

NEW STRATEGIES FOR WEED PREVENTION

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ABSTRACT. Over the past several thousand years, Man has moved many plant species far beyond their historical native range. Many introduced plants that have become established outside of cultivation are benign (so far). However, some introduced species with free-living populations pose a threat to the biodiversity of natural areas and/or diminish the production capacity of managed or agricultural ecosystems. In the United States, 16 federal agencies have formed the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). This committee has developed a National Strategy for Invasive Plant Management. Goals of the national strategy are: weed prevention, weed control, and restoration of degraded lands. Research, education, and partnerships are critical to the success of the strategy. Regulatory strategies to protect the United States and other countries from invasive plants include: production of weed-free commodities in exporting countries; preclearance of risk commodities at foreign ports of export; port of entry inspections; and finally, early detection, containment, and eradication, of incipient infestations before they spread. Currently, 10 federal noxious weeds are being eradicated from localized sites in the United States through cooperative projects with affected states.

INTRODUCTION

Throughout history, Man has intentionally and unintentionally transported thousands of different plants and animals far beyond their natural ranges to other parts of the world. Most of these species are beneficial to human society or show no signs of invasiveness (so far). However, hundreds of species now cause serious problems in agricultural and/or natural ecosystems within the United States. In the absence of co-evolved predators and parasites that usually keep them in check in their natural ranges, introduced species that find suitable habitats may thrive and outcompete or displace native species. Over the past several decades, serious problems caused by introduced plants and animals have raised concerns over the movement of species around the world (Elton 1958; Westbrook 1981; Mooney and Drake 1986; Eplee and Westbrook 1990; Schmitz 1990; Westbrook 1991; Westbrook 1993; Westman 1990; Zamora et al. 1989; Schmitz 1994). While change and disruption in ecosystems have occurred throughout history, the biological invasions that are now resulting from human commerce are truly different with regard to origins, rate of introduction, types of organisms, abruptness and magnitude of change (Wagner 1993).

Recognized invasive species that pose a threat to agricultural and managed ecosystems, or threaten the biodiversity of natural ecosystems, have been termed *biological pollutants* (McKnight 1993; Westbrooks 1993). **Unlike chemical pollutants that typically degrade in the environment, biological pollutants have the ability to grow, multiply, adapt and spread, and cause greater problems over time.**

Some examples of introduced species that have become biological pollutants in the United States include invasive plants, such as witchweed [*Striga asiatica* (L.) O.Kuntze] in the Carolinas; kudzu (*Pueraria lobata* Ohwi) throughout the southeast; and mile-a-minute vine (*Polygonum perfoliatum* L.). In the northeast, leafy spurge (*Euphorbia esula* L.); in the midwest and west, and *micocia* (L.) in Hawaii. These and thousands of other species have been transported around the globe as hitchhikers, contaminants, or on purpose. In either case, introduced species that become invasive typically receive little attention until they become major problems (Eplee and Westbrooks 1990). By the time a problem is recognized, environmental documentation is prepared, funding is obtained for control, and eradication is often impractical. At this point, an invasive plant becomes a permanent, expanding, and detrimental component of the invaded area.

In depauperate communities such as oceanic islands, exotic herbivorous mammals often become ecologically dominant, lead to wholesale species extinctions within several tropic levels, and cause severe degradation of the environment. In mainland environments, such taxa are more likely to cause decimation of sensitive or endangered species in addition to degradation of the environment (Coblentz 1993). The same adverse effects are often seen when invasive plants are introduced into a new environment.

ECONOMIC IMPACT OF INTRODUCED WEEDS IN THE U.S.

