

INVASIVE SPECIES STAKEHOLDERS

Collecting, Sharing and Using Information



Charles Valentine Riley
Memorial Foundation

COVER PHOTOGRAPHS

Top center: Yellow star thistle (J. Asher, Bureau of Land Management, DOI).

Left center: Asian longhorned beetle (Animal and Plant Inspection Service, USDA).

Right center: Orange infested with citrus canker (Animal and Plant Inspection Service, USDA).

Bottom left: Chinese mitten crab (Lee Mecum, California Department of Fish and Game).

Bottom right: Brown tree snake (T. Fritts, U.S. Geological Survey, DOI).

A brief description of each photo follows:

Yellow starthistle – *Centaurea solstitialis*, was introduced from southern Europe and the Mediterranean region in the mid-1800s. It has become a serious weed pest throughout the western U.S. This thistle now infests more than 10 million acres of rangeland in the western U.S. where it has greatly reduced forage production for livestock and disrupted natural ecosystems.

Asian longhorned beetle – *Anoplophora glabripennis*, is native to China where it is a serious pest of hardwood trees and has been introduced into the U.S. in infested wood in packing crates. If this insect becomes established in the environment, it could destroy millions of acres of treasured hardwoods.

Citrus canker – is a plant disease caused by the bacterium, *Xanthomonas axonopodius* pathovar *citri*, which infests fruit, twigs and stems. The disease was first reported in the U.S. in 1910 and, although contained by an aggressive prevention and management program, has reoccurred periodically. Only a continued state and federal program consisting of surveys to detect infested trees, removal and destruction of infected and adjacent trees and prevention through regulatory actions have prevented citrus canker from devastating the U.S. citrus industry.

Chinese mitten crab – *Eriocheir sinensis*, was initially reported in the San Francisco Bay in 1992 and its populations have expanded rapidly and are adversely affecting fish populations in selected areas. In addition, its burrowing activities are undermining stream banks and levees, leading to increased erosion and flooding, and disruption of agricultural irrigation systems.

Brown tree snake – *Boiga irregularis*, has become a serious pest in Guam where it has virtually eliminated the native forest birds. The snakes feed on a wide variety of animals including lizards, birds and small mammals as well as bird and reptile eggs. Snakes frequently invade poultry houses, homes and yards to consume domestic poultry, eggs, pet birds and small mammals. The species is mildly venomous and a possible health risk, especially to small children. Several specimens have been intercepted in cargo arriving in other parts of the U.S. from Guam. The establishment of the snake elsewhere in the U.S. could have very adverse consequences.

Cover design by

Fleishman-Hillard, Inc.
Kansas City, Missouri

INVASIVE SPECIES STAKEHOLDERS
COLLECTING, SHARING AND USING INFORMATION
Proceedings of a Roundtable

Washington, DC
April 26, 2000

United States Department of Interior
United States Department of Agriculture
Riley Memorial Foundation

Published by

Charles Valentine Riley Memorial Foundation
2229 Countryside Drive
Silver Spring, MD 20905-4520

January 2001

In collaboration with the

United States Department of the Interior
1849 C Street, NW
Washington, DC 20240

United States Department of Agriculture
14th and Independence Avenue, SW
Washington, DC 20250

Edited by

Richard L. Ridgway, Riley Memorial Foundation (RMF)
A. Gordon Brown, United States Department of Interior
Nelroy E. Jackson, Monsanto Company
William Jolly, Florida Department of Agriculture and Consumer Services

Steering Committee

Thomas M. Dille, RMF and Francis and Associates
Ralph E. Grossi, RMF and American Farmland Trust
John C. Gordon, RMF and Yale University

Electronic copies are available on the internet at

<http://www.invasivespecies.gov/other/stkhldr.pdf>

Paper copies may be purchased from:

U. S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Accession No. PB2001-102898

CONTENTS

Sponsors and Acknowledgements.....	iv
Foreword.....	v
Executive Summary.....	1
Introduction.....	3
A View from the U.S. Department of Agriculture.....	4
A View from the Department of Interior.....	6
Opportunities and Needs from Selected Federal Agencies.....	9
U.S. Geological Survey.....	9
Animal and Plant Health Inspection Service.....	10
Bureau of Land Management.....	12
National Oceanic and Atmospheric Administration.....	14
Case Studies of Computerized Databases.....	16
Aquatic Plants and Animals.....	17
Rangeland Weeds.....	20
National Plant Regulatory Databases.....	22
Case Studies of Processes for Utilizing Information.....	24
A Volunteer Process for Restricting Distribution of Ornamental Plants.....	24
Processes for Regulating Aquatic Organisms.....	26
A State-Level Process to Designate Noxious Weeds: Colorado’s Experience.....	28
A Risk Analysis Process for Non-Native Species.....	31
Non-Federal Stakeholder Perspectives.....	33
American Nursery and Landscape Association.....	33
American Seed Trade Association.....	35
Capitolink, LLC.....	36
Western Governors’ Association.....	37
Pet Industry Joint Advisory Committee.....	39
Great Lakes Commission.....	41
The Nature Conservancy and Association for Biodiversity Information.....	42
American Lands Alliance.....	44
Environmental and Economic Costs.....	45
The International Trade Context.....	46
Observations, Needs and Suggested Actions.....	48
Selected References.....	52
Acronyms.....	54
Program Advisory Committee.....	55
Appendix A – Participants.....	56
Appendix B – Alternate Participants and Observers.....	57

Sponsored by

United States Department of Interior
United States Department of Agriculture
David and Lucile Packard Foundation
Dow AgroSciences
Monsanto Company
BASF
Riley Memorial Foundation

Acknowledgements

The unselfish personal contributions by the members of the program advisory committee and the workshop participants are gratefully acknowledged as is the direct financial support and in-kind contributions provided by the sponsors and the substantial in-kind contributions provided by a number of organizations.

Special appreciation is extended to Erin Grossi and Valerie Berton for their assistance in collecting, assimilating and editing the proceedings.

FOREWORD

The introduction of invasive species is a multi-dimensional issue that poses a threat to all of the earth's surfaces. It is an ancient problem with limited known solutions at the present time. Furthermore, this threat is increasing with human population growth and global trade. The invasion of non-native species into ecosystems can have the unfortunate consequence of decreasing the abundance of native species and sometimes even causing their extirpation.

The problems and threats associated with invasive species are now coming to the forefront of our national agenda. Economic and ecosystem health concerns are becoming more apparent to government agencies, private businesses, non-government organizations and the general public. Some of the pressures that are exacerbating this growing problem of invasive alien species (population growth, development, international trade) are unlikely to decrease since effective market and environmental solutions and compromises are difficult to develop. Therefore, the need for a coordinated, centralized, yet locally-based effort is more important than ever. The Executive Order No. 13112 on Invasive Species signed on February 3, 1999, was issued with the intent of establishing such an effort.

All stakeholders must be involved for invasive species to be effectively controlled and their impacts diminished, since invasive species do not recognize boundaries within the landscape. To be successful, the national invasive species initiative has to balance environmental values for natural systems with a realization that current systems are strongly influenced by a legacy of past human values and management. Humans have been active agents for moving species around the world for a long time. Therefore, this initiative should distinguish between invaders causing loss of native species or decreasing ecosystem health and beneficial introduced species used in management. For example, many of our agricultural food crops are non-native species, yet they are beneficial. Nonetheless, non-native species have caused much ecological and economic harm.

Implementation of the invasive species initiative must be balanced so that some stakeholders are not being more negatively impacted than others. Some stakeholders may feel that they will bear the brunt of the costs for implementing this initiative because they happen to be in sectors (e.g., agricultural and forest industries) in which the economic consequences of invasives are much more apparent and easier to calculate, and therefore, to control. In less managed systems (e.g., natural areas) the environmental, social and economic impacts of invasive species are harder to estimate because the baseline information and tools to manage these systems are much less developed.

The invasive species stakeholders roundtable was organized to provide the opportunity for a broad-based group on non-federal stakeholders to interact with each other and with federal officials. The uninhibited exchange of information, ideas and positions that occurred should provide a framework for finding more common ground through collecting, sharing and using information as efforts are made to deal with the ever increasing and often devastating invasive species problem.



John C. Gordon
Pinchot Professor of Forestry, Yale University and
Founding President, Riley Memorial Foundation

EXECUTIVE SUMMARY

Many non-native plant and animal species are considered “invasive” and, as such, are extremely costly to both the U.S. economy and our environment. The costs of invasive species – including plants, insects, microbes, reptiles, fish, birds and mammals – that have been purposely or accidentally introduced into the U.S. are in the tens of billions of dollars per year. Some authorities estimate those costs exceed \$100 billion annually.

Additionally, invasive species play a major role in the decline of threatened and endangered species and pose a significant challenge to maintaining biodiversity.

Invasive species do not recognize boundaries. Therefore, all stakeholders in a given ecosystem/community/region must be involved to effectively control invasive species and diminish their impacts. Likewise, initiatives to control or limit invasive species must be balanced to keep management programs practical.

Effective communications between all levels of government, commercial concerns and the public are essential in developing unified efforts. That means creating strategies to take advantage of cutting edge information technology in collecting, sharing and using information is essential for such communications to take place. The overall goal of the invasive species stakeholders roundtable was to obtain inputs into developing a communications strategy that relies on participation of both federal and non-federal stakeholders.

Federal Perspectives. The complexity of dealing with invasive species and their impact on the economy, environment and agriculture has prompted the federal government to approach the problem strategically, a senior policy official from the U.S. Department of Agriculture (USDA) said. As a part of that strategy, federal departments are committed to sharing information among their agencies, other departments, state and local governments and private interests. At the roundtable, a senior policy official from the U.S. Department of Interior (DOI) highlighted several issues for stakeholders to consider, including: (1) screening non-native species, (2) rapid response, (3) biological

control agents, (4) transgenic fish, (5) restoration and (6) possible cultural changes. Policy officials from both USDA and DOI encouraged stakeholder groups to participate in developing a strategy to exchange information and develop partnerships.

Upper-level career officials from the Bureau of Land Management, DOI; the Animal and Plant Health Inspection Service, USDA; the U.S. Geological Survey, DOI; and the National Oceanographic and Atmospheric Administration, Department of Commerce, provided a range of perspectives on federal agency involvement with invasive species. Their presentations provided strong evidence that invasive species are receiving a lot of attention throughout the federal government. However, a strategy for coordinating federal activities, involving more than 20 agencies, was not clearly evident from those presentations.

Computerized Databases. Participants in an invasive species workshop conducted in late 1998 recognized that a wide range of stakeholders should help develop species databases. As a result, three databases were presented at the April 2000 stakeholders roundtable to provide the basis for future information needs. The databases presented included: (1) aquatic organisms, (2) invasive rangeland plants and (3) plant pests. One or more of these databases were recognized by state and private stakeholders as being useful. However, some stakeholders, particularly those representing commercial concerns, were anxious to learn more about how databases would be used before supporting further database development.

Processes for Using Information. Roundtable participants reviewed three processes for using: (1) a volunteer process for restricting the sale of invasive ornamental plants, (2) cooperative actions by state agencies to eliminate selected invasive aquatic organisms and (3) formal state listings of noxious weeds to be regulated.

Specific examples included negotiations between a state exotic plant council and a state nursery trade association facilitated by a state agency that led to agreement that all concerned would use

their influence to prevent the marketing of 11 species of invasive plants. A second example highlighted joint actions by a state department of fish and game and a state department of agriculture to apply their respective regulatory authorities in a joint effort to eliminate an invasive amphibian and an invasive aquatic plant. Finally, a third example detailed the use of surveys of county personnel, focus groups and formal hearings to designate 67 noxious plants for state regulatory purposes. Private-sector stakeholders urged continued emphasis on due process in designating invasive species as targets for action. An overview of risk assessments also was presented as a way to use information.

Non-Federal Stakeholders Perspectives.

Representatives from eight organizations including (1) three trade groups, (2) a commercial interest, (3) an association of state governments, (4) a regional commission and (5) two non-governmental organizations representing environmental and conservation interests provided their perspectives. The representatives all recognized that invasive species remain a major problem that needs attention. However, candid interactions among the non-federal stakeholders indicated that substantial effort will be required to develop broad-based support to deal with the invasive species problem. For instance, the non-federal participants voiced considerable concern that lists of invasive species, web sites and databases developed without due process may have unacceptable adverse economic impacts. Still, the non-federal stakeholders provided important guidance for practical database development. “(we) need to strike a balance between the resources expended on data collection, management, access and use with the need to take on-the-ground action,” one participant said.

International Perspectives. The critical need for considering the international implications of invasive species control was highlighted, and participants reviewed existing international mechanisms for dealing with invasive species.

Overarching Issues. Opportunities to enhance understanding of the invasive species problem were particularly evident in relation to the following issues:

- The term “invasive species” has different meanings to different people. Development of programs around specific organisms, groups of organisms or well-defined ecosystems may be desirable to clarify what is intended.
- The confusion about what is “invasive” is further highlighted by varying estimates of the number of non-native species in the U.S. That range is as wide as 7,000 on the low end up to 50,000 exotics. Participants also agreed about a lack of a comprehensive categorization of which species are “invasive.” One approach to dealing with the confusion might be to establish a national peer-reviewed evaluation model that scientifically assesses the degree of invasiveness of a limited number of species. The model could then be applied in prioritizing and allocating funds to the most economically damaging species. The model(s) also could become a part of formal risk assessments.
- The components of an environmental and economic cost estimate of \$137 billion per year are, in many cases, inadequate for use in the cost-benefit analyses often needed to justify exotic species control measures. Thus, differences in opinions may lead to disagreements on what action, if any, is desirable.
- Although a tremendous amount of information is available on invasive species, we appear to lack an overall strategy to develop invasive species information systems. “We are drowning in information and starving for wisdom,” one stakeholder said.
- Limited evidence surfaced during the roundtable concerning who is responsible for moving the total invasive species issue forward. For a major effort on invasive species to begin, an individual or well-organized coalition must become the “torch-bearer” who could muster support and move forward in concert with many diverse interests.

Needs and Suggested Actions. Needs to improve management information systems for invasive species and additional inputs into the development of policies and programs, particularly from non-federal stakeholders, became obvious from the roundtable presentations and discussions.

Some elaboration on those needs and suggested actions follow:

- More useful information systems are needed. Such systems, including databases and mapping for western rangeland noxious weeds (invasive plants), were identified as needing facilitated activities, such as technical workshops. If those workshops involved users, they hold the potential of being particularly productive. Invasive aquatic plants and animals and
- regulated plant pests were other areas of particular interest in this regard.
- Additional efforts are needed to obtain balanced inputs from all stakeholders, with particular emphasis on non-federal stakeholders at the local and state levels. Non-federal facilitated activities to assess the knowledge, attitudes and desires of non-federal stakeholders are suggested.

INTRODUCTION

The Riley Memorial Foundation (RMF) identified harmful invasive species as a key issue in December 1997. After discussions with federal officials, Foundation staff in May 1998 helped organize a forum on invasive species at Yale University intended to be “a public dialogue exploring new solutions to an old persistent problem.” In response to a need to have a better understanding of what was known about the many different groups of invasive species, RMF proceeded in November 1998, in conjunction with the U.S. Departments of Interior (DOI), Agriculture (USDA) and Commerce, to conduct a workshop on invasive species databases. At that workshop, 63 computerized databases were documented. Subsequently, in February 1999, Executive Order 13112 on Invasive Species was issued by President Clinton.

Presentations, demonstrations and discussions at the database workshop, involving more than 60 people from very diverse backgrounds, indicated that there was a need to design improved invasive species information systems for practical use. Although existing databases contain much useful information, they were of limited use by land and other resource managers in their current forms. Extensive discussions spanning several months between RMF and representatives from DOI, USDA, corporations, non-government organizations (NGO's) and various other stakeholders led to the development of a project that would help create improved invasive species information systems. Project organizers designed two primary means to reach that end: (1) a stakeholders roundtable and (2) a specialized database workshop. The primary

sponsors of the project are DOI, USDA and the David and Lucile Packard Foundation, with significant contributions from three corporations.

Project organizers established a broad-based program advisory committee to develop the program for a roundtable. They designed a roundtable format that would (1) display selected federal programs, (2) illustrate computerized databases as sources of information on invasive species, (3) provide examples of how information could be used to make informed decisions about invasive species management and (4) obtain input from a broad-based group of non-federal stakeholders about the information they wished to have developed and distributed. The roundtable was held on April 26, 2000, in Washington, DC, with 34 roundtable participants and 41 observers.

During opening comments made on behalf of RMF, roundtable participants were reminded that the overarching theme for the roundtable was “collecting, sharing and using information” and that RMF intended to bring disparate groups together to discuss important issues and help them find common ground. The presentations and discussions that followed provided the basis for these proceedings, which include (1) overviews from senior federal policy officials, (2) case studies of computerized databases, (3) cases studies of processes for utilizing information, (4) opportunities and needs from selected federal agencies, (5) non-federal stakeholder perspectives, (6) environmental and economic costs, (7) the international context and (8) observations and suggested actions.

A VIEW FROM THE U. S. DEPARTMENT OF AGRICULTURE

Michael V. Dunn

Under Secretary of Agriculture for Marketing and Regulatory Programs
U.S. Department of Agriculture

Each representative at this roundtable possesses specialized first-hand knowledge of invasive species, and the objective today is to discuss strategies for sharing this knowledge and using it most effectively. We are all aware that the problem we face is a big one – some of our most precious environmental and agricultural resources are at stake. As a result, federal, state and local governments – as well as scientific organizations, landowners and private interests – all need to be involved in efforts to halt ongoing damage and to prevent further introduction into this country of invasive animals and plants. Right now, the federal government, individual states, industry organizations and private citizens in the U. S. are spending substantial resources to address invasive species – yet we are still losing ground. For our future efforts to be successful, we will need to find effective ways of sharing information, working together and bringing our collective resources to bear on this immense problem.

In issuing the Executive Order that established the National Invasive Species Council (NISC), President Clinton acknowledged the seriousness of the threat that invasive species pose to this nation. The U.S. Department of Agriculture (USDA) co-chairs the NISC along with the Department of Commerce, which oversees marine issues, and the Department of Interior, which manages many federal lands and other natural resources. In establishing the Invasive Species Advisory Committee (ISAC), the invasive species council announced its intention to draw upon the expertise of leaders in the field of invasive species. In turn, the advisory committee is looking to everyone with an interest in halting invasive species and the damage they wreak. In effect, ISAC is looking to all of us here today. By exchanging information about our independent efforts to halt damage associated with invasive species, we can effectively inform, and in turn, guide ISAC and NISC.

USDA Agency Activities

The issue of invasive species gains greater national attention every day, but the USDA has been dealing with this threat for many years. USDA is providing the NISC with expertise in the areas of invasive species prevention, emergency response, control strategies and scientific research.

The Animal and Plant Health Inspection Service (APHIS) spearheads the USDA effort to address invasive species. APHIS carries out a broad range of activities to protect against the entry and establishment of exotic pests. These activities in combination are commonly referred to as our safeguarding system. They include pest and disease risk assessments, pre-clearance inspections of foreign commodities, port-of-entry inspections and early detection and eradication programs. When evaluated as a whole, these activities form an integrated, comprehensive system that reduces the risk of exotic pests entering the U.S.

A key component of any safeguarding system is information sharing, documentation and monitoring. One way in which USDA is furthering these goals is by establishing a North American forest pest information system. Officials of U.S. Forest Service (FS) within the USDA are working with their counterparts in the Canadian and Mexican governments to create a web-based tracking system that not only lists and describes potentially dangerous pests, but also rates their threat to our forests. The system also will provide information regarding the pests' biology and the ways in which they can be introduced into new environments. And, because the system is web-based, international experts and other government officials will be able to provide additional input about pests and related developments.

In conjunction with its cooperators, FS manages 191 million acres of National Forest System lands for invasive insects, plants and diseases. Another

USDA agency, the Natural Resources Conservation Service, uses its expertise in applied plant science technology to guide private and state land managers in combating invasive species. USDA also plays a leading role in invasive species research through its main research arm, the Agricultural Research Service (ARS). ARS identifies biological control agents for invasive species, develops new control methods and designs effective integrated pest management strategies. The Cooperative State Research, Education and Extension Service provides research grants to universities and scientific organizations and works directly with the public to share technology and increase invasive species awareness.

Cooperation

For the critical situations that need the most attention, USDA is ensuring that personnel within its many agencies are sharing information and resources and reducing repetitive activities. Because of the complexity of dealing with invasive species and also the growing economic, environmental and agricultural damage, USDA – in fact the U.S. government as a whole – has begun to approach this problem strategically. In a multi-faceted approach to invasive species management, USDA draws upon the expertise within several of its agencies.

An example of how USDA is working cooperatively among its own agencies to address invasive pests is demonstrated with the Asian longhorned beetle. We learned in 1996 that the Asian longhorned beetle had entered the U. S. via wood packing materials from China. We knew this beetle to be a difficult pest of hardwood, and we knew that the consequences of a nationwide infestation would be grave. Accordingly, APHIS officials immediately began survey and quarantine activities across the country. Trees in infested areas had to be removed and destroyed. On the international front, U.S. importers and the Chinese government were notified that all wood packing materials entering the country from China would have to be treated to prevent additional introductions.

USDA experts began studying the Asian longhorned beetle's natural habits and tendencies, its lifecycle and even its genetic makeup, all in an effort to pinpoint a weakness we can use to control and eradicate it. In addition, USDA personnel in the U. S. and in China began studying the beetle and testing its susceptibility to different chemical treatments. University partners also have made significant contributions to this fight.

