Europe and the Mediterranean region in the mid-1800s, is a serious rangeland weed throughout the western United States. (J. Asher, Bureau of Land Management, Portland, Oregon.)

Human & Animal Health

Until very recent times in history, most people lived in rural settings and were familiar, in a practical sense, with their natural surroundings. Today, more and more of the U.S. population live in urban areas, and have much less contact with or knowledge of the natural environment. As such, there is now a much greater chance for uninformed outdoor enthusiasts to experience problems with harmful plants. (Westbrooks and Preacher 1986).

Effects of poisonous plants include internal poisoning and/or irritation, skin rash or dermatitis cause by allergenic or irritant compounds, skin photosensitization resulting in rash or dermatitis and possibly scars, and airborne induced allergic reactions such as hayfever from pollen or respiratory irritation caused by volatile emanations from blossoms or foliage.

Well over 1,000 species of vascular plants that are native, cultivated, or established in the wild in the United States are known to be poisonous to people and/or animals. Some of the more common species of introduced poisonous plants are listed below.

Introduced Poisonous House and Garden Plants

- Castor bean—immature seeds are deadly
- Dumbcane (some species)—all parts
- English ivy—leaves
- Jerusalem cherry—all parts, unripe fruit
- Rhubarb—leaves (stems are non-toxic)
- Lantana—all parts

Introduced Poisonous Plants in Croplands, Rangelands, and Natural Areas

- Poison hemlock—leaves, unripe fruit, and roots
- Rattlebox—all parts
- Leafy spurge—all parts
- Halogeton—all parts
- Sicklepod—all parts
- Russian thistle—all parts



The risks of exposure to poisonous plants is evidenced by the fact that this category constitutes the third largest volume of calls to poison control centers in the United States.

BROOKS METTS
University of South Carolina

Castorbean, a landscape plant introduced from the old world tropics in the early 1900s, is a beautiful but deadly poisonous plant. (J. Preacher, Army Corps of Engineers, Charleston, South Carolina.)



Yellow starthistle has thorn-like bracts that can injure livestock or people. (J. Asher, Bureau of Land Management, Portland, Oregon.)

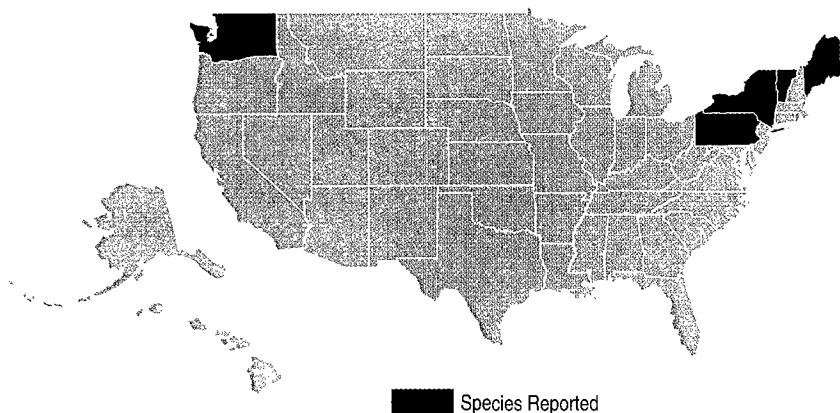
The Dos and Don'ts of Poisonous Plants

- Do learn to recognize poisonous plants in your area.
- Do identify all plants in the home. Have this information on hand for use in an emergency.
- Do lock away or dispose of seeds, berries, bulbs, and other plant materials that are known to be poisonous toxic.
- Do remove known toxic plants from the house, or place them out of the reach of children.
- Don't allow children to suck nectar from unknown flowers.
- Don't let children chew on leaves, fruits, seeds, or other parts of unknown plants.

- Don't let children use natural toys and jewelry made from unknown plants.
- Don't eat or make tea from unknown seeds, berries, leaves, flowers, or roots materials.
- Don't eat plants with milky or colored sap. Cultivated lettuce is an exception.
- Don't eat plant bulbs
- Don't let animals graze on poisonous plants.

If poisonous plant material is accidentally consumed or if a reaction is occurring due to contact with a poisonous plant, call a Poison Control Center immediately.

Invasive Plant Primer



Giant Hogweed

Heracleum mantegazzianum
Sommier & Levier

Giant hogweed, a biennial or perennial herb, grows up to 15 feet tall. It has a tap-root or fibrous roots. The stems of giant hogweed are hollow and the compound leaves grow up to four feet long. The small white flowers, arranged in large umbels (similar to Queen Anne's-lace), can reach up to one foot across. The plant is easily recognized because of its large stature and enormous leaves.

Giant hogweed was first introduced into the United States in the early 1900s as a landscape ornamental. It is known to occur in Vermont, New York, Pennsylvania, and Washington. In New York, the plant is

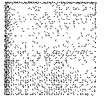
known to occur in about 40 small populations centered around Ithaca (Ed Cope, Cornell University, Ithaca, New York, personal communication, 1996). A recent survey found over 24 populations in Olympia, Washington, and dozens of other sites along the Puget Sound (Richard Old, Pullman, Washington, personal communication, 1997).

The sap of giant hogweed is a severe irritant and causes a skin reaction known as photo-dermatitis. Exposure to the sap sensitizes the skin to sunlight and results in swelling, blister, and eruptions of affected sites. In the 1970s, many cases of poisoning were seen in Great Britain where children played with the hollow stems of the plant as pea shooters or telescopes. The dried fruit of the plant is used as a spice in

Middle Eastern cuisine, and is thus frequently intercepted by Plant Protection and Quarantine officers (APHIS) during border clearance of tourists entering the United States from that region of the world. Such interceptions are seized and destroyed (Westbrooks and Preacher 1986).



Giant hogweed, a close relative of Queen Anne's-lace, was introduced into New York from eastern Europe in the early 1900s as a landscape ornamental. It is a potentially serious health hazard. Like poison ivy, the plant has an irritating sap that causes serious contact dermatitis. (E. Cope, Cornell University, Ithaca, New York.)



Appendices

More Facts About Invasive Plants by State & Territory

Alabama. Tropical soda apple was first identified in Alabama in January 1995. Since then, it has been found at 13 locations in 6 southern counties of the state. Infestations have been linked to movement of livestock and contaminated bahiagrass seed from infested areas in Florida (John Everest, Auburn University, Auburn, Alabama, personal communication, 1996).

Alaska. Alaska has a known total of 1,373 native and introduced plants. Of this total, 144 species, or 10.5%, are introduced species with free-living populations (Rejmanek and Randall 1994).

Arizona. Saltcedar dried up a spring at Bylas Springs on the Apache Indian Reservation, destroying the habitat of a population of the endangered desert pupfish. The insects disappeared, the birds fled, and the Apache lost their sacred water and medicinal yerba mens (Nelroy Jackson, Monsanto Corporation, Corona, California, personal communication, 1996).

- Hydrilla has been eradicated from Arizona, where it was recorded in the mid-1980s from two golf course ponds (Everett Hall, Arizona Department of Agriculture, Phoenix, Arizona, personal communication, 1996).

California. In the early 1980s, eastern cordgrass was discovered invading Humboldt Bay, California. By 1989, when the patch of cordgrass had grown to approximately 1,000 square yards, it was covered with a plastic sheet weighted down with sand bags, which killed that stand. Since then, there have been no further sightings of the species in the area (John Randall, The Nature Conservancy, Davis, California, personal communication, 1996).

- *Brassica tournefortii* is a mustard native to the Mediterranean region that is spreading through large areas of the southern California desert. Common along roadsides and abandoned crop fields, the species appears to thrive in disturbed areas. Vast areas of the Colorado Desert of California, a subdivision of the Sonoran Desert, are characterized by desert pavement, vast plains of interlocking pebbles with little or no plant life. However, the burrowing activities of badgers, kangaroo rats, and desert tortoises break through the armored surface and provide germination sites for both annual and perennial plants. Recent observations show that *B. tournefortii* take advantage of these natural disturbances, spreading into areas that are inhospitable. Thus, soil disturbances by native animals actually aid in the spread of this nonnative species (Jeff Lovich, U.S. Geological

Survey, Palm Springs, California, personal communication, 1996).

Colorado. About 130 native plant species (10% of the total) have been displaced by introduced invasive plants (Colorado Weed Management Association 1996).

District of Columbia. In recent years, Kenilworth Marsh, a 77-acre tidal/freshwater marsh in Washington, D.C., has been invaded by purple loosestrife. In response to this threat, the National Park Service has launched a multifaceted control program to protect this last vestige of a once prominent freshwater/tidal wetland along the Anacostia River (Stephen Syphax, Patuxent Wildlife Research Center, Laurel, Maryland, personal communication, 1996).

- The original design for Washington, D.C., created hundreds of acres of park land. Today, well over 3,000 acres of this park land are managed as natural areas and serve as sanctuary to a diverse group of native plants and animals. In recent years, forest edges, stream banks, and other areas of disturbance have been invaded by aggressive nonnative plants such as Oriental bittersweet, English ivy, porcelainberry, Japanese honeysuckle, and the infamous kudzu. In one floodplain area of the 106-year-old Rock Creek Park, lesser celandine has practically taken over an area once known for its great diversity of native wildflowers (Stephen Syphax, Patuxent Wildlife Research Center, Laurel, Maryland, personal communication, 1996).

