International Agricultural Trade and Policy Center

BRIDGING THE COMMUNICATION GAP BETWEEN ECONOMISTS AND BIOLOGICAL SCIENTISTS IN THE MANAGEMENT OF INVASIVE SPECIES

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MGTC 03-13 November 2003

MONOGRAPH SERIES

UNIVERSITY OF FLORIDA

Institute of Food and Agricultural Sciences

INTERNATIONAL AGRICULTURAL TRADE AND POLICY CENTER

MISSION AND SCOPE: The International Agricultural Trade and Policy Center (IATPC) was established in 1990 in the Food and Resource Economics Department (FRED) of the Institute of Food and Agricultural Sciences (IFAS) at the University of Florida. Its mission is to provide information, education, and research directed to immediate and long-term enhancement and sustainability of international trade and natural resource use. Its scope includes not only trade and related policy issues, but also agricultural, rural, resource, environmental, food, state, national and international policies, regulations, and issues that influence trade and development.

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The Center's objectives are to:

- Serve as a university-wide focal point and resource base for research on international agricultural trade and trade policy issues
- Facilitate dissemination of agricultural trade related research results and publications
- Encourage interaction between researchers, business and industry groups, state and federal agencies, and policymakers in the examination and discussion of agricultural trade policy questions
- Provide support to initiatives that enable a better understanding of trade and policy issues that impact the competitiveness of Florida and southeastern agriculture specialty crops and livestock in the U.S. and international markets

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Although the subject matter of economics appears to be quite different from that of biology, there are considerable similarities between the two disciplines in terms of the fundamental analytical structures employed and the terminologies used. Concepts such as scarcity, competition, equilibrium, and specialization are common to both fields. And terms used in economics, such as industry, innovation, progress, exchange, and long run, have their counterparts in terms used in biology, such as species, mutation, progress, exchange, and natural selection (Hirshleifer, 1977). The striking similarity between the two disciplines is no mere coincidence since economics focuses on understanding and analyzing the social behavior of the most dominant species (*Homo sapiens*) in the animal kingdom. As famed economist Alfred Marshal wrote in the 1920s, " …it [economics] is a branch of biology broadly interpreted"(Marshall, 1920).

However, despite such similarities and evidence suggesting that at one time there was considerable communication between the disciplines,[i] with the passing of time and with increased knowledge leading to greater specialization, the disciplines appear to have grown apart. A manifestation of this drift has been a tendency within the biological scientific community to treat the problem of biological pollution (i.e., the undesirable introduction and spread of invasive species) exclusively from an ecological perspective. Accordingly, the established decision-making framework for dealing with such issues is usually based on a set of biological strategies centered on prevention/exclusion, early detection, eradication, containment, and suppression. There has been little or no involvement of economists in the decision-making process. Where economic analyses have been carried out, they are either peripheral to the biological study or conducted by non-economists, and as such are of limited use (US GAO, 2002).[ii]

However, as management systems have become overwhelmed by increases in economic activity and the introduction and spread of invasive species, there appears to be a paradigm shift. The scientific community is once again calling for input by economics and other social science disciplines to answer questions and to assist with designing and carrying out strategic actions to address the problems.

The purpose of this article is to examine this change in paradigm by highlighting the economic dimensions of the problem of invasive species and demonstrating some of the key roles that economics can play in the fight against the growing incidences of biological pollution (invasions).

Shift in Paradigm

As mentioned earlier, while traditionally the problem of biological pollution has been considered the sphere of biological scientists, several factors appear to be causing a shift in this paradigm. These factors include:

1. Increased incidences of biological invasions linked directly to trade in agricultural commodities and movement of people.
2. Increased budgetary constraints and calls for greater public accountability—the need for trade-offs (Cost Benefit Analysis).
3. Increased demand for greater transparency of decisions taken and the growing influence of interest groups.
4. Increased need for better communication to implement desired strategies.

All of the above are more readily addressed within a social science framework. As a result, there have been calls for input by economics and other social science disciplines to contribute to improving the decision-making framework and to answer questions and carry out strategic actions to address the problem of biological invasions.[iii]

What Economics Has to Contribute towards Resolving the Problem of Invasiveness

The apparent disconnect between economists and biologists in some regard stems from a failure on the part of biological scientists to fully appreciate the discipline of economics and likewise on the part of economists to effectively communicate what the discipline is.[iv] Most biological scientists consider economics to be all about estimating costs and determining the cost effectiveness of different treatments. However, as Perrings, et al. (2002) made quite clear, economics is not just about calculating costs, rather it is a framework for understanding the complex causal interaction between human behavior and natural processes and for finding institutional and behavioral solutions to seemingly intractable problems (Perrings, et al., 2002). Consequently, economic analyses are not only essential to providing more accurate and comprehensive assessments of the benefits and costs of control alternatives to increase the effectiveness and efficiency of publicly funded programs (assist with the allocation of scare resources), but equally so in understanding the invasive species problem and in fashioning meaningful solutions.