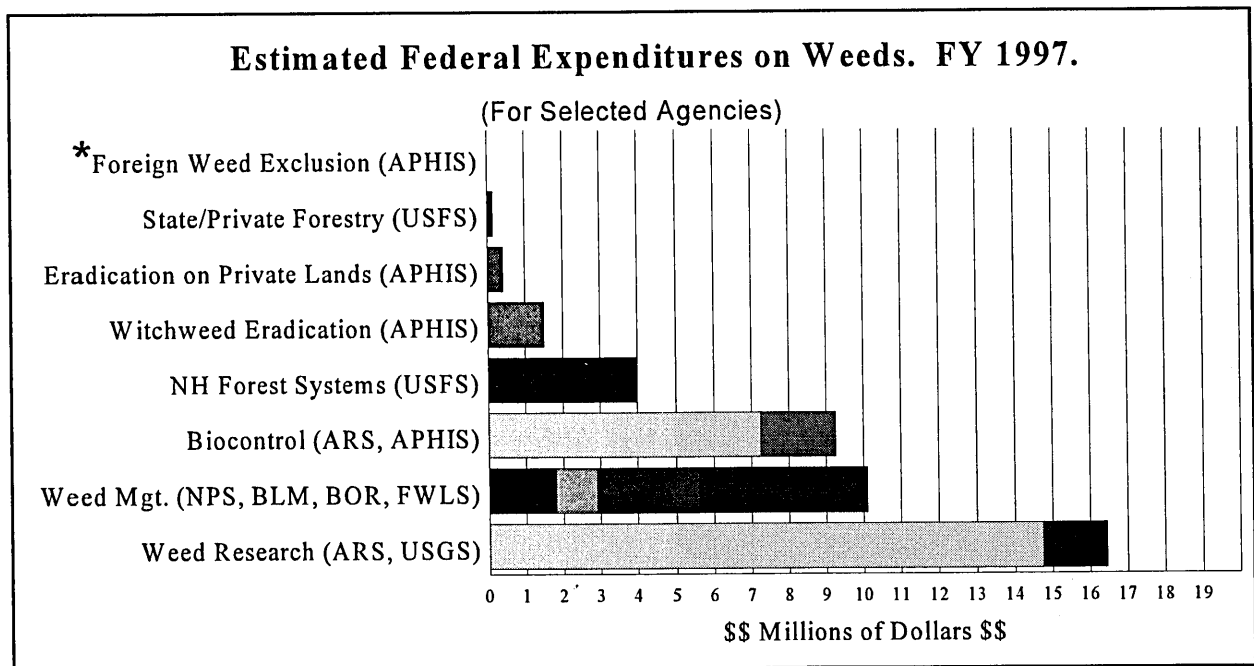
Weed Control Costs in the United States. Weeds cause billions of dollars of losses annually in the United States by competition with crops and by reducing the quality of food, feed, and fiber. During the 1950s, annual losses due to reduced crop yield and quality and costs of weed control were about \$5.1 billion per year (USDA 1965). In 1962, \$200,000,000 was spent in the United States on herbicides alone for weed control (Montgomery 1964). In 1979, it was estimated that 10-15% of the total market value of farm and forest products in the United States was being lost to weeds, a loss of 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 1985). At that time, about 17% of crop value was being lost due to weed interference and money spent controlling them (Chandler 1985).

In 1994, it was estimated that the economic impact of weeds on the U.S. economy equals or exceeds \$20 billion 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 \$10 billion per year. In non-crop sectors, including golf, turf, and ornamentals, highway right-of-ways, industrial sites, aquatic sites, forestry, and other sites, losses and control costs totaled about \$5 billion per year. 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**

weeds 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.

ROLE OF THE FEDERAL GOVERNMENT IN WEED MANAGEMENT

A number of federal agencies have a variety of responsibilities for dealing with weeds in the United States. Major areas of responsibility include: weed regulation, research, and management. Efforts to prevent the introduction of foreign weeds, as well as their establishment on private lands, are primarily the responsibility of the USDA’s Animal and Plant Health Inspection Service (APHIS). APHIS cooperates with state and local agencies, as well as private landowners/managers in eradicating newly introduced weeds on private lands. Natural enemies of introduced weeds are imported under quarantine to control large infestations on private lands (biocontrol). Basic research on agricultural weeds is conducted by USDA’s Agricultural Research Service (ARS). Weed research and management on federal lands is conducted by a number of agencies, including the U.S. Forest Service (USDA); U.S. Fish and Wildlife Service (FWLS); National Park Service (NPS); Bureau of Land Management (BLM); Bureau of Reclamation (BOR); U.S. Geological Survey (USGS); Bureau of Indian Affairs (BIA, U.S. Department of Interior); Department of Defense; and the Department of Energy. Estimated annual expenditures for weed research and control by some federal agencies in FY97 are listed below.



*Foreign weed exclusion by USDA APHIS is a part of Agricultural Quarantine Inspection (AQI) at U.S ports of entry. The AQI budget is about \$200,000,000.00 per year.

Invasive plants grow, adapt, reproduce, and spread without respect for agency jurisdictions or property boundaries. Therefore, an effective management strategy to thwart alien species often includes a number of participants and activities. Since the biology of a pest is not negotiable, the strategies of action must consider the total biology of the species as well as political and economic issues. There must be a recognition of need to eliminate the alien species, a commitment of will and resources to the effort, and good, practical science to developing control methodologies.

To be fully successful, any effort that is made in response to this serious global problem must bring together a complex set of interests that include private landowners, industry, and government agencies at all levels. One of the first challenges is to create a public awareness of this issue. A further challenge is to focus public and private resources in a partnership approach to deal with specific weed problems while prevention and control remain economically feasible.