Connecticut. Hydrilla has been thriving in a small pond in Connecticut since 1989. This most northerly occurrence of the Asian aquatic plant in the eastern United States has scientists concerned about the degree of cold tolerance the plant is exhibiting (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

Delaware. There are currently four plant species designated as noxious in Delaware: johnsongrass (1970), Canada thistle (1982), bur cucumber (1986), and giant ragweed (1986). In Delaware, landowners that allow a noxious weed to set seed or reach a height or length of more than 24 inches violate a state law and must pay a fine of \$100 or \$25 per acre, whichever is greater (Terry Van Horn, Delaware Department of Agriculture, Dover, Delaware, personal communication, 1996).

- Purple loosestrife occurs frequently in the tidal marshes of New Castle County, Delaware. Although not yet forming pure

stands, its establishment and expansion has been recognized as an issue for annual monitoring (Bill McAvoy, Delaware Natural Heritage Program, Smyrna, Delaware, personal communication, 1996).

Eastern U.S. Japanese honeysuckle thrives in forest openings and edges from New York to Georgia. Japanese honeysuckle can also invade deeply shaded sites, where it spreads slowly until a treefall, blowdown, or other disturbance gives it the opportunity to take over an open area (Albert Pittman, South Carolina Department of Natural Resources, Columbia, South Carolina, personal communication, 1996).

Florida. It is estimated that more than 1 million acres of Florida's remaining natural areas have become infested with nonnative invasive plant species that are destroying native plant diversity (Don Schmitz, Florida Department of Environmental Protection, Tallahassee, Florida, personal communication, 1996).

Georgia. In 1994, composted cow manure was confirmed as a vector in the interstate movement of tropical soda apple from Florida, when a "county fair blue ribbon" specimen was observed growing directly from a bag of cow manure at a residence in Vidalia, Georgia.

Guam. Two introduced plants that are causing the most difficulties in Guam are climbing hempvine and Siam weed. When storms open tree canopies on the island, these invasive species become rapidly established before native species can grow to fill the gaps (Lynn Raulerson, University of Guam, Mangilao, Guam, personal communication, 1996).

Hawaii. Hawaii has a total of 861 introduced plant species with populations outside of cultivation. This represents 47% of the total flora of the state (2,689 species) (Rejmanek and Randall 1994).



Idaho. Over the past 30 years, yellow starthistle has increased from a few small patches to more than 300,000 acres in Idaho. A further tenfold increase is expected (Robert Callihan, University of Idaho, Moscow, Idaho, personal communication, 1996).

- Since the 1960s, rush skeletonweed has expanded from 40 acres to more than 4 million acres (Robert Callihan, University of Idaho, Moscow, Idaho, personal communication, 1996).

Illinois. Illinois has a total of 782 nonnative plant species with populations outside of cultivation. This represents 27.5% of the total flora

of the state (2,840 species) (Rejmanek and Randall 1994).

Iowa. Yellow iris, originally from Europe and Africa, has for many years been displacing native plants in marshes and pond margins in the eastern United States. Its range has now expanded into Iowa.

- Bog bulrush, a Eurasian wetland species that occurs on both the east and west coasts of the United States, is now occurring in ponds in Iowa (Wilson 1992).

Kansas. Biocontrol has reduced the population of musk thistle in Kansas by 10% since 1992. The downward trend is continuing (William T. Scott, Kansas Department of Agriculture, Manhattan, Kansas, personal communication, 1996).

Kentucky. In 1989-90, about 5.7 million acres of field crops including tobacco, corn, soybean, sorghum, small grains, and hay were harvested in Kentucky. Each of these crops has an associated weed flora that reduces its yield by competition and contamination. Each year, over \$50 million is spent on weed control in corn and soybean alone in the state (Haragan 1991).

- Nonnative plants represent 12% of the flora in wetlands and riparian habitats of the Upper Green River Basin, a major watershed in south central Kentucky (Hoagland and Jones 1992).

Louisiana. Surveys of permanent vegetation plots in freshwater marshes of coastal Louisiana indicate that a nonnative aquatic weed species, water spangles, has increased its cover from 1% to 15%, and is replacing its native counterpart, duckweed. Duckweed has decreased in overall cover from 15% to 1% over the last decade (Tom Doyle, U. S. Geological Survey, Lafayette, Louisiana, personal communication, 1996).

Maine. The green fleece seaweed has been introduced to coastal waters of the Atlantic, where it colonizes shallow areas off the coast of Maine. This nuisance seaweed has a body of spongy tubes that interfere with recreational swimming and impact shellfish populations (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

Maryland. Two Asian vines, porcelainberry and Oriental bittersweet, which are still sold as landscape ornamentals, are damaging hardwood forests and shorelines along the George Washington Memorial Parkway. The aggressive woody vines climb up to and blanket the tops of trees, blocking sunlight to the leaves. Over

time, and especially during storms, the weight of the vines on the weakened branches pulls the trees down. As the trees fall and become uprooted, shoreline erosion becomes a problem. Additionally, tree regrowth is inhibited by the sprawling vines, which outcompete new tree seedlings (Dan Sealy, National Park Service, George Washington Memorial Parkway, McLean, Virginia, personal communication, 1996).

Massachusetts. Large spreading infestations of purple loosestrife are threatening the endangered bulrush (John Randall, The Nature Conservancy, Davis, California, personal communication, 1996).

Michigan. The aquatic weed Eurasian watermilfoil occurs in bays and harbors of lakes Michigan and Superior and is spreading through Michigan's lower peninsula (Nichols 1994).

Midwestern Prairies. Yellow and white sweet-clover are normally regarded as valuable livestock forage. However, both species are regarded as very serious pests of many midwestern prairie preserves. Tall fescue is a serious pest in prairies in northern Texas, Arkansas, and Oklahoma (John Randall, Nature Conservancy, Davis, California, personal communication, 1996).

Minnesota. In 1993, 36% of the boats and trailers exiting lakes in Hennepin County, Minnesota were found to be contaminated with fragments of Eurasian watermilfoil (Minnesota Department of Natural Resources 1993). In 1996, \$146,000 was spent for the control of Eurasian watermilfoil in 48 Minnesota lakes (Minnesota Department of Natural Resources 1996).

Mississippi. To date, tropical soda apple, a South American weed of pastures, crops, and natural areas, has been detected at 29 sites in 13 counties in Mississippi. All but one of the documented infestations have been traced back to movement of cattle and bahiagrass from infested farms in Florida (Charles Bryson, Agricultural Research Service, Stoneville, Mississippi, personal communication, 1996).

Missouri. Missouri has a total of 634 introduced plant species with populations outside of cultivation. This represents 24.8% of the total flora of the state (2,554 species) (Rejmanek and Randall 1994).

Montana. To date, all known infestations of yellow starthistle have been eradicated in Montana. Small infestations have been associated with contaminated seed and movement of recreational vehicles (Barbra Mullin, Montana

Department of Agriculture, Helena, Montana, personal communication, 1996.)

- Dyer's woad infests hundreds of thousands of acres in Utah. In Montana, dyer's woad infests about 320 acres (Fay 1992).
- Spotted knapweed, which was introduced from Eurasia as a contaminant of alfalfa and clover seed, was first collected in Montana in the 1920s. By 1988, it had infested more than 4.7 million acres in the state. Scientists estimate that it has now adapted to more than 46 million acres in Montana (Chicoine et al. 1978). Economic impacts of knapweed infestations on grazing land and wildland in Montana are about \$42 million annually, which could support 518 full-time jobs (Duncan 1997). Bucher (1984) estimated that if spotted knapweed infested all susceptible sites in Montana, the potential annual loss would be more than \$155 million. This would support over 1,900 full-time jobs.

Nebraska. Currently 2.3 million acres of grasslands in Nebraska are infested with noxious weeds. Spotted knapweed and diffuse knapweed have been added to the state noxious weed list because of their invasion from the West (Russ Shultz, USDA Cooperative State Research, Education and Extension Service, Lancaster County, Nebraska, personal communication, 1996).

- Purple loosestrife is currently spreading up and down the Platte River in Nebraska (Steve Schainost, Nebraska Game and Fish Commission, Lincoln, Nebraska, personal communication, 1996).

Nevada. Saltcedar has infested the springs at Ash Meadows National Wildlife Refuge, reducing the flow of water into the river that ends in Death Valley (Nelroy Jackson, Monsanto Corporation, Corona, California, personal communication, 1996).

New Hampshire. Lakes and ponds in New Hampshire are currently free from Eurasian watermilfoil. The New Hampshire Department of Environmental Services acted quickly in the early 1990s and drained a small pond on a fish and wildlife refuge that was newly infested (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

New England to the Midwest. Garlic mustard invaded and now dominates the forest ground layer on The Nature Conservancy preserves from New England through the midwest and from southern Ontario to Tennessee (John Randall, The Nature Conservancy, Davis, California, personal communication, 1996).

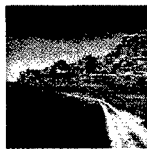


New Jersey. In New Jersey, musk thistle is a weed of perennial crops and roadsides. According to state officials, most of the infestations result from seed that is blown in from Pennsylvania (Rutgers University Cooperative Extension Service 1996).

- Over 34% of the flora at Cape May Point State Park is represented by nonnative species (Stalter et al. 1992).

New Mexico. New Mexico has a total of 229 introduced plant species with populations outside of cultivation. This represents about 7.9% of the total flora of the state (2,909 species) (Rejmanek and Randall 1994).

New York. Beginning in 1992, personnel at the New York Cooperative Research Unit at Cornell University established insectaries for mass rearing of three species of insects for biological control of purple loosestrife infestations. Since that time, satellite colonies have been established and insects are being distributed throughout the United States and Canada. (Bernd Blossey, Cornell University, Ithaca, New York, personal communication, 1996).



