Invasive Plant Management Issues and Challenges in the United States: 2011 Overview

ACS SYMPOSIUM SERIES 1073

Invasive Plant Management Issues and Challenges in the United States: 2011 Overview

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Sponsored by the ACS Division of Agrochemicals



American Chemical Society, Washington, DC

Distributed in print by Oxford University Press, Inc.



Library of Congress Cataloging-in-Publication Data

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Invasive plant management issues and challenges in the United States : 2011 overview / Anne R. Leslie, editor, Randy G. Westbrooks, editor.
p. cm. -- (ACS symposium series ; 1073)
"Sponsored by the ACS Division of Agrochemicals."
Includes bibliographical references and index.
ISBN 978-0-8412-7449-5
1. Invasive plants--United States. 2. Invasive plants--Control--Government policy--United States. I. Leslie, Anne R., 1931-2010. II. Westbrooks, Randy G., 1953- III. American Chemical Society. Division of Agrochemicals.
SB612.A21576 2011
581.6'2--dc23

2011033883

The paper used in this publication meets the minimum requirements of American National Standard for Information Sciences—Permanence of Paper for Printed Library Materials, ANSI Z39.48n1984.

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Foreword

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As a rule, only original research papers and original review papers are included in the volumes. Verbatim reproductions of previous published papers are not accepted.

ACS Books Department

Foreword

In February, 2000, an issue paper entitled "Invasive Plant Species" was published by the Council for Agricultural Science and Technology (CAST). This publication characterized invasive plant species as "one of the greatest threats to croplands, rangelands, aquatic areas, and wildlands in the United States". The paper included a table with a partial list of economically and ecologically important invasive plant species in the United States. It also included their habitat, scientific name, common name, and distribution. In the summary, it stated that "the formula for success" in addressing the problem "must include a coordinated effort at federal, state, institutional, and private sector levels that will involve long-term commitments of adequate planning, funding, scientists, and facilities to produce results based on sound science. Programs based on arbitrary geopolitical boundaries must be replaced by approaches based on ecosystem-scale realities".

Although written by a primarily agricultural group, the CAST paper addressed the threats of invasive plants to natural and managed areas, reasons for their increasing spread, and government measures that might be taken to counteract the problem. The remainder of the paper addressed the strengths and weaknesses of current programs, and provided recommendations for minimizing new plant invasions, and mitigating current damage from established species.

In the years since this paper was published, a number of events have taken place that address these concerns. Every year, during National Invasive Weed Awareness Week, conferences have been held in Washington, DC that bring together leaders from government, industry and the private sector to build relationships and report on progress. A number of invasive plant partnerships and coalitions have been built to address area-specific problems across geopolitical boundaries (e.g., state invasive species councils). A number of government agencies have made invasive species a higher priority for funding and programmatic efforts. In recent years, there has also been an increase in publications as well as online databases that provide links to information and mitigation strategies for invasive species.

In August, 2005, as part of this ongoing effort, a symposium entitled "Control of Invasive Species: Regulatory Concerns and Achievements", subtitled "New Approaches for Prevention, Regulation and Assessment of Invasive Species", was held in Washington, DC. The symposium, which was sponsored by the Agrochemical Division of the American Chemical Society (ACS), was organized by Anne Leslie (Environmental Protection Agency) and Randy Westbrooks (U.S. Geological Survey).

An ACS meeting in our nation's capital offered the opportunity of bringing together representatives of governmental and private organizations that have been

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working to control the spread of exotic invasive plant and animal species in the United States for many years. Although the problem has been recognized for quite some time, it has been lacking an adequate legislative mandate, public awareness, and sufficient funding to meet the challenge. The organizers felt that a dialog at this meeting could result in a publication that would showcase the many diverse efforts being made, especially in dealing with a problem that does not recognize arbitrary geopolitical boundaries. It also would recognize the global extent of the problem and compare the methods used in other countries with those of the U.S. This book is essentially a progress report on some of these efforts at the federal, state, and local levels, with recommendations of what still needs to be done.

The first chapter of the book provides an overview of the environmental challenges involved in meeting industry, agriculture and consumer demands for acquisition of useful plant material from around the world while preventing the introduction of species that have unwanted side effects on the environment. Two important keys for solving these problems include effective methods for screening proposed plant introductions, as well as ranking established weeds for action.

Chapter 2 provides an overview of that first key: pre-border and border weed risk assessment approaches for screening proposed plant introductions. This includes prohibited listing (traditional) as well as permitted listing approaches. Chapter 3 provides an overview of the second key: a post-border weed ranking system that was developed by NatureServe.

Chapters 4 and 5 provide an overview of current weed regulatory issues. Chapter four outlines environmental requirements for federal weed management programs under the National Environmental Protection Act (NEPA). Chapter five introduces a new model for aquatic weed herbicide registration.

Chapters 6, 7, 8, 9, and 10 give examples of invasive plant management on public and private lands in various areas of the country. This includes an overview of the USDA-Carolinas Witchweed Eradication Program, as well as invasive plant management on public lands (National Fish and Wildlife Refuges, National Forests, and Bureau of Land Management lands), and along the nation's highways (Federal Highway Administration).

Chapters 11, 12, 13, 14, 15, 16, and 17 highlight public-private partnerships and the methods they use to deal with area-specific species. This includes an introduction to the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), the Center for Invasive Plant Management at Montana State University, the Invasive Plant Atlas of New England, the Beach Vitex Task Force in the Southeast, the South Fork Weed Management Area in Wyoming, and the Southern Arizona Buffelgrass Coordination Center in Tucson, Arizona.

Chapters 18, 19, and 20 provide an indepth look at the various chemical, mechanical, cultural, and biological methods that are employed to control invasive plants.

Chapter 21 provides an overview of the 'lag phase' – a perplexing problem that prevents us from knowing how invasive a new species in a new region (without a history of invasiveness) will become – *sometimes for decades*.

The approaches and strategies outlined in this book show that much progress has been made in the effort to prevent the introduction and spread of non-native

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invasive plants in the United States of America. But our work is just beginning. According plant geographer John Kartesz (Chapel Hill, North Carolina), over 4,200 species of invasive plants have established free living populations outside of cultivation in the United States and Canada. However, this is just 15% of the 28,000+ invasive plants that have been documented by world weed geographer Rod Randall (Perth, Western Australia). *This is why we need to be extremely careful in introducing all those new and 'wonderful' plants from around the world*.

October, 2011

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Randy G. Westbrooks

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Editors' Biographies

Anne R. Leslie

Anne R. Leslie was a chemist with a special interest in invasive species. Anne received a B.S. degree in chemistry from Arizona State University in 1953 and an M.S. degree in chemistry from McGill University in Montreal, Canada in 1980. She also pursued additional graduate studies at the University of Utah. After joining the U.S. Environmental Protection Agency (EPA) in 1980, Anne worked as a pesticide alternatives specialist in the Office of Pesticides in Washington, DC. She also served as the EPA representative to the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). In the early 1990s, Anne edited a book entitled "Handbook for Integrated Pest Management for Turf and Ornamentals" that was published by the CRC Press in 1994. Since her retirement from the EPA in 1996, Anne continued to be active with invasive species issues. In 2005, she organized and co-hosted the ACS National Invasive Plant Management Symposium that led to the publication of this book.

Randy G. Westbrooks

Randy G. Westbrooks is a Federal Invasive Species Prevention Specialist with the U.S. Geological Suvey (USGS), National Wetlands Research Center, based in Whiteville, North Carolina. He also serves as the USGS representative to the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). Prior to joining the USGS in 2000, Randy served as a Plant Quarantine Officer at the Port of Charleston, SC (1979-1986), as an APHIS Federal Weed Regulatory Specialist in Whiteville, NC (1986-1996), and as the APHIS National Weed Program Coordinator from 1996-2000. Randy received his B.S. and M.S. degrees in Biology from the University of South Carolina (1976 and 1978), and a Ph.D. in Botany and Weed Science from North Carolina State University (1989). At the national and international levels, Dr. Westbrooks is currently working with state and provincial interagency groups to develop new capacity for early detection and rapid response to new invasive plants across the United States and Canada. The overall goal is to detect and eradicate new invasive plants before they become established and start to spread.

