Executive Summary

The Problem. Nonindigenous invasive species are adversely impacting America's landscape. Foreign animal, plant, and microbial species are displacing and killing native wildlife and plants and wreaking enormous financial and ecological damage. Alien species invasions are second only to habitat destruction in causing species to be endangered and costs are almost certainly in the tens of billions of dollars annually and may exceed $120 billion. Among other things, invasive alien species crowd out nutritious native forage, create fire hazards, limit recreation, clog lakes and waterways, destroy fisheries, and foul water pipes.

Information Needs. Resource managers and scientists in the United States (U.S). and abroad are increasingly calling for more information to help assess risks associated with invasive species and to help develop effective management strategies to minimize their impacts. Specific needs include: (1) characterizing patterns of invasion in space and time by species and transport mechanism, (2) identifying ecological and economic impacts, (3) predicting invasive species pathways and patterns and which species will be invasive, (4) establishing best management practices for prevention, eradication, and control, and (5) assessing effectiveness by monitoring how well invasions are being limited and curtailed. By sharing information with state and local governmental agencies, nongovernmental organizations, and sources from other nations, the body of knowledge increases and local on-the-ground management activities are encouraged and enhanced. Finally, information contained in databases can directly improve decision making, especially if it addresses costs and risks of available management approaches.

The Workshop. The database workshop held in Las Vegas, Nevada, on November 12–13, 1998, brought together more than 60 participants, most of whom had not met before. Also, the workshop marked the first time managers of databases covering all major taxonomic groups have joined forces to identify gaps in coverage, to discuss new strategies for linking databases, and to extend the value of nonindigenous species database resources. Abstracts from 34 databases were presented for discussion and analysis. Of these databases, 29 are actively providing data to users with 28 of these having a website on the Internet; 21 focus primarily or exclusively on nonindigenous species while the others, which do not deal directly with nonindigenous species, provide related information. References for another 28 databases, most with websites, are also included in these proceedings. The on-line demonstrations during the workshop generated lively debate, exchange of ideas, and commitments for future collaboration. Overview panels provided an opportunity for analysis and constructive criticism among the representatives from federal and state agencies, nongovernmental organizations, and academic institutions.

Issues. Workshop participants identified the need to resolve several data-related issues: (1) standardization of criteria for inclusion in databases; (2) standardization of naming, information content and quality, and compatibility needed for sharing between databases; (3) commitment to long-term support and continuity of funding, especially for national-scale databases; (4) sustainability of taxonomic expertise and reference material collections; (5) improvements to fill data gaps for baseline assessments of threat and risk of invasion; (6) data ownership and public access that complement agricultural, forestry, environmental and trade interests; (7) metadata standards and linkages to other databases; and (8) improvement of public understanding of, and support for, the role databases play in prevention, eradication, and control of biological invaders.

Short-Term Database Needs. State and local needs often drive data acquisition. With rapidly increasing access to the World Wide Web, state and local agency staff are demanding web-based sources of information. Hardware devices at affordable prices are now available. However, access via multiple search engines still requires diligence and persistence. Clearly, specialized search tools are necessary for such specialized topics as invasive species. There is an immediate need for concise and intelligent access to the information contained in multiple, linked databases. Databases must be designed to support risk assessments which can be used to prioritize efforts to exclude, eradicate, and control biological invaders. Also, needed are substantial biological,

ecological, and economic (or health) impact data as well as information on effectiveness, costs, and risks of various possible management procedures. Thus, new efforts will be needed to predict pathways and likely modes of dispersal; to document impacts at various ecological and economic levels, from ecosystems (regions) to individual species (local markets); and to support the plan of action most likely to succeed, given the need to control significant invaders. Also, databases with quarantine and trade implications should be designed to promote openness and sharing, rather than being restrictive.

The problems with biological invaders are international. Different countries can learn from one another's experiences. Sharing information through databases among agencies and countries can greatly reduce costs of control. Identification of high-risk species, vectors, and pathways to prevent the introduction and spread to new locations is the key to safeguarding both agriculture and native biodiversity. Data sharing on an international scale affords both warning and assistance once an invasion has begun. Participants agreed on the need to engage international colleagues and establish collaborative linkages among their databases.

Long-Term Database and Knowledge Needs. As interfaces improve and as it becomes known that one site links several databases in the easiest-to-use fashion, consolidation will increasingly occur. But concomitant evolution in standards for data entry and verification will take place only if those involved actively manage coordinated efforts with a clear vision of the integrated needs. Mature databases such as the Natural Heritage Network have already evolved through several generations of design and evaluation, but do not necessarily address invasive species *per se*. Only with cooperative efforts among interested groups can databases provide the basis for decisions on invasive species management strategies.

Other long-term needs include: (1) filling data gaps in taxonomic coverage, (2) documentation of pathways for transportation of biological invaders, (3) increased academic support for training in systematics to allow continued and improved identification of bioinvaders, and (4) continued basic research in the interactive effects of invaders and their biological competitors, predators, pollinators, vectors, and dispersal agents. Access to diverse databases linked across numerous common elements will aid researchers in investigating these interactions in a timely fashion and can lead to "one-stop" shopping.

Immediate Actions Indicated. The needs associated with dealing with the invasive species problem are extensive. The Executive Order on Invasive Species which was signed on February 3, 1999, should facilitate coordinated efforts to address those needs. However, in relation to databases some immediate action is suggested to take advantage of what has been learned. A *follow-up workshop* is recommended in which three to five groups of *related databases* would be reviewed and *small clusters* designed that would be *linked through a common search interface*. The objectives would include standardizing terminology and methodology in a linked array at multiple levels. This development of a limited number of integrated clusters of databases should *demonstrate the economic and scientific value* of shared information directed toward *specific practical uses* and should provide useful guidance for substantial expansion of database development. Clusters of databases to be considered include those dealing with rangeland weeds in the western U.S., aquatic weeds in the southeastern U.S., insects, diseases, and weeds in forests, and federally and/or state-regulated plant pests.

Although the workshop was organized primarily to inventory databases and to explore ways of improving them, the importance of *expanding the knowledge base* in the broadest context was so often reflected in the workshop presentations and discussions that this issue should receive special emphasis. The coordinating and planning mechanisms associated with the Executive Order on Invasive Species should, over time, address the needs for increased knowledge. However, databases provide a unique opportunity for linking the interests and achievements of a diverse array of stakeholders and there are some short-term opportunities to *enhance understanding* and to *move toward consensus* on some issues. Therefore, the *immediate conduct* of some sharply focused *facilitated activities* involving *stakeholders* as defined in the Executive Order should be pursued as soon as possible.