- In 1934, nonnative plants comprised 35% of the flora of Orient Beach State Park, Long Island, New York. In 1991, nonnative plants comprised 43.6% of the flora of the park (Lamont and Stalter 1991).

North Carolina. Musk thistle was first introduced into the United States in the mid-1800s and now occurs throughout the lower 48 states. Musk thistle was first recorded in Chatham County, North Carolina, in 1961. By 1993, 15 additional counties throughout the state reported musk thistle infestations. It was suspected that relief hay brought in from the midwestern United States during the drought of 1987-88 was contaminated with musk thistle seeds and led to its expanded distribution (Richard McDonald, N.C. Department of Agriculture, Raleigh, North Carolina, personal communication, 1997).

North Dakota. In 1996, North Dakota declared purple loosestrife and all of its cultivars as a state-listed noxious weed. There are only 10 known infestations within the state. Eradication will be the goal of the treatment program.

- A 1985 survey showed nine North Dakota counties reporting 54 acres infested with spotted knapweed. Ten years later, 23 counties reported a total of 1,074 acres infested with spotted knapweed (Cindie Fugere, North Dakota Department of Agriculture, Bismarck, North Dakota, personal communication, 1996).

Ohio. To date, 15 species of algae have been introduced into the waters of Lake Erie off the shore of Ohio. Many are brackish or marine in origin, having been introduced to the lake through ballast water (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

Oklahoma. Yellow floating heart, which was introduced into the United States for its showy displays in water gardens, has been known to form dense mats over ponds, channels, and other waterways in southern Oklahoma, shading out native submerged plants (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

Oregon. With a program begun in 1974, tansy ragwort has been controlled over an area of 16 million acres in western Oregon and prevented from establishing in the rest of the state. Biological control was effective on extensively managed lands, and chemical and cultural controls were successful on intensively managed agricultural lands. It is estimated that annual benefits from the control effort are \$5 million per year (Dennis Isaacson, Oregon Department of Agriculture, Portland, Oregon, personal communication, 1996).

Pennsylvania. Tropical soda apple was first detected in a home flower bed in Pennsylvania in the spring of 1996. Composted cow manure from Florida is suspected as the agent of spread. Quick action by the homeowner, federal, and state officials led to its removal (William Curran, Penn State University, University Park, Pennsylvania, personal communication, 1996).

Puerto Rico. Tropical soda apple was first collected in a pasture in Puerto Rico in 1995.

Rhode Island. Japanese barberry, a thorny shrub widely used by the nursery industry, has invaded woodlands throughout the state, including some of the state's most pristine and relatively undisturbed natural areas. At the same time this species is spreading, the population of white-tailed deer has increased dramatically. The deer dislike the prickly barberry and browse heavily on native shrubs and saplings, further encouraging the spread of Japanese barberry (Lisa L. Gould, Rhode Island Natural History Survey, Kingston, Rhode Island, personal communication, 1996).

South Carolina. A heavy infestation of giant salvinia was eradicated from a private pond in Colleton County in the fall of 1995. The source of this Brazilian floating weed is still undetermined.

South Dakota. In 1991, it was reported that because of reduced carrying capacity from leafy spurge infestations, ranchers and landowners in South Dakota were losing \$1.4 million per year. The lost forage would have supported beef herds that could have generated \$4.6 million in annual revenues (Bangsund and Leistriz 1991).

- Altamont Prairie Preserve in South Dakota is no longer managed as native prairie by The Nature Conservancy because of invasion by leafy spurge. The site is now used to study the effectiveness of grazing animals (goats and sheep) for controlling leafy spurge and prairie restoration (John Randall, The Nature Conservancy, Davis, California, personal communication, 1996).

Southeast. Over the past few decades, Chinese tallow tree has escaped from cultivation and taken over vast areas of habitat from the Carolinas to Texas. This tree was originally cultivated in China for oil and wax from its seeds and fruits, and has prolific rates of growth and reproduction. Tallow has shown itself capable of taking over both disturbed and natural habitats, and in the western Gulf coast is able to convert native tallgrass prairie to nonnative woodland if left unchallenged. Recently it was observed by researchers from the Department of the Interior that tallow was able to flower only nine months after germination, a remarkable feat for a tree. (Jim Grace, U.S. Geological Survey, Lafayette, Louisiana, personal communication, 1996).

Tennessee. Tennessee has a total of 507 introduced plant species with populations outside of cultivation. This represents 18.7% of the total flora of the state (2,715 species) (Rejmanek and Randall 1994).

Texas. Texas has a total of 492 introduced plant species with populations outside of cultivation. This represents 9.8% of the total flora of the state (4,990 species) (Rejmanek and Randall 1994).

Utah. In 1986, USDA Forest Service employees of the Ashley National Forest in Utah noticed a new patch of leafy spurge about 75 by 100 feet in extent. It was probably introduced by woodcutters. This small infestation was treated with herbicide (Tordon) over a six-year period. Annual monitoring now shows this weed patch was eradicated. Currently, there is no other known leafy spurge infestation in the Ashley National Forest (John Randall, The Nature Conservancy, Davis, California, personal communication, 1996).

- In 1980, a 39,000-acre infestation of goatsrue existed in Utah, the only known infestation

in the United States. By 1996, over 90% of the population had been removed by a federal/state cooperative eradication effort. (John Evans, Utah State University, Logan, Montana, personal communication, 1996).

Vermont. Recently, 13 species of highly invasive nonnative plants have been recognized as currently displacing native plants in Vermont. An additional 23 nonnative species have been recognized as having the potential to displace native species if not controlled (Holly Crosson, Vermont Department of Environmental Conservation, Waterbury, Vermont, personal communication, 1996).

- Water chestnut is found in five waterbodies in the Lake Champlain Basin in Vermont, totalling several hundred acres. So far, more than 2.5 million dollars have been spent on this species since 1982 and it continues to spread (Holly Crosson, Vermont Department of Environmental Conservation, Waterbury, Vermont, personal communication, 1996).

Virginia. Virginia has a total of 427 nonnative plant species with populations outside of cultivation. This represents 17.2% of the total flora of the state (2,483) (Rejmanek and Randall 1994).

Washington. In the spring of 1995, hydrilla was found growing in the 73-acre Pipe/Lucerne lake system in King County, southeast of Seattle. This is the northernmost occurrence of hydrilla on the West Coast of North America (Kathy Hamel, Washington State Department of Ecology, Olympia, Washington, personal communication, 1996).

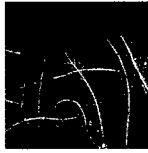
- In southeast Washington, yellow starthistle increased from approximately 1,000 acres in 1954 to more than 140,000 acres today (Asher 1995).

West Virginia. The West Virginia Natural Heritage Program has compiled a list of nonnative plants and categorized them according to the severity of the threat posed to natural areas in the state. Fifty-eight species are recognized as a severe threat; 122 are a significant threat, 44 are a minor threat, and 60 have been put on a watch list. Eulalia, purple loosestrife, and mile-a-minute are regarded as the worst threats.

Wisconsin. Wisconsin has approximately 2,100 species of plants growing outside of cultivation. Of this total, about 521 are not native to the state. At least 231 of the nonnative species are invasive in either wildlands, agricultural areas, or garden settings (Kelly Kearns, Wisconsin Department of Natural Resources, Madison, Wisconsin, personal communication, 1996).

- Eurasian watermilfoil has been confirmed in





over 70 Wisconsin lakes, in the bordering waters of Lakes Superior and Michigan, and along the shoreline of the Mississippi River (Colette Jacono, U.S. Geological Survey, Gainesville, Florida, personal communication, 1996).

Wyoming. It is estimated that 85,000 acres are infested with leafy spurge in Wyoming. Russian knapweed infests 50,000 acres in the Wind River/Big Horn River Drainage. Whitetop infests 50,000 acres in Big Horn County (Marty Griffith, Bureau of Land Management, Cheyenne, Wyoming, personal communication, 1996).

- In 1996, purple loosestrife populations were reported from the Shoshone, Tongue, Niobrara, and Platte Rivers; from Diamond Creek; and in water bodies within the city of Cheyenne (John Larson, APHIS, Plant Health Director for Wyoming, Cheyenne, Wyoming, personal communication, 1996).



Federal Weed Laws

Federal Noxious Weed Act [Public Law 93-629 (7 U.S.C. 2801 et. seq.; 88 Stat. 2148)]. The Federal Noxious Weed Act enacted January 3, 1975, established a federal program to control the introduction and spread of foreign noxious weeds into the United States. The Secretary of Agriculture was given the authority to designate plants as noxious weeds by regulation, and the movement of all such weeds in interstate or foreign commerce was prohibited except under permit. The Secretary of Agriculture was also given authority to inspect, seize, and destroy products, and to quarantine areas if necessary to prevent the spread of such weeds. The Secretary was also authorized to cooperate with other federal, state, and local agencies, farmers associations and private individuals in measures to control, eradicate, retard, or prevent the spread of noxious weeds.