Chapter 4

Applying NEPA Requirements for Federal Weed Management Programs

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Under the National Environmental Protection Act (NEPA), federal land management agencies such as the Bureau of Land Management are required to assess the environmental impacts of all federal actions on public lands. This includes projects that involve control and treatment of invasive plants. NEPA addresses unintentional and intentional actions that can happen when multiple use activities such as an oil and gas operations or recreation use occur on federal lands. These activities can introduce invasive plants through vectors such as vehicles, roads, and wildfires, or a non-federal action such as casual recreation use could lead to further natural spread by wind, water, and animals. In turn, when there is a proposal to treat invasive plants on federal lands, federal land management agencies conduct a NEPA analysis on the proposed treatments. In addition to fulfilling NEPA requirements regarding federal actions on federal lands, each federal agency reviews its own internal policies regarding the use of pesticides, such as herbicides for invasive plants as well as for other vegetation control. Among other things, such reviews normally weigh the benefits of control against the environmental, economic, and social impacts of introduced species.

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I. Introduction

Under the National Environmental Policy Act (NEPA), U.S. federal agencies such as the Bureau of Land Management (BLM) are required to evaluate and assess the environmental effects of all federal actions. This includes projects that involve controlling and treating all invasive species from plants to animals. NEPA requires that federal agencies utilize an **environmental impact analysis process** that permits decision makers and the public to conduct environmentally sound field programs that:

Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences," (1).

Agencies must also integrate the requirements of NEPA with other planning and environmental review procedures required by law or by agency practice, and encourage public involvement in decisions that may affect the quality of the human environment.

The application of NEPA to federal invasive species management programs differs based on the activity and the level of analysis that is needed. The analysis can range from Categorical Exclusions (CX), to Environmental Assessments (EAs) and Environmental Impact Statements (EIS). It is incumbent upon the federal agency to determine the appropriate level of analysis.

All internally and externally proposed actions on or affecting public lands or resources under BLM jurisdiction are reviewed for NEPA compliance. NEPA addresses circumstances that could introduce invasive plants through intentional and unintentional actions such as:

- Natural pathways: Wind, water, wildlife, wildfire, etc.
- Man-made pathways enhanced or created by human activity (e.g., gravel pits, roads, etc.)
- Viable seeds, whole plants, or vegetative plant parts.

To do this, each federal agency must screen the proposed action in order to determine the appropriate response for ensuring NEPA compliance. Such proposed actions fall into one of the five types:

- Exemptions,
- Categorical Exclusions CX
- Determination of NEPA Adequacy DNA
- Environmental Assessment EA, and
- Environmental Impact Statement EIS.

Exemptions – Certain types of actions are exempted from NEPA requirements. One example is congressionally exempt actions such as floods, fire, or hurricanes. Emergency actions can be exempt when certain emergency circumstances require immediate action, although they may have significant environmental impacts, but follow-up with NEPA is required.

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Categorical Exclusions (CX) - Weed projects using herbicides typically require an Environmental Assessment (EA) and in some instances Weed Management programs require a much more comprehensive Environmental Impact Statement (EIS). Projects and programs that do not appear to require an EA or an EIS are conducted under a Categorical Exclusion. Categorical Exclusions are approved by the Council for Environmental Quality (CEQ).

Environmental Assessments serve as documentation that an EIS is not required. EAs are typically conducted on minor federal actions, which do not have significant impacts and can be part of the step down analysis from an EIS.

Determinations of NEPA Adequacy (DNA) are actions covered by existing NEPA environmental documents. The BLM encourages programmatic EAs so that BLM Field Offices can tier to a programmatic NEPA document to plan their project work accordingly and be prepared to implement Early Detection and Rapid Response (EDRR) strategies when new infestations are found on public lands.

Environmental Impact Statements are typically conducted on major federal actions, which are determined to have a significant impact on the quality of the human environment. These actions require more in-depth analysis than the other types of NEPA documents. The BLM has one programmatic EIS that addresses the use of chemicals for vegetation treatments including weeds. This covers 17 western states including Alaska (Table 1) (2).

II. Human Health and Ecological Risk Assessments

Even if an herbicide is already approved and labeled by EPA, the BLM goes a step further to comply with 40 CFR Parts 1500-1508. Part 1502.22 deals specifically with incomplete or unavailable information, more commonly known as "data gaps". These are instances when an agency does not have enough information about an issue to reach a conclusion based on the scientific record alone. This requires a federal agency to deal with reasonable foreseeable significant adverse effects. If development of the data is affordable, the data must be developed and provided within the body of generally available science. In the use of chemicals, specifically herbicides, this requirement is fulfilled by the BLM through Herbicide Assessments.

Human Health and Ecological Risk Assessments are conducted by the BLM to evaluate the risks that a chemical may pose to control weeds and other invasive vegetation control poses to the health of humans, wildlife, and native ecosystems. Risk assessments present known information about hazards, patterns of use (exposure), and dose-response relationships of pesticide use. They also provide projections of information to address the data gaps in all three of these areas.

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Herbicide Use by State Chemical	AK	AZ	СА	со	ID	MT	NE	NV	NM	ND	ОК	OR	SD	TX	UT	WA	WY
2,4-D	•	•	٠	•	•	٠	•	•	•	•	•	٠	•	•	•	•	•
Bromacil	•	•	•	•	•	٠	•	•	•	•	•	٠	•	•	•	٠	•
Chlorsulfuron	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Clopyralid	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Dicamba	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Diflufenzopyr + dicamba	0	•	0	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Diquat	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Diuron	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Fluridone	•	•	٠	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•
Glyphosate	•	•	•	•	•	٠	•	•	•	•	•	٠	•	•	•	•	•
Hexazinone	•	•	•	•	•	٠	•	•	•	•	•	•	•	•	•	•	•
Imazapic	0	•	0	•	•	٠	•	•	•	•	•	•	•	•	•	•	•
Imazapyr	•	•	•	•	•	٠	•	•	•	•	•	•	•	•	•	•	•
Metsulfuron methyl	•	•	0	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Picloram	0	•	0	•	•	٠	•	•	•	•	•	•	•	•	•	•	•
Sulfometuron methyl	•	•	0	•	•	٠	•	•	•	•	•	٠	٠	٠	•	•	•

Table 1. Current list of approved herbicides for use on BLM administered lands

Herbicide Use by State Chemical	AK	AZ	CA	CO	ID	MT	NE	NV	NM	ND	ОК	OR	SD	TX	UT	WA	WY
Tebuthiuron	0	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Triclopyr	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

• Based upon the current EISs, these herbicide active ingredients have been analyzed and approved for application on BLM-administered lands. • Based upon the current EISs, these herbicide active ingredients have been analyzed and approved for application on BLM-administered lands, but application is not allowed based on registration status in the state.

III. Internal Agency Policies on the Use of Chemicals for Weed Control

In addition to fulfilling NEPA requirements regarding federal actions conducted on public lands, each federal agency typically reviews its own internal policy requirements regarding the use of chemicals for weed control. The BLM is no exception. The BLM:

- Weighs benefits of control against the environmental, economic and social values that may be threatened.
- Determines scope of project and integrates into the plan positive measures for protecting wildlife and other values.
- Determines for each target pest the possible courses of action and evaluates relative merits for controlling the pest with the least adverse effect on the environment. An integrated pest management approach must be followed in arriving at the decision to use a chemical pesticide. Further policy requires that the BLM may only use BLM approved herbicides and formulations through a Record of Decision (ROD).