To date, the pest's presence in the U.S. has been confined to limited urban areas in Chicago and New York City. Although tree removal is still the best way to limit the pest's spread, research into chemical insecticides has shown promise against the beetle in trials. In the battle against this pest, USDA's agencies are effectively sharing their resources and expertise and working closely with state and university partners. The Asian longhorned beetle program now in place clearly outlines roles and duties and helps ensure that enough resources and personnel are directed toward areas that need the most assistance. The progress made is largely due to this cooperation.

Information Sharing

USDA is committed to sharing information not only between its own agencies, but with other federal departments, state and local governments, outside scientific organizations, landowners and private interests. In return, we hope to benefit from the knowledge and expertise of those operating beyond the scope of the USDA in the effort to address the very serious threat posed by invasive species.

The purpose of this roundtable is to encourage discussion among diverse stakeholder groups with diverse viewpoints on invasive species issues. Together, let us develop a strategy for the exchange of information and the development of cooperative partnerships. I look forward to a constructive and informative dialog and hope that this forum enables us to jointly benefit from one another's ideas and expertise on this important issue.

A VIEW FROM THE DEPARTMENT OF INTERIOR

William Brown

Science Advisor to the Secretary
U.S. Department of Interior

The assembled interests at this roundtable have demonstrated a lasting commitment to make a difference on the issue of invasive species. This issue is one of a handful representing the most significant environmental and economic problems facing our country and the world. Invasive species rank with climate change, habitat loss and pollution prevention as major issues of our time. Invasive species represent major global change – a historical process that is transforming the surface of the earth. We have begun to document the harmful side of that metamorphosis: economic harm estimated at \$137 billion in the U.S. alone and ecological harm estimated in nearly 45% of listed species to be the primary reason for endangered and threatened status (see Pimentel et al. in selected references).

We all agree that the U.S. government needs to do more. The laws and programs now in place represent a start, but probably are not adequate to fully address this problem. Most of those center on agriculture – that has been the focus of our strength and sophistication historically. The Executive Order on Invasive Species (EO) helps. It assigns specific duties to federal agencies and creates a National Invasive Species Council (NISC) and an Invasive Species Advisory Committee (ISAC) charged with a set of tasks. A dynamic series of management plans will also help. The first one, due in the latter part of 2000, will be less specific and more visionary, but it will be updated every two years and will evolve over time to focus the U.S. government on what needs to be done. In addition, we in the U.S. Departments of Interior (DOI), Agriculture (USDA) and Commerce are doing what we can to increase the budget, committing new resources in this area. We have reason for optimism given the increases approved by the U.S. Congress and the bipartisan support this issue elicits. Thus, we are building momentum.

Six issues come to mind when I reflect on the charges of the EO. I do not have exact solutions, but I hope you who are present today will consider them carefully as part of the process needed to move us forward.

Screening to Prevent Harmful Introductions

Not every introduction is harmful, and we need to acknowledge that. There are two sides to this problem. One is the screening of creatures you know are brought into the country intentionally, but whose effect is unknown, whether plant, animal or micro-organism. The other, somewhat less precise and more difficult to analyze, is the screening of organisms that come in unintentionally through pathways or vectors not yet fully understood. Plainly, we need a more effective screening process. The vastly under-measured impacts on nature and natural systems and the well-known impacts on agriculture and aquaculture make that clear.

Governments have progressed on somewhat different paths to advance screening methodologies. For example, Australia has devised a system that screens, in principle, the importation of every potentially harmful flowering plant. Utilizing an Excel spreadsheet, fewer than 50 questions allow assignment of potential imports into one of eight categories. One sample question on the history of the plant asks simply, “Has this organism been invasive in any other country?” Other questions focus on more intrinsically biological issues, such as, “Does the plant reproduce vegetatively or does it reproduce sexually and, if so, how many seeds does it produce?” A key question for me is the size of the unsure category that would necessitate further study before allowing importation. The current estimate is around 20% – a very favorable average. Clearly, we need more investment in the science of determining what is likely to be inva-

sive despite its imprecision. Numerous organisms demonstrate a long lag time before becoming invasive; at first nothing untoward happens, then a hundred years later, the numbers explode and the organism begins to cause harm. We need to acknowledge the uncertainties, but we need to invest more in blending science and management sophistication. Then, we need to be sophisticated about the development and the phased implementation of such a system to assure the American public that we will not allow an organism entry unless we have a good measure of confidence that it is not going to cause harm.

On the unintentional side, creativity is needed. Ballast water reigns as the flagship example of unintentional pathways. However, the Asian long-horned beetle deserves mention also, since USDA has had to enforce pathway restrictions on the import of soft wood-packing materials from China to prevent the beetle's dangerous spread to North American forests. Each case requires different biological and trade analysis methods to be discovered and evaluated. We need to improve our examination and evaluation of unintentional pathways; impacts to natural systems have been overly neglected in the past.

Rapid Response

When a new harmful organism establishes, we have to respond more quickly to the problem. Two models are worthy of consideration: one, the interagency response to fire demonstrates a proven method to utilize multi-year funding for emergency response. Second, the Centers for Disease Control and Prevention use a widespread network of informants, responding doctors and other public health officials to fight breakouts of infectious organisms. Even hazardous waste spills have generated plans for rapid response and remediation. They may not be totally effective, but the responsible institutions have a system in place to respond quickly in emergencies.

We do not have a comparable system for invasive species. Despite a strong program on aquatic nuisance species and long-term attention to county weed management in the West, there is not an

easy way to tap the resources needed to deal with the problem. We need to think through that and make some new proposals for action.

Biological Control

If a plant becomes established in an ecosystem, there are three traditional ways to control it. You (1) pull it up, (2) spray something on it or (3) contain or reduce its population with a biological agent. Each tool has its place. If the species establishment is quite limited or secondary impacts are a major concern, you can pull it up in areas that you especially care about, such as Dinosaur National Monument. Some of the sensitive riparian areas are receiving extra care to protect valued plant and animal resources. Other circumstances argue for the use of chemicals for which we need to ensure safety, both in manufacture and application practices.

On the other hand, we are never going to deal completely with a problem like cheatgrass or saltcedar without the use of some sort of biological control mechanisms. There have been some problems in the past with specificity, but more biologists care about this issue now and methods have improved markedly in pre- and post-release testing and monitoring. Problems may occur in the future, but we have advanced a great deal, and our technology has advanced to adequately reduce the risk of control agents themselves causing harm. As long as we use the agents with the proper controls, the harm that is being caused by failure to use them is, in a number of cases, much greater.

Saltcedar is a case where the USDA is much more invested in biological control than DOI. DOI is conservative on these things, and in some ways for good reasons. They are the protectors of all organisms, and they want to protect native species across the full array of habitats. Some staff say, "We are going to bring in a problem to deal with a problem." There is value in carefully assessing the potential for cumulative or unforeseen impacts, but on this issue of biological control, we need to move forward more rapidly.

Transgenic Organisms

All of us involved in the politics of invasive species try to keep the genetically modified organisms (transgenic organisms) debate separate because everyone wants to deal with invasive species. There is bipartisan and non-partisan support, and public support is clear for the most part. In the case of transgenics, there is a passion that surrounds food. The concern is that if you link them in a discussion, the disruptive politics of transgenics will step in. From an ecologist's point of view, the issues are very closely related. Indeed, Bt corn gives off pollen that in some cases is harmful to butterflies. The larger issue is the potential invasive effect if transgenic organisms escape in a live form into the environment and establish to become predators of and competitors with other organisms. In that respect, they are a subset of the invasive species issue. Some of the same policy issues arise – the patchwork of laws for dealing with invasive species is mirrored by a patchwork of laws for dealing with the potential ecological effects of the release of transgenic organisms. For example, what law currently tracks the ecological impacts on wild salmon (or other organisms) of an Atlantic salmon that grows ten times as fast as the current ones if you insert a mammalian growth hormone?

Restoration

The Bureau of Land Management has spent millions of dollars to buy seeds for post-fire restoration; about half were not native species. We cannot just pull or spray something or release agents and expect the environment to return to a “natural” state. If the environment gets disturbed as you plant, you can actually cause more problems than you might solve, according to Tom Stohlgren of the U.S. Geological Survey. We need to have more native plants and seeds available for use. The NISC can help by providing guidelines for procurement of native plants, as called for in the EO. In addition, the Fort Collins Agricultural Research Service

lab is willing to take wild plant material and store it, but they need agency assistance for collection and genetic characterizations (via germination experiments). With some stakeholder companies helping us to tailor some new programs, we look forward to stimulating a market for native seed.

There are great parallels between this issue and recycled paper. At first, skepticism about the government's intentions snarled that effort. Eventually, through carefully phased-in market incentives, recycled paper caught on. Now we use a lot of recycled content in our paper.

Current Cultural Influence

Perhaps the trickiest issue we face is how to tailor Executive Branch execution to the current culture on invasive species. Principally, the USDA and DOI will take the lead. As we work to improve the current system, we have to make sure that it works with these two agencies. On the control and restoration issues, just as on coordination, we can work together with no problems. On the import side, we need to recognize that the backbone of import regulation of invasive organisms is largely funded and implemented by the USDA. We also should recognize that the USDA is evolving from focussing on crops to focussing more on wildlife and nature. The leadership is moving in the right direction. DOI has a much more limited investment in port regulation in endangered species and wildlife. With their passion for wildlife and protecting ecosystems, DOI agencies can help USDA leverage the resources needed. The inspectors' technical skills complement each other. We need to encourage those two agencies to tap those elements of what they do well and work together. We will see overlap, and the agencies will respect the overlap. The NISC and ISAC working with stakeholders such as those assembled today can help tremendously. We should try to be clear to the public by speaking through a single voice as best as we can.

OPPORTUNITIES AND NEEDS FROM SELECTED FEDERAL AGENCIES

Introduction

The Executive Order on Invasive Species designates seven federal departments and one independent agency to be represented on the National Invasive Species Council (NISC). The seven departments represent more than 20 agencies that have major involvement with invasive species management. Representatives of four agencies with rather different missions were asked to provide their perspectives on their agencies' roles in controlling invasive species with emphasis on needs and opportunities. Those agencies include U.S. Geological Survey (USGS) within Department of Interior (DOI), Animal and Plant Health Inspection Service (APHIS) within U.S. Department of Agriculture (USDA), Bureau of Land Management (BLM) within DOI and National Ocean and Atmospheric Administration (NOAA) within Department of Commerce (DOC). The presentations, although not intended to represent all federal agencies, provide examples of the range of issues facing federal agencies as they address invasive species problems.

U. S. Geological Survey

Susan Haseltine

Associate Chief Biologist for Science

The many interesting ideas, problems and systems presented here at this roundtable emphasize that if we are going to develop, share and use a common information system for invasive species, then we must agree on priority issues. Even though we all have different views, there is general consensus that the issue and problem we are trying to address with these information systems is the increasing economic, environmental and extinction impacts of invasive species throughout the globe as the human imprint on the earth increases. Whether in agriculture, business or other arenas, the enormous economic, short-term impact due to invasive species is apparent. The short-term impact on the environment is also important, as people are particularly concerned about the ecological impact of these species, which influence the resources provided to society by our

ecosystems (such as ground water, surface water, sedimentation rates, fire, etc.). Furthermore, while extinctions have occurred throughout the earth's history and are a part of the natural process, as are invasive species, increasing rates of extinctions have been documented all over the globe in all taxa due to the influence of human activity on both natural and managed systems. Consequently, the earth is becoming increasingly vulnerable to these invasive species requiring a holistic approach. Whether we are in a research, regulatory, federal, state or business community, we must evaluate the impacts both on our respective communities and our responsibilities in a global process. After all, on the long-term we are all stakeholders for an earth that provides both ecological and economic services to human society.

Terminology. A common theme of presentations has been how differently we all use terms. Differing definitions associated with invasive species have created a hurdle for communication between stakeholder communities. To build some consensus and success, perhaps we need to stick to the middle ground of the problems that are caused by invasive species and define our priorities in terms of those problems. However, the question of how to go about building some common information to address these shared problems of increasing economic and ecological impact and increasing extinction rates still remain. Therefore, instead of focusing on how we, within our stakeholder community, define terms such as "introduced species," "invasive species" or "impact," when listening to people outside of our community, we should give special attention to how they interpret them and not assume that they are the same definitions we use within our own community.

Beyond our differences in terms and information use, we share a lot of common values and needs. So, one of the most critical issues in developing common databases is to establish clear common definitions. We all will have to give some ground on those definitions. But as long as there is clarity, we do not have to define everything. We need to

have good definitions, but they do not have to be perfect. We need to have consensus on them, and we need to make them a working document that we use and can amend.

Accessible Data. When developing these definitions, there are several issues to consider. We do not need a centralized database, we need a distributed data system with common standards and common definitions and a large amount of metadata and quality control data, so people can determine whether to use that data. This system has to be open to all. Many of us have a specific interest in a particular taxa or geography. As a community, we need to design these systems to have complete geographic and taxonomic coverage and to be easily accessible to the rest of the world. On this note, these databases should be developed with the idea that they are going to be used globally, nationally, regionally and locally. Global use and contribution to the system will be of increasing importance, and accommodation for fine and coarse scales in time and space will be critical.

Additionally, we need skills that can be used for marketing of this issue. If we can unite and develop our middle-of-the-road priorities for species in the targeted areas, we have to be able to access information at the local, regional and national scale that decision-makers can use and react to. We also need an adaptive accomplishment component with continuous updating and database fields that say these people took “these actions for these reasons.” If those actions did, or did not, make a difference to the impacts of invasive species, we need to be able to provide feedback to database users, especially decision-makers. We also need to have a record of accomplishments to show to people interested in the issue.

Risk Assessment. A second thing we need to show decision-makers is assessment of risk of invasive species. If we can get common definitions, we can perhaps set some priorities. Think about common criteria for assessment of risks both ecologically and economically. These common criteria should be easily built into a database that is explainable along with the strengths and weaknesses of the data. For instance, you should be able to go to your local town council and explain a risk to them with the data and database

without having a battery of technical experts, either in information management or biology to explain the problem to them. Most of all, we need to focus on future risks since all current information indicates that this problem is escalating. So, we need to think of these databases as the prediction of future risks and decide how are we going to build that model in the future. We need to think about pathways for future introduction, the ecology and biology of the systems these species will be introduced to, the economic and ecological landscapes of human communities and the uses humans will put the information to. Finally, of lesser priority, but still critical, we need to think about building an early detection system for these databases.

Summary. In these databases, we need to think about all taxa, all biomes, and they need to hang together. There needs to be common explanations and definitions. We cannot have a splintered approach where you have to go to the national aquatic database that has a different explanation than invasive weeds databases. We need to address scale geographically and in terms of time. Many of these taxa have different time scales of invasion that have to be built into the system. We need to approach these databases regionally, but the information must be compatible to summarize and synthesize nationally and globally. We all have a role in this issue, in every taxa and at every geographic scale, in the mission of agencies and organizations. But, most essentially, we need to take off our particular organization’s hat, listen to what the needs of others are, select common needs and priorities and get on with building a successful information exchange.

Animal and Plant Health Inspection Service

Richard L. Dunkle
Deputy Administrator

Historically, USDA’s APHIS has worked hard to safeguard American agricultural resources and natural ecosystems from the introduction and establishment of invasive species. This is a central part of APHIS’ mission to protect American agriculture. In this way, APHIS is an asset to both farmers and consumers because we support U.S.

agricultural productivity and facilitate safe agricultural trade.

Due to significantly increased levels of global commerce and travel, the volume of passengers and number of pathways for the movement and introduction of foreign, invasive pests and diseases into the U.S. is currently at an all time high. In the last decade, both passenger and cargo volume at airports has doubled, in effect doubling the risk of pest and disease introductions. It is no wonder that the estimated economic harm to the U.S. from these biological invaders runs in the tens of billions of dollars and has been estimated at \$137 billion.

APHIS' overall strategy to protect U.S. agricultural resources from invasive species is through a comprehensive, integrated safeguarding system. This system emphasizes the use of prevention, preparation, response and recovery measures.

Prevention and Preparation. APHIS' safeguarding system encompasses a broad range of exclusion activities. For example, APHIS requires shipments of approved commodities to be accompanied by official sanitary or phyto-sanitary certification indicating that any pest and disease risk has been sufficiently mitigated. Certain approved commodities must pass pre-clearance inspection before being shipped to the U.S. Others must undergo sanitary or phyto-sanitary treatments and/or mandatory quarantine prior to being allowed entry into the U.S. Decisions about whether to allow agricultural imports and under what conditions are based primarily on scientific risk assessments.

At all U.S. international ports-of-entry, APHIS maintains personnel who are specifically trained to inspect passenger and crew baggage, commercial cargo and mail. Our inspectors use x-ray machines and specially trained beagles to help search for possible prohibited agricultural items. Also, APHIS veterinary personnel inspect shipments of live animals and animal products for possible pests or diseases.

APHIS' exclusion activities have proven effective in preventing the establishment of many harmful invasive species in our country. In fiscal year 1999,

APHIS pre-clearance and port-of-entry inspectors intercepted nearly 2 million potentially damaging plant and animal products from international mail, cargo shipments and airline passengers and crew members. More than 52,000 of those interceptions carried potentially harmful pests or diseases.

Response. Despite APHIS' extensive efforts to prevent the introduction of harmful invasive organisms, occasional outbreaks of exotic agricultural pests and diseases occur. APHIS has specific emergency response guidelines for many of the invasive pests and diseases that are most likely to enter the U.S. The agency maintains rapid response teams in each region of the U.S. that act as independent pest and disease eradication forces and manage federal, state and industry cooperative emergency efforts. To better coordinate its emergency eradication efforts, APHIS is developing a world class emergency management operations center that will provide daily incident monitoring and ensure preparedness and rapid response in the face of any national plant or animal health emergency.

Recovery. Once an outbreak of an invasive species is under control, APHIS stands ready to assist affected communities as appropriate in recovering from its impact. Recovery activities could include livestock carcass disposal, preventive sterile insect release programs and enhanced pest or disease monitoring. Most importantly, APHIS takes steps to ensure that a re-infestation or re-infection of an invasive species does not occur.

APHIS has demonstrated the safeguarding system's effectiveness in several recent cases. When outbreaks of Mediterranean fruit flies were detected in Florida in 1997 and again in 1998, APHIS and state officials immediately established quarantine areas, restricted the interstate movement of regulated articles from those areas and initiated trapping and treatment activities in infested areas. Those efforts protected Florida's \$6 billion citrus industry from establishment of the pest.

While APHIS has responded to a string of emergency plant pest and disease outbreaks in recent years, we have been fortunate in that no major animal pest or disease outbreak has occurred

in our country since 1983. However, in 1996, Veterinary Services responded to an outbreak of low pathogenic avian influenza in Pennsylvania. APHIS cooperated with state officials to swiftly impose quarantines and destroy contaminated flocks. This quick response averted disaster in the form of lost markets and eradication expenses.

Working Towards Improved Methods. While APHIS's record in preventing the introduction or establishment of harmful agricultural invasive species is noteworthy, we recognize that the system APHIS uses to safeguard U.S. agricultural resources is stressed and in need of improvements. This fact is highlighted by the ongoing assaults made by invasive species such as Asian longhorned beetle in Illinois and New York, plum pox virus in Pennsylvania, exotic fruit flies in California and Florida and citrus canker in Florida.

To raise public awareness of the devastating effects of invasive species, and as part of our ongoing efforts to identify ways we can improve our work, Secretary Glickman visited several of our inspection facilities across the nation.

To improve our ability to safeguard U.S. resources from invasive species, APHIS contracted with the National Plant Board to conduct a thorough review of all aspects of its safeguarding system. The review group, comprised of state, industry and university representatives, made approximately 300 recommendations that will assist APHIS in adapting its safeguarding efforts to better manage drastic increases in trade and international travel. APHIS plans to implement the report's recommendations to improve its safeguarding system.

As in the past, APHIS remains committed to preventing the introduction, establishment and spread of harmful, invasive species. Looking to the future, APHIS has developed prevention, preparedness, response and recovery strategies to safeguard U.S. resources from this growing threat.

Bureau of Land Management

Henri R. Bisson

Assistant Director, Renewable Resources and Planning

DOI is unique due to the variety of mandates our agencies are founded upon. From preservation to multiple use, we run the gamut. The one common denominator we share is the landscape we manage. The nature of invasive species demands cooperation among affected parties to achieve sustainable progress. Invasive species problems offer all federal, state and private managers an opportunity to combine forces for the good of the land. Ownership boundaries are ignored by harmful, invasive species.

Current Cooperative Efforts. DOI agencies are continually working to build cooperative relationships. Each agency participates on a DOI invasive species committee to facilitate the sharing of successful management strategies. The sharing of invasive species data, both mapping and treatment protocols, is the greatest opportunity and need we face in the battle against invasive species. As we look for cooperative ventures that produce results, the BLM has clearly benefited from collaborating with stakeholders. Some examples of cooperative weed control efforts among private parties, state officials and BLM include the following:

- In Juab County, UT, a BLM seasonal-spray crew spent two weeks treating thousands of Scotch thistle plants in an area that had burned the previous summer. The following year BLM staff found only a dozen plants. The successful control of this weed in this area was a result of vigilance and timing. Had they missed this window of opportunity, repeated control measures would have been required for the next 20 years. This project saved the BLM thousands of dollars.
- Again in central Utah, during the "Cove Fort Weed Day," BLM and several hundred high school and middle school students volunteered to dig thistles. The result of their efforts has been an increase in the quality of elk habitat within Millard County.
- In Elko, NV, 4.5 million acres were inventoried for weeds in one field season. All BLM Elko Field Office staff and local volunteers were trained and participated in this survey. Working as a team, BLM and stakeholders gathered this much-needed information for the benefit of all.