Amendments to the Federal Noxious Weed Act (1990). Amendments to the Federal Noxious Weed Act under the 1990 Farm Bill address “undesirable plants,” which are defined such that they include, but are not limited to, the definition of noxious weeds. The act amendments mandate that each federal agency: *Designate an office or person to develop and coordinate an undesirable plants management program for Federal lands under the agency’s jurisdiction. Establish and fund an undesirable plants management program. Implement cooperative agreements with State agencies regarding the management of undesirable plant species. Establish integrated management systems to control or contain undesirable plant species targeted under cooperative agreements.*

Alien Species Prevention Enforcement Act of 1992. The Alien Species Prevention Enforcement Act of 1992 — Section 631 of the Treasury, Postal Service and General Government Appropriations for Fiscal Year 1993, (P.L. 102-393, October 6, 1992) requires the Secretary of Agriculture to operate a program to protect Hawaii from the introduction of prohibited plants, plant pests, and injurious animals that may be contained in the mail. The Department of Agriculture is to work with the Department of the Interior, the Postal Service, and the State of Hawaii to carry out activities under the program. The Postal Services’ “non-mailable matter” provisions (U.S.C. Title 39)

are amended to include fish, wildlife, and plants that are prohibited from transportation pursuant to the Lacey Act.

Nonindigenous Aquatic Nuisance Species Prevention and Control Act of 1990. The Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 — Title I of P.L. 101-646 (104 Stat. 4761, 16 U.S.C. 4701, enacted November 29, 1990) established a broad new Federal program to prevent introduction of and to control the spread of introduced aquatic nuisance species and the brown tree snake. The U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration all were assigned major new responsibilities, including membership on an Aquatic Nuisance Species Task Force established to develop a program of prevention, monitoring, control, and study. The act was reauthorized in 1996.

Organic Act of 1944 (7 U.S.C. 147a). This act authorizes the Secretary of Agriculture to detect, eradicate, suppress, control, prevent, or retard the spread of plant pests in the United States. “Plant pests” are defined such that they could include weeds if the weeds are parasitic plants (e.g., witchweed) that directly or indirectly cause injury, disease, or damage to any plant or plant product.

Federal Plant Pest Act of 1957 (7 U.S.C. 150aa-150jj). This act prohibits the movement of plant pests (same definition as in the Organic Act above) from a foreign country into or through the United States or interstate unless such movement is authorized by the Secretary of Agriculture. The act provides for inspections, seizures, and emergency measures such as quarantines to protect American agriculture.

Federal Seed Act of 1939 (7 U.S.C. 1551-1611). This Act regulates interstate and foreign commerce in seeds, and addresses “noxious weed seeds” that may be present in agricultural (e.g., lawn, pasture) or vegetable seed. APHIS administers the foreign commerce provision of this act; while the Agricultural Marketing Service administers its interstate commerce provisions.

Federal Contacts

USDA, Animal and Plant Health Inspection Service

Randy G. Westbrooks, Noxious Weed Coordinator
P.O. Box 279
Whiteville, NC 28472
910-648-6762
FAX: 910-648-6763
rwestbrooks@weblink.net

USDA, Agricultural Research Service

Ernest Delfosse
National Program Leader for Weed Science
National Program Staff
Room 218, Building 005, BARC-WEST
Beltsville, MD 20705
301-504-6725
FAX: 301-504-5467
esd@ars.usda.gov

USDA, Forest Service

Deborah C. Hayes, Noxious Weed Coordinator
Co-chair FICMNEW
Range Mgt., 3-S
201 14th St. SW
Washington, DC 20090
202-205-0847
FAX: 202-205-1096
deb@hayes-ent.com

USDA, Agricultural Marketing Service

Harold Laswell
Seed Regulatory & Testing Branch, Room 209,
Bld. 306
Beltsville, MD 20705-2325
301-504-9430
FAX: 301-504-5454
harold_w_laswell@usda.gov

USDA, Cooperative State Research, Education and Extension Service

James V. Parochetti
AgBox 2220
Washington, DC 20250-2220
202-401-4530
FAX: 202-401-4888
jparochetti@reeusda.gov

USDA, Natural Resources Conservation Service

Richard S. White
P.O. Box 2890
Room 6154-5
Washington, DC 20013
202-720-2587
FAX: 202-690-0249
rwhite@usda.gov

USDI, Office of the Secretary

Gordon Brown, Invasive Species Coordinator
Room 5248 MIB
1849 C. St. NW
Washington, DC 20240

202-208-6336

FAX: 202-219-0229

a_gordon_brown@ios.doi.gov

USDI, National Park Service

Gary Johnston, Biologist
Co-Chair FICMNEW
MS 3223,
1849C St. NW,
Washington, DC 20240
202-208-5886
FAX: 202-208-4620
gary_johnston@nps.gov

USDI, Fish and Wildlife Service

Linda Lyon
4401 N. Fairfax Drive
(MS 670 ARLSQ)
Arlington, VA 22203
703-358-2043
FAX: 703-358-1826
linda_lyon@fws.gov

USDI, U.S. Geological Survey, Biological Resources Division

William P. Gregg
International Affairs Officer
12201 Sunrise Valley Drive
Reston, VA 20192
703-648-4067
FAX: 703-648-4039
william_gregg@usgs.gov

USDI, Bureau of Land Management

Colin Voigt
1849 C St., NW
(LS 204),
Washington, DC 20240
202-452-5053
FAX: 202-452-7709
cvoigt@wo.blm.gov

Kniffy Hamilton
National Weed Coordinator
222 No. 32nd St.
Billings, MT 59107-6800
406-255-2766
knhamilt@mt0003wp.mtso.mt.blm.gov

USDI, Bureau of Indian Affairs

Mark Bradford
MS-MIB 4513
1849 C St., NW
Washington, DC 20240
202-208-3598
FAX: 202-501-1760
mbradfor@ltdoc.bia.gov

**USDI, Bureau of Reclamation, Program
Analysis Office**

Robert Bochar
(W-5000)
1849 C St. NW
Washington, DC 20240
202-208-5673
FAX: 202-208-6262
rbochar@usbr.gov

Max Haegele
(D-5100)
P.O. Box 25007
Denver, CO 80225-0007
303-236-9336 Ext. 299
FAX: 303-236-3930
mhaegele@do.usbr.gov

U.S. Department of Defense

Dr. Peter Egan
Armed Forces Pest Mgt. Board
Forest Glen Section, WRAMC,
Washington, DC 20307-5001
301-295-7485
FAX: 301-295-7492
eganpj@acq.osd.mil

U.S. Department of Energy

Weed Management Specialist
EH-412
1000 Independence Ave. SW
Washington, DC 20585
FAX: 202-586-3915

**Department of Transportation,
Federal Highway Administration**

Bonnie Harper-Lore
FHWA/USDOT Room 3240
400 7th St. SW
Washington, DC 20590
612-291-6104
FAX: 612-291-6000
bonnie.harper-lore@fhwa.dot.gov

U.S. Army Corps of Engineers

Al Cofrancesco
Waterways Expt. Station
3909 Halls Ferry Rd.
Vicksburg, MS 39180-6199
601-634-3182
FAX: 601-634-2398
confrana@ex1.wes.army.mil

U.S. Environmental Protection Agency

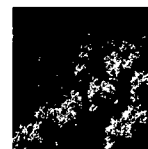
Russell Jones
401 M Street, NW (7511C)
Washington, DC 20460
703-308-5071
FAX: 703-308-7026
jones.russell@epamail.epa.gov

Aquatic Nuisance Species Task Force

Robert Peoples
Executive Secretary
Division of Fish and Wildlife Management
Assistance
U.S. Fish and Wildlife Service
4401 N. Fairfax Dr.
Arlington, VA 22203
703-358-2025
FAX: 703-558-8773
robert_peoples@fws.gov

Also visit:

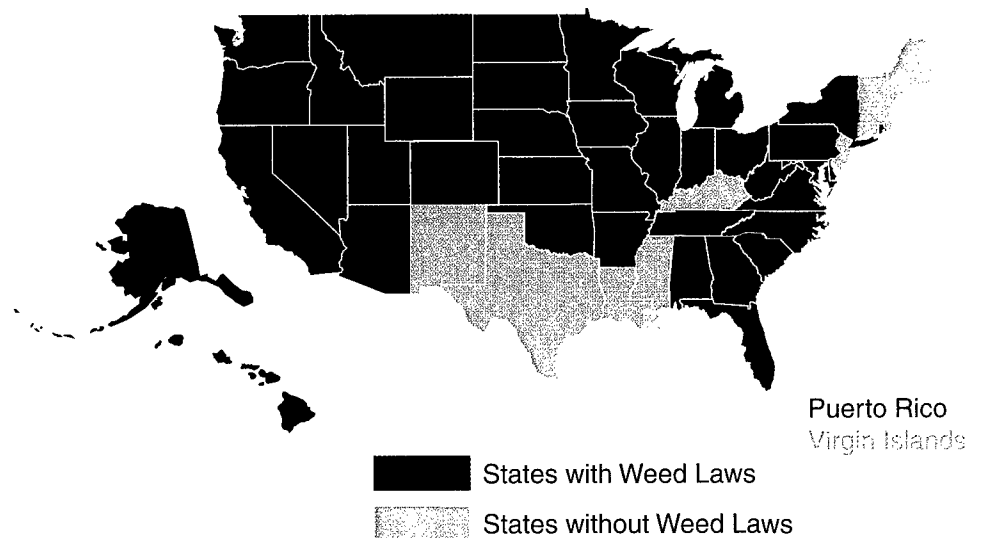
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State & Territory Noxious Weed Laws

In 1997, the American Nursery & Landscape Association, Washington, D.C., published its *Federal and State Quarantine Summaries*. From their report, it is evident that many states have established and funded weed programs. Currently, 40 states and territories have noxious weed laws and/or regulations. More than 500 weeds are designated as noxious by either weed or seed laws in the United States and Canada (Lorenz and Dewey 1988).