IV. Overview of the Environmental Information Gathering Process

In order to determine the environmental scope of a federal action, certain information is needed. Questions to ask when any action is proposed include:

- Will the action or lack of an action introduce or spread invasive plants?
- What can be done to mitigate and/or stop or reduce the spread?
- What measures can be taken to enhance the effectiveness of weed management efforts (e.g., specific weed prevention practices, stipulations in permits, leases, or sales, surveys and inventories, and treatments of existing infestations).
- What tools are available for mitigation or restoration (e.g., use of weedfree forage products such as straw, hay, grain, seed, and mulch).

Thus, in addition to assessing the potential impacts of control measures on humans, wildlife, and native ecosystems, the NEPA process provides an opportunity for a federal agency to develop a clear rationale for managing a particular invader to help meet the general goals and objectives of the agency.

V. Addressing Differences between Agencies When Dealing with Invasive Plants

Since invasive plants do not respect boundaries, differences in agency mission and land use goals can sometimes complicate how different federal agencies implement invasive plant management programs. The invasion of riparian invaders such as saltcedar (*Tamarix ramosissima* Ledeb.) along streams

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and rivers might be seen as an imminent threat to high value natural resources in National Parks and National Wildlife Refuges, and treated as a high priority for Early Detection and Rapid Response. However, on federal lands that are managed for timber or grazing, such an invader might not rank as high in the overall management scheme. Such programs are also affected by available funding and labor. NEPA documentation permits different agencies to provide a rationale for managing the same invader in different ways.

VI. Summary

The National Environmental Policy Act (NEPA) is a federal law that requires federal agencies to take steps to ensure that their actions do not cause harm to human, wildlife, or native ecosystem health. Federal actions under NEPA are categorized as Exemptions, Categorical Exclusions, Determination of NEPA Adequacy, Environmental Assessments, or Environmental Impact Statements. Federal actions are categorized as Exemptions under NEPA by federal law, or during emergencies that require immediate action. Federal Actions that do not require an Environmental Assessment or an Environmental Impact Statement are conducted under Categorical Exclusions. Categorical Exclusions are approved by the Council for Environmental Quality. An Environmental Assessment is conducted for minor federal actions; those that are judged to not have significant Comprehensive Environmental Impact Statements are generally impacts. conducted for major agency programs. The BLM has a National Programmatic Environmental Impact Statement for using herbicides on public lands to control vegetation that was issued in 2007. In addition to assessing the potential impacts of control measures on humans, wildlife, and native ecosystems, the NEPA process provides an opportunity for developing a clear rationale for managing a particular invader in fulfillment of agency goals and objectives. NEPA ensures that all of these 'good sense' management practices are employed on public lands all across the country.

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Chapter 5

Aquatic Herbicide Registration New Model

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Over the past several decades, aquatic herbicides have served as the major management tool for aquatic weeds in the United States. However, until 2001, only six active ingredients had been given national Environmental Protection Agency (EPA) Section Three aquatic registrations. Between 1977 and 2001, only two of these herbicides received EPA Section Three labels. The discovery of fluridone resistant hydrilla in the southeastern United States showed the need for a more diverse pool of chemicals to help minimize the development of herbicide resistance, and indicated the need for a more streamlined aquatic herbicide registration process. To meet this need, the chemical industry, the research community and the EPA formed a Federal Aquatic Herbicide Working group to assist in the registration of minor use aquatic herbicides. As a result of this new level of cooperation between industry, researchers, and federal regulators, a number of new aquatic herbicides have been registered in the past several years. In addition, there is a broader understanding of the need for aquatic herbicide registration, as well as their responsible use in the field.

I. Introduction

Water resources are critical to the well-being of the United States, as they are necessary for the production of food and fiber, transportation of goods, industrial processes, drinking water, recreation, and habitat for fish and wildlife - including threatened and endangered species. One of the greatest threats to maintaining healthy water resources is the introduction, establishment and spread of invasive plants. Invasive plants can impact all types of aquatic sites including rivers, lakes,

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reservoirs, wetlands, and irrigation/drainage canals. If left unchecked, these aggressive weeds block potable water intakes, displace native fish and wildlife habitat, decrease biodiversity, disrupt recreational activities, and degrade human health (1).

Examples of the most widespread and troublesome invasive aquatic plants include the submersed species, Eurasian watermilfoil (*Myriophyllum spicatum* L.), hydrilla (*Hydrilla verticillata* L.f. Royle), Brazilian elodea (*Egeria densa* Planch.), and Curlyleaf pondweed (*Potamogeton crispus* L.); the floating species, Water hyacinth [*Eichhornia crassipes* (Mart.) Solms], Water lettuce (*Pistia stratiotes* L.), and Giant salvinia (*Salvinia molesta* Mitchell); and the emergent plants, Purple loosestrife (*Lythrum salicaria* L.), Common reed [*Phragmites australis* (Cav.) Trin. ex. Steud.], and Giant reed (*Arundo donax* L.). All of the above plants have been introduced into the United States from other parts of the world, and once released in the wild, can be transported within and across watersheds, by animals, water flow, and humans. Because watersheds may fall within several states, invasive plants do not respect political boundaries, and infestations can progress from a local to regional to national level.

There are a number of techniques available to manage or control invasive aquatic and wetland vegetation – chemical biological, and mechanical/physical - and best management practices have been established for this purpose (I). An important management goal is to reduce the abundance of weed infestations, while minimizing injury to non-target plants – a technique commonly know as species-selective control. While herbicides could achieve species-selective and economical control objectives, the path to registration for aquatic products had become poorly understood, cumbersome and extremely slow. Clearly, a new registration model was needed.

II. The Role of Herbicides in Management of Invasive Aquatic and Wetland Plants – Evolution of a New Registration Model

Herbicides have been key tools in aquatic plant management, and they continue to play a major role in controlling nuisance aquatic vegetation in waters of the United States (2). Moreover, the prescriptive use of herbicides can provide species-selective plant control in aquatic sites. Attributes of aquatic herbicides that make them a keystone management tool comprise aspects such as: a) species selectivity, inherent to particular molecules or dose related; b) minimal risk to the environment and human health – low toxicity to fish, invertebrates, and mammals; and c) residual half-lives in water and sediment are short. While serving as the major management tool, only two new active ingredients received U.S. Environmental Protection Agency (EPA) Section 3 labels for use in aquatic sites throughout the U.S. from the period 1977 through 2001: glyphosate (1977) and fluridone (1986). In addition, at the end of that 25-year period, only six active ingredients had national, EPA Section 3 labels were approved by EPA, and three other products received EPA Experimental Use Permits (EUP), or Section

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5 labels. Several factors converged to initiate the resurgence in the development and registration of aquatic herbicides. A new registration model was evolving.