- High school students from Columbus, MT, along with their instructor, successfully introduced the use of the horned beetle to reduce the spread of leafy spurge. Starting with 200 beetles, the student efforts produced millions of insects.
- In Montrose, CO, the BLM and the Sierra Club have received national recognition for their weed partnership. Members from across the country pay money to attend a service vacation where they work along the Dolores River, digging and pulling harmful weed species from some of the most heavily used boating stops along the river.
- Six million acres in southeast Montana has been surveyed and treated for leafy spurge using biocontrol and chemical methods. This project includes all the lands in four counties and will cover more than 1.5 million acres when completed.

The Joint Fire Science Program. Another good example of collaboration is the Joint Fire Science Program (JFSP). The JFSP is a six-agency partnership authorized and funded by Congress to address wildland fuel issues with a focus on federal lands. The U.S. Forest Service, BLM, Fish & Wildlife Service, National Park Service, Bureau of Indian Affairs and USGS are the principal partners. The JFSP issues Requests for Proposal (RFP's) to solicit proposals for appropriate fuel-related research.

The JFSP has worked with invasive plant specialists from several federal agencies to develop and issue a RFP soliciting research proposals on the relationships between fire and invasive plants. The specific Task Statement was titled "Determine how invasive plants influence fire behavior and occurrence, which ecosystems are at greatest risk from fire-invasive plant interactions, and how fire and non-fire treatments could be used to control invasions." Invasive plant specialists from the federal and state governments and academia also will be involved in the peer review process.

The JFSP also has partnered with the California Association of Fire Ecology, Tall Timbers Research Station and the International Association of Wildland Fire to conduct *Fire Conference 2000: The First National Congress on Fire Ecology, Prevention*

and Management at the Town and Country Resort and Convention Center, San Diego, CA, during November 27-December 1, 2000. The conference, designed to be national in scope, included, as one of about eight sessions, a symposium on fire and invasive plants. The fire/invasives symposium included both invited and contributed papers from six "eco-regions" of the U.S. and are to be published separately.

Weed Inventory and Prevention. By the end of the year 2000, BLM anticipates being able to inventory a total of 7 million acres of public land for weed occurrence. In addition, the BLM plans to fund new cooperative weed management projects in each of the public land states. Field offices have submitted approximately 200 detailed proposals for high priority work. As we continue to implement cooperative strategies, resources will be directed toward the following areas:

- Weed pilot projects - cooperative partnership efforts to help prevent the spread of weeds at the local level
- Weed prevention and early detection - development of strategies for education, prevention and early detection of new infestations of weeds
- Control treatments - a successful weed management program must include aggressive control measures
- Inventory - to find new infestations and monitor existing ones

To find new infestations, we need vegetative inventories. Cooperative inventories involving state, local and private partners continue throughout the areas BLM manages. These partners improve the cooperative relationships needed to combat a common problem, which crosses ownership boundaries.

BLM already has begun to inventory weeds by state and has designated the Worst Weeds in the following western states:

- Arizona - Mediterranean grass, Canada thistle
- California - Mediterranean grass, medusahead
- Colorado - halogeton, houndstongue, bull thistle, Canada thistle
- Idaho - leafy spurge, diffuse knapweed, rush skeltonweed, spotted knapweed

- Montana - spotted knapweed, leafy spurge
- Nevada - *Tamarix* species, perennial pepperweed
- New Mexico - African rue, *Tamarix* species, Malta starthistle
- Oregon/Washington - yellow starthistle, medusahead, halogeton, rush skeletonweed
- Utah - halogeton, *Tamarix* species, squarrose knapweed, Mediterranean grass
- Wyoming - Canada thistle, leafy spurge, diffuse knapweed

This list identifies the weeds by state, based upon estimates of infested BLM acres, but may not identify weeds the states consider their worst problems. For example, cheatgrass infestations are substantial and are not included in this list.

By working with federal, state, local and tribal governments and with private landowners, BLM strives to keep healthy land from becoming infested with harmful invasive plants. Future generations of Americans deserve to inherit ecologically healthy and productive wildlands, not vast landscapes infested with weed species that make the public lands unfit for people, livestock and native wildlife. We must be committed to implementing weed control partnerships so that the spread of weeds can be prevented or controlled.

National Oceanic and Atmospheric Administration

Leon Cammen

Program Director for Research of the National Sea Grant College Program

DOC is one of the three Departments that co-chair the NISC. However, DOC is unique from the perspective that we do not have a regulatory function dealing with invasive species. Historically, the role that we have had is as a provider of information through research, outreach and education to try to reach the stakeholders.

Most of the invasive species activities in the DOC are focused on NOAA with responsibilities ranging from the Great Lakes to the coasts. Occasionally DOC is involved in the interior of the country, but, by and large DOC focuses on coasts. DOC activi-

ties started in earnest about 10 years ago with the invasion of the zebra mussel, and we have had a pretty significant program ever since. In the mid-1990's, activities expanded from zebra mussel to other invasive species but still focused on the Great Lakes. Then around 1997, DOC took a broader view approach by working in marine environments. DOC now has activities on all the coasts.

The overall effort in DOC is somewhere between \$5 million and \$6 million. Sea Grant's effort is only about \$3 million, which seems like a lot, but when considering that it includes over 30 different species, this is not a lot of research and outreach for different species. Additionally, there are a variety of problems across the entire country, not just focused on one particular region.

Research. Other than the emerging marine problems, DOC also is focusing on ballast water. In fact, NOAA is conducting ballast water research in addition to the Coast Guard. The DOC and the DOI also have some responsibility for trying to develop ballast water technology and alternatives to ballast water exchange.

In general, activities have focused on ballast water research. For the last three years, DOC has been primarily looking to provide alternative technologies. To actually put these technologies on board ships and do large-scale testing is beyond the scope of the funding available. Hopefully, this may change. In the meantime, we are looking at a multitude of technologies.

With regard to general pathway research, NOAA is looking at, for example, the bait fish industry, shipment of live seafood and recreational boating. This is intended to provide information on what risks are involved in these pathways, how important they are and how we can interrupt some of them.

Also, there is a variety of ongoing research surveys involved in monitoring. Within this category, there is a lot of research around identifying new invaders, the effects they have on the environment, assessing how severe a problem they pose, looking at how the organisms are spreading, where they are coming from, and developing technologies to help find their points of origin. NOAA

is responsible for the national marine sanctuaries and the estuary research reserves, and rapid assessments in some of the sanctuaries in cooperation with the National Fish and Wildlife Foundation will begin this year. Finally, small-scale monitoring efforts are proceeding in the national estuary research reserves. Hopefully, these efforts will be expanded with additional funding. At the moment, it is pretty scattered.

As far as control activities, NOAA is looking at technology development. In addition to ballast water, we are looking at possible control for other species. A lot of work has been done to try to develop control mechanisms for zebra mussels. We tried a variety of potential chemical controls, engineering controls and robots to fit in pipes. People are very imaginative about ways to approach the problem. In fact, we are looking right now at controlling with killed bacteria or other species.

Finally, we are carrying out research in diseases carried by green crabs, shrimp and oysters. It is somewhat of an open question whether some of the oyster diseases in the Chesapeake Bay can be considered invasive species.

Outreach. Within the Sea Grant invasive species program, we fund not only research, but also outreach and education activities. Sea Grant has an extension network of about 300 agents throughout the country and the coast. One of the things that we have realized is that it is extremely important to have a mechanism for delivering information to people, as opposed to just having the information available, so that they do not have to come to you to get it. The simplest example targets recreational boaters by distributing cards with every boating license in several of the Great Lakes states illustrating what they can do to combat zebra mussels. We also have posted signs on boat ramps and conducted small workshops in boater education. These measures seem to be more effective in preventing the spread of zebra mussels than our research activities.

We have conducted zebra mussel conferences for several years to bring together scientists, managers and other stakeholders. Also, we have held

a conference for marine bio-invasion that will be repeated.

Information and Education. We provide information resources through the prior Invasive Species Clearinghouse and the Sea Grant non-indigenous species web site. Ideally, we want one point of entry that Sea Grant has generated on invasive species. The web site, which is under development to become more user-friendly, has a variety of information on several different species on which we have conducted research. This site captures publication abstracts, education materials and outreach materials. It not only has a list of species, but it actually discusses the biology of the organisms and possible control mechanisms that have been developed. This site also serves as a general source of information for those species. We have information on biological control, economic impacts, environmental impacts and predicting the spread of the species.

The other main source of information that Sea Grant has been responsible for is the National Aquatic Nuisance Species Clearinghouse. This began almost from the outset of our zebra mussel effort about 10 years ago as the Zebra Mussel Clearinghouse, and the concept was to capture all of the technical literature in one place and make it available to researchers, industry and agency people. It includes all of the technical literature on zebra mussels. It has an extensive translation of Russian and Eastern European literature as well. And it is available/searchable through the web. There are efforts to get most of the articles electronically available. The ones with copyright problems are available by photocopy, so it works like a lending library. In the mid-1990s, we began adding some fresh-water species, and in the last two years, we have been adding marine species. So, the collection now numbers more than 3,000 publications. It is not only published literature; gray literature is also included. The difference between this and the previous web site is that this one really is a technical source of information. This is housed at Cornell University and is funded by Sea Grant, New York state agencies and industry.

Because most of our activities are actually the result of external funding, information needs of

the people who do the work in addition to the agencies must be identified. In that sense, the research and outreach communities are also stakeholders as well as industry and state and local governments. The three problems that our stakeholders identify that they really need information on are: (1) patterns of distribution, (2) consequence of invasion (i.e. what do these things do and what is the impact?) and (3) methods for prevention and control. Virtually all of our research projects have at least one or two graduate students, supported by fellowships, associated with the projects. So, we are developing the community.

The kind of information they need are: (1) baseline biodiversity data for marine protected areas (specifically for NOAA and for coastal areas, in general); (2) species distributions in maps; (3) technology and research databases keyed by looking geographically, by species, or by technology (i.e. If a control technology has been developed by one organism, it may be applicable to another one.); and (4) annotated bibliography research (i.e. that is analogous to what the clearinghouse is doing for us as one source of technical information.). Another area that was mentioned was

obtaining records of distribution on a variety of pathways that have been difficult to access, such as live seafood, pet industry, aquarium industry and bait species. The idea behind that is if we are asking our people to do risk analysis, they need to have a source for this information. Also, they want the risks of indigenous and non-indigenous species.

Another need they identified is “clean” lists. For example, one of the problems that some of the people in the Great Lakes aquaculture industry had is getting a list of invasive species they can work with rather than having to use a separate determination for every species. They want to know, from the start, what they are allowed to work with. I had not mentioned aquaculture before, but it is an issue for the Department and for NOAA. There is a new DOC aquaculture policy with emphasis on environmentally responsible development. This means that we are looking not only to identify pollution from aquaculture, but we are actually looking out for biological pollution. The emphasis is going to be on operations that are safe and really will not have the possibility of accidental releases.

CASE STUDIES OF COMPUTERIZED DATABASES

Introduction

James F. Quinn

Professor, University of California, Davis

Information systems associated with invasive species issues are really overwhelming. There are hundreds of species that have large economic impact. With dozens of agencies and programs, 50 states, a number of universities and some private organizations gathering data on invasive species, it has been a real challenge to turn that massive data into information that can inform decision-makers, particularly on the immediate and timely basis that is needed in biological management issues.

This session features two programs that are

focused on invasive species information becoming public and affecting policy. The first, on aquatic settings, will be presented by Pam Fuller from a non-indigenous aquatic species program with the U.S. Geological Survey (USGS) in Gainesville, FL. The second is from Peter Rice from University of Montana, who developed the INVADERS Database System, which primarily looks at weeds in rangelands, and has developed some powerful predictability capabilities to get proactive on these issues. Following that, Ron Stinner from North Carolina State University, who is also the Director of the new National Science Foundation (NSF) Center for Integrated Pest Management (IPM), will take a step back and look at an overview of regulatory programs in the government and the degree to which they are addressing some of these needs.

Aquatic Plants and Animals

Pam L. Fuller

U.S. Geological Survey, Department of Interior

The USGS' Nonindigenous Aquatic Species (NAS) Program maintains a nationwide database of introduced aquatic organisms, both freshwater and marine. It is a locational database that documents the distribution of introduced species. The NAS Program is unique in that it relates all records to drainages, using the USGS Hydrologic Unit Code (HUC) system. Because these organisms are aquatic, they are limited by geological and hydrological boundaries of watersheds. Therefore, it is important to document aquatic introductions in this manner. The NAS database also can be used as an aid to determine which areas the organism may next invade – generally downstream, or potentially upstream for mobile organisms.

The NAS database includes all nonindigenous species, including exotics (species from a foreign country) and transplants (native to this country but introduced outside the native range). It also includes information on introductions, whether they have become established or not. This allows tracking of what has been released and what survives and potentially allows tracing the origin of an established population that might initially have been considered an isolated occurrence.

The database consists of 60 fields including location, drainage, habitat parameters, date of introduction or collection, status of the population (established, collected, extirpated) and the original source for the information (a publication or personal communication). The sources of data include published scientific literature, museum and herbarium specimens, field studies, state and federal agencies, universities and private citizens. Information about each introduction is assigned a unique record number. All records are backed up by a document (paper) file in our office. Reports from private citizens are verified before they are included in the database. As of August 1, 2000, the database contained more than 24,500 records of introduced animals and approximately 20,000 records of introduced plants. A database of non-indigenous species literature is also maintained in

conjunction with the distribution database. This database currently contains more than 3,000 records.

All records are geo-referenced at the finest scale possible. Because of the differing degree of reporting accuracy, this may be at the state, county, drainage (HUC) or point level. Our goal is to geo-reference all reports to an 8-digit HUC.

Access to portions of the NAS database is provided via the Internet at <http://nas.er.usgs.gov>. From this location, a taxonomic group of interest can be selected and queries can be performed by either state or drainage. Distribution maps, species accounts and summary information are also available from the web site.

Much of the information is also available in a recently published book, *Nonindigenous Fishes Introduced into Inland Waters of the United States*. Published by the American Fisheries Society, the book is a compilation of more than 20 years of work with the NAS database. It includes scientific and common names, references to aid in species identification, maximum size for adults, native range, nonindigenous occurrences, means of introduction, reproductive status and persistence, impacts from introduction, voucher specimens for foreign species, remarks, range map and reported occurrences for more than 500 introduced fish species. Historical trends and spatial patterns of fish introductions are also summarized.

The database can be used to generate a variety of products that allow analysis of patterns of where introduced species are coming from, how they are getting here, if they become established and what areas are most susceptible (such as areas downstream of an introduction).

Because the fish portion of the distribution database is the best developed, emphasis will be placed on this to illustrate the different ways the data can be used. Examples of analyses include:

Composition and Origins of the Introductions.

- Composition of introduced fishes nationwide (native vs. foreign) - Nationwide, most fish species are native to the U.S. but have been transplanted outside their native range.

Transplanted fishes are the most likely to become established and spread.

- Composition of introduced fishes in a state, county or drainage (native vs. foreign) - This same type of analysis can be performed at different scales, often yielding different results because of unique factors affecting each area. For example, unlike the country as a whole, most fish species introduced into Florida are of foreign origin, due to the presence of tropical fish farms and Florida's warm climate that allows these species to survive.
- Origins of foreign species (fish, reptiles, amphibians, etc.) - The region of the world where foreign introductions are coming from can be determined. Most of the introduced foreign fish species are from South America, followed by Asia, Africa and Central America. In the case of reptiles, although on a nationwide basis 64% are transplanted natives, South America and Asia are the two main regions of origin of foreign species. The remaining continents provide only a small percentage of the introductions.
- Composition and origin of species introduced into a state - A similar type of analysis can be performed on a state, rather than national level, looking at origin choices of: (1) native to the state but transplanted to a non-native area within the state; (2) native to the U.S. but not the state (introduced from another state); (3) not native to the U.S. (foreign); or (4) artificially produced hybrid. When examining data of introduced fishes at this level, Florida and Hawaii both show high percentages of foreign introductions. Western states are characterized by high percentages of species not native to the state but introduced from another state; many of these are East Coast species transplanted to the West Coast. Virginia and North Carolina are characterized by high percentages of species that are native to the state, but that have been moved outside of their native range within the state; many of these are a result of a diverse fauna and the presence of the Appalachian divide. Numerous species in this area have been transplanted across the divide, many by angler's bait buckets. This type of analysis could also be done on a drainage basis. Such an analysis has been performed

on fish introductions into the Chesapeake Bay Basin.

Temporal Trends. Because the database has a time component, analysis can be performed on the rates of introduction. The number of fish species being introduced into this country has increased dramatically in the past 50 years, which are attributed to both native transplants and foreign introductions.

Establishment. The distributional database can be used to analyze what proportion of introduced species have become established, then look at trends based on region of origin, taxonomic group, region of introduction or a combination of these. However, often the status of the introduction is not reported, so it is not known if a species became established in an area.

Spatial Trends. Number of species introduced into a state, region or drainage - The database can be used to perform spatial analysis in order to look for patterns or hotspots. The scale of analysis used affects the outcome. For example, on a state basis, California has had the most species of fishes introduced, followed by Florida. On a large, regional drainage scale (2-digit HUC), the South Atlantic-Gulf has many more introductions than the California drainage. On a more refined level, the Upper Tennessee, Kanawha and South Florida are the drainages with the most fish species introduced.

Pathways or Vectors. The NAS distributional database can be used to analyze relative strengths of pathways by source area, receiving area or taxonomic group. For nonindigenous fishes nationwide, stocking accounts for almost half of the introductions, followed by aquarium release (25%) and bait release (16%). However, in Florida, aquarium release or escapes from tropical fish farms account for 75%, while stocking accounts for only 17%. In the case of reptiles, pet release is the major vector (75%); however, in amphibians, although pet release is still the major vector, it only accounts for 28% of the introductions. Changes in pathways or relative strengths of a pathway over time can be examined.

Drainage Distribution Maps. Species distributions can be mapped by drainages, indicating drainages with native and introduced populations. Examples of this include the American shad that was introduced in the 1870s from the East Coast to the West Coast and chinook salmon introduced from the West Coast to the East Coast. Grass carp, a species native to Asia, has been widely stocked for biocontrol of aquatic vegetation. However, because of its biology it can only become established in large rivers. Flathead catfish, a central U.S. native, has been stocked outside its native range for sport fishing. The majority of these introductions have taken place when this species was transported from the west side to the east side of the Appalachian divide. Introductions on the Atlantic Slope have had serious adverse impacts on native species through predation.

Point Location Maps. When alerted to the introduction of a new species, point location maps can be generated. This has been the case with several ballast water introductions in the Great Lakes. Although the round goby and the tubenose goby were introduced at the same time and place, the round goby has spread throughout the Great Lakes and is poised to enter the Mississippi River, while the tubenose goby has remained in the Lake St. Clair vicinity. Information is also available on the ruffe's distribution as it spread eastward in Lake Superior, then jumped to Lake Huron.

Using One Species to Track Another. Fish aren't the only group of organisms introduced from the aquarium trade. One species of snail, the red-rimmed melania, *Melanooides tuberculatus*, has become established in several areas of the country. Researchers in Texas found that this snail carries a parasitic gill fluke that infects and causes mortality in native fish, including the endangered fountain darter. By knowing the distribution of the snail, researchers know where to also look for the parasite. Another example is the red shiner, *Cyprinella lutrensis*. This fish is raised in aquaculture as a bait minnow and is sometimes grown in ponds with grass carp. Imported grass carp brought with them the Asian tapeworm, *Bothriocephalus acheilognathi*. This parasite infected red shiners in the ponds. The shiners were shipped to Nevada as bait minnows where an

angler released leftover bait (and the parasite). Once in the wild, the tapeworm infected another species, the woundfin, *Plagopterus argentissimus*, an endangered minnow. The parasite is now considered one of the major threats to the survival of this endangered minnow.

Another example of using one species to provide information about another is shown in the case of two introduced aquatic plants. One researcher is using the distribution of *Salvinia minima* to investigate the distribution of an associated weevil that may act as a biocontrol agent for the closely related *Salvinia molesta*. This researcher has also used the known range of *S. minima* and *Eichhornia crassipes* as a predictor of the potential range for *S. molesta*.

Population Status. The African clawed frog, *Xenopus laevis*, has demonstrated the ability to become established in a variety of latitudes from southern California to northern Virginia. For species like this, population status (established vs. reported) can be indicated on the maps. Similarly, *Hydrilla verticillata*, is documented nationwide, and maps depict established and eradicated populations at an 8-digit HUC.

Range Expansion. When the history of an organism's introduction and spread is well documented, maps can be produced showing the range expansion over time. One example where this has been done is for the aquatic plant, *Hygrophila sp.*

Fact Sheets. The NAS Program produces species-specific fact sheets for high-profile invasive species. These fact sheets are intended to help managers and to educate people about the problems posed by a particular species. In the case of giant salvinia, *S. molesta*, the fact sheets have served as a mechanism for detecting new populations – resulting in several new populations being reported. Additional fact sheets that are currently being prepared include: black carp, Asian swamp eel, green mussel and New Zealand mud snail.