Connecticut, Kentucky, Louisiana, Maine, Massachusetts, Mississippi, New Hampshire, New Jersey, New Mexico, Texas, Vermont, and the Virgin Islands do not have noxious weed laws or regulations.



State Weed Scientists

Alabama

John W. Everest
Agronomy and Soils
Auburn University 107 Extension Hall
Auburn University, AL 36849-5633
Phone: 334-844-5493
FAX: 334-844-4586
Email: jeverest@acesag.auburn.edu

Alaska

Wayne Vandre
Alaska Cooperative Extension
University of Alaska - Fairbanks
2221 E. Northern Lights Blvd. - Suite 118
Anchorage, AK 99508-4143
Phone: 907-279-6575
FAX : 907-279-2139
Email: afwgw@orion.alaska.edu

Arizona

William McCloskey
Plant Sciences
University of Arizona
Yuma, AZ 85364-9623
Phone: 520-621-7613
FAX: 520-621-7186
Email: wmcclosk@ag.arizona.edu

Arkansas

John Boyd
University of Arkansas
Box 391
2301 S University
Little Rock, AR 72203
Phone: 501-671-2224
FAX: 501-671-2303
Email: jboyd@uaex.edu

California

Clyde Elmore
Weed Science Program
University of California
Davis, CA 95616
Phone: 916-752-9978
FAX: 916-752-4604

Colorado

K. George Beck
Colorado State University
Wed Research Lab, Rm 116
Ft. Collins, CO 80523
Phone: 303-491-7568
FAX: 303-491-0564

Connecticut

Frank Himmelstein
University of Connecticut
24 Hyde Avenue
Cooperative Extension System
Vernon, CT 06066
Phone: 860-875-3331
FAX: 860-875-0220

Delaware

Mark Van Goessel
University of Delaware
Research and Education Center
RD 6 Box 48
Georgetown, DE 19973
Phone: 302-856-7303
FAX: 302-856-1845
Email: mju@udel.edu

District of Columbia

Cooperative Extension Service
901 Newton Street, NE
Room 102
Washington, DC 20017
Phone: 202-274-6907
FAX: 202-274-6930
Email: jhazel@esusda.gov

Florida

Donn Shilling
Agronomy Department
University of Florida -P.O. Box 110300
Gainesville, FL 32611-0300
Phone: 352-392-1823
FAX: 352-392-7248

Georgia

Timothy Murphy
Georgia Experiment Station
University of Georgia - P.O. Box 748
Tifton, GA 31793
Phone: 912-386-3901
FAX: 912-386-3356
Email: tmurphy@uga.cc.uga.edu

Guam

James McConnell
Agricultural Experiment Station
University of Guam
Mangilao, Guam 96923
Phone: 671-735-2129
FAX: 671-734-6842
Email: mcconnel@uog.edu

Hawaii

Phillip Motooka
Cooperative Extension Service
University of Hawaii at Manoa
Kealakekua, HI 96750
Phone: 808-322-0488
FAX: 808-322-2493
Email: ta_haw3@avax.ctahr.hawaii.edu

Idaho

Robert H. Callihan
Plant/Soil Science Dept.
University of Idaho
Moscow, ID 83843
Phone: 208-885-6617
FAX: 208-885-6274
Email: bcallihan@marvin.csr.v.uidaho.edu

Illinois

Ellery L. Knake
 Crop Sciences Dept.
 University of Illinois
 N-323 Turner Hall
 1102 South Goodwin Avenue
 Urbana, IL 61801
 Phone: 217-333-4424
 FAX: 217-333-5299
 Email: e-knake@uiuc.edu

Indiana

Thomas N. Jordan
 Botany/Plant Pathology
 Purdue University
 West Lafayette, IN 47907
 Phone: 317-494-4629
 FAX: 317-494-0363
 Email: thomas.n.jordan.1@purdue.edu

**Iowa**

Robert Hartzler
 Agronomy Dept
 Iowa State University
 2104 Agronomy Hall
 Ames, IA 50011
 Phone: 515-294-1923
 FAX: 515-294-9985
 Email: hartzler@iaState.edu

Kansas

Dallas E. Peterson
 Agronomy Dept
 Kansas State University
 Throckmorton Hall
 Manhattan, KS 66506-5501
 Phone: 913-532-5776
 FAX: 913-532-6315
 Email: dpeterso@oz.oznet.ksu.edu

Kentucky

J.D. Green
 Agronomy Dept University of Kentucky
 106B Ag Science Bldg
 Lexington, KY 40546
 Phone: 606-257-4898
 FAX: 606-257-2185
 Email: jgreen@ca.uky.edu

Louisiana

Dearl Sanders
 Cooperative Extension
 Louisiana State University - 261 Knapp Hall
 Baton Rouge, LA 70803
 Phone: 504-388-6195

Maine

Maxwell McCormack
 University of Maine
 CFRU
 P.O. Box 34
 Orono, ME 04473-0034
 Phone: 207-581-2903
 FAX: 207-581-2833
 Email: maxweldime@aol.com

Maryland

Donald Scott Glenn
 Agronomy Department
 University of Maryland - College Park
 1114 H.J. Patterson Hall
 College Park, MD 20742-5821
 Phone: 301-405-1329
 Email: dg11@umail.umd.edu

Massachusetts

Prasanta Bhowmik
 Univ. Of Massachusetts
 Plant and Soil Sciences - Stockbridge Hall
 Stockbridge Hall
 Amherst, MA 01003
 Phone: 413-545-5223
 FAX: 413-545-6555
 Email: pbhowik@pssci.umass.edu

Michigan

Karen Ann Renner
 Crop & Soil Sciences
 Michigan State University
 466 Plant/Soil Science Bldg
 Crop & Soil Sciences
 East Lansing, MI 48824
 Phone: 517-353-9429
 FAX: 517-353-5174
 Email: renner@msue.msu.edu

Minnesota

Roger Becker
 Agronomy & Plant Genetics
 University of Minnesota - Twin Cities
 411 Borlaug Hall
 St Paul, MN 55108
 Phone: 612-625-5753
 FAX: 612-625-1268
 Email: becke003@maroon.tc.umn.edu

Mississippi

John D. Byrd
 Plant and Soil Sciences
 Mississippi State University
 312 Dorman Hall - Box 9555
 Mississippi State, MS 39762
 Phone: 601-325-4537
 FAX: 601-325-4590
 Email: jbyrd@dorman.msState.edu

Missouri

Fred Fishel
Cooperative Extension
45 Agriculture Building
University of Missouri
P.O. Box 407
Columbia, MO 65211
Phone: 573-884-6361
FAX: 573-884-5405
Email: ueffishe@muccmail.missouri.edu

Montana

Roger Sheley
Plant, Soil & Environmental Sciences
Montana State University
334 Leon Johnson Hall - P.O. Box 3120
Bozeman, MT 59715-3120
Phone: 406-994-5686
FAX: 406-994-3933
ussrs@msu.oscs.montana.edu

Nebraska

Alexander R. Martin
Agronomy Department
University of Nebraska
362 Plant Science Bldg
Lincoln, NE 68583-0915
Phone: 402-472-1527
FAX 402-472-7904
Email: agro151@unlvm.unl.edu

Nevada

Robert Wilson
White Pine County Cooperative Extension
University of Nevada - Reno
P.O. Box 210
Ely, NV 89301-0210
Phone: 702-289-4459
FAX: 702-289-1642
Email: wilsonr@fs.scs.unr.edu

New Hampshire

James Mitchell
University of New Hampshire
Nesmith Hall
131 Main Street
Durham, NH 03824-3595
Phone: 603-862-3204
FAX: 603-862-4757
Email: james.mitchell@unh.edu

New Jersey

Bradley Majek
Rutgers University
Rutgers Research & Development Center
121 Northville Road
Bridgeton, NJ 08302-9499
Phone: 609-455-3100
FAX: 609-455-3133

New Mexico

Richard Lee
Plant Sciences Department
New Mexico State University
P.O. Box 30003 Dept 3AE
Las Cruces, NM 88003
Phone: 505-646-2888
FAX: 505-646-8085
Email: rlee@nmsu.edu

New York

Bernd Blossey
Natural Resources - 207 Fernow Hall
Cornell University
Ithaca, NY 14853
Phone: 607-255-5314
FAX: 607-255-0349
Email: bbww@cornell.edu

North Carolina

Stratford Kay
Crop Science Department
North Carolina State University
4401-B Williams Hall - Box 7620
Raleigh, NC 27695
Phone: 919-515-5654
FAX: 919-515-5315
Email: skay@wolf.ces.ncsu.edu

North Dakota

Richard K. Zollinger
Department of Plant Sciences
North Dakota State University
Loftsgard Hall - Box 5051
Fargo, ND 58105-5051
Phone: 701-237-8157
FAX: 701/237-8474
Email: rzolling@ndsuxext.nodak.edu

Ohio

Mark Loux
Horticulture and Crop Science
202 Kottman Hall
Ohio State University
2021 Coffey Road
Columbus, OH 43210
Phone: 614-292-9081
FAX: 614-292-7162
Email: loux.1@osu.edu

Oklahoma

Thomas F. Peeper
Agronomy Dept
Oklahoma State University
Stillwater, OK 74078
Phone: 405-744-6417
FAX: 405-744-5269
tfp@soilwater.agr.okState.edu



Oregon

Larry Larson
 OSU Agriculture Program
 Eastern Oregon State College
 LaGrande, OR 97850
 Phone: 541-962-3547
 FAX: 541-962-3444
 Email: llarson@eosc.osshe.edu