Compound	Date Registered	Major Aquatic Use						
Copper, Copper chelates	1950's	Algae control and combination with aquatic herbicides						
2,4-D	1959 (ester) 1976 (amine)	Systemic herbicide, selective for dicots and broad-leaved plants						
Endothall	1960	Contact herbicide, broad spectrum -selective per application timing, submersed only						
Diquat	1962	Contact herbicide, broad spectrum						
Glyphosate	1977	Systemic herbicide, broad spectrum, emergent plants only						
Fluridone	1986	Systemic herbicide, broad spectrum – rate selective, large-scale or whole-lake management, submersed plants						
Triclopyr	2002	Systemic herbicide, selective for dicots and broad-leave plants						
Imazapyr	2003	Systemic herbicide, emergent plants only						
Carfentrazone	2004	Contact herbicide for dicots						
Bispyribac	2006 (EUP)	Systemic herbicide, broad spectrum, large-scale or whole lake management, submersed plants						
Flumioxazin	2006 (EUP)	Contact herbicide, broad spectrum						
Penoxsulam	2007	Systemic herbicide, broad spectrum, large-scale or whole-lake management, submersed plants						
Quinclorac	2007 (EUP)	Systemic herbicide						
Imazamox	2008	Systemic herbicide, broad spectrum, emergent plants and large-scale or whole-lake management, submersed plants						

 Table 1. A list of registered aquatic herbicides with U.S.-wide (Section 3) and Experimental Use Permit (Section 5) labels and primary uses patterns

Publication Date (Web): September 15, 2011 | doi: 10.1021/bk-2011-1073.ch005

One key ingredient in this registration resurgence was the discovery of fluridone resistant hydrilla. The ability to manage important water resources in Florida and other states would be hindered if other effective and economical tools were not developed to supplement fluridone. In addition, development of herbicide resistance by hydrilla and Dotted duckmeat [*Landoltia punctata* (G. Mey.) D. Les & D. Crawford] suggests that other major weed species may also have this capacity. Another important factor was the business climate created by the advent of glyphosate-resistant row crops, such as Roundup Ready® soybeans, corn, cotton. This occurrence greatly limited market share of crop protection products competing for development funding in the major row crop commodity arena. As a consequence, the loss of market share in row crop herbicides made minor-use markets, such as non-crop lands and aquatics, more attractive to registrants. The old economic paradigm of costly research, development, and registration processes versus a low return on investment in a specialty market (2) was falling by the wayside.

A linchpin in moving the aquatic registration process forward again was the regulatory community's acceptance of the pressing need for new herbicides and the realization that these products could address invasive weed problems while providing an acceptable risk to human health and the environment. For nearly three decades, technical communication and collaboration between the third-party research community (both agency and academia) and respective registrants was operating on an "as needed" basis. While communication between the registrants and the regulatory community functioned as required by laws and policies during this same time period, meaningful and consistent dialogue between aquatics researchers and regulators was lacking.

In the late 1990s, recognition of this communication gap by the research community, including such groups as the U.S. Army Corps of Engineers, the University of Florida, and the U.S. Department of Agriculture (USDA), led to a technical and educational outreach initiative with the EPA Office of Pesticide Programs (OPP). By 2004, collaboration and information exchange between the researchers and the EPA-OPP was strengthened with the formation of a Federal Aquatic Herbicide Work Group and a unique relationship with the USDA's IR-4 Project concerning the registration of minor use herbicides (3). These federal government interactions were then blended with key state regulatory and natural resource management agencies and evolved into partnerships with scientific societies and nonprofit organizations, such as the Weed Science Society of America, the Aquatic Plant Management Society, and the Aquatic Ecosystem Technology transfer focused on the need for new Restoration Foundation. products, the re-registration of old chemistries, use patterns in aquatic sites, improvements in labeling, revisions to use restrictions that allowed for selective control of target weeds, and protection of human health and the environment Due to this cooperation between industry, regulators, and researchers, (4).understanding the need for aquatic herbicide registrations and their responsible use is at its highest point in history. This cooperation will be increasingly critical as the EPA moves toward more complex pesticide regulations concerning impacts on threatened and endangered species via the Registration Review process, and potential permit requirements for aquatic pesticide applications via the National

Pollution Discharge Elimination System (NPDES) under the jurisdiction of the U.S. Clean Water Act.

III. The Future – Maintaining the New Registration Model

In order to maintain and improve this new aquatic herbicide registration model, it is recommended that three primary goals be achieved:

- 1. Strengthen and utilize the Federal Aquatic Herbicide Working Group. This working group should enhance interactions with the Federal Interagency Committee on Management of Exotic and Noxious Weeds, the Federal Invasive Species Advisory Committee, and the National Invasive Weed Awareness Week coalition.
- Provide a non-industry, third-party, aquatic plant control research and development (R&D) network. This R&D network should cover all regions of the US, and should include government agencies and selected academic institutions.
- 3. Expand interactions with R&D groups and the regulatory community. These interactions should include the permanent establishment of a Subject Matter Expert position within the EPA that cooperatively works with registrants, regulators, user-groups, and the greater R&D community.

It will difficult to achieve the goals outlined above without a long-term and consistent commitment of adequate resources (e.g., investigators, facilities, and funding) by agencies or institutions. Unless this resource commitment is met, the ability to conduct the required research, provide the needed solutions, and maintain a viable registration process will not be fully achieved. Finally, the considerable problems posed by invasive aquatic plants cannot be overcome unless a truly integrated cross-discipline effort is conducted, including contributions from plant scientists, toxicologists, aquatic ecologists, fisheries scientists, regulators, and public policy makers.

IV. Summary

Over the past several decades, aquatic herbicides have served as the major management tool for aquatic weeds in the United States. However, until 2001, only six active ingredients had been given national Environmental Protection Agency (EPA) Section Three aquatic registrations. To meet the challenge of herbicide resistance caused by over dependency on a few major chemicals, industry, researchers, and the EPA formed a Federal Aquatic Herbicide Working group to assist in the registration of minor use aquatic herbicides. As a result, a number of new aquatic herbicides have been registered in the past several years. In order to maintain and improve this new aquatic herbicide registration model, it is recommended that the Federal Aquatic Herbicide Working Group be utilized and strengthened; that a non-industry, aquatic plant control research and

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development network be established; and that interactions between research and development groups and the regulatory community be expanded.

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Chapter 8

USDA Forest Service National Strategy and Implementation Plan for Invasive Species Management

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The Chief of the Forest Service has identified invasive species as one of the top four threats to our Nation's forest and rangeland ecosystems. In response, the agency is taking a leadership role to "raise the bar" for increased action against this national and global threat, beginning by taking a strategic approach with one focused goal: "To reduce, minimize, or eliminate the potential for introduction, establishment, spread, and impact of invasive species across all landscapes and ownerships". The release of the USDA Forest Service National Strategy and Implementation Plan for Invasive Species Management was a major step forward in reaching this goal, and will guide the agency as it builds capacity to strategically and effectively meet the invasive species challenge in collaboration with other partners. The National Strategy and Implementation Plan is built around four program elements. This includes prevention, early detection and rapid response, control and management, and rehabilitation and restoration. Each program element includes a description of success, achievable accountability measures, and prioritized strategic actions that are specific and achievable steps to reach the stated goal. The Strategy also contains guidance related to four common themes. This includes Partnerships and Collaboration; Scientific Basis (scientific information, assessment and monitoring, and prioritization), Communication and Education, and Organizing for Success (incorporating the themes of improving capacity,

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procedural streamlining, and funding flexibility with long-term commitment).

I. Introduction

Invasive species have been compared to a "wildfire in slow motion." Thousands of invasive nonnative plants, insects, fish, mollusks, crustaceans, pathogens, mammals, birds, reptiles, and amphibians have infested hundreds of millions of acres of lands and waters across the Nation, causing massive disruption in ecosystem function, reducing biodiversity, and degrading ecosystem health in our forests, prairies, mountains, wetlands, rivers, and oceans. Invasive species not only affect the health of America's forests and rangelands, but also the health of wildlife, livestock, fish, and humans.

Where technology cannot prevent or eradicate invasive species, our options for restoring native communities and ecosystems lessen, and our ability to sustain ecosystems for the public in the future is diminished. Invasive species are not new to the country; however, the invasive species problem is expanding rapidly owing to the increased variety of nonnative invasive species and infestation "pathways." Global trade has increased the opportunities for insects, plants, and diseases to cross continental and geographic boundaries like never before. A second factor is that natural controlling processes and limiting factors that kept species in check in their native ecosystems are not present in their "new homes," and their populations can sometimes flourish and begin to spread. Invasive species are often able to outcompete native species, especially when ecosystem health is stressed by factors such as drought, fire, pollution, over-utilization of resources, or increases in unmitigated disturbances.