In recent months, FICMNEW has developed a National Strategy for dealing with invasive plants in a coordinated fashion. Principal goals of the national strategy are: (1) to minimize further introductions of foreign invasive plants in the United States; (2) to detect, report and assess incipient infestations; (3) to prevent the movement of invasive plants from infested to noninfested areas within the United States; (4) to eradicate or control weeds that have already become established; and (5) to restore degraded agricultural lands, rangelands, and other ecosystems to a healthy and productive state. The strategy will serve as a road map to guide the nation in addressing this growing problem.

REGULATORY STRATEGIES FOR EXCLUSION OF FOREIGN WEEDS

One aspect of the mission of APHIS is to prevent the entry of certain foreign pests into the United States. Foreign pests regulated by APHIS include, but are not limited to invasive plants, insects, plant diseases, animal diseases, and mollusks that are of foreign origin. Plant Protection and Quarantine (PPQ) is an operational section of APHIS that has the responsibility for implementing the exclusion of such pests from the United States. Regulatory strategies for protecting the United States by preventing the entry of harmful non-indigenous species include:

- **prevention** (requiring or encouraging the production of pest-free commodities in foreign countries to minimize the world movement of recognized pests);
- **preclearance** (inspection/certification of certain commodities at the port of export, prior to being shipped to the United States);
- **exclusion** (port of entry inspections and treatments, designed to detect or remove prohibited pests in imported commodities, and to mitigate pest risk of contaminated shipments);
- **detection** (conducting surveys and communicating with scientists and state agencies for early detection of incipient infestations of prohibited foreign species);

- **containment** (establishment of regulatory rules and programs to prevent the spread of prohibited species from infested areas);
- **eradication** (total elimination of incipient infestations of prohibited species by appropriate means); and
- **biological control** (utilizing biological agents to control certain pests if they cannot be eradicated).

PLANT TAXA LISTED AS FEDERAL NOXIOUS WEEDS

In 1976, 26 taxa of foreign weeds were designated as Federal Noxious Weeds (FNWs). The FNW list now includes 94 taxa with 89 species, all species of the parasitic genera *Aeginetia*, *Alectra*, and *Striga*; plus all species of *Cuscuta* and *Orobanche* that are not native to the United States. *Melaleuca* (*Melaleuca quinquenervia* [Cav. T. Blake]), a tree in the myrtle family from Australia that is causing major problems in the Florida Everglades, was added to the FNW list in 1992. Tropical soda apple (*Solanum viarum* Dunal), a serious new weed of pastures in Florida, was added to the list in 1995.

DETECTION OF NOXIOUS WEEDS AT PORTS OF ENTRY

Between 1976 and 1988, resource materials available to APHIS personnel in enforcing the Federal Noxious Weed Act included a list of target species, a short list of high risk commodities, and sampling procedures for inspecting commodities for noxious weeds. At that time, greasy (raw) wool, soil-contaminated equipment, aquatic plant shipments, and seed shipments, had been recognized as high risk vectors for introducing foreign weeds (Westbrooks 1989; Westbrooks and Eplee 1991).

In the mid- to late-1980s, a Noxious Weed Inspection System (NWIS) was developed to enhance the ability of PPQ Officers to detect weed contaminants in high risk commodities at ports of entry. The purpose of the system is to provide officers with information on potential associations of target weeds and commodities that originate in habitats where such weeds could be expected to grow. NWIS is based on the principle that certain weeds are likely to be associated with certain commodities from certain countries. NWIS is comprised of a Federal Noxious Weed Inspection Guide, a Federal Noxious Weed Identification Guide with monographs, line drawings, and range maps on all listed species, and a Noxious Weed Seed Collection. Each PPQ work station at U.S. ports of entry has one set of NWIS materials (Westbrooks 1989; Eplee and Westbrooks 1991; Westbrooks and Eplee 1991; Westbrooks 1993).

NEW WEEDS WITHIN THE UNITED STATES

Strategies for Early Detection, Reporting, and Rapid Response. If noxious weeds do enter the United States, despite regulatory efforts to exclude them, the next goal is to detect, contain, and eradicate incipient infestations before they become entrenched and start to spread. A critical element in this process is early detection. At present, new plant species that are collected in the United States are typically stored at one of the 600+ public or private herbaria that exist around the country. Generally speaking, weed scientists and other plant specialists learn about such new state and national records through word of mouth or through notes published in botanical journals. Experience has shown that

if an infestation is detected early, it can be generally contained and eradicated at a relatively low cost compared to what it will cost for control once it becomes established.

One way to enhance early detection and reporting of new infestations of weeds would be to create a Weed Detection Network in each state. Such a network could be established by creating communication links between plant collectors, herbarium curators, and appropriate state and federal agencies. Botanists, farmers, county agents, and land managers, are just some of the people who need to be encouraged to report new plants that they observe.