Palau

Rogelio Ragus
 Cooperative Research & Extension
 Palau Community College
 P.O. Box 9
 Koror, PW 96940
 Phone: 680-488-2746
 FAX: 680-488-3307

Pennsylvania

William Curran
 Penn State Univ.
 116 Agricultural Science & Industry Bldg.
 Dept. Of Agronomy
 University Park, PA 16802-3504
 Phone: 814-863-1014
 FAX: 814-863-7043
 Email: wsc2@psu.edu

Puerto Rico

Yamil Oulijano
 Agricultural Extension Service
 University of Puerto Rico - Mayaguez
 Box 305
 Camuy, PR 00627-0305
 Phone: 787-898-2270
 FAX: 787-879-5662

Rhode Island

Raymond Taylorson
 University of Rhode Island
 Department of Plant Sciences
 Kingston, RI 02881
 Phone: 401-792-2106

South Carolina

Edward C. Murdock
 Agronomy & Soils Dept
 Clemson University
 275 Poole Agricultural Center
 Clemson, SC 29634
 Tel. 864-656-3517
 FAX: 864-656-3443
 Email: emrdck@clemson.edu

South Dakota

Leon J. Wrage
 Agriculture & Bio Science
 South Dakota State University
 229 Ag. Hall, Box 2207A
 Brookings, SD 57007
 Phone: 605-688-4591
 FAX: 605-688-4602
 Email: sdsuweed@brookings.net

Tennessee

Gilbert Rhodes
 Agricultural Extension Service
 363 Ellington Plant Sci.
 University of Tennessee
 P.O. Box 1071
 Knoxville, TN 37901-1071
 Phone: 423-974-7208
 FAX: 423-974-8850
 Email: nrhodes@utk.edu

Texas

Paul Baumann
 Soil and Crop Sciences
 Texas A & M University
 College Station, TX 77843
 Tel. 409/845-0877
 FAX: 409/8450604
 p-baumann@tamu.edu

Utah

Steven A. Dewey
 Plants/Soils/Biometeorology
 Utah State University
 Logan, UT 84322-4820
 Phone: 801/797-2256
 FAX: 801/797-3376
 Email: steved@ext.usu.edu

Vermont

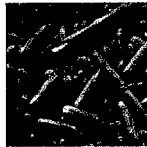
Sid Boseworth
 Plant & Soils
 University of Vermont
 Burlington, VT 05405
 Phone: 802-650-0478
 FAX: 802-650-4656
 Email: pss_dept@uvmvax.uvm.edu

Virginia

Scott Hagood
 Plant Path., Phys., and Weed Science
 Virginia Tech - 410 Price Hall
 Blacksburg, VA 24061-0331
 Phone: 540-231-6762
 FAX: 540-231-7477
 Email: shagood@vt.edu

Washington

Joseph Yenish
 Crop and Soil Sciences
 Johnson 201A, Box 646240
 Pullman, WA 99164-6420
 Phone: 509-335-2961
 FAX: 509-335-1758
 Email: yenish@wsu.edu



West Virginia

John Hinz
Plant and Soil Sciences
West Virginia University
P.O. Box 6100
Morgantown, WV 26506-6108
Phone: 304-293-2219
FAX: 304-293-2960
Email: jhinz@wvnmvs.wvnet.edu

Wisconsin

Chris Boerboom
Agronomy Department
University of Wisconsin - Moore Hall
1575 Linden Drive
Madison, WI 53706-1597
Phone: 608-262-1392
FAX: 608-262-5217
Email: boerboom@facstaff.wisc.edu

Wyoming

Tom Whitson
Plant/Soil/Insect Sciences
University of Wyoming - P.O. Box 3354
University Station
Laramie, WY 82070
Phone: 307-766-3113
FAX : 307-766-5549
Email: twhitson@uwoyo.edu



State Plant Regulatory Agencies & Noxious Weed Coordinators

Alabama
Plant Protection Division
Dept. of Agriculture
P.O. Box 3336
Montgomery, AL 36109-0336

Alaska
Dept. of Natural Resources
Division of Agriculture
P.O. Box 949
Palmer, AK 99645-0946

Arizona
Everett Hall
Arizona Department of Agriculture
Plant Services Division
1688 West Adams Street
Phoenix, Arizona 85007

Arkansas
State Plant Board
Plant Industry Division
P.O. Box 1069
Little Rock, AR 72203

California
Ross O'Connell
Department of Food and Agriculture
Division of Plant Industry
1220 N. Street, Room A-35
P.O. Box 942871
Sacramento, CA 94271-0001
916-654-0768

Colorado
Department of Agriculture
Division of Plant Industry
700 Kipling Street, Suite 4000
Lakewood, CO 80215-5894

Connecticut
Agricultural Experiment Station
123 Huntington Street
Box 1106
New Haven, CT 06504

Delaware
Terry Van Horn
Department of Agriculture
Plant Industry Section
2320 South Dupont Highway
Dover, DE 19901-5515

Florida
Florida Department of Agriculture and
Consumer Services
Florida Division of Plant Industry
P.O. Box 147100
Gainesville FL 32614-7100

Georgia
Department of Agriculture
Capital Square
Atlanta, GA 30334

Hawaii
Department of Agriculture
Plant Industry QBR
701 Ilalo Street
Honolulu, HI 96823

Idaho
Loal Vance
Department of Agriculture
Plant Industries
120 Klotz
Box 790
Boise, ID 83702-0790
208-334-3240

Illinois
Department of Agriculture
Division of Natural Resources
9511 Harrison Street, Room A169
Des Plaines, IL 60016

Indiana
Department of Natural Resources
Division of Entomology & Plant Pathology
402 W. Washington Street, Room W290
Indianapolis, IN 46204-2212

Iowa
Dept. of Agriculture & Land Stewardship
Entomology/Seed Bureau
Wallace Building, E. 9th & Grand Avenue
Des Moines, IA 50319

Kansas
Bill Scott
Dept. Of Agriculture
Division of Plant Health
109 SW 9th St.
Topeka, KS 66612-1266
913-296-3016

Kentucky
Department of Entomology
Division of Pests & Noxious Weeds
S-225 Ag. Sci. Ct. North
Lexington, KY 40546-0091

Louisiana
Department of Agriculture & Forestry
Division of Horticulture & Quarantine
P.O. Box 3118
Baton Rouge, LA 70281-3118

Maine

Department of Agriculture
 Food & Rural Resources
 Division of Plant Industry
 28 State House Station
 Augusta, ME 04333

Maryland

Department of Agriculture
 Division of Plant Industries and Pest
 Management
 Wayne A. Cawley, Jr. Building
 50 Harry S. Truman Parkway
 Annapolis, MD 21401

Massachusetts

Department of Agriculture
 Pest Control Bureau
 100 Cambridge Street
 Boston, MA 02202

Michigan

Michigan Department of Agriculture
 Division of Pesticide & Plant Pest Mgt.
 P.O. Box 30017, 4th Floor, Ottawa Bld.
 Lansing, MI 48909

Minnesota

Department of Agriculture
 Division of Plant Protection
 90 West Plato Boulevard
 St. Paul, MN 55107-2094

Mississippi

Department of Agriculture and Commerce
 Division of Plant Industry
 P.O. Box 5207
 Mississippi State, MS 39762

Missouri

Department of Agriculture
 Division of Plant Industries
 P.O. Box 630
 1616 Missouri Blvd.
 Jefferson City, MO 65102

Montana

Harold Stepper
 Department of Agriculture
 Agricultural Sciences Division
 P.O. Box 200201
 Helena, MT 59620-0201
 406-444-5400

Nebraska

Gene Friisoe
 Department of Agriculture
 P.O. Box 94756
 Lincoln, NE 68509-4756
 402-471-2394

Nevada

Dick Rowe
 Department of Agriculture
 Division of Plant Industry
 350 Capitol Hill Avenue
 P.O. Box 11100
 Reno, NV 89510-1100
 702-789-0180

New Hampshire

Department of Agriculture
 St. Lab Bld. Lab D, 6 Hazen Dr.
 Concord, NH 03301

New Jersey

Department of Agriculture
 Division of Plant Industry
 CN330
 Trenton, NJ 08625

New Mexico

Department of Agriculture
 Division of Ag./Environmental Services
 Box 300005, Dept. 3BA
 Las Cruces, NM 88003

New York

Dept. of Agriculture & Markets
 Division of Plant Industry
 1 Winners Circle
 Albany, NY 12235

North Carolina

Gene Cross, Weed Specialist
 North Carolina Department of Agriculture
 Plant Industry Division,
 Plant Protection Section
 P.O. Box 27647
 Raleigh, NC 27611

North Dakota

North Dakota Department of Agriculture
 600 East Boulevard
 State Capitol, 6th Floor
 Bismarck, ND 58505-0020

Ohio

Department of Agriculture
 Division of Plant Industry
 8995 E. Main Street
 Reynoldsburg, OH 43068-3399

Oklahoma

Department of Agriculture
 Division of Plant Industry &
 Consumer Services
 2800 N. Lincoln Blvd.
 Oklahoma City, OK 73105-4298



Oregon

Dennis Isaacson
Department of Agriculture
Division of Plant Industry
635 Capitol Street, NE
Salem, OR 97310-0110
503-378-4987

Pennsylvania

Pennsylvania Department of Agriculture
Bureau of Plant Industry
2301 North Cameron Street
Harrisburg, PA 17110-9408

Puerto Rico

Department of Agriculture
Plant Quarantine Services
P.O. Box 10163
Santurce, PR 00980-1163

Rhode Island

Dept. of Environmental Mgt.
Division of Agriculture
83 Park Street, 6th floor
Providence, RI 02903