In many cases, there is inadequate knowledge about how non-native species function in their new environment, which significantly undermines our ability to detect and eradicate new or small infestations. In addition, ongoing control efforts are further complicated by the lack of an effective national early warning and rapid response system. Finally, there is a paucity of environmentally safe and effective techniques that limit impact on non-target areas and sensitive native species. Control efforts can be further hampered when working across multiple political jurisdictions and ownerships such as in metropolitan and on private lands. Rehabilitation and restoration efforts also require new and expanded sources of native plant materials.

In 2003, Chief Dale Bosworth articulated a clear vision of the path that the Forest Service needs to take in addressing exotic invaders. In simple terms, the agency needs to:

- prevent the introduction of new invasive species onto Forest Service lands;
- detect and eradicate new invaders before they become established and begin to spread;
- 3) contain and control established infestations ; and
- 4) restore invaded habitats to a balanced state.

The long term goal is to reduce the invasive species problem on Forest Service lands to manageable/livable levels.

Forest Service administrators know it is impractical to eliminate all invasive species from the country, any more than fire can be totally prevented in an ecosystem. But administrators expect the agency to develop a long term approach to break the strangle-hold of invasive species on Forest Service lands. Thus, the charge to the Forest Service was given, and the battle against invasive species became part of the agency's **Top 4 Threats Campaign**, along with *Wildfire/Fuels*, *Forest Fragmentation/Urban Sprawl*, and *Impacts from Unmanaged Recreation*.

Elevating invasive species management as a priority natural resource management issue was unprecedented across land management agencies in the U.S. Department of Agriculture or the U.S. Department of the Interior. This major re-focus of Forest Service priorities shook the 100-year-old organization. In addition, the program includes all types of terrestrial and aquatic invasive species threats, from pathogens and invertebrates, to plants and animals. Building an effective program against invasive species will require significantly different approaches and coordination activities across the agency, while taking advantage of current agency capabilities, strengths, and infrastructure. Further complicating the process is the fact that new funding for domestic natural resource issues is already limited, and the Forest Service is receiving projections for even larger program reductions. Needless to say, improving program efficiency and accelerating action against invasive species are both critical for long term program success.

II. Role of the Forest Service in the National Invasive Species Effort

The Forest Service has some unique characteristics that will allow it to play a major role in the fight against invasive species. To begin with, it has authority to directly manage 192 million acres of national forests and grasslands (approximately 9% of total acres in the United States). The agency also has the responsibility and authority to provide technical and financial assistance for all of the nation's 731 million acres of forest lands including urban forests; state, private, and tribal forest lands; and forested lands managed by other federal agencies (35% of total acres in the United States).

The Forest Service is recognized internationally for its land management and research expertise. It has thousands of specialists including 150 forest entomologists, forest pathologists, botanists, and ecologists as well as over 500 research scientists. Forest Service Technology Centers specialize in the development and application of the latest in technology. The Forest Service also conducts research, scientific collaboration, and review to ensure a scientific foundation that fills priority information gaps. Staffs also include experts in public communication, legislative affairs, and technology transfer and education.

The National Forest System extends across the United States from Alaska and Hawaii to the Caribbean and New England. National forests and grasslands are found in 44 states, Puerto Rico, and the Pacific Island territories, with

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offices in over 650 communities nationwide. As a result, the Forest Service has established relationships in thousands of communities across the country. It has working relationships with all other federal agencies that are involved in invasive species activities, including the Animal and Plant Health Inspection Service (APHIS), as well as all leading national and international organizations that focus on invasive species. It also has ongoing partnerships with all of the state and territorial agencies with responsibility for invasive species; and has a long history of providing financial assistance to states and territories for dealing with natural resource problems. Finally, the Forest Service has formal working relationships with most major colleges and universities, and with a number of forest protection agencies in other countries. As a result of our authorities, expertise, relationships, and presence, the Forest Service is uniquely positioned to be a leader in the fight against invasive species.

III. Strategic Approaches for Addressing Invasive Species on Forest System Lands

Soon after the Chief called for action against invasive species, a multidisciplinary team of specialists, program leaders, managers, and researchers was established to lead an effort to develop a national agency-wide strategy to address invasive species issues. From a design standpoint, the development of a strategic approach became the foundation on which all invasive species work in the agency would be built. This strategic foundation focused on a single goal: *"To reduce, minimize, or eliminate the potential for introduction, establishment, spread, and impact of invasive species across all landscapes and ownerships."* The national strategy for invasive species management was not designed to serve as a comprehensive, all-encompassing strategy or a listing of all the things the Forest Service needs to do to combat invasive species. Instead it was intended to identify a strategic direction for Forest Service programs spanning Research, International Programs, State and Private Forestry, and the National Forest System program areas of the Forest Service. It identified a number of strategic actions to help the Forest Service reach its goals related to invasive species.

The team identified the role of the Forest Service as a leading forest research, forest health, and federal resource management agency and evaluated the agency's abilities to address the invasive species problem in collaboration with its partners. The team highlighted the Forest Service's significant role in collaboratively addressing invasive species threats at the local, state, and national levels as well as internationally, and noted that the best chance for success would come from working strategically and collaboratively to use all of the agency's scientific, management, and partnership resources in unison.

The information compiled by the team was used to develop guidance for Forest Service programs to implement a more effective approach to address the invasive species problem, in support of the agency's stewardship mission and the implementation of the *Invasive Species Executive Order 13112*. The strategic approach developed by the team was divided into two major parts, including approaches for addressing invasive species, and the capacity-building

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activities that would be required to be effective in utilizing those approaches. These approaches center around four major activity categories, termed "*Program Elements*", that are designed to effectively address invasive species threats at all levels. These include:

- Prevention—Keep invasive species out.
- Early Detection and Rapid Response—Detect and eradicate incipient infestations of new invasive species.
- Control and Management—Suppress and contain infestations of widespread invaders.
- Rehabilitation and Restoration—Heal, minimize, or reverse the effects from invasive species.

These four program elements also reflect the priority areas of emphasis identified in the National Invasive Species Management Plan of 2001 issued by the National Invasive Species Council. These Forest Service approaches to addressing invasive species are also linked to the Forest Service Strategic Plan, and addressed each of the Chief's Four Threats either directly or indirectly.

IV. Guiding Principles and Common Themes

Interwoven with the program elements in the Forest Service strategy against invasive species is the need to: 1) use a science-based prioritization of invasive species problems in all programs, 2) enhance collaboration on the solutions to those problems, and 3) establish an improved system of accountability agency-wide that ensures the most efficient use of limited resources at all levels of the organization. Although the national strategy was developed from existing field information, policies, and authorities from Forest Service program areas, the team also identified gaps in (among other things) policy, research, and field-level operational capacity.

The Forest Service's ability to implement the four program elements identified for the national strategy in a proactive, holistic, collaborative, and adaptive manner is dependent on the agency and its partners having the capability and sufficient knowledge for invasive species management. The national strategy development team determined that the keys to enhancing this capability should be grouped into four categories, including: (1) partnerships and collaboration, (2) a scientific basis, (3) communication and education, and (4) organizing for success.

A. Partnerships and Collaboration

Collaboration is an important overarching need in all the national strategy elements. Forest Service invasive species management activities need to be coordinated at all levels of the organization and across all programs. Collaboration also extends outside the agency to the broader federal family, state and local governments, tribal interests, non-governmental organizations and others in the private sector, and international stakeholders. Collaboration also implies

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cooperating across ownerships, state lines, and political jurisdictions. Examples of some opportunities include coordination with native plant species groups or invasive plant coalitions, aquatic nuisance species organizations, pest advisory groups, international agencies, and invasive insect and pathogen coalitions. In support of the National Strategy, the Forest Service plans to expand partnership development with non-traditional organizations and increase national cooperation and coordination with environmental groups, recreational groups, and industry. The Forest Service will also facilitate the establishment of cooperative invasive species management areas, participate in research activities, and design recreation and management programs that do not increase the threats and impacts of invasive species.