Collaboration. The USGS NAS Program and the Smithsonian Environmental Research Center (SERC) National Marine Invasions Laboratory have entered into a collaborative relationship formalized by a Memorandum of Understanding (MOU).

Under this MOU, the two programs will divide the freshwater and marine ecosystems to avoid duplication. The NAS Program will continue to track freshwater introductions, while SERC will cover the marine introductions. The two programs have been working together on database design, management and integration. The compatible databases will contain records from both the literature and field studies. We are also designing the framework of an aquatic species database we hope will be used by other groups gathering similar information in order to facilitate data exchange worldwide. Toward this effort, we have invited participation by the Center for Research in Invasive Marine Pests in Australia and others. SERC held a workshop at the American Society of Limnologists and Oceanographers meetings in Copenhagen in June 2000, to discuss larger scale cooperation. The workshop included researchers from Europe and Russia conducting similar research.

Rangeland Weeds

Peter M. Rice

Research Associate, University of Montana
Division of Biological Sciences

The INVADERS project started in 1992. The INVADERS Database System was designed for ease of use and to meet decision-making needs identified by weed regulatory and natural resource agency personnel. The earlier interfaces to the database were DOS and Windows programs. The web-based INVADERS Database System for early detection, alert and tracking of alien invasive plants and weedy natives has been available at <http://invader.dbs.umt.edu> since January 1998. There are four primary conceptual areas covered by the current online version of INVADERS:

- Weed distribution data for the Pacific Northwest region
- Noxious weed lists for U.S. states and Canadian provinces
- Species-specific database engine that links to other sites with information on individual weed species
- Case examples of how weed managers use INVADERS for strategic planning

Pacific Northwest Distribution Data. The Pacific Northwest weed distribution database tracks the historic spread of approximately 1,000 exotic plants introduced to Washington, Oregon, Idaho, Montana and Wyoming since 1875. Core data include 82,000 distribution records. Minimum required data standards are weed name, county where found, year of record and source of record. Optional data include locale statements, point locations as a geo-coordinate, associated vegetation, site characteristics and any other collector comments. The distribution records come from 51 different sources including herbaria, weed identification labs, agency surveys, professional plant collectors and botanical publications. The distribution data can be verified by the source, and most have voucher specimens or originate from experienced weed taxonomists. All distribution records have at least county level spatial resolution.

Online outputs include county level distribution maps, time lapse maps, spread rate graphs and lists of noxious weeds or all exotics by user-specified state or county groupings. Queries can be initiated by multiple scientific names, Weed Science Society of America common names or maps. Pick-lists of plant and county names circumvent spelling errors.

Taxonomically qualified users can submit new weed reports directly to the INVADERS web site. The new distribution records are immediately available in output graphics and lists. INVADERS also provides managers with automatic e-mail notification of new reports of user selected weeds. Users can pick which weed species and geographic areas will be on their custom alert notification list. The INVADERS web software scans the database each night for any new reports in the subscriber's selected areas that match their weed list and then sends next-day e-mail notices.

States and Provincial Noxious Weed Lists. The weeds declared legally noxious by the 48 states and the six southern tier Canadian provinces are accessible from a custom interface. Users can obtain up-to-date listings of which states have declared a weed as noxious, the complete noxious weed list for any state, or a summary output of all

taxa that have been declared noxious with the ranked frequency of their listing by state governments.

Species-Specific URL Database Engine. A database engine provides live links to other URLs with species specific information. The INVADERS web search engine was developed to provide quick and efficient access to online information related to the identification, biology, ecology and management of exotic plant species in the U.S. and Canada. We index pages on university, agency, commercial and conservation organization web sites that contain information useful to vegetation managers and ecologists working with invasive plants. Students majoring in botany check the content of these sites for accuracy and relevance to weed management. Most of the links go directly to a page dealing with a particular weed, although some links are to pages containing information on multiple species. Topics include photos and other identification aids, control methods, ecology, nomenclature and taxonomic standing, fact sheets and species abstracts. We do not index home pages of the more general invasive plant web sites, nor do we index sites that only list invasive plants without additional ecological or biological information. A robot is used periodically to scan the weed URL database for broken links.

Case Examples of Data Use. The web site provides some examples of how weed managers and researchers utilize data from the INVADERS system. Historic distribution information is used by state and federal agencies for risk assessments, environmental impact statements and listing of new weeds as noxious species. Year of introduction, rate of range expansion, geographic distribution and regional species lists are relevant to most attempts to develop strategic plans for weed control and regulation.

INVADERS has been used to determine which new and recent species are invading specific regions or states, to identify habitat types, cover types and environments susceptible to invasion by individual weeds and to predict the rate of geographic spread in future years. Distribution records with point locations can be imported to geographic information systems and climate grids for climate

matching and other spatial modeling purposes. Recent practical applications include developing bioclimatic envelopes for exotic weeds that have established in North America and then matching those climatic conditions to their Eurasian origins to select foreign areas to explore for new biocontrol agents that are pre-adapted to conditions in the neo-range of that weed.

User Statistics. The INVADERS web site was publicly announced in June 1998, after an initial five months of development and testing. The NT 4.0 web server logs allow users to analyze who uses the site, what type of output they generate and how much work they do (ratio of pages viewed per visit). User visits have increased steadily as professional weed managers, educators and the general public have become aware of the INVADERS site. As of April 2000, INVADERS was averaging 3,000 unique visitors per month who made in excess of 12,000 page requests per month. A national scale weed tracking system could expect a ten-fold greater use than the current system that has distribution data for five states.

The site is accessed 55% by commercial (.com and .net) domains, 18% by schools and universities (.edu), 5% by government and military (.gov and .mil) and 1% by organizations (.org). We could not resolve the IP addresses for 21% of the users. Many agency users have told us that they use commercial Internet service providers rather than their agency systems. Most requests originate from North America, 84% from the U.S. and 4% from Canada, while 12% of the requests come from other continents. Among the top ten countries are Australia, United Kingdom, New Zealand, France and Japan.

For the non-commercial IP addresses that can be resolved, we see that 55% of the users are at educational institutes, 25% work for the federal government, 6% are with foreign governments, 5% are with state or county governments, 2% with corporations and 6% with other organizations that are primarily conservation groups. Most of the major university users are in the western U.S.

Over 40 U.S. government agencies and laboratories have been accessing INVADERS. The top five federal department and agency users are U.S.

Department of Agriculture (USDA), U.S. Forest Service (FS), Bureau of Land Management (BLM), USGS and National Park Service. The Japan Agriculture, Forestry and Fisheries Research Council is among the foreign non-ISP organizations that access the INVADERS site. State and local government use has been increasing since we recently brought the legal noxious weed lists online.

Sponsors. The INVADERS project has been supported entirely by grants and contracts. The Montana Department of Agriculture and the Northern Region of the FS have provided most of the funding for data acquisition, software development, maintenance and special analyses of data. In the last two years, the USDA Agricultural Research Service has been a significant contributor of funds and in-kind scientific support. The Idaho Department of Agriculture, Montana State Office of BLM, Bureau of Reclamation and Animal and Plant Health Inspection Service (APHIS) Cooperative Agricultural Pest Survey have also provided funding for special projects.

National Plant Regulatory Databases

Ronald E. Stinner

Director of National Science Foundation Center for Integrated Pest Management
North Carolina State University

USDA's APHIS, through its Plant Protection and Quarantine (PPQ) programs, has responsibility for protecting and safeguarding America's plant resources through its regulatory authority. APHIS is a "data-intensive" organization. APHIS/PPQ arranges its data needs into three types when developing databases: (1) internal information for both safeguarding and trade facilitation, (2) public information for education and regulatory purposes and (3) international cooperative data-sharing efforts to enhance both safeguarding and trade facilitation. Some of the databases serve more than one purpose, with both internal and external information needs.

It is important to recognize that APHIS has a primary obligation to enforce U.S. laws and regulations. Data collected for regulatory purposes does not always meet requirements for full reporting of

invasive species when that information is not a part of the regulatory decision. Furthermore, the importance of trade facilitation mandates that pest information provided by APHIS be as accurate as possible. Tentative and incorrect identifications can have serious economic and political consequences.

Internal Databases. The primary databases within APHIS for exclusive or partial internal use dealing with invasive species are the Port Interception Network (PIN)-309 Interception Database and the National Agricultural Pest Information System (NAPIS). PIN-309 is an internal database of port interceptions. This database does not contain all interceptions. If the intercepted species is not on the APHIS Regulated Pest List, the record is discarded because it is no longer needed for a regulatory decision. The historical cost of data entry and storage of all interceptions has been prohibitive. New and less expensive data entry and storage options may change this and provide a permanent electronic record of pathways for new potential invaders.

NAPIS, the database for the Cooperative Agricultural Pest Survey, is the main pest distribution database within APHIS. It is maintained at the Center for Environmental and Regulatory Information Systems at Purdue University. Because of regulatory-related sensitivities, this web site for the database has both public (www.ceris.purdue.edu/napis/) and closed areas. However, we think there are opportunities to increase use of the NAPIS database through more public access without jeopardizing APHIS regulatory actions.

There are a number of other internal databases, such as the developing Risk-Based Staffing Model and secure access to U.S. Customs Service information. Up until now, each of those databases has essentially stood alone. APHIS has begun development of Port Interception Network – Operations (PINOPS), an integrated suite of these databases with a web-enabled front end. When completed, this system should integrate almost all of the internal APHIS/PPQ databases. At this time, integration with external information is not a part of PINOPS. As new web technologies become avail-

able, there likely will be an opportunity for appropriately integrating databases while maintaining security for the regulatory sensitive data.

External (Public) Databases. Within APHIS, and by cooperating with a number of other agencies and organizations, APHIS has developed four databases containing both regulatory and non-regulatory invasive species information. The new APHIS Permitting System (www.aphis.usda.gov/ppq/) allows organizations to apply for permits (biotechnology, plant pest, plants and plant products and wood import) online and to check the status of their applications. The Regulated Plant List database (www.aphis.usda.gov/ppq/regpestlist/) and the Federal Noxious Weeds (www.invasivespecies.org/fedweeds.html) databases feature online, searchable taxonomic and host information about APHIS-regulated species (in cooperation with the NSF Center for IPM). Finally, Invasive Species Fact Sheets include information on the taxonomy, biology, distribution, symptoms and general descriptions of key potentially invasive insects, diseases and weeds (presently being developed in cooperation with the Entomological Society of America, the American Phytopathological Society and the Weed Science Society of America).

Additionally, APHIS has established ongoing support for the USDA's Natural Resources Conservation Service National PLANTS (<http://plants.usda.gov/plants>) database, to continue development of a detailed distributional and reporting system for noxious plants in the United States.

International Cooperative Data Sharing. There are at least two examples of APHIS's international cooperative efforts in North America alone: the Phytosanitary Alert System (www.PestAlert.org), being developed by the North American Plant Protection Organization, and the Exotic Forest Pest Information System for North America (www.ExoticForestPests.org), a database effort of the North American Forest Commission. APHIS's Center for Plant Health Science and Technology is playing a vital role with both of these efforts. Both of these systems have online report and search capability and provide key information on identifi-

cation, symptoms, distribution and other biological parameters. The Phytosanitary Alert System has a Wireless Application Protocol (WAP)-phone version and should be available to the public before long.

The Future. Most museums and collections are rapidly going online with searchable databases of their holdings. Within the next five to ten years, anyone with Internet access will be able to go to key web sites, type in a species name and see the locations of specimens in collections and museums globally. The Species Analyst is a set of tools already developed for just this purpose. Although based on the old Z39.50 protocol, it is rapidly being converted to Extensible Mark-up Language (XML) and the http protocol ("the Web").

Regulatory agencies such as APHIS need to be aware of the potential impact of the information from museums and develop the technology both to use and to respond to such "outside" sources of information.

Why should regulators, with both facilitation and safeguarding responsibilities, care to cooperate with those outside the regulatory arena?

- To be forewarned of errors and misidentifications, so as to refute them, not to be caught by surprise at negotiations
- To not let trade facilitation endanger safeguarding
- To take maximum advantage of vast non-regulatory networks already monitoring species distributions and identifications, providing an early warning system

Federal and state regulators have a real opportunity to cooperate with all stakeholders under the Executive Order on Invasive Species and the National Invasive Species Council to engage in science-based decision support. The regulatory databases have the potential to provide key up-to-date information on invasive species, but need significant updating and integration with other available data.

Both internally and externally, APHIS, by integrating its database resources and exploring the new wireless technologies, could increase its productivity. This integration could include information

from databases external to agency servers, such as the fact sheets and Phytosanitary Alert System mentioned above. Such a strategy could provide the on-site data needed for “risk-based” inspections, more rapid risk assessments, significantly improved detection notification, containment and eradication.

Through carefully designed integration of databases, port officers could securely access cargo manifests, select inspections based on risk, identify potentially dangerous “stowaways” and report their findings with wireless communication to seamlessly integrated databases, using XML and WAP technology. Palm Pilot already uses encrypted communication to and from secure servers. By restricting the software distribution, specifying the Palm Server Internet Protocol (numerical Internet address) and requiring login/password for access, port officers could have secure access to sensitive information, such as recent interception frequencies from specific cargoes and countries.

There are opportunities for APHIS to provide protocols for the filtering and review of internal information so that such information could be more readily shared with other agencies and the public. Integrating information such as the top past interceptions with biological, distributional and pictorial information from other sources (e.g., fact sheets, state noxious weed programs, museums and Cooperative Extension management recommendations) would provide both public recognition to APHIS and the educational information that is needed to recognize and manage invasive species. An array of Internet-based technologies is quickly making inter-operability feasible. By defining database structure externally, minimum coding now allows global access to multiple data sources and information analysis to provide invasive species information to specific stakeholder groups in appropriate formats. The commercial sector already has embraced these technologies for information sharing. APHIS and other regulatory agencies also can benefit from these same technologies to make the best use of their resources.

CASE STUDIES OF PROCESSES FOR UTILIZING INFORMATION

Introduction

Some stakeholders have expressed concern about the adverse economic impacts that might result, directly or indirectly, from the Executive Order on Invasive Species (EO). In response, roundtable organizers selected case studies to illustrate how information can be used to make decisions on actions with regard to “alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.” The case studies presented included a volunteer process involving ornamental plants, a state-level process for designating undesirable plants and processes associated with aquatic organisms. Roundtable speakers also presented a general description of risk analysis. These presentations were intended to assist stakeholders in determining the specific invasive species information that they would like the public sector to collect, share and use.

A Volunteer Process for Restricting Distribution of Ornamental Plants

William Jolly

Environmental Specialist, Florida Department of Agriculture and Consumer Services

The impetus for beginning the negotiations that resulted in the voluntary restriction and distribution of certain ornamental plants was a continuation of policy of the Florida Department of Agriculture and Consumer Services (FDACS). FDACS has taken the position that voluntary cooperation and permit streamlining can accomplish more than regulation in all areas of agriculture.

A branch of FDACS, the Office of Agricultural Water Policy (OAWP), has facilitated discussions between the Florida Nursery Growers Association (FNGA), the Tampa Bay Wholesale Growers (TBWG) and the Florida Exotic Pest Plant Council (FLEPPC). FNGA and TBWG promote the interests

of its organization members, and its members represent the various participants in Florida's environmental horticulture industry. The membership of FLEPPC is composed largely of land managers, academia and professional botanists. This group has been instrumental in educating the public about harmful non-native plant infestations. It also monitors the spread in natural areas of harmful non-native species and develops corresponding control programs.

In 1997, OAWP initiated discussions between FNGA, TBWG and FLEPPC to find common ground and to seek solutions to the increasing menace of harmful non-native plants in Florida's natural areas. The discussions centered around the FLEPPC publication, *List of Invasive Species*. That brochure lists plants in two categories. Category I includes "species that are invading and disrupting native plant communities in Florida," while Category II plants are "species that have shown a potential to disrupt native plant communities." The combined lists total 124 species based upon criteria established by FLEPPC. The list is biennially updated.

The environmental horticulture industry was critical of some of the plants on the list for several reasons. For example, the list was not reviewed by individuals outside of FLEPPC and was constructed using anecdotal information. Additionally, local governments used the lists to restrict the sale of certain species even though geographic and climatological factors had been ignored. However, the main concern of the industry was that the list had negative economic impacts to the growers and others within the horticultural industry.

During a series of ongoing meetings, representatives from FNGA, TBWG and FLEPPC examined each species on the list. The environmental horticulture industry polled their members and used trade publications, which list nursery stock currently for sale, to determine which of the FLEPPC listed species were of economic value. Some of the plants were not grown commercially (included in this category are those on state and federal restricted lists), some were of significant economic value, and the remaining category included 11 plant species of slight economic importance. FNGA has actively solicited its members not to

grow the species of the latter category which include:

<u>Common Name</u>	<u>Scientific Name</u>
Woman's tongue	<i>Albizia lebbbeck</i>
Orchid tree	<i>Bauhinia variegata</i>
Bischofia	<i>Bischofia javanica</i>
Carrotwood	<i>Cupaniopsis anacardioides</i>
Cat's claw vine	<i>Macfadyena unguis-cati</i>
Chinaberry	<i>Melia azedarach</i>
Sword fern	<i>Nephrolepis cordifolia</i>
Guava	<i>Psidium guajava</i>
Oyster plant-large variety	<i>Rhoeo spathacea</i>
Java plum; jambolan	<i>Syzygium cumini</i>
Seaside mahoe	<i>Thespesia populnea</i>

As a result of this "meeting of the minds," FNGA published an article in its periodical, *Greenline*, listing and urging growers to cease cultivation of those 11 species. In a press release, Ben Bolusky, FNGA Executive Vice President stressed that "Nursery growers (in Florida) have a very good record of environmental responsibility and recognizing which plants are becoming potential ecological problems." Furthermore, the FNGA "look(s) forward to continuing the dialogue and to doing what's right for Florida." On a similar note, Tony Pernas, FLEPPC Chairman, said that the exotic pest plant council is "pleased to be working with FNGA," and "appreciate(s) this productive relationship that is taking a pro-active approach to addressing the invasive species problem." FLEPPC also published an article in its periodical, *Wildland Weeds*, flagging those 11 species.

The meetings prompted the University of Florida's Institute of Food and Agricultural Sciences (IFAS) to develop specific criteria for the evaluation of the degree of invasive characteristics of non-native plant species presently found in Florida. Those criteria will be an assessment guide for species now in the state and will not be used as a model for prediction. Thus, recent actions by FDACS and IFAS are the beginning of a new era of cooperation between organizations. It is quite

possible that the same methods used in Florida to voluntarily restrict the cultivation of harmful non-native species could be applied to other states or at the federal level.

Processes for Regulating Aquatic Organisms

Lawrence Riley

Chief of Fisheries, Arizona Game and Fish Department

It strikes us that a principal concern regarding the implementation of the EO is how its overall goal will be achieved. The goal of protecting and ensuring our American plant and animal resources, the economic value and productive use of those resources and ensuring public health is hard to assail. What is at question is how you achieve this goal, as the EO at this point is still policy in search of process. In our experience, a successful process should fully involve the public, local government and state government alongside our federal partners.

I cannot claim that Arizona’s processes are the model upon which all others should be based; however, I can provide some examples where these processes have worked in Arizona to address some invasive species issues. In Arizona, authorities for plants and animals are divided among agencies of state government. The Arizona Game and Fish Commission has authority for wildlife resources; the Arizona Department of Agriculture has authority for plant and domestic animal species as well as livestock health; and the Arizona Department of Health Services has authority for handling diseases communicable from animals to humans. Those authorities are exercised through existing rule-making processes to determine what kinds of plants and animals can be imported or possessed. The rule-making process provides for public involvement and participation, economic impact assessment and regulatory review as key, deliberative steps that must occur before those agencies can restrict the public’s ability to possess or use some kinds of plants or animals. While some may argue that the system is unwieldy or unresponsive, I can provide some examples from the Arizona Game and Fish

Department's viewpoint where the process has worked.

A Restricted Wildlife Success Story. African clawed frogs were detected and addressed in Arizona in the late 1980s and early 1990s. I believe this can be viewed as a success story for Arizona, one that involved public participation and eventually cooperation with the pet industry. I cannot say that the process was uncontentious or smooth – it certainly wasn’t, but it did come to a consensus outcome. Consequently, one genus of clawed frogs, *Xenopus*, is restricted for possession in the state of Arizona.

African clawed frogs of the genus *Xenopus* were detected at a Tucson golf course in the mid-1980s. Their origin is only speculative; however, state agencies became concerned about the potential for broader introduction and establishment in Arizona. Clawed frogs had been introduced in California and were implicated in significant losses to aquatic wildlife. The capability of this species as a predator or potential predator on native fishes and amphibians, as well as its capability to displace native frogs based upon the California experience prompted the Department to recommend that possession of this species be restricted, given the vulnerability of native aquatic resources. This recommendation was forwarded at a time when “raise a frog” kits were being marketed, featuring clawed frogs as the main attraction. There was a need for action, and there was a need for a process that involved the public. The formal rule-making process that restricted possession of *Xenopus* species was long, contentious, described by many as “painful” and dealt with more families, genera and species than just this one genus of clawed frogs. But, when it came to a conclusion, after incorporating public process, the Game and Fish Commission in the early 1990s included the genus *Xenopus* on its list of restricted live wildlife.