South Carolina

H.B. Jackson
Clemson University
Department of Plant Industry
511 Westinghouse Road
Pendleton, SC 29670

South Dakota

South Dakota Department of Agriculture
Division of Regulatory Services
445 East Capitol
Anderson Building
Pierre, SD 57501

Tennessee

Department of Agriculture
Division of Plant Industry
Box 40627, Melrose Station
Nashville, TN 37204

Texas

Department of Agriculture
Plant Quality Program
P.O. Box 12847
Austin, TX 78711

Utah

Steve Burningham
Department of Agriculture
Division of Plant Industry
350 North Redwood Road
Salt Lake City, UT 84116

Vermont

Department of Agriculture, Foods & Markets
Division of Plant Industry
116 State Street, Drawer 20
Montpelier, VT 05320-2901

Virginia

Department of Agriculture & Consumer
Services
Plant Protection Office
P.O. Box 1163
Richmond, VA 23209

Washington

Laurie Penders
Department of Agriculture
Washington Weed Control Board
1851 S. Central Place, Suite 211
Kent, WA 98031-7507

West Virginia

Department of Agriculture
Division of Plant Industry
1900 Kanawha Blvd. East
Charleston, WV 25305-0191

Wisconsin

Department of Agriculture & Trade
Bureau of Plant Industry
P.O. Box 8911
Madison, WI 53708-8911

Wyoming

Roy Reisenbach
Department of Agriculture
Division of Technical Services
2219 Carey Avenue
Cheyenne, WY 82002-0100
Rockford, WY 82401
Phone: 815-964-6666



TREES

COSMOPOLITAN

White Poplar (*Populus alba*)

Street and landscape tree that has naturalized throughout North America; has water-hungry roots that can clog sewers and drainpipes.

Black Locust (*Robinia pseudoacacia*)

Eastern North American native, now invades disturbed woodlands of urban and rural landscapes throughout the continent.

EAST

Princess Tree (*Paulownia tomentosa*)

Colonizes rocky cliffs and sandy stream banks; causes maintenance problems along roads and utility rights-of-way and in gardens; Mid-Atlantic and Southeast regions.

Norway Maple (*Acer platanoides*)

Outcompeting native sugar maples in the East and Northwest.

Tree-of-Heaven (*Ailanthus altissima*)

Forms dense thickets that displace native vegetation; especially invasive along streambanks in the West; Massachusetts to Texas.

Paper Mulberry (*Broussonetia papyrifera*)

Hardwood forests in the Northeast to Missouri and southward.

Earleaf Acacia (*Acacia auriculiformis*)

Undisturbed pine rockland habitats in south Florida.

Bishopweed (*Bischofia javanica*)

Hardwood forests, roadsides, waste areas in south Florida.

Australian Pine (*Casuarina equisetifolia*)

Mangrove habitat, rocky shorelines, and sandy beach dunes in south Florida.

Carrot Weed (*Cupaniopsis anacardioides*)

Salt tolerant, forms dense thickets in tropic hardwood hammocks in south Florida.

Banyan Fig, Laurel Fig (*Ficus benghalensis*, *Ficus microcaroia*)

Pine rockland and hardwood forest ecosystems throughout southern Florida.

Melaleuca, Cajeput Tree (*Melaleuca quinquenervia*)

Freshwater wetlands in south Florida.

Schefflera (*Schefflera actinophylla*)

Invades hardwood forests and margins, roadsides and

cultivated grounds in tropical and warm temperate regions of Florida.

Chinaberry Tree (*Melia azedarach*)

Grows prolifically throughout the Southeast. A very serious problem in Florida; four counties in Florida have banned its use.

SOUTHEAST

Chinese Tallow Tree, Popcorn Tree (*Sapium sebiferum*). Invades wetlands, swamps, and bottomland forests; along the Gulf Coast from Texas to Florida and up the East Coast to North Carolina.

MIDWEST

Amur Maple (*Acer ginnala*) Hardwood forests in Illinois and Missouri.

WEST

Saltcedar (*Tamarix ramosissima*, *T. chinensis*, *T. parviflora*)

Streambanks in every western state but Washington and North Dakota.

Siberian Elm (*Ulmus pumila*)

Invades dry areas and moist soils along streambanks, in pastures, prairies, and along roadsides; Utah and Idaho eastward.

CALIFORNIA

Bluegum Eucalyptus (*Eucalyptus globulus*) Prolific producer of fire-prone litter. Invasive in wildland settings, especially grasslands and shrublands of coastal California.

Edible Fig (*Ficus carica*)

Invades streamside forests and canal banks in the Central Valley and southern coast of California.

SHRUBS

COSMOPOLITAN

Amur Honeysuckle, Morrow Honeysuckle, Tartarian Honeysuckle (*Lonicera maackii*, *L. morrowii*, *L. tatarica*)

Mostly throughout the United States in open to shaded habitats.

Smooth or Glossy Buckthorn (*Frangula alnus*)

Aggressively invades bogs, marshes, river banks, fens, pond margins, sand forests, roadsides, and prairies.

Winged Euonymus, Burning Bush (*Euonymus alata*)

Problematic in open woods, mature second growth forests, and pastures in the eastern United States and Midwest.

Ornamentals Invading Natural Areas in the Continental United States

(Randall and Marinelli 1996)

At least 45% of the invasive non-native plant species that plague Florida's public lands were imported for ornamental reasons.

At least 39% of the worst invasive plant species in Florida are still commercially available for sale and continual spread.

DON SCHMITZ
Florida Department of Environmental
Protection

EAST

European Privet, Chinese Privet, Japanese Privet (*Ligustrum vulgare*, *L. sinense*, *L. japonicum*) Form dense, impenetrable thickets throughout the East.

Multiflora Rose (*Rosa multiflora*) Invades pastures, old fields, roadsides, and other open habitats from Maine to Minnesota and south to Alabama. Classified as a noxious weed in several states.

Japanese Spiraea (*Spiraea japonica*) Readily infests streambanks, roadsides, spreading into forests, thickets, and overgrown fields from New England to Indiana and south to Tennessee and Georgia.

NORTHEAST

Japanese Yew (*Taxus cuspidata*) Now appearing in woodlots and young forests throughout southern New England.

Japanese Barberry (*Berberis thunbergii*) New Jersey, Connecticut, New York; also becoming a problem in other eastern and midwestern states.

Common or European Buckthorn (*Rhamnus cathartica*)

Forms dense, impenetrable thickets in woodlands, savannahs, prairies, and abandoned fields in the Northeastern and North Central United States.

MID-ATLANTIC

Butterfly Bush (*Buddleja davidii*) Colonizes roadsides and streamsides from Pennsylvania to North Carolina and California, Oregon, and Washington.

SOUTHEAST

Heavenly Bamboo (*Nandina domestica*) Escaped from cultivation in the Southeast where it grows in pine flatwood communities.

Autumn Olive (*Elaeagnus umbellata*) Forms thorny, impenetrable thickets in the Midwest, Northwest, and Southeast.

FLORIDA

Shoebuttan Ardisia (*Ardisia elliptica*) Hardwood forests and abandoned agricultural fields in South Florida.

Beach Naupaka (*Scaevola sericea*) A salt-tolerant shrub that colonizes sandy dunes and competes with native coastal vegetation in south Florida.

Brazilian Pepper (*Schinus terebinthifolius*) Has invaded thousands of acres of wetlands, hammocks, pinelands, and other habitats in central and south Florida.

NORTH CENTRAL

Common or European Buckthorn (*Rhamnus cathartica*) Forms dense, impenetrable thickets in woodlands, savannahs, prairies, and abandoned fields in the northeastern and north central United States.

MIDWEST

Autumn Olive (*Elaeagnus umbellata*) Forms thorny, impenetrable thickets in the Midwest, Northwest, and Southeast.

Winter creeper, Climbing Euonymus (*Euonymus fortunei*) Forests and rocky bluffs in the East and Midwest from Chicago south.

WEST

Russian Olive (*Elaeagnus angustifolia*) Takes over streambanks, lake shores, and wet meadows throughout the West.

NORTHWEST

Singleseed Hawthorn (*Crataegus monogyna*) Forms dense thickets in woodlands, hedgerows, and other natural habitats in the Pacific Northwest.

Scotch Broom (*Cytisus scoparius*) Covers more than 2 million acres in Washington, Oregon, and California.

English Holly (*Ilex aquifolium*) Ancient forests of the Northwest.

Butterfly Bush (*Buddleja davidii*) Colonizes roadsides and streamsides from Pennsylvania to North Carolina and California, Oregon, and Washington.

Autumn Olive (*Elaeagnus umbellata*) Forms thorny, impenetrable thickets in the Midwest, Northwest, and Southeast.

Gelder Rose (*Viburnum opulus var. opulus*) Established from southern Canada south to Virginia, Nebraska, and Washington.

CALIFORNIA

Cotoneaster (*Cotoneaster* spp.) Wildlands and foggy central and northern coast of California.

Myoporum (*Myoporum laetum*) Produces dense stands in the coastal area of southern California.



ANNUAL AND PERENNIAL HERBS

COSMOPOLITAN

Dame's Rocket (*Hesperis matronalis*)

Dominates moist areas of meadow, forest edge, and alluvial woods all across the country. So widespread that some people think it is a native wildflower.

NORTHEAST

Crownvetch (*Coronilla varia*)

Invades sunnier areas in the Northeast and Midwest, climbing over shrubs and small trees.

Periwinkle (*Vinca minor*)

Persists in shady areas of second-growth woods, usually near the original planting, in most northeastern and north central states.