B. A Scientific Basis

Based on research and used in conjunction with other socioeconomic considerations, scientific information is a foundation for not only for determining actions appropriate to achieving the desired result, but also for prioritizing those actions as well.

Incorporate Scientific Information

The national strategy guides the Forest Service to conduct appropriate research and development activities to ensure management programs are effective and science based. Sound scientific information is critical in guiding management activities, determining the magnitude of invasive species problems, planning future research and management programs, and improving intervention efforts. Where technology or knowledge gaps occur, the extensive and diverse research and technology of the Forest Service and other entities can serve a vital role in developing new techniques and obtaining up-to-date information to achieve comprehensive invasive species management goals. Collaborative partnerships with universities, States, other agencies, and the private sector can be the foundation of invasive species science and technology programs.

Assess and Monitor for Success

The current invasive species monitoring and inventory systems need to be improved through research and expanded to provide an adequate baseline of infested forest and grassland acres. These systems will also enable the Forest Service to adjust, if needed, the prioritizations of actions, targeted species, and methods and to modify activities contributing to the invasive species spread. Measuring performance and reporting accomplishments will be managed through existing networks with emphasis on cross-program reporting requirements. Monitoring for prevention and early detection of invasive species in urban areas is one of the first lines of defense in protecting all lands, including forests and rangelands. The massive amount of diverse information requires the agency to

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improve its data management systems and increase its networking capacity with the external data sources of its partners. Such a system will build on existing databases of inventory and monitoring information and link to protocols, models, assessments, and analysis results.

Prioritize

The national strategy calls for a prioritization of programmatic and species-specific activities in order for the Forest Service to effectively use its limited resources. Prioritization of activities must be a dynamic and flexible process that enables decisions to be made by using the best available scientific information. Risk assessments will be used to set priorities. Priority setting will occur at different hierarchical levels (for example, spatial, agency, taxonomic) as appropriate. Priorities should be set at the lowest level practical to ensure that the appropriate result is achieved on the ground. Generally, the Forest Service will prioritize activities by focusing on highly productive and efficient elements first, such as prevention or early detection/rapid response (EDRR); for example, treating "outliers" may be a productive strategy. When setting priorities; species characteristics; infestation consequences; and the availability, feasibility, and likelihood of success of treatment versus non-treatment must all be considered. Developing risk assessment models can help achieve consistency in prioritization among landowners and invasive species managers.

C. Communication and Education

An important factor that spanned all program elements in the national strategy is the need to clearly communicate information and ensure that it is understood. It is important for the public to develop an understanding of the magnitude and urgency of the invasive species problem. Education, communication, and interpretation programs can help to engage the public in preventing, detecting, and controlling invasive species. They also provide a means for gathering public input on agency program plans, and help to promote and implement partnerships with other organizations. Internal communication will raise awareness of the problem among Forest Service employees and help them incorporate practices that are sensitive to invasive species control efforts into their day-to-day activities. Communication with other agencies will foster relationships and partnerships.

D. Organizing for Success

Although the Forest Service has an organizational foundation for implementing the national strategy, several factors could enhance its ability to succeed.

Improving Capacity

In all aspects of the strategy, the Forest Service can increase effectiveness by building on its existing efforts and those of its partners in invasive species research and management. It is important to assess existing efforts to determine where additional effort is needed. The Forest Service can increase capability by working with partners that have the needed expertise, training current employees to expand their expertise, enlisting the help of all employees in their daily activities, eliciting volunteer assistance, and hiring new employees with the requisite expertise. In the Forest Service, making invasive species management a part of the agency's day-today activities could be facilitated through appropriate agency policy, guidance, and direction, including manuals, handbooks, and technical guides. This plan includes appropriate forest plan direction, best management practices, contract and permit language, and terms and conditions for issued authorizations.

Procedural Streamlining and Improvement

Under law and policy, the agency is responsible for proper planning and analysis of potential impacts before taking action. As with wildfire situations, however, the Forest Service needs to be able to respond quickly to prevent new invasive species populations from becoming established or to capitalize on opportunities to be more effective in the future. This rapid response needs to occur without violating legal mandates or public trust. The national strategy calls for identifying opportunities in advance and developing guidance and policy to improve agency effectiveness and reduce the time required for adequate planning and project analysis.

Funding Flexibility and Long-Term Commitment

Without a flexible, functioning, and responsive budget structure and associated funding mechanisms, the strategic approaches and activities in each program element may not provide the means to achieve Forest Service goals related to invasive species management. In many cases, several years of monitoring may be required to detect sufficient trends in species spread to characterize risks and threats. In the meantime, new invasive species may be detected that have characteristics that may make them a higher priority for treatment. Flexibility in funding, staffing, and program direction will allow a shift in focus as required. Invasive species management and research efforts operate on long timeframes. Research on control methods, for example, requires several years before protocols can be designed and tested to ensure effectiveness. Prevention and early detection require continued vigilance, and control efforts require persistent efforts to achieve success. Long-term funding support requires a commitment to the program internally and externally and may also require budget process and structure changes that allow and secure multi-year and continuing funding.

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E. Program Performance

One of the most important aspects of developing the guidance and strategic approaches against invasive species through the program elements is to describe what success would look like. Having a performance target is critical in helping program managers measure their effectiveness. At the behest of the National Forest System division of the agency, the team established a set of interim performance measures ("Accomplishment Measures") to accompany each of these targets ("Description of Success"). This coupling of actions and performance will ultimately support significant changes being recommended by the Office of Management and Budget with respect to agency-wide performance and accountability.

F. Program Elements

Element 1: Prevention

The most effective strategy against invasive species is to prevent them from being introduced and established. Preventative measures typically offer the most cost-effective means to minimize or eliminate impacts. Prevention relies on a diverse set of tools and methods, including education. The Forest Service has a wealth of experience and skills within its own organization in addition to those available through numerous collaborators. As an agency capable of working across the landscape and with international partners, the Forest Service occupies a solid position to lead efforts to prevent potential invaders. As discussed above, the "Description of Success" for the Prevention element was developed for the national strategy as: "New introductions of invasive species are prevented and infestations of established invasive species are contained". This target is a vital component for measuring invasive species prevention effectiveness.

In developing the National Strategy, Forest Service invasive species prevention activities were compiled from all levels of the organization and across all programs. A sub-set of these activities was included in the National Strategy to help describe the breadth of work that is underway and capacity that is already in place. In addition to describing what is already underway across the agency, the national strategy provides the agency with a set of priority short-term and long-term (Strategic) actions associated with prevention activities.

Element 2: Early Detection and Rapid Response

Sometimes considered the "second line of defense" behind prevention, early detection rapid response (EDRR) has been identified as a critical component of any strong invasive species management program. The National Strategy provides guidance for developing EDRR capacity across the National Forest System. When new invasive species are detected, a quick and coordinated containment and eradication response is necessary to reduce environmental and economic impacts and result in lower cost and less resource damage than

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implementing a long-term control program after the species is established. Early detection of new infestations requires vigilance and regular monitoring of the managed area and surrounding ecosystem. The Forest Service is well suited to improve its early detection capabilities through the collaborative and coordinated efforts of numerous agency programs, our field offices, and our partners.

Successful EDRR activities require both the capacity to swiftly detect and respond to invasive species threats. The description of success for the EDRR program element was developed as: "*New occurrences of targeted invasive species are detected and eliminated before establishment and spread*".

As with the prevention element, Forest Service invasive species EDRR activities were compiled from all levels of the organization and across all programs. A sub-set of those activities was included in the National Strategy to help describe the breadth of work that is underway, the capacity that is already in place, and to help highlight program gaps for EDRR. As an attempt to fill some of those gaps in Forest Service EDRR capabilities, a set of priority short-term and long-term (strategic) actions associated with EDRR in the national strategy was identified.