An Interagency Success Story. Not all actions are rule makings, but are instead responses to invasion using the resources at hand. The aquatic plant *Hydrilla* had been recognized as a threat to Arizona’s wildlife, waterways and agriculture based upon the experiences of California and

other southern tier states. When it was detected in a golf course west of Phoenix, the Arizona Game and Fish Commission took a lead role in the success story of *Hydrilla* eradication in Arizona during the 1980s. Networking with bordering states played a key role in *Hydrilla* detection because often whatever happens in California also will occur in Arizona. Additionally, the relatively quick eradication involved cooperation with the Arizona Department of Agriculture, the water community and the pet industry. Networking with the Department of Agriculture was essential because it has the vested authority for plants and plant pests in Arizona, as well as the certification of pesticide applicators. In addition, because water is a very precious commodity in the arid Southwest, assessing risks from invasive aquatic plants and the potential to influence water resources becomes a very delicate subject requiring support from the water community. Working with the pet industry also was important because there was a fair risk of distribution of *Hydrilla* as aquarium items. This alliance proved absolutely essential and very beneficial in terms of addressing sources and distribution of *Hydrilla*, treating the infestation and educating the public.

A Regional Cooperative Process in Progress. An ongoing experience is an infestation of the aquatic plant, giant salvinia, along the Colorado River in Arizona and California. Detection of giant salvinia in Arizona, at least from the wildlife perspective, occurred when a colleague at the Fish and Wildlife Service (FWS) determined that she had an interesting water fern in her backyard pond and found out what it was. Then, she informed her associates within FWS and Arizona Game and Fish Department about giant salvinia and some of the problems that had been experienced in places like Texas and Florida. Almost immediately after informing the network of wildlife professionals in Arizona, rafts of salvinia were detected near Imperial Wildlife Refuge on the Colorado River – prompting interagency and interstate concern. Fortunately, the progression of the giant salvinia infestation has not been as rapid as had been feared from conferring with colleagues in Texas who had experienced its potential to infest and essentially overtake entire bodies of water.

Giant salvinia is a rather interesting story because it highlights the network for detection. The point of introduction was the Palo Verde Irrigation and Drainage District in California. From that point, as detected by refuge staff on the Imperial Wildlife Refuge, salvinia feeds through drainage systems into the Colorado River. Thanks to the network detection system, an interagency force led by California Food and Agriculture and FWS and including Arizona Game and Fish and Agriculture, wildlife agencies, the Bureau of Land Management and the Bureau of Reclamation surveyed and identified locations where giant salvinia exists in the river. This multi-jurisdictional cooperation is essential to combat the potential economic impacts of species like giant salvinia, especially when talking about the influence upon water, agriculture, wildlife and recreation in Arizona and California – certainly in the billions of dollars.

While we had been able to marshal forces and move rapidly against *Hydrilla* only a couple of decades before, we found several issues that slowed our response to this new threat. One thing that has become apparent over the last 20 years is that rapid response has become more difficult. In particular, some of the compliance steps are rather complicated. If these kinds of infestations of undesired aliens are indeed emergency situations and rapid response is dictated, then compliance steps need to reflect the emergency status or we need to develop our readiness and capability to allow for rapid compliance assessment and action.

General Comments on Process. In general, three things can be pointed out from these experiences: (1) we need to build dependable processes that includes the stakeholder to identify what is to be treated as invasive, (2) we need to build the capability to detect what works through networks and (3) we need to build the capacity to respond to the emergency situation.

The public's right to possess or distribute becomes a very difficult issue, and I believe a core source of concern for stakeholders. In a public policy forum, telling people that the universe is closed unless it is determined entirely safe is, perhaps, the right position – but seemingly unfair and

untenable. Consequently, agencies often have to operate from the perspective of what is prohibited and address threats as they come along. It may not be the best of all possible worlds, but it is one that we live in, and it must include the participation of the stakeholders.

Equally disconcerting is our capability or capacity to respond. Today, even when we can identify a consensus threat, we have limited capacity to address an infestation emergency. Capacity to respond at multiple levels must be developed.

Observations on the Executive Order. The main concerns of state regulatory agencies about this EO is not its goals, but its interpretation, its breadth of application and the uncertainty of this developing federal process. This EO appears to be a policy in search of process. As this process develops, as it involves stakeholders and as it works its way down to application at the local level, we will hopefully become more comfortable. But, at this point, we fear that we have something to risk. In particular, we are concerned about any erosion of our authority for the management of wildlife, the uncertainty of process, who will be the interpreter of the definitions in the EO and how the stakeholders will be involved. Because of its pervasiveness, the EO may be viewed by some as an intrusion of federal authority in a host of activities that are not federal roles.

Coming to consensus on process and implementation is only the first step – yet to be discussed is how we address the threats presented by those species that emerge from the process as our “invaders of concern.” Organization will be key to successfully address this issue. We must be capable of communicating and responding. In this regard, we are truly at a loss. To my knowledge, we have created no human capability, financial capability or planning capability to address emergency situations. We are looking at a situation where, by the time we respond, it will be an unplanned obligation. We must construct the capability and build the flexibility to respond when it is prudent and necessary to do so – and we must design it with the stakeholders. What we need is assistance – assistance in the form of a carrot and not in the form of a stick.

A State-Level Process to Designate Noxious Weeds: Colorado’s Experience

Eric M. Lane

State Weed Coordinator, State of Colorado

Developing Colorado’s Noxious Weed List. In 1990, the state of Colorado adopted a noxious weed management statute that defines a noxious weed as a plant species that is non-indigenous to the state and meets one or more of the following criteria:

- Aggressively invades or is detrimental to economic crops or native plant communities
- Is poisonous to livestock
- Is a carrier of detrimental insects, diseases or parasites
- Is detrimental to the environmentally sound management of natural or agricultural systems, either directly or indirectly

To identify which non-indigenous plant species should be considered for designation as noxious weeds, the Colorado Department of Agriculture conducted a survey of Colorado’s local weed advisory boards to determine which species caused the most economic and/or environmental harm to the natural resources of their counties. In addition, the Department convened an “ad hoc technical advisory group” of stakeholders including members of Colorado’s nursery and seed industries, weed scientists from Colorado State University, weed management professionals and natural resource managers from Colorado’s state and federal land management agencies. This advisory group provided a forum for discussion concerning species proposed by the local advisory boards for inclusion on the state’s noxious weed list. After meeting with stakeholders, developing a proposed rule and providing five public hearings scattered around the state, the state of Colorado designated 67 species as noxious weeds.

Developing Regulatory Restrictions on the Sale of Seed and Nursery Stock. Having identified species that meet the legislated criteria of a noxious weed, the Commissioner of Agriculture asked staff to suggest and evaluate potential regulations of seed and nursery industry sales and practices that would better reflect the reality of Colorado’s

noxious weed situation. For example, if purple loosestrife is identified as a noxious weed, should we regulate its sale as seed or nursery stock? Over a year, the Department initiated dialogues with both industries, met with the Nursery and Seed Advisory Committees (statutorily established advisory committees), conducted surveys of business association members to determine potential loss of profits, made presentations at industry/association meetings and conducted two public hearings. Once the Department achieved general agreement with industry stakeholders, identified appropriate phase-out periods to accommodate stock and buyers' contracts and reviewed proposed regulations with the Agriculture Commission (the advisory body to the Department), the Department adopted new regulations for both seed and nursery stock sales. The new nursery regulations prohibited the sale of 67 noxious weed species in nursery stock (<http://www.ag.state.co.us/DPI/rules/nursery.pdf>). Although technical reasons made it impractical to list every noxious weed in the revised seed regulations, the new seed regulations added 21 species to the prohibited weed seed list and five species to the restricted weed seed list (<http://www.ag.state.co.us/DPI/rules/seed.pdf>).

Issues and Concerns Raised During the Regulatory Process. As a result of the process to designate Colorado's noxious weed species and regulate their sale as seed and nursery stock, participants raised a number of issues for discussion:

- Is it possible to develop a more rigorous, scientific (quantitative or qualitative) basis for designation? Many stakeholders, especially industry members, are particularly interested in developing a more rigorous and predictable means to identify existing and future noxious weeds so costs can be avoided or at least minimized. Some models may help to qualify and/or quantify the aggressive or invasive nature of established non-indigenous species and predict the invasive nature of species yet to be introduced to the state, nation or continent. Although these models still need improvement, they provide some insight into how stakeholders can collectively and more objectively assess the nature of suspect species.
- While research and information regarding the impacts of noxious weeds upon agriculture is abundant, data regarding species that invade primarily natural areas and wildlands are scant. Consequently, it is more difficult to establish consensus among stakeholders regarding the degree to which a species harms environmental systems and values such as biodiversity, wildlife habitat, soil erosion, water quality or ecosystem function. Furthermore, who should pay for such research if it is necessary or desired?
- What constitutes sufficient harm to warrant consideration of a species for designation? While some species such as leafy spurge and Canada thistle are clearly aggressive invaders and can thoroughly dominate the desired plant community, other species such as common mullein and bull thistle are less able to develop monocultures. Yet, the harm caused by these less aggressive species becomes apparent, particularly in native plant communities, as the landscape is slowly transformed by a multitude of non-indigenous species that infiltrate, but perhaps not dominate, desired plant communities.
- Is some amount of harm acceptable given resource constraints for management as well as potential benefits of commercial sales? Similar to conventional air and water pollution laws, some amount of harm (environmental or agricultural contamination) may be acceptable if the costs to further reduce the harm is excessive and/or the benefits of sales or utility of problem species offset the costs.
- Are the economic values of a species used for ornamental or agricultural purposes cause to reconsider its designation as a noxious weed? Obviously, only those species that provide a financial benefit to the industries cause any concern. Consequently, those species that provide some significant financial income to the industries are re-examined to confirm their status as noxious weeds.
- When a species goes awry, who should bear the cost of its management, e.g. the industry, the public taxpayers or the affected landowners? Weed management is not simply a biological endeavor. The invasion of non-indigenous species has many social ramifications, not the

least of which is the question of who should pay to control escaped species. Some participants argue that when an industry is responsible for the introduction and distribution of a noxious weed that it alone is responsible for the costs of control. Others argue that the landowners who have let a species escape (such as an escaped ornamental) should bear the costs of management. In the absence of a solution, it is the public taxpayer who bears the cost.

- Current laws may not adequately reflect current social needs or concerns. For example, the Colorado Seed Act provides for the regulation of seed used primarily on cultivated and agricultural lands. However, seeds are increasingly used for re-vegetation efforts in Colorado's natural areas, particularly on federal lands – which are prized by the public for their environmental, not agricultural, values.
- Regulations are club-like in nature rather than surgical. Although a species may affect only certain biogeographical regions of the state, it is not possible to prohibit the sale of a species in only some areas of the state – regulations are often one-size-fits-all.

Those issues, to some extent unresolved, are the focus of ongoing scrutiny and discussion among Colorado's community of weed scientists, industry members, weed management professionals and regulatory officials.

Areas for Future Improvement. While many states continue to improve the regulatory process of defining noxious weeds and developing appropriate regulations, a number of areas continue to need improvement. Specifically, it is desirable to develop:

- A greater consensus, or at least a more thorough understanding, of the nature of invasive plant species (noxious weeds).
 - What are the biological characteristics of noxious weeds?
 - To what degree of certainty can one predict that a specific species will become an aggressive noxious weed if introduced into a given environment?
 - What precautions should be taken to ensure

that a naturalized species will not become a noxious weed in the future? As many have observed, naturalized species often undergo a period of stasis followed by rapid expansion of population size and distribution.

- More frequent opportunities for communication and frank discussion among stakeholders including industry members, regulatory officials, weed scientists, environmental and agricultural interests and professional weed managers. Such discussions can lead to more productive and satisfactory resolution of problems (real or perceived), enhanced decision-making processes, increased trust and collaboration among stakeholders and more efficient and effective government regulations.
- A greater respect among all stakeholders for the needs of the American citizenry as well as our nation's businesses. Specifically, there must be:
 - Greater respect for the business community's desire for stability and/or certainty with regard to potential regulations and business practices.
 - Greater respect for the values of our society as well as the costs inflicted upon the public tax-payer and other private businesses that result from the introduction of noxious weeds.

Conclusions. Colorado's experience with designating and regulating noxious weed species largely has been successful, but it has not been without difficulties and opportunities for improvement. Other states also are struggling with how to define and designate species for control and regulation. It is incumbent upon states to increase their communication with one another so they can share their successes and failures. Members of industry, environmental and agricultural interests, natural resource managers and regulators share a tremendous interest and concern regarding the establishment and spread of noxious weeds. More frequent and open communication among states and their stakeholders may help to limit position-taking by all sides, speed resolution of the issues surrounding the designation and regulation of noxious

weeds and result in more effective prevention and management programs that mitigate the impacts caused by noxious weed species.

A Risk Analysis Process for Non-Native Species

Richard L. Orr

Senior Entomologist, Animal and Plant Health Inspection Service, U.S. Department of Agriculture

Formal risk analysis began in the late 1960s to early 1970s when the National Research Council (NRC) addressed a communication problem between government agencies and scientists. Scientists felt that their science was not being used wisely by the policymakers. On the other hand, policymakers responded that scientists were sending information that was either conflicting or not useful in helping them make regulatory decisions. Unfortunately, at times both statements were true. The need to facilitate communication between the two groups became what is now referred to as a risk assessment.

In general, risk is the likelihood and magnitude of an adverse event, risk assessment is an estimation of risk, risk management is the decision-making process concerned with what to do about that risk and risk analysis is the process of information gathering for risk assessment and risk management. The basic function of risk assessment is to organize information or data into a format that can be understood and used by policymakers. This is best done in a two-prong approach of estimating the likelihood of an adverse event and estimating the consequences of that event, if it happens.

Criteria. In addition to meeting the basic definition of estimating the likelihood and probability of an adverse event, the following criteria are essential for a risk assessment:

- Comprehensive - detailed review of the subject with sources of uncertainty identified in the data
- Logically sound - up-to-date, justifiable, unbiased and sensitive to different aspects of the problem
- Practical - commensurate with the available resources

- Conducive to learning - enough scope to have carry-over value for similar assessments
- Open to evaluation - sufficiently detailed record so that the process can be reviewed and challenged by qualified independent reviewers
- Flexible and dynamic - accommodates a variety of approaches to risk depending on the resources available, accessibility of the biological information and the state of the risk methodology at the time of the assessment

Therefore, when completed, a risk assessment should provide a reasonable estimation of the risk, communicate effectively the amount of uncertainty involved, and if appropriate, provide recommendations for the mitigation measures that would reduce the risk.

It is important to include scientific uncertainty in a risk assessment because it is an unavoidable limit that is inherent in the knowledge and methods by which scientific facts are established. Fundamentally, the three types of uncertainty that show up in a risk assessment are the uncertainty of the process (or methodology), uncertainty of the assessors (or human error) and the uncertainty associated with the biology of the organism and the environment in which it is introduced. Because scientific knowledge is basically probabilistic rather than absolute, and provisional rather than final, it can never be devoid of uncertainty or the possibility of inaccuracy or incompleteness. Thus, the dream of a risk assessment based on science that eliminates uncertainty is not attainable. However, the ability of a risk assessment to effectively communicate the degree of uncertainty surrounding an invasive species issue is a feasible goal.

Risk Assessment for Invasive Species. The evolution of risk analysis as associated with non-native species began in the early 1990s with the NRC's workshops associated with the development of *Issues in Risk Management*. Much of the focus was put on the development of a *Paradigm for Ecological Risk Assessment*, which included non-native species.

There was little time for future development of a non-indigenous species risk process, since a new trade route was opening to allow shiploads of

untreated Siberian logs (more than 30,000 per ship) from Siberia to the Pacific Northwest. Considering that trees are an ecosystem in themselves containing an array of associated organisms, there was concern that forest pests from Siberia would establish and cause extensive damage to forests of the Pacific Northwest. It was with this assessment that the principles gleaned from the NRC's workshops were first tested and refined.

Concurrently with the Siberian Log Risk Assessment, the U.S. Environmental Protection Agency (EPA) had started to look into how to conduct an ecological risk framework that included non-native species, or what they referred to as biological stressors. Thus, the EPA ecological framework provided additional input to the Siberian log risk process and the NRC's *Paradigm for Ecological Risk Assessment* for the development of a non-native species risk process.

Risk Model. From the review process, a risk model is applied for evaluating a pathway carrying unwanted invasive species. This model is broken down into seven elements dealing with the probability of introduction and magnitude of damage expected if a non-native species becomes established. The elements that relate to the probability of establishment include the likelihood of the organism or organisms of concern (1) being in the pathway, (2) surviving the journey, (3) becoming established in the new environment and (4) spreading beyond their initial establishment. The elements composing the consequential portion of the risk model include the likelihood of the organism or organisms of concern, if they become established, to produce (5) economic, (6) environmental and/or (7) social damage. With this model, the assessors can then organize the available information on the exotic organisms and convey it to policymakers.

It is important to recognize that under the colonization potential, the ability of an introduced organism to become established involves a mixture of the characteristics of the organism and the environment in which it is introduced. In reality, the level of complexity between the organism and the new environment is such that the species success can be based on minute idiosyncrasies of that interaction. In many cases, the turbulence

and chaos of the ecological dynamics hinder accurate prediction of future ecological events. Furthermore, if the species becomes established, the magnitude of damage can affect the degree of acceptable risk that is based on the probability of introduction.

Operational Steps. The following four risk management operational steps should be accomplished when addressing non-native species: (1) maintain communication and input from interested parties, (2) maintain open communication between risk managers and risk assessors without attempting to drive or influence the outcome of the assessment, (3) match the available mitigation options with the identified risks and (4) develop an achievable operational approach that balances resource protection and utilization. At an operational level, regulations and policies must be based on sound, verifiable and unbiased scientific data. Preventing the establishment of invasive species through an existing pathway requires that each one of the steps in the process be examined with the risk assessment as a foundation. We also must evaluate the current conditions covering the pathway including industry and regulatory standards. After that, mitigation measures should be evaluated for feasibility and applied to ensure that the identified invasive species are effectively being stopped from entry. Finally, a system should be developed to monitor and ensure that all mitigation requirements are maintained.

Decision Making. Clearly we wish to make a decision that will benefit the American people overall. However, many decisions involving invasive species are multifaceted. While most would agree that sound science should be the basis for decisions involving invasive species, the political world is much more complex. In a society as fragmented in thought and values as the United States, any action will impact negatively on some individuals. If those individuals or special interest groups have clout, then political pressure enters into the decision formula.

Also, if we are going to enjoy our current lead position in international trade, we will have to learn to live with an acceptable level of risk or tolerance when it comes to non-native species. This will be a tough task, because the degree of risk an

individual will take in a value judgment can not be directly answered by the scientific method. We also need to learn how best to compare the benefits of non-native species with the risks of them becoming invasive.

While risk assessment is an effective tool for relating science to policy, risk assessment does not, and should not, replace the need for good scientific or other types of information, nor does it

replace the need for someone to make a decision. Even with a good risk assessment in hand, a tough problem can still generate a difficult decision-making process. Furthermore, when it comes to predicting which exotic species will establish and, for those that do so, which will cause unacceptable economic and/or environmental damage, we as risk assessors, scientists and stewards of our natural heritage, still have a long way to go.

NON-FEDERAL STAKEHOLDER PERSPECTIVES

Introduction

At the roundtable, we placed a special emphasis on the concerns, needs and opportunities from the perspectives of state and private stakeholders. Representatives from eight organizations including three trade groups, a commercial interest, an association of state governments, a regional commission and two non-governmental organizations representing environmental and conservation interests were asked to provide their perspectives. Although the perspectives presented may vary in some aspects, they all recognize that invasive species management is a major problem that needs attention. The expanded summaries of eight individual presentations follow:

American Nursery and Landscape Association

Craig J. Regelbrugge

Senior Director of Government Relations

The invasive species issue, broadly defined, is of growing significance and concern in the U.S. nursery industry. As background, the industry is considered by the U.S. Department of Agriculture (USDA) to be perhaps the fastest growing segment of agriculture. It now represents 11% of agricultural crop value at the farm gate, and at retail, the nursery and landscape industry is over a \$40 billion industry, not counting related supplies, materials and services. That makes us bigger than the motion picture industry! The industry has long

played a major role in improving crop and forestry production, the quality of the “built environment” and our quality of life. Increasingly, the industry is being looked to as the source of the plant material needed for environmental remediation, restoration and environmental enhancement.

The nursery industry is diverse in terms of business focus and geography. It has historically relied a good bit on plant introduction and plant improvement. In fact, the very fabric of our food, fiber, plant and animal agriculture is based on species introduction and improvement. The desire for the new and different, for tough and adaptable plants, is a cultural reality to which the commercial industry is trying to respond.

Along with the movement of people and products come pests, and the industry has long been concerned with the introduction of harmful plant pests. When new pests gain a foothold and become established, they nearly always pose production problems and trigger market-disrupting quarantines for plant producers. As a result, the nursery industry strongly supports coherent and effective measures to exclude, detect and eradicate invading plant pests of all types.

The American Nursery and Landscape Association (ANLA) was grateful for the opportunity to play a meaningful role in the development of last year's *Safeguarding American Plant Resources* stakeholder review of the pest safeguarding system that is overseen by USDA's Animal and Plant Health Inspection Service (APHIS). That review produced

a report that covers in detail a number of issues relevant to today's roundtable discussion. Those issues include the need for functional databases and database linkages to aid decision-making. International partnerships beyond what we have seen to date will be key. Countries such as Australia were found by the review team to be leaders in the plant protection field simply because they have succeeded at capturing and using information.