To facilitate action on such reports, a state weed team in each state could be established. Such a team would be comprised of state and federal officials from agencies and institutions that are involved with weed management and research in a particular state. The goal of a state weed team would be to develop a coordinated plan of action and to leverage available resources and expertise for dealing with important weeds of common concern. Having one interagency spray crew to cover multi-jurisdictions would be far more efficient and cost effective than having separate county, state, and federal crews in a particular area.

Once a state weed team is informed about a new infestation, it will need input from technical specialists on how to proceed. One way to do this would be to establish a National Rapid Response Weed Team. The purpose of such a team would be to provide technical support to federal, state, and local agencies, in evaluating new infestations of introduced weeds. The national team which would consist of recognized weed regulatory and control specialists from participating federal agencies, would cooperate with weed scientists, botanists, and state plant regulatory officials in affected states. Such an interdepartmental team would provide a shared pool of expertise that is not normally available to individual agencies. When this or a similar system is adopted nationwide, we will be in a much better position to detect new weeds and to respond to them appropriately. Early detection, reporting, and rapid response, are three major goals of the APHIS Noxious Weed Policy Implementation Plan, the U.S. Department of Agriculture Strategic Plan for Weeds, and the National Strategy for Invasive Plant Management.

FEDERAL/STATE NOXIOUS WEED ERADICATION PROJECTS

A Few Success Stories. Currently, about 45 species of the 94 taxa that are listed as FNWs are known or reported to occur in the United States to a limited degree. Over the past 40 years, APHIS and its predecessors have been involved in cooperative federal/state efforts to eradicate a number of these species from the United States. These include:

- **Witchweed** (*Striga asiatica* [L.] O. Kuntze). 177,000 ha infested in NC and SC; now reduced to 11,000 ha in 17 counties in NC, and in three counties in SC;
- **Branched broomrape** (*Orobanche ramosa* L.). 283 ha infested in Karnes County, TX;
- **Goatsrue** (*Galega officinalis* L.). 16,000 ha infested in Cache County, UT;

- **Mediterranean saltwort** (*Salsola vermiculata* L.). 550 infested in San Luis Obispo County, CA;
- **Hydrilla** (*Hydrilla verticillata* (L. f.) Royle). 310 km of canals infested in the Imperial Irrigation District, Imperial Valley, CA; now 99% eradicated;
- **Japanese dodder** (*Cuscuta japonica* Choisy). 1 ha infested in the SC Botanical Garden, Clemson, SC;
- **Small broomrape** (*Orobanche minor* Smith). Spot infestations in Washington County, VA; Pickens, Abbeville, and Aiken Counties, SC; and in Baker County, GA;
- **Catclaw mimosa** (*Mimosa pigra* L. Var. *Pigra*). 405 ha infested in Martin and Palm Beach Counties, FL;
- **Asian common wild rice** (*Oryza rufipogon* Griffith). A rhizomatous red rice; 0.5 ha infested in the Everglades National Park, FL;
- **Wild sugarcane** (*Saccharum spontaneum* L.). A rhizomatous wild sugarcane; 13 spot infestations along the southeastern shore of Lake Okeechobee in Martin County, FL, totalling less than 1 ha.

Most of the early weed eradication projects (e.g., witchweed, goatsrue, and hydrilla) involved large acreages. However, in recent years, there has been a general trend toward projects that are smaller in scope and duration (1-2 ha; 3-5 yr). This measure of success is mostly due to increased networking between weed scientists and botanists in recent years. Weeds detected early can be eliminated for less money in less time.

STRATEGIES TO PREVENT THE SPREAD OF ESTABLISHED INVASIVE PLANTS

The first line of defense against introduced invasive plants is **early detection of new infestations**. As already noted, the work of amateur and professional field botanists is critical in early detection and reporting of new plant species as they are observed.

The second line of defense against invasive plants is to **contain and eradicate incipient infestations** as soon as they are detected.

The third line of defense against invasive plants is to **prevent movement into noninfested areas**.

The fourth line of defense against invasive plants is to develop effective and environmentally sound methods and procedures for control of large infestations.

SUMMARY

Harmful non-indigenous plants are biological pollutants that threaten agricultural production and the biodiversity of natural ecosystems in the United States. Federal agencies in the United States, through FICMNEW, are developing a coordinated national strategy for dealing with invasive plants. One role of USDA APHIS in biological protection of ecosystems is to prevent the introduction of foreign invasive plants into the United States. APHIS also cooperates with affected states to combat incipient infestations of Federal Noxious Weeds before they become widespread. The most effective way to deal with invasive plants is to prevent their introduction from other countries, to detect incipient infestations at an early stage, and to implement an effective eradication program before they begin to spread to other farms and states. Money spent on weed prevention is a wise investment that will help to minimize future losses and control costs that are typically associated with widespread weeds.

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