Element 3: Control and Management

When invasive species become established as free-living populations in an ecosystem, a strategic approach for control is required to minimize their impacts or reduce their spread. Effective control relies on a clear understanding of the target species including its biology and associated pathways. It also relies on persistent follow-through. The National Strategy stressed that Forest Service control and management activities should be founded upon integrated pest management principles that may include any combination of physical/mechanical, biological, cultural, and chemical techniques. This integrated approach also includes assessments of risk, identification of thresholds for action, and planning to reach the most desired outcome. Forest Service control and management activities against invasive species are considered successful when: "Existing infestations of targeted species are eradicated, controlled (ongoing suppression), or contained (outlying infestations are eradicated). New infestations of targeted species are eradicated." The national strategy team recognized that the bar is being set high in this program element, but concluded that this will help advance the priority of invasive species and challenge agency employees to a higher standard. Priority short- and long-term (strategic) actions to help achieve this end for control and management were identified in the national strategy.

Element 4: Rehabilitation and Restoration

Rehabilitation is needed to respond to the effects of disturbances, and restoration is needed to move previously invaded areas toward our desired conditions. This element in the invasive species program provides a vital foundation for sound management of invasive species invading terrestrial or

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aquatic ecosystems. This element includes actions that are both proactive and reactive in practice. Rehabilitation and restoration of previously invaded areas should be conducted to establish conditions that could strengthen ecosystem resistance to reinvasion or to invasion from a different species. Because each invasion characteristic is unique, specific restoration and rehabilitation programs need to be designed at the appropriate level. Success is defined as: *Ecosystems impacted by invasive species have been effectively restored or rehabilitated to desired conditions and to conditions that reduce vulnerability to invasion or reinvasion by invasive species.*"

The Forest Service has experience in conducting rehabilitation and restoration programs from the project level to an eco-regional scale, addressing effects of disturbance from a variety of sources to restore ecosystem sustainability. In addition to this experience, the Forest Service pools its expertise with that of its partners in many rehabilitation and restoration efforts. A subset of activities related to restoration and rehabilitation against invasive species was included in the national strategy, and used to promote these practices and help identify additional actions needed. Both short-term and long-term (strategic) actions related to this program element were identified in the national strategy.

V. Priority Actions Associated with Themes Common to All Program Elements

•Work internally and externally to identify budget and capacity to implement the national strategy.

•Establish multidisciplinary (for example, wildlife biologists, forest health protection specialists, botanists, forest and rangeland staff, researchers, engineers, ecologists, and hydrologists) invasive species management coordination teams in each region/station to implement the national strategy and implementation plan.

•For all program areas of the Forest Service, develop a comprehensive invasive species policy that incorporates the National Fire Plan and Healthy Forest Restoration Act as they relate to invasive species and that provides guidance for incorporating related desired conditions, goals, and objectives into forest plan revisions.

•Pursue using the National Environmental Policy Act categorical exclusions and emergency authorities to ensure that environmental analysis does not inhibit environmentally sound rapid response or control efforts.

•Update, revise, and enhance the Forest Service's invasive species Web site to serve as a comprehensive internal and external communication tool.

•Work with partners to accomplish these tasks:

- Develop a targeted marketing strategy to achieve public awareness of invasive species and understanding of the role citizens can play in all program elements.
- Complete the invasive species best management practices video series and handbook.

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- Expand quarantine facilities for plant, insect, and pathogen control research.
- Increase availability of taxonomists to identify new invasive species.

•Host national Forest Service invasive species conferences to improve coordination and collaboration among managers, researchers, and partners.

•Work with other agencies, such as Economic Research Service, to expand economic impact assessments for priority invasive species.

•Develop standard invasive species prevention language for use in contracts, permits, and closure orders.

•Ensure that national and regional programmatic performance measures correlate directly with the Forest Service Strategic Plan and track activities to achieve the goal in the national invasive species strategy.

•Work with agencies and partners to develop common, agreed-upon, and desired conditions in priority areas; reference points characterizing existing conditions/trends; and performance measures that use sustainability criteria and indicators that link to desired conditions and multi-scale monitoring efforts designed to gauge progress and help focus scarce resources to highest priority areas.

VI. Summary

The National Strategy and the proposed actions described in it are guiding Forest Service programs to employ an effective, integrated, comprehensive, and science-based approach for addressing the invasive species problem. The National Strategy focuses on developing priority operational activities supported by scientific research to achieve results on the ground against the invasive species threat. By effectively executing this strategy, the Forest Service is fulfilling its commitment to protect the Nation's forest and rangeland ecosystems. In the process of fully executing this strategy, the agency will monitor its progress and make the appropriate corrections on its course in the future. The full content of the National Strategy and Implementation Plan can be viewed on-line at http:// www.fs.fed.us/invasivespecies/documents/Final National Strategy 100804.pdf.

Note: Since the completion of the Forest Service "National Strategy and Implementation Plan" in 2004, and this presentation in 2005, the Forest Service has successfully implemented over 80% of its top priority actions, and has completed a satisfactory Program Assessment Rating review by the Office of Management and Budget of its program performance effectiveness. The Forest Service continues to identify opportunities for program improvement at all levels, and uses program performance as one of the criteria for the annual budget allocation process to the National Forest System.

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Regional Centers of Excellence: The Center for Invasive Plant Management

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The Center for Invasive Plant Management (CIPM) was established in 2000, and grew out of the invasive plant milieu particular to the western United States at that time. Responding to stakeholder needs has been a crucial element in the success of CIPM. Additional "centers of excellence" are emerging in other regions of the country. Working at a regional scale has many advantages. Stable baseline funding and a formalized, non-hierarchical communication network among Centers are now needed to maximize the efficiencies, expertise, and services offered by these regional organizations. Drafted in 2007, this chapter reflects the groundswell of emerging organizations and energy of the time. Many other organizations have appeared in the meantime, but the need for national coordination remains. The author was Director of CIPM from 2000 to 2008.

I. Introduction

In September 1997, a group of state and federal agency representatives, university scientists, agribusiness personnel, and ranchers gathered in Bozeman, Montana, to discuss the concept of a "Center for Noxious Weed Management". The idea of a center that would coordinate education, research, and agency interests in the western states appealed to everyone. The Minutes from that meeting reflect excitement for what could be accomplished by working together.

Over the next two years, a diverse and ever-expanding group of participants from western states developed a mission statement, goals, and objectives

for such a regional organization. The plan focused on education, research, and implementation. A congressional pass-through allowed the Center for Invasive Plant Management (CIPM) to open its doors at Montana State University-Bozeman in June, 2000. A diverse, 10-member Steering Committee and five-member Science Advisory Council were appointed to represent varied agencies, institutions, and interests of the western United States.

II. Mission of the CIPM

The mission of CIPM, as defined at its first Steering Committee meeting is: "To promote ecologically sound management of invasive plants in western North America by sponsoring innovative research, advancing education, and facilitating collaboration among scientists, educators, and land managers." Serving people has been central to CIPM's approach and can be further seen in its stated vision of "well-informed invasive plant professionals who have the contacts, information, and resources necessary to accomplish their goals."

III. CIPM – Accomplishments from 2000-2006

By the end of 2006, CIPM had a staff of five and had awarded more than \$1 million in grants to scientists and cooperative weed management areas in 22 states; coordinated or sponsored 20 regional or national symposia; created a popular, national website and information clearinghouse (www.weedcenter.org); developed or sponsored 22 publications; presented information on a variety of subjects in 23 states; and actively partnered with a long list of agencies, institutions, and organizations. CIPM is now recognized as a valuable source of science-based information by federal agencies in Washington, DC, and scientists and land managers throughout the West.