For the United States to succeed equally, functional federal/state relationships will be critical. More than ever, decision-making at all levels of government relative to invasive species will need to be science-based, transparent and sensitive to complementary roles. And it will be important that we collaborate closely with our North American neighbors, especially Canada, if we hope to have any meaningful success toward invasive species exclusion and management priorities. In the interest of time, I will encourage you to read the report in full, specifically the information needs and management recommendations.

The nursery industry is also well aware of the increasing concern over some intentional introductions that simply have done too well, becoming noxious in some instances. Some of these intentional but now harmful introductions occurred decades, even centuries ago. Some were brought in by government to serve specific purposes, some by commercial interests and some by interested amateurs and plant enthusiasts. Some have naturalized and become part of North America's flora, now recognized only by a few experts as so-called "aliens." A few have established and now severely disrupt or change the functioning of ecosystems.

Information Needs and Concerns. Regarding information issues, I wish to comment on the growing dialogue among the nursery industry and the related academic community regarding potential controls on intentional species introductions. Most, but not all, introductions in the commercial horticultural trade involve improved varieties of species that have been introduced many times in the past, generally with considerable benefit and without serious problems. Yet, there is growing agreement that some type of pre-introduction

screening – whether voluntary or regulatory – should occur for those new plant taxa being brought into North America for the first time.

A focus on screening truly new taxa proposed for introduction begs the question, "What is already here?" This is perhaps the most fundamental and unmet information need we face in the area of intentional plant introductions.

There are predictive models in various stages of development that show promise toward helping us exclude some of the potential worst actors. Are they perfect? No. Do they have a long way to go? Clearly. Meanwhile, the models should be communicated, tested and improved. The many pathways other than plant introduction by professionals also should be recognized. If the United States were to adopt a highly rigorous "guilty until proven innocent" standard, it would likely leave us with a false sense of security. New species will still find their way here, but the pathways will be more diffuse and difficult to target. It would accomplish little to target the trade only when entry pathways are more complex.

While discussing information and information management, the topic of lists must be raised. People love to create lists. We make lists every day – our to-do list, the grocery list, etc. Clearly, lists can empower – so long as the list creator and the list user fully understand the criteria and rigor that were applied and the intended use of the list. The same is true, of course, for databases. Unfortunately, in the arena of invasive plants, and especially managing existing problems, open discussions on list criteria and intended use often are given short shrift. So we are seeing a proliferation of lists leading to polarization and resulting political intervention in the invasive species management debate. One could say we are drowning in information and starving for wisdom.

There are bright spots – the states or localities that have encouraged outreach and education first, and reached some consensus on priorities and intended outcomes are the ones moving forward. From the nursery industry's standpoint, we have heard from two today – Florida and Colorado. Massachusetts is a third state where a robust dialogue is taking place. There are plenty of negative examples too.

From where we stand, the use of lists is a good vantage from which to understand the broader challenges and sensitivities associated with information collection, manipulation, sharing and use. Major lessons and observations so far include:

- There is a great need for education and outreach – both among the industry and to the consumer. Within the industry, we have found that common ground exists when an informed conversation about priorities and options occurs.
- Policymakers and resource managers would be wise to understand the industry dynamic relative to marketplace pressures and decision timelines. This is especially true where production phase-outs and shifts to alternatives are being encouraged.
- We have much to learn regarding how to respond in a coherent and science-based way, given the regional, indeed local, nature of the issue.
- There are tremendous unfulfilled research needs. The nursery industry is trying to address some of those research needs, and we have hope that certain useful plants viewed as invasive can be bred to address invasiveness concerns.
- More than ever before, invasive species priority-setting will require collaboration – international, federal, state and local; government, academia, industry and other interest groups must be involved.
- Decisions must be transparent, made with a sound science foundation, consider benefits and be practical about intended outcomes.

In closing, ANLA is pleased to be a part of this roundtable today and a player in the invasive species dialogue. We believe that this dialogue will help to frame and encourage appropriate responses to the invasive species issue that are compatible with the sustainable growth and health of the nursery industry for years to come.

American Seed Trade Association

Dean Urmston
Executive Vice President

The American Seed Trade Association (ASTA) has long recognized the need to identify, monitor and, when necessary, control or eradicate plant species that significantly adversely affect the environment, production agriculture, conservation efforts or otherwise cause harm to the economy, environment or human health. ASTA is concerned, however, that state or federal agencies may take or may already have taken ill-considered or otherwise inappropriate measures, including development of lists to control so-called invasive species. Such measures could significantly harm the distribution and use of many beneficial crops that have long been used in production agriculture.

It is the position of ASTA that the harm the species is likely to cause must far outweigh the economic and related losses that would be incurred by the seed industry and the public in general should an existing agricultural crop, turf, conservation or ornamental be considered “invasive” under the Executive Order No. 13112 (EO).

ASTA also understands that several states have in existence local plant councils or committees that are engaging a limited constituency in the discussion of invasive/alien plants. These state “listing” procedures appear both procedurally and substantively deficient. First, the listing process continues in most instances without input from all interested parties, including state seed control officials, ASTA and state and regional seed industry associations, Land-grant University Extension personnel, state plant material specialists, turf specialists or representatives from production agriculture. Second, the manner in which the state and local councils and committees are designating species indicates that they are failing to apply coherent, scientifically based criteria and may be ignoring the substantive law. In fact, in many instances, they seem to be simply amalgamating various lists, developed on the basis of widely varying criteria

ASTA is committed to cooperating with the National Invasive Species Council (NISC) and all interested state and federal government agencies through the provision of technical support, economic data and other means in addressing the legitimate challenges posed by invasive species. That process must include the application of

appropriate standards and take into account the full economic impact of a species' identification as "invasive." Failure to undertake this critical cost/benefit analysis will threaten the future availability of commercially useful species for farms, lawns, athletic fields and conservation areas.

ASTA supports efforts to protect our nation and its agricultural industry from harmful, invasive species and will cooperate with the NISC and interested state agencies in the development of management plans and other tools to protect against unreasonable adverse harm to the economy, environment, or human health. ASTA will oppose and challenge, however, any efforts to list as "invasive" – or otherwise jeopardize the legitimate use and viability of – species beneficial to agricultural crops, turf, conservation or ornamental purposes.

Capitolink, LLC

Thomas R. Hebert
Partner

Capitolink is a small government affairs consulting firm in Washington, D.C., and I am one of three people on the staff. I worked in the public sector from the late 1980s until two years ago, and throughout that time, I focused on agriculture, natural resource conservation and environmental issues. Two years ago, I left the federal government and joined the private sector. I am involved in this discussion today because of work I do with a company called SePro Corporation, which has interests in aquatic invasive plant management, in herbicide work, in developing biological control agents and in management of aquatic systems in general, using geographic information systems and related services.

As part of my work with SePro, I am involved with a group called the Invasive Weeds Awareness Coalition (IWAC) which some of you, I am sure, know about. IWAC is an informal group of non-governmental organizations that work here in town on invasive or noxious weed issues, private sector folks such as SePro and others involved in these activities. Some of the relevant federal agencies will drop in and visit with us, and we keep each other informed of activities and identifying proper

areas where we can support the activities of the federal agencies. Last year, it became apparent to IWAC that several events and opportunities were going to present themselves in February 2000 in Washington, D.C., to draw attention to the needs of invasive weeds management. We decided to try to facilitate all these opportunities and called it National Invasive Weeds Awareness Week (NIWAW). In our view and relative to our objectives, NIWAW went well, although improvements are most definitely possible.

As we prepared for NIWAW and for all of the people who were coming to town to meet with Congressional staff to discuss these issues, we all started to think about the messages we would be using with Congress. My own area of focus was on aquatic invasive plants. One of my goals was to be able to put before Congress a solid, factual and credible case for why more funding is needed to manage them. IWAC as a whole wanted that kind of message for all invasive weed species to be available to educate Congress.

When educating Congress, your job is to develop as clear a picture of the problem and needs as possible. And then you try to demonstrate that if monies are made available, there is a good and effective plan of action for dealing with the problem and meeting the needs. The need for a clearer, more definitive picture in many ways boils down to an issue of databases, one of the major subjects for today's roundtable.

As a practitioner trying to educate members of Congress, my view is that there are excellent databases with a lot of great information, but as education tools, they fall short of what we really need. This is not a criticism. People have worked hard to pull together the considerable amounts of data that are available, and the results are impressive and useful. I just think we need more.

That being said, in that context and relative to aquatic invasive plants, in preparation for NIWAW, I worked with a few people, and we were able to assemble a respectable and effective package of information that would matter to members of Congress. We used the U.S. Geological Survey's (USGS) Non-indigenous Aquatic Species Database, APHIS's National Agricultural Pest Information System, Natural Resource Conservation Service's

Plants Database and Biota of North America Program. We supplemented those with maps and descriptive information from a few key states from around the country, provided by aquatic invasive plant program managers in those states. The assembled package was a respectable presentation about the nature and extent of aquatic invasive plant problems in the country.

When working with Congress you often can find that it is not enough to provide a picture of the problem, the needs and a good plan of action. You also will need respectable political constituencies who are willing to go to bat for you. And you find that to a certain extent, deficiencies in one area (i.e., incomplete depiction of problem and need) can be made up with strength in the second area (i.e., motivated and respected political constituencies), and vice versa. I have found over the years that you can make up for lack of good analytical work with good political constituencies – and the inverse is true.

There are limits to how far this substitution can go, and there is no beating having both of these elements in top form – great information and great political support. But the point is that your information does not have to be perfect to be effective in Congress or other centers of decision-making. The world is imperfect and filled with uncertainty, and decision-makers are used to making decisions with imperfect and uncertain information.

In the case of aquatic invasive plants and NIWAW, we have had pretty good luck in getting people's attention on the aquatic invasive plant side. People are willing to talk to us, in part because we had a respectable presentation about the nature and extent of the problem, and we had a respectable set of political constituents there at the same time. We have made a little bit of progress in this area as a result.

But we can do better, and I believe a key to success will be better database tools. We need better and more accessible information on where the infestations are occurring, what their consequences are, both ecologically and economically, and why they should matter to somebody in Congress. We have to be able to demonstrate why it matters to the people that vote for members of Congress. All politics are local.

My second point is the following. I was at USDA for several years and acted as its representative on the Federal Geographic Data Committee for that time. One of the things that I learned in that process is that when it comes to the federal agencies that play an active and direct role in the management of land, it is extremely difficult for them to make their data and data systems inter-operable. These agencies have so much at stake in the data that they generate and pull together. Each of their missions differ, and the political constituencies that support their funding are different. As a result, it can be very hard or impossible to have these agencies generate a seamless, inter-operable data system.

The clear exceptions to this problem are the agencies that are dedicated to doing data work. USGS and others provide examples. But for their data sets to be as valuable as possible, they need to have access to all the valuable information that all these other action agencies are pulling together. My observation is that there will never be enough incentives for the action agencies to do it on their own and to come together. It is tough enough within agencies to do it on their own, let alone cross agency lines. That being said, the efforts on inter-operability are fantastic, and we need some real gains.

My point is that I believe you have to find a way to pull the private sector into this data management issue. You have to find people who believe that they can make money from inter-operable databases to help the public sector do this work and help build the bridge between the action agencies who are pulling data together, and the private sector folks. So, I ask those of you who are working on these matters to be aware of that as we do our work.

Western Governors' Association

Paul E. Gertler

Natural Resources Consultant

The Western Governors' Association (WGA) is a non-partisan association of 18 western states and three Pacific flag islands. WGA became involved in the invasive species issue as a result of a resolution passed in June 1998 that called for the association to try to develop strategies to deal with inva-

sive species. A working group with diverse representation was established to recommend a focus where the Western Governors' invasive species program could be most productive. Ultimately, the working group recommended that the Western Governors focus on building capacity within the western states at all levels – federal, state, local and private.

As we move toward building capacity, a number of different issues come to mind that may be valuable for us to consider. Most are directly related to data collection, access and use. However, I'll start with two concerns that are not data-related. First is the need to take a holistic approach that we not divide into different groups with different areas of interest or specialization. Although there may be value when discussing scientific, technical and strategic issues to focus those discussions on specific areas of expertise (i.e., terrestrial and aquatic), it is critical for the invasive species community to stand together when pursuing political and financial support. I think it is essential to maintain a consolidated front on the massive issue of invasive species when dealing with policymakers and appropriators.

Second is the value of steering our efforts to the middle. Right now, because we are steering to the middle, we have a broad consensus among a diverse set of interests on important priorities in dealing with invasive species. There are some outlying issues, some of which are legitimate invasive species issues, but are so divisive that they could seriously impede our ability to make significant progress. This does not mean that they should not be dealt with later. As we build trust and as we build successes, we can start dealing with some of the more difficult issues. But we must now take advantage of the existing broad consensus on the wide middle of this issue.

Now, I'd like to touch on six issues related to data. First, I think there is an urgent need to assess and document efforts currently being conducted by the numerous governmental and non-governmental entities. We need to know who is doing what with which resources, what money is available and what is being spent so that we can go to policymakers, decision-makers and appropriators and responsibly identify what is being done, what is not being done, where the gaps are and what are the highest priorities.

Second, we must be mindful of the credibility of the data that we use, especially when we are talking to the public or seeking support from those who are not necessarily intimately aware of everything we are doing. Is it possible that some of us are batting around figures that may not stand up to scientific scrutiny? Our continued credibility requires us to be cautious and prudent about the way that we use information.

Third is the issue of the availability of data and how to make it accessible and useful. A corollary to this issue is the need to consider quality assurance and quality control (QA/QC) of these data. People who use these data need to understand the QA/QC that apply to different data sets.

Fourth is the need to be cautious about developing centralized databases. Perhaps, it might be more efficient to take a different approach. There are always going to be databases that have many different uses. It might be more effective and efficient to focus on developing specific standards and criteria by which data are gathered and put into databases rather than trying to create large centralized databases that tend to be expensive to create and maintain, take a long time to develop and are often outdated as soon as they are completed.

Fifth is the need to strike a balance between the resources expended on data collection, management, access and use with the need to take on-the-ground action. Total funding for invasive species work is limited and likely to remain so. With this in mind, we must find a balance between addressing data needs and taking on-the-ground action.

Finally, there is the need to ensure that the level of data gathered and stored in databases is commensurate with the use they will be put to. For example, when dealing with national issues, the level of information will be general and broad. In contrast, the information will need to be more detailed and specific when dealing with local issues such as noxious weed control on a specific land area.

I believe that if we carefully consider these issues and continue meaningful dialogue about how information is to be used, we will be "steered to the middle," and that together we can muster the resources needed to have a major impact on the invasive species problem.

Pet Industry Joint Advisory Committee

N. Marshall Meyers

Executive Vice President and General Counsel

The Pet Industry Joint Advisory Council (PIJAC), the largest pet industry trade association, has a long history of involvement with invasive species issues, dating more than 30 years. PIJAC's representation is limited only to issues involving live organisms. These involve acquisition, import/export, interstate movement, sale and possession of companion pets, including aquatic organisms. These run from puppies to live rock. Virtually every pet that we own in this country is technically an "alien," some of which are invasive and prohibited, others that have possession restricted where their impact is detrimental to local ecosystems.

The pet industry's concern is traceable to an attempt by the U.S. Fish and Wildlife Service in the early 1970s to adopt regulations banning all imports of non-native species until proven innocent. The pet industry would have been compelled to prove on a species-by-species basis that the importation would not be harmful to the environment, agriculture, other wildlife or humans. Once proving the "negative," importation might be approved. Needless to say, these regulations were not adopted.

Over the course of a year, PIJAC monitors more than 10,000 proposed laws and regulations that affect the \$23 billion pet industry. Sixty-one percent of U.S. households own and care for thousands of different species. Pets are an integral part of American society. So, we must keep that in perspective in determining how we are going to have an overarching regulatory system to try to deal with the invasive species issue. It is a complex and sometimes highly emotional issue.

The pet industry historically has been dependent on non-native species and recognizes its responsibility to avoid introducing harmful invasive species. Over the years, the industry has worked with state governments in regulating, and sometimes prohibiting, the importation, sale and/or possession of certain species that have been

demonstrated to be harmful invasives. The industry is opposed to wholesale, nationwide bans absent clear demonstration that a species is, in fact, harmful on a nationwide basis. On the other hand, the pet industry has supported a myriad of listings, restrictions and regulatory mechanisms to minimize adverse impacts.

With that brief background, I will address several concerns regarding this highly complex issue.

First, and of major concern – decision-making based on inadequate or incorrect science or simply for political expediency. Simplicity – ban until proven innocent – really does not work. You cannot sell it to the public; you cannot sell it to industry.

Second concern – reliance on research conducted for other purposes, but now being interpreted to infer invasiveness.

Third concern – lack of basic criteria or research protocol(s) for ascertaining invasiveness. What attributes indicate or predict invasiveness? What criteria or standards should be employed to measure impacts or aid in determining whether a specific invasive alien is harmful and therefore should be prohibited, controlled or eradicated?

Fourth concern – quality of data. Significant data gaps exist, particularly with respect to the biology of many species, the vulnerability of receptive habitats, etc.

Fifth concern – databases. Reliance upon databases, absent thorough investigation and analysis, will lead to ill-conceived listings and bad decision-making. While databases have their place, they can be easily misused by shortcutting the process. Simplistic or user-friendly databases on the Internet are not necessarily a virtue. They can lead to misinformation, disinformation or misinterpretations. We must avoid the apt characterization a few moments ago of "garbage in and gospel out." Something needs to be done to ensure credibility of the data being utilized by the risk assessment assessors, decision-makers and policymakers.

I am intrigued when I review on-line Internet surveys where one can enter sites with little to no verification. Specimens of a species reportedly

spotted and identified in a single pond are recorded as “introduced,” possibly “established,” and the entire state is marked “red” on a national database map. Databases replete with references to articles or reports generated for other purposes than invasiveness are relied upon to justify a listing as an invasive. Scientific scrutiny and scientific-based decision-making is made of sterner stuff. Work needs to be done to establish standards to qualify information in databases and to provide warning about the data gaps or other inadequacies in the databases. QA/QC needs to be an integral part of the emerging database industry – we need some form of codes or flags to indicate the relevancy of the plethora of data in these databases.

Sixth concern – lack of standardized terminology. A cursory review of the history of federal and state regulation of invasive species depicts conflicting and sometimes contradictory terminology. What is meant by the term “introduced?” Is it restricted to imports into the United States, interstate commerce, translocations outside the natural range or placement into an ecosystem? Does the term “invasive” automatically mean harmful, or are some invasives acceptable if the impact is minimal or possibly beneficial? Are terms of art applicable equally to fauna and flora? We believe that we need to standardize terminology and create a glossary of terms.

Seventh concern – credibility of risk assessments. The credibility of the risk assessment process is dependent upon (1) standardized processes, (2) relevant and reliable data, including qualified anecdotal information, (3) clear explanation of uncertainties – what is not known, (4) stakeholder involvement at all stages, (5) assessors and regulators being independent, (6) flexibility and (7) transparency. The Aquatic Nuisance Species Task Force’s *Generic Non-indigenous Aquatic Organisms Risk Analysis Review Process*, (October 21, 1996) is being used by a number of states for aquatic and non-aquatic species. This process provides a template for conducting comprehensive and comprehensible assessments.

Eighth concern – “precautionary principle.” This term of art has multiple meanings and applications, depending upon the arena in which it is being utilized. Reliance upon the philosophy of

“when in doubt, keep it out” is not realistic in a global community in which trade is an integral part of our activities. Thus, my precautionary principle is avoid – prevent going down a path that the public cannot buy into and industry cannot accept. All we will achieve is unresolvable confrontation and we will not deal with the real issues of trying to figure out how to control those invasive species causing real harm.

Ninth and final concern – regulatory mechanisms. Databases must be pragmatic, affordable, effective and implementable. And we cannot do it, in my opinion, only at the federal level. Most of the control and regulation is at the state level. The states cannot be ignored or excluded. One must look at what has happened in Florida, Arizona, California, Wisconsin and Colorado over the last couple years – they work with stakeholders; they conduct risk assessments applicable to their ecosystems; they prepare and implement a variety of management plans. Partnering with the states is essential; preemption will result in inappropriate and bad regulation.

So what are a few of the opportunities? From the standpoint of the pet industry, we need to enhance public awareness mainly through education. We can pass all the laws and rules we want, but possession of a lot of these critters will go underground if we are not careful. Industry educational efforts on how to handle unwanted pets and fish needs to be expanded. PIJAC’s disease education initiative, such as a collaborative poster with the Centers for Disease Control and Prevention on reptile-associated *Salmonella*, needs to be expanded. PIJAC is currently exploring ways to encourage owners of unwanted aliens to surrender those animals to PIJAC-member stores rather than release them into the environment. We need to work with other stakeholders on how such initiatives can be implemented.

What are some of the needs? Recognition of the economic importance of the pet industry in general and the important role alien species play in our society. Most importantly, we must recognize that the 50 states, as others have indicated today, are at the ground level where regulation is most effective. Collaboration and dialogue should not be minimized.

In closing, PJAC remains committed to seeking more effective ways to minimize adverse impacts from species in our trade. We support collaborative efforts that involve all relevant stakeholders and processes that include methods for ascertaining the economic and other benefits resulting from ownership of live animals and plants.

