Weed Technology. 2004. Volume 18:1305–1308

Symposium

Risk Assessment for Invasive Plant Species[1]

MARK R. POWELL[2]

Abstract: Various domestic and international initiatives have elevated invasive species issues onto the policy agenda. In the invasive plants arena, risk assessment efforts have focused on classifying the invasive potential of nonindigenous plants. Currently, however, the field of risk assessment for invasive species is in an early stage of development, and there is a lack of broad scientific principles or reliable procedures for identifying the invasive potential of plants in new geographic ranges. Furthermore, identifying potential hazards may be just the first step in a more comprehensive risk assessment. At least for those regulatory decisions that may be disputed internationally or domestically, scientifically ambitious risk assessment for invasive plants is not optional. Therefore, there is a pressing need to formulate adaptable, biologically plausible methods and approaches in this emerging field that strike an appropriate balance between the demand for accuracy and precision in predicting risks and the constraints of limited information, time, and other resources.
Additional index words: Regulatory analysis, Sanitary and Phytosanitary Agreement.

INTRODUCTION

The entry, establishment, and spread of nonindigenous plants in new environments can cause major economic and environmental damage. The U.S. Department of Agriculture (USDA) annual budget for invasive species activities alone exceeds $500 million, and invasive plant species constitute a substantial portion of the overall invasive species problem. Taken alone, the estimated economic damage resulting from individual invasive plant species can be significant. For example, leafy spurge (*Euphorbia esula* L.) causes estimated economic damage in excess of $100 million per year (National Invasive Species Council 2001).

In addition to direct economic damage, invasive plant species disrupt the provision of nonmarket environmental goods and services. The full scope of these impacts is difficult to estimate because the effects can be indirect or delayed. Furthermore, to present a complete picture of net impacts, we would also need to consider compensating benefits of the introduced species, travel, and trade. Nevertheless, the overall magnitude of the problem is large by any measure, easily exceeding the federally defined threshold of $100 million per year for ''major'' economic impacts.

Internationally, the World Trade Organization (WTO) Sanitary and Phytosanitary Agreement (SPS Agreement) establishes rights and obligations to adhere to the discipline of scientific risk analysis to ensure that SPS measures are applied only to the extent required to protect human, animal, and plant health and do not constitute arbitrary or unjustifiable technical barriers to trade (WTO 1995). Consequently, risk assessment for invasive species has been elevated onto the international policy agenda.

RISK ASSESSMENT FRAMEWORK

As an orientation to risk assessment concepts, it is useful to consider the paradigm that has evolved in the United States to address ecological risks due to chemical, biological, or physical stressors. This framework consists of three principal elements: problem formulation, analysis of exposure and effects, and risk characterization. Problem formulation leads to specifying the scope of the risk assessment, which requires identification and description of the known or potential stressors, their sources, the susceptible ecological resources, and the relevant exposure pathways. In many cases, the invasive potential of a particular plant species is well understood, but in other cases, the purpose of the assessment is to predict how a nonindigenous species will behave if introduced

[1] Received for publication January 14, 2004, and in revised form May 5, 2004. Disclaimer: the opinions expressed herein are the views of the author and do not necessarily reflect the official policy or position of the U.S. Department of Agriculture.

[2] Risk Scientist, U.S. Department of Agriculture, Office of Risk Assessment and Cost Benefit Analysis, 1400 Independence Avenue, South West, Room 5248 SAG, Washington, DC 20250. Corresponding author's E-mail: mpowell@oce.usda.gov.

into a new environment. Evolution and adaptation contribute uncertainty to predictions about a plant's invasive potential in new environments. For invasive species, exposure analysis involves estimating the likelihood of introduction, establishment, and spread. In cases where introduction is intentional, this simplifies the analysis somewhat because the probability of introduction does not have to be estimated (it is equal to one). In many cases, however, we are concerned with unintentional introductions. Effects analysis for invasive species involves estimating the probability and severity of economic and environmental consequences of invasion. Risk characterization integrates information from the problem formulation, exposure, and effects components to synthesize an overall conclusion about risk and address the uncertainties and assumptions.

CURRENT RISK ASSESSMENT PRACTICES

The USDA and other government agencies have been practicing risk assessment of invasive species for some years. The current state of risk assessment for invasive species is primitive, however. According to the National Research Council (2002, p. 9) ''there are currently no known broad scientific principles or reliable procedures for identifying the invasive potential of plants, plant pests, or biological control agents in new geographic ranges . . . '' The task of risk assessment practitioners, therefore, is to use the best available alternatives while working toward improvement in risk assessment data, models, and procedures.