IV. CIPM – Identifying Regional Invasive Plant Needs

Since the very first discussion of a western regional center, it has been critical to identify regional needs so that CIPM can respond with programs and products that are relevant and valuable. CIPM's representative Steering Committee and Science Advisory Council have assisted CIPM staff – who regularly interact with diverse stakeholders – in defining and responding to western regional needs. When CIPM was established in 2000, many western states already had a legal and regulatory infrastructure (such as county weed districts, state weed coordinators, and noxious weed laws) to address invasive plants. In addition, most western states had statewide weed control associations. Regional issues had been discussed through the all-volunteer, nonprofit Western Weed Coordinating Committee. Therefore, western regional needs did not focus as much on organizing groups or finding information as on coordinating existing groups and sorting through reams of information that could help those groups meet their short term and long term goals.

In Invasive Plant Management Issues and Challenges in the United States: 2011 Overview; Westbrooks, R., et al.; ACS Symposium Series; American Chemical Society: Washington, DC, 2011.

Over time, CIPM has understood regional needs to be:

- An information clearinghouse;
- Support for innovative research and community-led, on-the-ground initiatives;
- Outreach products and professional development opportunities for land managers;
- · Coordination of multi-institutional projects; and
- Communication and technology transfer between scientists and land managers.

V. CIPM – Responding to Regional Invasive Plant Needs

CIPM has responded to these needs in a variety of ways as described below.

A. Information Clearinghouse

CIPM's extensive website (www.weedcenter.org) offers comprehensive information about invasive plant ecology and management. The site includes news, weed profiles, searchable databases, educational curricula, lists of grant opportunities, and resources for weed management areas. CIPM staff also regularly responds to requests for information, products, contacts, facilitation, and project coordination from many different groups and regions.

B. Support for Innovative Research and Community-Led, On-the-Ground Initiatives

Support for new research and providing research results to land managers and landowners is critical in developing long-term, sustainable, ecologically-based invasive plant management. Between 2001 and 2006, CIPM awarded 66 research grants totaling \$646,293 to scientists in 19 states. Support – financial and otherwise – is also needed by practitioners in Cooperative Weed Management Areas (CWMAs). Between 2002 and 2006, the Center for Invasive Plant Management awarded 98 CWMA grants totaling \$471,272 to local weed management groups in 16 states. CIPM grant dollars leveraged more than \$1.5 million of in-kind and cash contributions from private landowners and local, state, and federal partners in these communities.

C. Outreach Products and Professional Development Opportunities for Land Managers

CIPM has developed a number of resources for land managers including multi-author publications such as *Inventory and Survey Methods*, outreach materials such as life-sized plastic weed models, and online learning workshops and modules. In almost all cases, these materials are developed in partnership with other agencies and multiple subject-matter experts.

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D. Coordination of Multi-Institutional Projects

"Partnerships" and "working together" are often encouraged and yet the time to coordinate multiple entities is not allotted in very many people's jobs. CIPM has tried to fill this gap. CIPM has facilitated a five-state initiative to address saltcedar, organized cross-disciplinary and multi-organization symposia and workshops, maintained logistical support such as listserves and Web pages for stakeholder groups, and other activities.

E. Communication and Technology Transfer between Scientists and Land Managers

Invasive plant management is most successful when scientists and land managers share ideas and perspectives. Ideally, information flows both ways. Sponsorship of interactive workshops and coordination of publications that provide good science to practitioners are two ways through which CIPM has supported the linkage of science and management.

VI. Establishment of Other Regional Centers and Networks

Growing awareness of the ecological and economic threat of invasive plants has led to the germination of several regional, non-governmental organizations and centers of expertise and coordination across the United States. These centers may be associated with universities or they may be nonprofit organizations, but in all cases they have established successful programs to respond to the needs of public and private land managers working on invasive plant management. Using criteria of 1) an established organization with paid personnel and a permanent location, and 2) regional (typically multi-state) vision and responsibilities with broad recognition as a valuable resource among the region's land managers, several regional centers and networks should be noted:

The California Invasive Plant Council (Cal-IPC) is a nonprofit organization with 1,000 members that provides technical support on invasive plants for people working in the field and in outreach efforts for public education. See http://www.cal-ipc.org for more information.

The *Center for Aquatic and Invasive Plants* is a multidisciplinary research, teaching, and extension unit directed to develop environmentally sound techniques for the management of aquatic and natural area weed species. It is associated with the University of Florida. See http://plants.ifas.ufl.edu for more information.

The *Invasive Plant Atlas of New England* (IPANE) is a consortium based at the University of Connecticut to gather and disseminate plant species data. It also maintains a corps of 500 trained volunteers and provides technical assistance to many organizations. See http://www.ipane.org for more information (see also Chapter 14 of this publication).

The *Midwest Invasive Plant Network* (MIPN) is a nonprofit organization based in Indiana that develops educational materials for diverse stakeholders, offers workshops on developing cooperative weed management areas, and hosts

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an annual symposium on invasive plants. See http://www.mipn.org for more information.

VII. Meeting Future Challenges

Regional centers of excellence – that is, centers that typically focus on multiple states – can be valuable resources to natural resource managers, scientists, and the public. A *regional* focus (as opposed to a local or national focus) allows:

- Development of information (e.g., plant species, treatments, research initiatives, outreach projects) specific to the ecology, culture, and human demographics of a region. Information and approaches can be shared within regions without significant redesign, thereby maximizing efficiency.
- Effective, hands-on coordination or facilitation of management, research, and educational programs requested by stakeholders. This can be done at a local, state, or regional scale more easily than at a national scale.
- Personal working relationships between the Center staff and regional stakeholders – that is, the Center does not become a distant, faceless institution. Also, the Center staff is able to work with diverse stakeholders in light of other regional activities and potential partners that could add value to a project.
- An informed yet "neutral" approach that allows a Center to coordinate multi-state or multi-agency projects as a facilitator trusted by all.

VIII. Summary

CIPM and the other Centers mentioned above all combine service to stakeholders with leadership of and vision for new programs in their regions. All of them work in partnership with many organizations, agencies, and institutions. All of them meet a public demand for science-based information. And four out of five are funded entirely on "soft money," i.e., on a year-to-year basis. For regional Centers to offer prompt, efficient, science-based, ecologically- and culturally-relevant services to stakeholders, two needs must be met: 1) stable baseline funding, and 2) communication among regional Centers.

Stable baseline funding would allow Centers to develop long-term programs, including granting and research programs. It would allow Centers to maintain high-quality staff that develops histories of working with people and programs in the region. It would also allow Centers to use more of their resources for on-the-ground programs and less in fundraising. An ideal scenario would be ongoing Federal funding for baseline activities (salaries/benefits for core staff, office space and functions, communications) with an expectation that program dollars would be derived from partnerships, competitive grants, and provision of services. A stable financial foundation, then, would be overlaid with shorter-term, program-specific funding to respond flexibly to stakeholder needs in the region. This partnership scenario builds on the differing strengths

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of the federal agencies (long-term stability) and non-governmental organizations (flexibility and responsiveness).

Finally, to maximize efficiencies, the Centers should formalize a collaborative, non-hierarchical *network* of centers that shares information, resources, and responsibilities. This network would essentially serve as a "virtual center" for the nation without the need for new "brick and mortar" structures or additional layers of administration. Leveraging the synergy of multiple organizations spread across the country, the network could coordinate training for land managers and volunteers, mentoring of cooperative weed management areas, and an early detection communications infrastructure, for example.

Non-governmental, regional, invasive plant "centers of excellence" such as CIPM can provide valuable services to natural resource managers, scientists, educators, and the public. It is appropriate that they germinate and evolve differently, according to the needs and resources of a particular region. The national need now is to encourage regionally appropriate organizing, stable baseline funding, and a decentralized communication network among them. The result will be a "virtual center" that serves the nation.

Publication Date (Web): September 15, 2011 | doi: 10.1021/bk-2011-1073.ch012

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