Great Lakes Commission

Kathe Glassner-Shwayder

Environmental Policy Analyst/Project Manager

As a representative of the Great Lakes Commission and the Great Lakes Panel on Aquatic Nuisance Species, I will be sharing a brief assessment of aquatic nuisance species (ANS) prevention and control issues evolving in the Great Lakes region.

As we look at needs and opportunities in regard to prevention and control in the Great Lakes, we need to take a glimpse at the hydrology and socio-economic characteristics of systems where ANS problems are emerging. The following facts and figures about the Great Lakes Basin are presented to help put the magnitude of the prevention and control challenge into perspective.

Close to 100,000 square miles of fresh surface water are found in the Great Lakes system; that is 90% of the U.S. supply and one-fifth of the world's supply. Twenty-five million of the Basin's 40 million residents rely on the lakes for their drinking water. And the economic significance of this resource is staggering. Manufacturing, tourism, recreation, sport fishing and maritime transportation are all multi-billion dollar industries. The Great Lakes system is, in many ways, "Grand Central Station" for ANS as the system links global transportation routes with the interior of the United States. Thus, prevention and control is an imperative – not only for our ecological and economic well-being – but for many other freshwater systems potentially impacted by Great Lakes infestations.

We in the Great Lakes Basin have documented the arrival of approximately 145 aquatic nuisance species since the early 1800s. Over a third have been introduced in just the last three to four decades, with maritime transportation as a lead-

ing vector. About 10% of those species – such as the sea lamprey, zebra mussel, ruffe, round goby, purple loosestrife and watermilfoil – have proven to be problematic. The ecological and economic impacts of such species are increasingly well documented; we find they're proving to be substantial and, in some cases, staggering.

Enactment of the federal Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990 was due largely to the unintentional introduction of the zebra mussel in the Great Lakes and the subsequent economic and ecological impacts. The 1996 National Invasive Species Act reauthorized the original legislation and expanded its national scope.

The Great Lakes Panel on Aquatic Nuisance Species was convened in late 1991 with the following primary responsibilities for the Great Lakes region:

- To identify priorities for the Great Lakes with respect to ANS
- To make recommendations to the Aquatic Nuisance Species Task Force regarding programs to carry out a zebra mussel demonstration program
- To assist the Task Force in coordinating ANS program activities in the Great Lakes
- To provide advice to public and private individuals
- To submit annually a report to the Task Force describing activities within the Great Lakes related to ANS research, prevention and control.

The wide range of membership of the Panel has been established to ensure that its policy positions provide a balanced and regional perspective on ANS issues in the Great Lakes region. Through its diverse membership, the Panel is able to provide a healthy forum for discussion, consensus-building, coordination and action among relevant Great Lakes user groups from public and private sectors both in the United States and Canada.

The inter-jurisdictional, regional approach to prevention and control is strongly promoted by the operation of the Great Lakes Panel, which is staffed by the Great Lakes Commission, an interstate compact agency. In brief, the objective is to

instill a sense of ownership by participating agencies, build upon and showcase their successes, operate by consensus, provide a coordination/catalyst/convenor function and serve as a single regional voice to elected leaders and other policy-makers.

The Panel is led by elected officers and meets regularly to establish priorities, cultivate partnerships and explore an array of funding opportunities to address our priorities. The following list of selected Panel initiatives illustrates where this regional entity has focused efforts in the past decade regarding ANS prevention and control:

- Model comprehensive state management plan on ANS prevention and control
- Model guidance on legislation, regulation and policy for ANS prevention and control in the Great Lakes region
- Aquatic invaders television special
- Ballast water management symposium
- ANS action plan
- Legislative and appropriations priorities
- Biological invasions brochure
- ANS update newsletter
- Information/education strategy
- Information/education inventory
- Research inventory

In conclusion, I would like to leave you with the following questions that encapsulate priorities regarding unmet needs and opportunities that emerged from a recent workshop of Panel membership and other stakeholders:

- What action can be taken to more effectively prevent future ANS introduction and dispersal?
- How can ANS management programs be designed to effectively control established populations?
- How can detection and monitoring programs be strengthened to facilitate a more proactive approach to ANS prevention and control?
- How can information/education programs and associated stakeholders function to raise the profile on ANS issues with the goal of promoting action on prevention and control?
- What measures can be taken to strengthen multi-jurisdictional coordination critical to preventing ANS introduction and dispersal on an ecosystem level?

The Nature Conservancy and Association for Biodiversity Information

John Randall

Wildlife Invasive Species Program, The Nature Conservancy

Nancy Benton

Botanical Research Associate, Association for Biodiversity Information

The Nature Conservancy. An invasion is underway that is undermining our nation's economy and endangering our most precious natural treasures. The intruders are alien species – non-native plants and animals introduced into this country either intentionally or by accident. Attention to the problem of alien, or exotic, species often centers on their costs to agriculture, ranching, forestry and industry. The price they exact from the nation's forests, grasslands and waterways, however, is at least as great. Unfortunately, many alien species are proliferating unfettered, causing severe environmental or economic damage.

The Nature Conservancy (TNC) is particularly concerned about invasive species because they are a major threat to its mission of protecting the organisms that make up the diversity of life on Earth by protecting the lands and waters they need to survive. TNC is one of the largest non-profit conservation organizations in the world and is active in North America, South America and the Pacific Basin. At present, TNC owns and manages more than 1,300 preserves scattered across the United States. TNC carries out invasive species control programs on its preserves and works to promote the prevention and control of invaders that threaten biological diversity on its property and elsewhere. When TNC stewards from around the nation were surveyed in 1992, 1995 and 1998, 48 states reported invasive plant problems and about 60% ranked invasive plants among their top-ten conservation concerns in each survey. Over 12% ranked invasive plants as the greatest conservation challenge they face. And higher percentages would have been obtained if questions about invasive animals had been included in the survey. Federal and state land-managing and conservation agencies also report severe problems with invasive species. When U.S. National Park superintend-

ents were surveyed, 61% of the 246 respondents indicated that non-native plants were a moderate or major problem. The area of U.S. Bureau of Land Management lands infested with weeds increased from an estimated 2.5 million acres in 1985 to roughly 6 million acres in 1991 and an estimated 8.5 million acres in 1994. These estimates indicate a 14% annual increase in area infested. Animal invaders (vertebrate and invertebrate) are similarly widespread and, in some cases, cause more severe damage.

Role of TNC in Invasive Plant Control. Weed control programs are now in place on TNC preserves across the United States, employing techniques ranging from manual removal, mechanical methods, prescribed fire, judicious use of herbicides, the release of biological control agents and encouragement of native competitors. The most successful endeavors follow an adaptive management strategy in which plans based on the goals of the preserve are developed, weeds that interfere with those goals are identified and prioritized, and control measures are selected and implemented where appropriate. Emphasis is placed on preventing new weeds from becoming established and on early detection and elimination of incipient infestations. Managers must focus on the vegetation or community to take place of the weeds and periodically re-evaluate whether their programs are moving them toward this objective.

TNC works with public and private partners who share concerns about invasive species, including federal, state and local land management agencies and agriculture departments, ranchers, farmers, nursery growers and other agricultural interests and other conservation organizations.

TNC also works with private industries and organizations to prevent the entry of new weeds and to control existing problems. For example, we are working with nursery industry representatives to develop protocols to screen newly introduced species for potential to become invasive. If adopted, potential invaders that are identified by the protocol would not be introduced or distributed. We are also working with U.S. and Canadian arboreta and botanical gardens to develop similar

protocols for these institutions. Such protocols will not stop all new pests from entering but every pest species we prevent will avoid tremendous additional biodiversity losses and save large sums of money and time in the future.

The Need for Invasive Species Databases.

Documenting current invasions and preventing new invasions are vital to the protection of biological diversity. Data on non-native invasive species present in the United States are incomplete, and data that are available are scattered in a variety of published and unpublished accounts and databases. This makes it difficult or impossible for land managers to identify, much less properly manage invasive species on their lands. In addition, the lack of data makes it more difficult to prevent invasions by new species into areas in which they have not yet been introduced because access to information on their previous invasive ability is mostly unavailable. Studies have shown that the best predictor of whether a new species will become invasive is whether it has invaded elsewhere. We see development of a network of invasive species databases as crucial to our ability to manage existing invasions, to halt or slow their spread and to prevent new invasions. Prevention, early detection, containment and eradication will be most possible if other nations also develop invasive species databases, and so we seek ways to make this happen, too. Only a network of invasive species databases from many nations will contain the information needed to make such predictions and hence prohibit entry of species with high potential to invade. It is our hope that these databases also will contain information on how to control pest species, since this may be crucial to efforts to quickly eradicate or contain them if they are first discovered in a new area. Eradication and containment are most possible and cost-effective for species that have just been detected and whose populations are still small.

Other groups concerned with biodiversity protection also see construction and maintenance of invasive species databases as crucial. For example, the IUCN (World Conservation Union, formerly International Union for the Conservation of Nature and Natural Resources) Invasive Species Specialist

Group's first priority is developing a network of invasive species databases.

Association for Biodiversity Information. Since 1980, TNC, in partnership with the Natural Heritage Network, has maintained data on classification, distribution and status of thousands of non-native species – as well as many thousands of native species – in its central scientific databases. The Association for Biodiversity Information (ABI) is a new nonprofit organization that was formed in July 1999 when TNC and the Heritage Network jointly established an independent institution to achieve their mutual goal of advancing the application of biodiversity information to conservation. ABI's mission is to manage and distribute authoritative information about the world's plants, animals and ecological communities. Working in partnership with 85 independent Natural Heritage programs and Conservation Data Centres that gather scientific information on species and communities, ABI has aggregated into a single data set key biological data for more than 50,000 plants, animals and ecological communities of the United States and Canada.

Heritage and ABI staff adhere to rigorous data collection, management and quality control standards that allow data to be compared and combined across the network of databases. The Heritage network is best known for its work in maintaining locational information on rare species and in ranking native species based on their conservation priority.

Just like we need to rank native species to prioritize conservation efforts, we believe there is a critical need to review non-native species to determine which are priorities for early detection and management, as well as to determine which species land managers do not need to worry much about. For the past few years, the Conservancy and ABI have worked together to create an invasiveness priority assessment system to classify non-native species into various categories of invasiveness. We are currently seeking ways to fund and expand this effort and incorporate these rankings of invasiveness into the Heritage databases.

American Land Alliance

Faith T. Campbell
Invasive Species Program

American Lands Alliance is a 501(c)(3) environmental organization focused on protecting and restoring forests, grasslands and aquatic and other ecosystems. We accomplish our mission by strengthening grassroots conservation networks, helping to provide advocacy services and improve communication and coordination among these groups and other societal institutions. I have represented American Lands on invasive species issues since 1997; previously, I represented other environmental organizations on invasive species policy issues.

Our goal is to stimulate more effective programs to curtail introductions and minimize the damage caused by invasive alien species, with a focus on “plant pests” and invasive plants. We see increasing public awareness, support and pressure as crucial to needed improvements. For this reason, we welcome today's information about the growing network of publicly accessible data on bio-invasion. And we endorse the call that these and other databases be both accessible and complete. Political considerations must not be allowed to determine which species are contained in such databases.

We would like to highlight several additional concerns about invasive species information. First, while several non-governmental sources can provide valuable information about established species – and are doing so for at least some groups of invaders – only the government can provide data on what species are coming in on which pathways. And this information is crucial to developing priorities for pathway-closing programs (whether voluntary or regulatory) and in assessing the effectiveness of these programs. As a previous speaker indicated, current “interception” data maintained by APHIS fall far short of the needed standard. It is vitally important to obtain statistically valid sampling data that cover all pathways in proportion to the true “size” of the pathway, and that include all species found there.

Second, information programs – taken together – must have sufficient breadth. I note the absence of forest pest experts from this workshop and my general sense that they are poorly represented in the entire process under the EO. American forests have suffered severe damage as a result of introduced species, and they are at high risk of additional introductions. Leaders of the various projects that seek to implement the EO need to make efforts to include people knowledgeable about and concerned about forest pests, as well as any other “orphan” groups.

Another aspect of “breadth” concerns invasive plants. Hundreds of species of plants shown to be

invasive in natural systems are not included on any federal or state “noxious weed” list – nor are they likely to be in the future. Nevertheless, they are part of the phenomenon being addressed here. These species need to be included in databases and other information sources; they need to be the subject of research; they need to be managed.

Thank you for the opportunity to express one environmental organization’s perspective on invasive species information issues. American Lands looks forward to working with a wide array of stakeholders on solving the many challenges bio-invasion present.

ENVIRONMENTAL AND ECONOMIC COSTS

David Pimentel

Professor of Ecology and Agricultural Science, Cornell University

In the history of the United States, according to our estimates, approximately 50,000 non-indigenous (non-native) species have been introduced into the country. This number includes 25,000 plants, 20 mammals, 97 birds, 53 reptiles and amphibians, 138 fish, 4,500 arthropods, 88 mollusks and 20,000 microbes. Earlier estimates by the Office of Technology Assessment indicated that at least 4,500 species of foreign origin have established free living populations in this country. A more recent estimate by the U.S. Geological Survey indicates that the number now exceeds 7,000.

Introduced species, such as corn, wheat, rice and other crops, cattle, poultry and other livestock, now make up more than 98% of the U.S. food system at a value of approximately \$800 billion per year. Other exotic species have been introduced for landscape restoration, biological pest control, sport, pets and food processing. Some non-indigenous species, however, have caused major economic losses in agriculture, forestry and several other segments of the U.S. economy, in addition to harming the environment. The invading non-indigenous species cause major environmental damage and losses adding up to more than \$137

billion per year. About 42% of the species on the threatened or endangered species lists are at risk primarily because of non-indigenous species.

Estimating the full extent of the environmental damage and the number of species extinctions caused by exotic species is difficult because little is known about the estimated 750,000 species in the United States, half of which have not even been described. Nonetheless, about 400 of the 958 species that are listed as threatened or endangered under the Endangered Species Act are considered to be at risk primarily because of competition with and predation by non-indigenous species. In other regions of the world, as many as 80% of endangered species are threatened due to the pressures of non-native species. Many other species not on the list are also negatively affected by alien species and/or the ecosystem changes they cause.

Estimating the economic impacts associated with non-indigenous species in the United States is also difficult; nevertheless, enough data are available to quantify some of the impacts on agriculture, forestry and public health. We have assessed as much as possible the magnitude of the environ-

mental impacts and economic costs associated with the diverse non-indigenous species that have become established within the United States. Although species translocated within the United States also can have significant impacts, this assessment is limited to non-indigenous species

that did not originate within the United States or its territories. A detailed report upon which this presentation is based is available on the Internet at http://www.news.cornell.edu/releases/Jan99/species_costs.html.

THE INTERNATIONAL TRADE CONTEXT

John K. Greifer

Director, Animal and Plant Inspection Service, U.S. Department of Agriculture

At a global level, several international institutions feature as their primary purpose the exchange of pest, disease and other quarantine related information among its members. The International Plant Protection Convention (IPPC) (<http://www.fao.org/waicent/FaoInfo/Agricult/AGP/AGPP/PQ/Default.htm>) and Office International des Epizooties (OIE) (<http://www.oie.int/home.htm>) are two prime examples of international institutions that have evolved to meet the need among countries to share information related to pest and disease issues, particularly as it relates to the movement of people and commodities.

The driving issue that has brought quarantine officials together at the IPPC and OIE has been the dual interest in preventing pest spread and doing this in a fashion that does not unnecessarily interfere in commerce between countries. In this regard, these international organizations have maintained and promoted since their inception the concept that regulatory actions that affect other countries have a technical justification and rationale.

About the IPPC and OIE

The IPPC and OIE each have a membership of more than 110 countries. The IPPC was established in 1952 and the OIE dates back to the 1920s. As previously indicated, the IPPC and OIE share the common purpose of promoting international cooperation in the prevention of pest and disease spread. The IPPC is strictly focused on plant pests while the OIE is focused on animal disease risks.

The Agreement on Application of Sanitary and Phytosanitary Measures (SPS Agreement), which went into effect in 1995 as part of the broader package of trade agreements in the Uruguay Round, recognizes the international standards developed under the IPPC and OIE. The SPS Agreement encourages, but does not require, countries to base their phytosanitary measures on standards developed by IPPC (OIE for animal health and Codex Alimentarius for food safety standards). The purpose for these provisions in a trade agreement, like the SPS Agreement, is to promote harmonization of health measures between countries and thereby make the trade system more predictable and stable.

While the IPPC, OIE and Codex standard-setting functions have become more visible as a result of the World Trade Organization Agreement, we know less about these institutions information-sharing functions.

Information-Sharing Aspects

The IPPC contains several provisions regarding specific kinds of information to be exchanged between members, including pest reporting, pest listing, notifications of non-compliance, phytosanitary measures and pest status.

Pest Reporting Members are required to inform each other about the occurrence or outbreak of pests within their territories that may pose a potential threat to other members. A working group met in September 2000 to develop standard

procedures for such reporting. (Member-to-member process).

Pest Listing. Members are required to establish and keep up-to-date lists of regulated pests. The purpose is to keep other members informed of which pests are subject to phytosanitary requirements and to help facilitate phytosanitary certification for exports. A working group met in January 2000 to develop a standard format for such lists. (Members submit to Secretariat, and Secretariat distributes to other members).

Notifications of Non-Compliance. Under the Convention, members are obligated to notify exporting members of incidents of non-compliance of imported shipments (e.g., phytosanitary certification deficiencies and pest interceptions). A working group met in December 1999 to develop a standard approach for these kinds of notifications. (Member-to-member process).

Phytosanitary Measures. The IPPC requires members to share copies of new or amended phytosanitary legislation or regulations to other members who may be affected. This includes providing on request the rationale for these new or amended phytosanitary measures. (Member-to-member responsibility).

Pest Status. The Convention requires members to conduct surveillance and maintain information regarding pests within their territories. This is intended to support pest categorization, pest reporting and the development of appropriate phytosanitary measures. A standard currently exists (ISPM #8 – Determination of Pest Status in an Area) that emphasizes good reporting practices.

The newly revised text of the IPPC (amended in 1997) requires members to establish official contacts. Generally, the chief plant protection officer at the national level is the official contact for IPPC purposes. The intent of establishing a system of official contacts is to facilitate the exchange of information directly between members. These are critical for making it easier to communicate on urgent issues related to export certification, pest issues and other phytosanitary matters.

The Secretariat also plays a vital role in helping distribute information to members (e.g., maintaining IPPC web site, distributing hard copy reports, etc.) as well as guiding individual members to useful information sources.

Future Direction

IPPC members have a number of goals with regard to improving its information-sharing activities. These include:

- Promoting increased access and use of electronic communications and the Internet
- Promoting assistance to regional plant protection organizations in the information technology area
- Developing a clearinghouse mechanism for members to deposit completed pest risk analyses, bilateral agreements, current research and other information
- Finalizing standardized procedures for sharing different types of information as called for in the Convention

Final Comments

The IPPC provides a venue for ongoing discussion of emerging pest issues. Members are free to bring issues of possible global interest to the attention of other IPPC members and recommend possible areas of cooperation.

As an example, the U.S., Mexico and Canada raised a question about the need for an international standard on wood-packing material, given our increasing concern with pests associated with dunnage. Building on work we did at the regional level, we then went to the annual session (1999) of the Interim Commission on Phytosanitary Measures (ICPM) and were successful in obtaining ICPM agreement that this was a priority quarantine issue. Furthermore, the commission agreed that a global standard, based on our regional standard, needed to be developed as rapidly as possible. The result was international consensus to begin developing a global wood-packing standard this year.

These institutions operate on the basis of consensus. While the United States has an excellent opportunity to provide leadership in these organi-

zations, due to our rich scientific resources, we need to be mindful that our effectiveness in getting international cooperation on pest and disease issues depends on our actual and perceived behavior as a partner.

Finally, access to current information regarding IPPC and OIE activities and standards is available through several channels. First, the Animal and Plant Health Inspection Service (APHIS) publishes an annual *Federal Register Notice* in June/July that

describes the current activities within these organizations. That notice seeks comments on IPPC and OIE activities, but, more importantly, provides contact names and web site addresses for those interested in more detailed information. Second, APHIS recently created a special web site where it posts draft standards (IPPC) for public comment. Lastly, information is always available directly from the OIE and IPPC through their web sites.

OBSERVATIONS, NEEDS AND SUGGESTED ACTIONS

Observations

The following observations come primarily from presentations and discussions at the roundtable, but were, in some cases, augmented by the editors and steering committee members who were involved with the deliberations of the program advisory committee and the technical database work session. The database session, held immediately after the roundtable, attracted 30 individuals, most of whom also attended the roundtable.

Federal Perspectives. Policy officials from both the U.S. Departments of Agriculture and Interior encouraged stakeholder groups to participate in developing a strategy for the exchange of information and the development of partnerships. Presentations by the federal officials provided strong evidence that invasive species are receiving a lot of attention throughout the federal government. However, a strategy for coordinating federal activities, now involving more than 20 agencies, was not clearly evident from those presentations.

Computerized Databases. Three case studies involving computerized databases provided a diverse perspective of the kinds of databases being developed. One or more of those databases were recognized as useful by state and private stakeholders. However, some stakeholders, particularly those representing commercial interests, were anxious to learn more about how databases were to be used before enthusiastically supporting further development. The diversity in approach

and use of the databases made it clear that there is a need for an overall strategy in defining purpose and use in databases so that stakeholders can clearly understand their value.