Traditional approaches to risk assessment of invasive plant species have been mostly qualitative. For nonindigenous plant species that have not yet been introduced, the primary focus has been on developing classification schemes to predict invasiveness (e.g., identifying attributes of species that correlate historically with invasiveness). The National Research Council (2002) provides an evaluation of predictive systems based on climate matching or species traits. For both nonindigenous species and invasive plant species that have established, risk assessment typically seeks to identify susceptible resources and dissemination pathways (APHIS 2002). In many cases, surveillance data, models, or both may be used to estimate the rate of spread, but this is more common for species that are established. The National Research Council (2002) provides a useful, concise discussion of dispersal models that have been applied to a variety of organisms. Because the analysis of nonindigenous plant species is often limited to classification as invasive or noninvasive (e.g., for noxious weed listing), there is commonly a gap between the risk assessment endpoint and the potential consequences of introduction.

The USDA Animal and Plant Health Inspection Service (APHIS) regulates plant pests and noxious weeds under the authority of the Plant Protection Act of 2000 (7 U.S.C. 7701-7772). APHIS (2000) presents guidelines for plant pest risk assessment of proposed imports (e.g., of a new commodity). APHIS (2002) presents guidelines for conducting weed risk assessments that provide a basis for noxious weed classification decisions. Both guidelines describe procedures for categorical rating (e.g., low, medium, or high) of risk elements associated with the likelihood and consequences of introduction or spread of a plant pest or noxious weed. Risk elements include, for example, habitat suitability, dispersal potential, economic impact, and environmental impact. A collective risk measure is determined by combining the scores for the likelihood and consequences of introduction. The National Research Council (2002) critiques the APHIS 1999 cape tulip (*Homeria* spp.) weed risk assessment to illustrate the strengths and limitations of qualitative risk assessment for invasive plant species. An important limitation of qualitative risk assessment is the frequently subjective nature of scoring risk elements. Even if the rationale for the assigned rating is well documented, different assessors may mean very different things by ''low'' environmental impact, for example. On the other hand, quantitative risk analysis also requires substantial subjectivity in assigning probability distributions to model inputs (National Research Council 2002).

IMPORTANCE OF THE SPS AGREEMENT TO RISK ASSESSMENT

Although most plant pest risk assessments are qualitative, the SPS Agreement has raised the bar as to what qualifies as an adequate risk assessment—at least for measures that might be disputed as unnecessarily trade restrictive. Article 5.3 of the SPS Agreement states that ''in assessing the risk to animal or plant life or health and determining the measure to be applied for achieving the appropriate level of sanitary or phytosanitary protection from such risk, Members shall take into account . . . the potential damage in terms of loss of production or sales in the event of the entry, establishment, or spread of a pest or disease; the costs of control or eradication in the territory of the importing Member; and the relative cost-effectiveness of alternative approaches to limiting risks.'' Members are free to set their own level of protection under the SPS Agreement, but Article 5.3 estab-

lishes a legal obligation to consider damage, control costs, and alternatives.

In settling a 1998 dispute over Australia's ban on imports of fresh and frozen salmon from Canada to prevent entry of 24 identified fishborne diseases, a WTO Appellate Body established a three-pronged test for what would qualify as an adequate risk assessment under the SPS Agreement: (1) identification of the hazards and possible biological and economic consequences of their entry or spread; (2) evaluation of the likelihood of entry, establishment, or spread; and (3) evaluation of the impact of SPS measures on the likelihood of entry, establishment, or spreading of the hazards (Victor 2000). Simply identifying a hazard (e.g., identifying a fishborne disease in the exporting country or classifying a plant species as invasive), therefore, does not satisfy the criteria for an adequate risk assessment under the SPS Agreement.

More recently, identifying a hazard and a viable but unquantified exposure pathway also was found to be insufficient in the context of the SPS Agreement. In a dispute over numerous measures required by Japan on apples imported from the United States to prevent introduction of the plant pathogen fireblight (*Erwinia amylovora*), a WTO panel concluded that the measures required by Japan were disproportionate to the negligible risk posed by imports of mature, symptom-free apples (World Trade Organization 2003a). The panel's ruling was upheld on appeal (World Trade Organization 2003b). By invoking the concept of ''negligible risk,'' the Japan-Apples case may establish an important risk assessment precedent under the SPS Agreement.