EAST

Japanese Knotweed (*Polygonum cuspidatum*)

Forms dense stands along riverbanks and other wet areas. Occurs through the eastern United States, Colorado, Utah, northern California, Oregon, and western Canada.

NORTH CENTRAL STATES

Babysbreath Gypsophila (*Gypsophila paniculata*)

A problem on freshwater dunes along the Great Lakes.

Purple Loosestrife (*Lythrum salicaria*)

Wetland habitats, meadows, marches, river banks, lake shores, and ponds throughout the north central states, now rapidly spreading. Declared as a noxious weed in several states; still being sold as an ornamental in some areas.

Erect Cinquefoil (*Potentilla erecta*)

Very competitive in grasslands and forest habitats where tree cover has been reduced. Well established in the Northeast and Great Lakes region, rapidly expanding into western states and Canada.

Periwinkle (*Vinca minor*)

Persists in shady areas of second growth woods, usually near the original planting, in most northeastern and north central states.

MIDWEST

Crownvetch (*Coronilla varia*)

Invades sunnier areas in the Northeast and Midwest, climbing over shrubs and small trees.

Birdfoot Deervetch (*Lotus corniculatus*)

Planted throughout the United States and Canada for livestock forage and erosion control along roadsides; very problematic in tallgrass prairie.

NORTHWEST

Garden Cornflower, Bachelor's Button (*Centaurea cyanus*)

Particularly invasive in increasingly rare native grassland and prairie habitats, especially in the Northwest.

Purple Foxglove (*Digitalis purpurea*)

Colonizes disturbed lands such as burned fields and logging clearcuts, especially in coastal areas of the Pacific Northwest.

CALIFORNIA

Iceplant (*Mesembryanthemum crystallinum*)

Invades beach, dune, coastal scrub, and coastal bluff communities through coastal California. Common in disturbed areas, along highways, on former military bases.

Cardoon, Wild Artichoke (*Cynara cardunculus*)

Invades grasslands, canyon bottoms, stream banks, chaparral, and coastal sage scrub throughout California.

GRASSES

COSMOPOLITAN

Giant Reed (*Arundo donax*)

Forms huge conal colonies that may cover hundreds of acres. Invades freshwater habitats in warmer climates from California to Maryland.

EAST

Chinese Silver Grass, Eulalia (*Miscanthus sinensis*)

Grows in clearings in wooded areas throughout the eastern United States from Florida to Texas, north to Massachusetts and New York.

GULF COAST

Cogongrass (*Imperata cylindrica*)

Infests roadsides, surface-mined lands, and pine plantations, and is inferior livestock forage in pastures; invades a wide variety of natural habitats such as desert dunes, wetlands, savannahs, and forests; is highly flammable. Mississippi, Alabama, Georgia, Florida.

MIDWEST

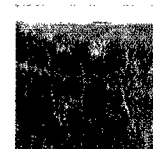
Tall Fescue (*Festuca arundinacea*)

Invades remnant prairies in the Midwest, eastern plains, and north Texas.

WEST

Reed Canary Grass (*Phalaris arundinacea*)

Invades wetland habitats such as wet prairies in the Midwest and is rapidly invading alpine and montane habitats in the western United States and Canada; found widely from coast to coast.





CALIFORNIA

Pampas Grass (*Cortaderia* spp.)

Open, sandy soils in California's coastal areas. Still grown as an ornamental nationwide.

VINES

EAST

Oriental or Asiatic Bittersweet

(*Celastrus orbiculata*)

Invades open woods, thickets, and roadsides, overtopping native species; escaped from cultivation in 21 states, from Maine to Georgia.

Japanese Honeysuckle (*Lonicera japonica*)

Spreads rapidly, overtopping and smothering small trees and shrubs; occurs in the eastern United States from Massachusetts west to central Illinois and Missouri and south to Kansas and Texas.

NORTHEAST

Porcelainberry (*Ampelopsis brevipedunculata*)

Overtakes open, sunny, disturbed habitats such as river banks, railroad tracks, and forest edges; grows abundantly along the Northeast coast from Washington, D.C., to Boston, Massachusetts.

FLORIDA

Gold Coast Jasmine, Brazilian Jasmine (*Jasminum dichotomum*, *J. fluminense*)

Vigorous invaders of hardwood forests and cultivated grounds throughout Florida; introduced into cultivation in the United States in the 1920s; still planted for their fragrance.

Wood Rose (*Merremia tuberosa*)

Invades hardwood forests, cultivated grounds, and overgrown disturbed sites in south Florida.

GULF COAST

Japanese Climbing Fern (*Lygodium japonicum*)

Invades pinelands, cypress swamps in Louisiana and beech forests in east Texas; a problem from central Florida across the Gulf coast states.

NORTHWEST

English Ivy (*Hedra helix*)

Forms "ivy deserts" in forests, inhibiting regeneration of wildflowers, trees, and shrubs; occurs from coast to coast; especially invasive in western Oregon and Washington.

AQUATIC PLANTS

SOUTHEAST AND GULF COAST

Floating Water Hyacinth (*Eichhornia crassipes*)

Troublesome aquatic weed in the Gulf coast states and central California; forms a dense floating mat on waterways.

SOUTHEAST, GULF COAST, MID-ATLANTIC, CALIFORNIA, WASHINGTON

Hydrilla (*Hydrilla verticillata*)

Lakes and rivers throughout the Southeast, as far north as Connecticut, west to Texas; also in California and Washington states.

Scientific Names and Index of Cited Plants

Note: Bold-faced numerals indicate location of species primer.

- Amur Honeysuckle Bush [*Lonicera maackii* (Rupr.) Herder] 95
 Amur Maple (*Acer ginnala* Maxim.) 95
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- Babysbreath Gypsophila (*Gypsophila paniculata* L.) 97
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 Banana Poka [*Passiflora mollissima* (Kunth) L.H. Bailey] 53, 54, 58
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 Beach Naupaka (*Scaevola sericea* Vahl) 96
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 Bishopweed (*Bischofia javanica* Blume) 95
 Black Locust (*Robinia pseudoacacia* L.) 95
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 Cogongrass [*Imperata cylindrica* (L.) Palisot] 33, 97
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- Cotoneaster (*Cotoneaster* spp.) 96
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 Croton (*Crotalaria spectabilis* Roth) 13
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- Dalmatian Toadflax [*Linaria genistifolia* (L.) Miller] **58-59**
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 Duckweed (*Lemna* spp.) 78
 Dumbcane [*Dieffenbachia seguine* (Jacq.) Schott] 71
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- Earleaf Acacia (*Acacia auriculiformis* Cunn. ex Benth.) 95
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- Field Bindweed (*Convolvulus arvensis* L.) 5, 14
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- Japanese Climbing Fern [*Lygodium japonicum* (Thunb. ex Murr.) Swartz] 98
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- Japanese Knotweed (*Polygonum cuspidatum* Sieb. & Zucc.) 97
- Japanese Privet (*Ligustrum japonicum* Thunb.) 96
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- Knapweed (*Centaurea* spp.) 14, 23
- Knotweed (*Polygonum* spp.) 19
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- Strawberry Guava (*Psidium cattleianum* Sabine) 54, 57
- Tall Fescue (*Festuca arundinacea* Schreber) 79, 97

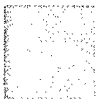
Tansy Ragwort (*Senecio jacobaea* L.) 80
Tartarian Honeysuckle (*Lonicera tatarica* L.) 95
Tobacco (*Nicotiana tabacum* L.) 78
Torpedo Grass (*Panicum repens* L.) 48
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Yellow Starthistle (*Centaurea solstitialis* L.) 25, 66, 69, 72, 78, 79
Yellow Sweetclover [*Melilotus officinalis* (L.) Lam.] 79

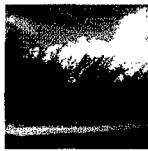
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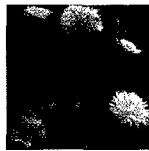
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For Further Reading

David Bridges, Ph.D., Associate Professor,
University of Georgia, Griffin, Georgia.

Charles Bryson, Ph.D., Research Botanist,
USDA Agricultural Research Service,
Stoneville, Mississippi.

Faith T. Campbell, Ph.D., Executive Secretary,
National Association of Exotic Pest Plant
Councils, Washington, D.C.

Terry English, USDA APHIS,
Oxford, North Carolina.

Al Elder, Deputy Administrator, USDA APHIS
PPQ, Washington, D.C.

Bonnie Harper-Lore, Vegetation Management
Coordinator, Federal Highway Administration,
Minneapolis, Minnesota.

Colette Jacono, U.S. Department of the Interior,
USGS, Biological Resources Division,
Gainesville, Florida.

John Kartesz, Biota of North America Program,
UNC – Chapel Hill, North Carolina.

John Randall, Ph.D., Exotic Weed Specialist,
The Nature Conservancy, Davis, California.

Elizabeth Rieben, U.S. Department of the
Interior, Bureau of Land Management,
Washington, D.C.

Matthew Royer, Ph.D., and Sid Cousins, USDA
APHIS PPQ, Riverdale, Maryland.

Mark Schaefer, Ph.D., Deputy Assistant
Secretary for Water and Science, U.S.
Department of the Interior, Washington, D.C.

Don Schmitz, Biologist, Florida Department of
Environmental Protection, Tallahassee, Florida.

National Wetlands Research Center Staff:
Tammy Charron, Rhonda Davis, Richard Day,
Natalie Gormanous, Jim Lynch

Special Thanks