Processes for Using Information. Three case studies involving processes for restricting the spread of invasive species provided useful examples of how due process can be used to get broad-based input into both voluntary and regulatory actions. One case study was particularly unique – a process was used to obtain broad-based input into actions designed to voluntarily discourage the marketing of invasive ornamental plants. Stakeholders representing commercial interests urged continued emphasis on due process in designating invasive species as targets for action.

Non-Federal Stakeholder Perspectives. Invasive species initiatives need to be implemented in a balanced way so that practical preventative measures occur only after informed decisions. Some sectors, such as the agriculture, forestry, nursery, seed and pet industries, feel that they may be asked to bear the brunt of the costs for implementing initiatives. Those concerns were reflected in the following quotes from stakeholder presentations:

“the nursery industry strongly supports coherent and effective measures to exclude, detect and eradicate invading plant pests of all types.”
(from p. 33)

“So we are seeing a proliferation of lists leading to polarization and resulting political intervention in the invasive species management debate. One could say we are drowning in information and starving for wisdom.” (from p. 34)

“(the seed industry) supports efforts to protect our nation and its agricultural industry from harmful, invasive species and will cooperate with the (National Invasive Species Council) and interested state agencies” (from p. 36)

“(the seed industry) will oppose and challenge, however, any efforts to list as ‘invasive’ – or otherwise jeopardize the legitimate use and viability of – species beneficial to agricultural crops, or when used for turf, conservation or ornamental purposes.” (from p. 36)

“Simplicity – ban until proven innocent – really does not work. You cannot sell it to the public; you cannot sell it to industry.” (from p. 39)

“Simplistic or user-friendly databases on the Internet are not necessarily a virtue. They can lead to misinformation, disinformation or misinterpretations.” (from p. 39)

“regulatory mechanisms. Databases must be pragmatic, affordable, effective and implementable. And we cannot do it, in my opinion, only at the federal level. Most of the control and regulation is at the state level. The states cannot be ignored or excluded. One must look at what has happened in Florida, Arizona, California, Wisconsin and Colorado over the last couple years – they work with stakeholders...” (from p. 40)

These candid comments in an interactive setting among a diverse group of private stakeholders indicate substantial effort will be required to develop broad-based support to deal with the invasive species problem.

Important guidance also was provided by non-federal stakeholders on the collection of data on invasive species:

“(we) need to strike a balance between the resources expended on data collection, management, access and use with the need to take on-the-ground action.” (from p. 38)

“(we) need to ensure that the level of data gathered and stored in databases is commensurate with the use they will be put to.” (from p. 38)

“People are willing to talk to us, in part because we had a respectable presentation about the nature and extent of the problems – But we can do better, and I believe a key to success will be better database tools.” (from p. 37)

“Data on non-native invasive species present in the United States are incomplete, and data that are available are scattered in a variety of published and unpublished accounts and databases. This makes it difficult or impossible for land managers to identify, much less properly manage invasive species on their lands.” (from p. 43)

“only the government can provide data on what species are coming in on which pathways. And this information is crucial to developing priorities for pathway-closing programs (whether voluntary or regulatory) and in assessing the effectiveness of these programs – current ‘interception’ data – fall far short of the needed standard.” (from p. 44)

“Hundreds of species of plants shown to be invasive in natural systems are not included on any federal or state ‘noxious weed’ list – nor are they likely to be in the future... These species need to be included in databases and other information sources; they need to be the subject of research; they need to be managed.” (from p. 45)

Economic and Environmental Costs. We see a large amount of evidence that invasive species are responsible for widespread, large economic and environmental costs. However, environmental and economic cost estimates often are inadequate for cost-benefit analyses that may be needed to justify expenditure of public or private funds for specific actions. Furthermore, differences in opinions – often derived from narrow experiences – lead to disagreements on what actions, if any, are desirable.

Also, we saw disagreement about what organisms should be considered invasive. This “definition” problem is illustrated by widely varying estimates of the number of non-native species in the U.S. – ranging between 7,000 and 50,000 – and the lack of a comprehensive categorization of which species

are invasive. Thus, there is often disagreement about which organisms or groups of organisms are most costly to control.

Overarching Issues. Opportunities for enhancing understanding of the invasive species problem were particularly evident in relation to the following issues:

- The term “invasive species” has different meanings to different people. Development of programs around specific organisms, groups of organisms or well-defined ecosystems may be desirable to clarify what is intended.
- The disagreement about what organisms should be considered invasive is creating confusion among those whose support is needed to take action. One approach to ameliorate this confusion is to establish a national peer-reviewed evaluation model that scientifically assesses the degree of invasiveness of a limited number of species. The model could then be applied in prioritizing and allocating funds to the most economically damaging species. The model(s) also could become a part of formal risk assessments.
- The components of an environmental and economic cost estimate of \$137 billion per year are, in many cases, inadequate for use in cost-benefit analyses that may be needed to justify expenditure of public or private funds for specific control policies. Thus, differences in opinions – often derived from narrow experiences – lead to disagreements on what actions, if any, are desirable.
- Although a tremendous amount of information is available on invasive species, we appear to lack an overall strategy to develop invasive species information systems that instill confidence in stakeholders. For example, one stakeholder was quoted as saying, “We are drowning in information and starving for wisdom.”
- Limited evidence surfaced during the roundtable concerning who is responsible for moving the total invasive species issue forward. For a major effort on invasive species to begin, an individual or well-organized coalition must

become the “torch-bearer” who could muster support and move forward in concert with many diverse interests.

General Strategy. There is considerable merit in pursuing a range of different approaches to deal with invasive species on a problem-specific basis through the appropriate integration of local, state, regional and federal interests. However, the total invasive species community should stand together when pursuing political and financial support. Therefore, the community should maintain a holistic view. However, since the invasive species problem is so varied and complex, some focus on specific areas may be necessary to make progress in developing information management systems for practical use. Thus, two strategies are suggested for programmatic activity: (1) information systems for selected problem areas and (2) cross-cutting efforts that will foster a holistic approach.

Presentations at the roundtable – combined with formal and informal discussions associated with the roundtable – suggest that the following focus areas may provide unique opportunities for expanded partnership development and for collecting, sharing and using information: (1) rangeland invasive plants on public and private lands, (2) aquatic invasive animals in fresh and marine waters, (3) aquatic plants in fresh water, (4) information technology to support intervention of invasive species at points of origin and/or at ports of entry and (5) biodiversity on private and public lands specifically designated for that purpose.

Cross-cutting thrusts of interest that are worthy of special attention and that will contribute to maintaining a holistic view include: (1) assess attitudes and priorities of private landowners concerning state and federal actions related to invasive species, (2) review policies and responsibilities of federal agencies on public lands used by private interests, (3) develop policy options, including the use of incentives, to deal with resistance to adopting desired practices and (4) investigate innovative funding options.

Needs and Suggested Actions. Needs for improved management information systems for invasive species and additional inputs into the

development of policies and programs, particularly from non-federal stakeholders, were obvious from the presentations and discussions. Some elaboration on those needs and suggested actions follow:

- More useful information systems are needed. Roundtable participants identified systems such as databases and maps for western range land noxious weeds (invasive plants), as areas where facilitated activities, such as technical workshops involving users, had the potential of

being particularly productive. Invasive aquatic plants and animals and regulated plant pests were other areas of particular interest in this regard.

- Participants indicated that they need additional efforts to obtain balanced inputs from all stakeholders, with particular emphasis on non-federal stakeholders at the local and state level. They suggested non-federal facilitated activities to assess the knowledge, attitudes and desires of non-federal stakeholders.

SELECTED REFERENCES

- Aquatic Nuisance Species Task Force. 1996. Generic Non-indigenous Aquatic Organisms Risk Analysis Review Process. Risk Assessment and Management Committee. October 21. 32 pp.
- Benson, A.J. 2000. Documenting over a century of aquatic introductions in the United States. Pages 1-31 *In* R. Claudi, and J.H. Leach (eds.), *Non-indigenous Freshwater Organisms: vectors, biology and impacts*. CRC Press LLC, Boca Raton, Florida.
- Carey, J. R., P. Moyle, M. Rejmánek, and G. Vermeij (eds.). 1996. Special Issue: Invasion Biology. *Biological Conservation*. 78:1-214.
- Carlton, J. T. 1996. Marine Bioinvasions: The Alternation of Marine Ecosystems by Nonindigenous Species. *Oceanography*. 9(1):36-43.
- Cherrett, J. M., and G. R. Sugar (eds.). 1977. *Origins of Pest, Parasite, Disease and Weed Problems*. Blackwell Scientific Publications. London. 413 pp.
- Christmas, J., R. Eades, D. Cincotta, A. Shiels, R. Miller, M. J. Siemien, T. Sinnott, P. Fuller. 2000. History, management, and status of introduced fishes in the Chesapeake Bay Basin. Pages 97-116 *In* G.D. Therres (editor). *Conservation of Biological Diversity: A Key to the Restoration of the Chesapeake Bay Ecosystem and Beyond*. Maryland Department of Natural Resources, Annapolis, MD.
- Clinton, William J. 1999. Executive Order 13112 on Invasive Species. February 3.
- Cohen, A.N., and C.T. Carlton. 1995. Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta. Washington, D.C. U.S. Fish and Wildlife Service.
- Committee on Environment and Natural Resources. 1999. *Ecological Risk Assessment in the Federal Government*. Washington, D.C. National Science and Technology Council.
- Federal Interagency Committee for Management of Noxious and Exotic Weeds. *Pulling Together: A National Strategy for Management of Invasive Plants*. 2nd edition. 1998. U.S. Government Printing Office. 22 pp.
- Foin, T.C., S.P. Riley, A.L. Pawley, D.R. Ayres, T.M. Carlsen, P.J. Hodum, and P.V. Switzer. 1998. Improving Recovery Planning for Threatened and Endangered Species. *BioScience* 48(3):177-184.
- Fuller, P.L, L.G. Nico, and J.D. Williams. 1999. Nonindigenous Fishes Introduced into Inland Waters of the United States. American Fisheries Society, Special Publication No. 27. Bethesda, MD. 613 pp.
- Great Lakes Panel on Aquatic Nuisance Species. 1998. *Biological Invasions*. August. Leaflet.
- Jacono, C.C., and C.P. Boydston. 1998. Proceedings of the Workshop on Databases for Nonindigenous Plants, Gainesville, FL, September 24-25, 1997. U.S. Geological Survey, Biological Resources Division, Gainesville, FL. 27 pp.
- Kurdila, J. 1995. The Introduction of Exotic Species into the United States: There Goes the Neighborhood. *Environmental Affairs*. 16:95-118.
- Layne, J.N. 1997. Nonindigenous Mammals. *In* *Strangers in Paradise*, D. Simberloff, D. C. Schmitz, and T.C. Brown (eds.). Washington, D.C. Island Press. pp. 157-186.
- Liebold, A.M., W.L. MacDonald, D. Bergdahl, V.C. Mastro. 1995. Invasion by Exotic Forest Pests: A Threat to Forest Ecosystems. *Forest Science*. 41(2):1-49.
- Long, J.L. 1981. *Introduced Birds of the World: The Worldwide History, Distribution, and Influence of Birds Introduced to New Environments*. New York. Universe Books.
- Mack, R.N. 1996. Predicting the Identity and Fate of Invaders: Emergent and Emerging Approaches. *Biological Conservation*. 78:107-121.

- National Invasive Species Council. 2001. Management Plan: Meeting the Invasive Species Challenge. January 18. 89 pp.
- Nico, L.G., and P.L. Fuller. 1999. Spatial and temporal patterns of non-indigenous fish introductions in the United States. *Fisheries* 24(1):16-27.
- Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of non-indigenous species in the United States. *BioScience* 50(1): 53-65.
- Randall, J.M. 1996. Weed Control for the Preservation of Biological Diversity. *Weed Technology* 10:370-381.
- Reichard, S.E. 1997. Prevention of Invasive Plant Introductions on National and Local Levels. *In* Assessment and Management of Plant Invasions, J.O. Luken and J.W. Thieret (eds.). Springer-Verlag. New York.
- Ridgway, R. L., W. P. Gregg, R. E. Stinner and A.G. Brown. 1999. Invasive Species Databases: Proceedings of a Workshop. Proceedings of a workshop held on November 12-13, 1999, in Las Vegas, NV. Charles Valentine Riley Memorial Foundation, Silver Spring, MD. 50 pp.
- Sandlund, O.T., P.J. Schei, and A. Viken (eds.). 1996. Proceedings of the Norway/UN Conference on Alien Species. Trondheim: Directorate for Nature Management and Norwegian Institute for Nature Research.
- Scott, J.K. and F.D. Panetta. 1993. Predicting the Australian weed status of southern African plants. *Journal of Biogeography* 20: 87-93.
- Simberloff, D., D.C. Schmitz, and T.C. Brown (eds.). 1997. Strangers in Paradise. Impact and Management of Nonindigenous Species in Florida. Washington, D.C. Island Press.
- Temple, S.A. 1992. Exotic Birds, a Growing Problem with No Easy Solution. *The Auk*. 109:395-397.
- The Nature Conservancy. 1996. America's Least Wanted: Alien Species Invasions of U.S. Ecosystems. Arlington, VA: The Nature Conservancy. 31 pp.
- U.S. Bureau of the Census. 1998. Statistical Abstract of the United States 1996. 200th ed. Washington, D.C., U.S. Government Printing Office.
- U.S. Congress. Office of Technology Assessment. 1993. Harmful Non-indigenous Species in the United States. 391 pp.
- U.S. General Accounting Office. 2000. Invasive Species, Federal and Selected State Funding to Address Harmful, Nonnative Species. 63 pp.
- Westbrooks, R. 1998. Invasive Plants, Changing the Landscape of America: Fact Book. Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW), Washington, D.C. 109 pp.
- Wilcove, D.S., and M.J. Bean. 1994. The Big Kill: Declining Biodiversity in America's Lakes and Rivers. Washington, D.C.: Environmental Defense Fund.
- Williamson, M.H., and A.Fitter. 1996. The Characters of Successful Invaders. *Biological Conservation*. 78:163-170.
- Wilson, C.L., and C.L. Graham. 1983. Exotic Plant Pests and North American Agriculture. Academic Press. New York. 522 pp.

ACRONYMS

ABI	Association for Biodiversity Information	NAPIS	National Agricultural Pest Information System
AFBF	American Farm Bureau Federation	NAS	Non-indigenous Aquatic Species
ANLA	American Nursery and Landscape Association	NCBA	National Cattlemen’s Beef Association
ANS	Aquatic Nuisance Species	NCSU	North Carolina State University
APHIS	Animal and Plant Health Inspection Service, USDA	NFWF	National Fish and Wildlife Federation
ARS	Agricultural Research Service, USDA	NISC	National Invasive Species Council
ASTA	American Seed Trade Association	NIWAW	National Invasive Weed Awareness Week
BLM	Bureau of Land Management, DOI	NOAA	National Oceanic and Atmospheric Administration, DOC
CSREES	Cooperative State Research, Education and Extension Service, USDA	NPS	National Park Service, DOI
DOC	Department of Commerce	NRC	National Research Council
DOI	Department of the Interior	NSF	National Science Foundation
EDF	Environmental Defense Fund	OAWP	Office of Agricultural Water Policy, FDACS
EO	Executive Order No. 13112	OIE	Office International des Epizooties
EPA	U.S. Environmental Protection Agency	PIJAC	Pet Industry Joint Advisory Council
ESA	Entomological Society of America	PIN	Port Interception Network
FDACS	Florida Department of Agriculture and Consumer Services	PINOPS	Port Interception Network – Operations
FLEPPC	Florida Exotic Pest Plant Council	QA/QC	Quality Assurance/Quality Control
FNGA	Florida Nursery Growers Association	RFP	Request for Proposal
FS	U.S. Forest Service, USDA	RMF	Riley Memorial Foundation
FWS	U.S. Fish and Wildlife Service, DOI	SEC	Office of the Secretary
GLC	Great Lakes Commission	SDA	State Department of Agriculture
HUC	Hydrologic Unit Code	SERC	Smithsonian Environmental Research Center
ICPM	Interim Commission on Phytosanitary Measures	SI	Smithsonian Institution
IFACS	Institute of Food and Agricultural Sciences, University of Florida	SPS	Application of Sanitary and Phytosanitary Measures
INEEL	Idaho National Engineering and Environmental Laboratory	TBWG	Tampa Bay Wholesale Growers
IPM	Integrated Pest Management	TNC	The Nature Conservancy
IPPC	International Plant Protection Convention	UC	University of California
ISAC	Invasive Species Advisory Committee	USDA	United States Department of Agriculture
IWAC	Invasive Weeds Action Coalition	USGS	United States Geological Survey, DOI
JFSP	Joint Fire Science Program	WAP	Wireless Application Protocol
MOU	Memorandum of Understanding	WGA	Western Governors’ Association
		WSSA	Weed Science Society of America
		XML	Extensible Mark-up Language

PROGRAM ADVISORY COMMITTEE

Members

Mary Barber
Ecol. Soc. of Am.

Bill Callison
National Plant Board

Gabriela Chavarria
NFWF

Ernest S. Delfosse
ARS, USDA

Michael J. Donahue
Great Lakes Commission

Mitch Dubensky
Am. Forest and Paper Assoc.

Paul Dunn
FS, USDA

Jack P. Edmundson
APHIS, USDA

Jeff Eisenberg
TNC

William P. Gregg
USGS, DOI

Thomas R. Hebert
Capitolink, LLC

Robert H. Hedberg
WSSA

Myra Hyde
NCBA

Nelroy E. Jackson
Monsanto Co.

N. Marshall Meyers
Pet Industry Joint Adv. Council

John Obryki
CSREES, USDA

Ronald E. Stinner
North Carolina State Univ.

Colin Voigt
BLM, DOI

Craig J. Regelbrugge
AN& LA

Gregory M. Ruiz
SI

Sarah Reichard
University of Washington

Sue A. Tolin
Virginia Tech

Dean Urmston
ASTA

Rosemarie Watkins
AFBF

David Wilcove
EDF

Dean Wilkinson
DOC

Special Advisers

Rebecca A. Bech
SEC, USDA

A. Gordon Brown
SEC, DOI

Deborah C. Hayes
SEC, USDA

Timothy J. Playford
IWAC

APPENDIX A PARTICIPANTS

Rebecca A. Bech
SEC, USDA

Nancy Benton
TNC/ABI

Henri R. Bisson
BLM, DOI

David M. Bourgeois
Westvaco Corp.

William Brown
SEC, DOI

A. Gordon Brown
SEC, DOI

Leon M. Cammen
NOAA, DOC

Faith T. Campbell
Amer. Lands Alliance

Ernest S. Delfosse
ARS, USDA

Thomas M. Dille
RMF

Richard L. Dunkle
APHIS, USDA

Michael V. Dunn
SEC, USDA

Pam L. Fuller
USGS, DOI

Paul E. Gertler
WGA

E. Ann Gibbs
National Plant Board

Kathe Glassner-Shwayder
GLC

John C. Gordon
RMF

John K. Greifer
APHIS, USDA

Ralph E. Grossi
RMF

Susan Haseltine
BLM

Thomas R. Hebert
Capitolink, LLC

William Jolly
FDACS

Eric M. Lane
SDA, CO

N. Marshall Meyers
PIJAC

Richard L. Orr
APHIS, USDA

David Pimentel
Cornell University

James F. Quinn
UC, Davis

Craig J. Regelbrugge
AN&LA

Peter M. Rice
Univ. of MT

Lawrence Riley
AZ Game and Fish Dept.

Cathleen I. Short
FWS, DOI

Ronald E. Stinner
NCSU

Thomas J. Stohlgren
USGS, DOI

Sue A. Tolin
Virginia Tech

Dean Urmston
ASTA

APPENDIX B

ALTERNATE PARTICIPANTS AND OBSERVERS

Gabriela Chavarria NFWF	Ron Hiebert NPS, DOI	Ronald A. Sequeira APHIS, USDA
Joshua Dein USGS, DOI	Myra Hyde NCBA	Susan L. Solarz USDA
Paul Dunn FS, USDA	Nelroy E. Jackson Monsanto Co.	Jil Swearingen NPS, DOI
Jack P. Edmundson APHIS, USDA	Jean Larson ARS, USDA	James L. Tate INEEL
William P. Gregg USGS, DOI	Bryan Logan EarthData	Timothy R. Toplisek U.S. Army C. of Eng.
Sharon Gross USFWS-ANS Task Force	Susan McCarthy ARS, USDA	Vivian Vera USGS, DOI
Erin E. Grossi RMF	Peter C. Meisel USGS, DOI	Colin Voigt BLM, DOI
Thomas Gunther Off. Water/Sci, DOI	Larry Morse ABI	Jennifer Vollmer BASF
Kevin J. Hackett ARS, USDA	Coanne E. O'Hern APHIS, USDA	Jeff Waldon Virginia Tech
Betsy Hart Nat. Aquaculture Assoc.	William Pardee Cornell University	Randy Westbrooks USGS, DOI
Tim Hartzell BLM, DOI	Timothy J. Playford Dow AgroSciences	David Wilcove EDF
Deborah C. Hayes USDA	Patty Pringle-Roberts EarthData	Dean Wilkinson NOAA, DOC
Robert H. Hedberg WSSA	Richard L. Ridgway RMF	
Lori Hidingier Ecol. Soc. of Amer.	Donna Ridgway RMF	

NOTES