Domestically, in a 1980 decision that invalidated the Occupational Safety and Health Administration standard for benzene exposure in the workplace, the U.S. Supreme Court (1980) endorsed the concept of ''de minimis risk,'' a level so low as to be indistinguishable from zero. Below this threshold, there would be a presumption that regulation to further reduce risk was unwarranted. The Court distinguished a de minimis risk from a ''significant risk'' for which there would be a presumption that regulation would be required. The decision left considerable latitude for regulatory agencies to make case-specific determinations about acceptable levels of risk but established the need for a quantitative, de minimis threshold for a risk that may be regulated. The reason that the so-called ''Benzene decision'' is regarded as a landmark case in the field of domestic risk policy is that it compelled regulatory agencies, many of which had—and continue to have—some good arguments for advocating a qualitative approach to risk assessment in some cases, to adopt a more quantitative approach. It remains to be seen whether the Japan-Apples case will have a similar effect under the SPS Agreement.

CONCLUDING REMARKS

Because of demands originating from the legal and policy realms, the practice of risk assessment for invasive plant species is challenged to progress beyond its traditional focus on qualitative identification of hazards, pathways, and susceptible resources and to extend its quantitative analysis to consider establishment, spread, the degree of risk reduction achieved by risk management measures, and the potential consequences of biological invasions. At least for measures that may be subject to dispute under the SPS Agreement or through domestic litigation, scientifically ambitious risk assessment is not optional. Risk assessment practitioners, therefore, are looking to the scientific community to provide biologically plausible methods and procedures to inform regulatory decisions about invasive plants. Like the demand for any good or service, the demand for situation-specific empirical evidence is limitless. Therefore, the development of risk assessment methods and procedures must acknowledge that the demand for situation-specific empirical evidence is likely to persistently outstrip supply. This situation calls for adaptable procedures that strike an appropriate balance between the demand for accuracy and precision in predicting risks and the constraints of limited information, time, and other resources.

LITERATURE CITED

[APHIS] U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2000. Guidelines for Pathway-Initiated Pest Risk Assessments: Web page: http://www.aphis.usda.gov/ppq/pra/commodity/cpraguide.pdf. Accessed: April 8, 2004.

[APHIS] U.S. Department of Agriculture Animal and Plant Health Inspection Service. 2002. Weed-Initiated Pest Risk Assessment Guidelines for Qualitative Assessments: Web page: http://www.aphis.usda.gov/ppq/weeds/Wragui5-2.pdf. Accessed: April 8, 2004.

National Invasive Species Council. 2001. National Management Plan: Meeting the Invasive Species Challenge. Washington, DC: National Invasive Species Council: Web page: http://www.invasivespecies.gov/council/mp.pdf. Accessed: April 8, 2004.

National Research Council. 2002. Predicting Invasions of Nonindigenous Plants and Plant Pests. Washington, DC: National Academy. 194 p.

U.S. Supreme Court. 1980. Industrial Union Department, AFL-CIO v. American Petroleum Institute, 448 U.S. 607.

Victor, D. G. 2000. Risk management and the world trading system: regulating international trade distortions caused by national sanitary and phytosanitary policies. *In* National Research Council, Incorporating Science, Economics, and Sociology in Developing Sanitary and Phytosanitary Standards in International Trade: Proceedings of a Conference. Washington, DC: National Academy. Pp. 118–169.

[WTO] World Trade Organization. 1995. Agreement on the Application of Sanitary and Phytosanitary Measures. Geneva, Switzerland: World Trade Organization: Web page: http://www.wto.org/english/docs_e/legal_e/15-sps.pdf. Accessed: April 8, 2004.

[WTO] World Trade Organization. 2003a. Report of the Panel on Japan—Measures Affecting the Importation of Apples. Geneva, Switzerland: World Trade Organization: Web page: http://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm. Accessed: April 8, 2004.

[WTO] World Trade Organization. 2003b. Report of the Appellate Body on Japan—Measures Affecting the Importation of Apples. Geneva, Switzerland: World Trade Organization: Web page: http://www.wto.org/english/tratop_e/dispu_e/dispu_e.htm. Accessed: April 8, 2004.