Economics has traditionally been concerned with decision-making, particularly with what decisions are made rather than how they are made—although to some extent the discipline has started to embrace the latter. This is based on the premise that economic agents (individuals, firms) are capable of making rational decisions (i.e., decisions that will maximize or minimize some objective function within the framework of a given set of constraints). The notion of economics as an efficient allocator of scarce resources has had universal appeal and is responsible for the spread of economics into non-traditional areas. The discipline has developed a set of analytical capabilities that can aid decision makers in arriving at a set of rational and consistent decisions. Analytical capabilities, as pertaining to the problem of invasive species, include rational decision-making over a range of pest threats and management interventions, monetary valuations, cost-benefit analysis as a tool to evaluate public intervention strategies, allocation of scarce resources, and formal consideration of risk and uncertainty. The discipline has also developed several empirical techniques to assess the value of non-marketed environmental and health effects, hence providing additional insights into whether and to what extent resources are being allocated efficiently. With the increasing demand for transparency in decision-making due to commitments to international agreements and pressure from various interest groups, effective and convincing communication is essential to implement the desired strategies. When such communications are based on sound economic analysis, efficiency in bargaining can be greatly enhanced.

Economic Dimension of the Problem of Biological Invasiveness

The economic dimension and interest by economists in the problem of invasive species are growing from at least two perspectives. First, there is an increasing awareness that economics is central to the cause of biological invasiveness, and that the consequences of pest incursions go far beyond direct damages or control costs. Second, modeling the economic and trade impacts of technical trade barriers are becoming more important.

Economics is central to the cause of biological invasiveness, as most cases of invasiveness can be linked to the intended or unintended consequences of economic activities (Perrings, et al., 2002). The increased spread of invasive species reflects rapid globalization and trade liberalization—economic phenomena. These developments have spawned greater long-distance hitchhiking by invasive species of pests and diseases, especially in the trading of live animals and horticultural and raw animal products. The Animal and Plant Health Inspection Service of the United States Department of Agriculture (USDA/APHIS, 2001) has cited a dramatic increase in the incidence of invasive pests and diseases in the United States. Specifically, the study noted the increased outbreak of exotic fruit fly infestations in California and Florida, the entry of the Asian longhorn beetle into New York and Illinois, the introduction of the Asian gypsy moth in North Carolina and Oregon, and the infestation of citrus canker in Florida (USDA/APHIS, 2001).

It is only now being widely recognized and acknowledged, the extent of the damage and cost for the eradication and control of invasive species. For example, invasive species can harm agricultural systems and native plants and animals, particularly endemic species because their natural predators and parasites are usually not present in the new environment. Thus, an invasive species that is not a pest in its native land could cause significant damage in a new environment. In the extreme, such damage could lead to the loss of biodiversity. One example is the Asian longhorn beetle, which was first discovered in the United States in New York, in 1996, and Chicago, in 1998, is expected to damage millions of acres of hardwood trees throughout U.S. forest and suburban landscapes. State and local governments have already invested more than $30 million to eradicate this pest and to protect 6.7 million trees in the infested regions. Another example is the eradication of citrus canker in Florida, which has cost the state over $300 million dollars since 1996 (Macdonald and Van Wilgen, 2002; FDAC, 2002).

Invasive species can adversely affect important environmental service flows such as cropping systems, livestock grazing, and water systems used for human consumption and recreational uses (e.g., when pests clog rivers, irrigation systems, and shorelines). In addition, invasive species can have negative impacts on ecological services provided by one resource for other resources or an entire ecological system (Evans, Spreen, and Knapp, 2002).

As noted earlier, modeling economic and trade impacts of measures to stem the arrival and spread of invasive species is becoming an area of interest to many trade economists. While sanitary and phytosanitary measures are within the rights of a country for economic and social prosperity, they can also impose unnecessary social costs, thwart commercial opportunities, and reduce competition and economic growth. Sound economic analysis can assist with the design and implementation of these measures to ensure the benefits exceed the costs.

Assessing the Economic Consequences of Invasive Pests and Diseases

Considerable effort is being devoted to assessing the full economic impact of invasive pests and diseases. The goal is to develop effective management programs to help prevent, control, or mitigate such invasions. Previously, the focus was on identifying the most cost-effective means of treatment for outbreaks. Now the emphasis is on the benefits and costs of managing a particular pest and/or disease.

Assessing the economic consequences is both challenging and imprecise. As noted earlier, the full range of economic costs of biological invasions goes beyond the immediate impact on agricultural producers. Often included are secondary and tertiary effects such as shifts in consumer demands, changes in relative input prices, and loss of important biodiversity and other natural resource and environmental amenities. The range of economic impacts can be broadly classified into two categories: direct and indirect (Bigsby and Whyte, 2001). Direct impacts are host specific and affect a particular pest or host disease. Indirect impacts are non-host specific, since they are created by the presence of a pest rather than by the pest-host dynamics—public health issues such as compromising key ecosystem functions, general market effects such as changes in consumer attitude toward a given product, research requirements, market access problems, and impacts on tourism and other sectors of an economy.

In addition, there are six types of economic impacts: (1) production; (2) price and market effects; (3) trade; (4) food security and nutrition; (5) human health and the environment; and (6) financial cost (FAO, 2001).

Production Impacts—These are considered the most direct economic impacts associated with the host, resulting in the loss or reduced efficiency of agricultural production (e.g., yield decline). Even though production impacts may be relatively easy to identify, they can be difficult to measure. Disease can have long-lasting effects on the host in ways that are not always obvious. In livestock, for example, there could be delays in reproduction, resulting in fewer offspring. Pesticides applied to treat a given pest could pollute soil and surface water. Sometimes it is hard to distinguish production impacts from other impacts, such as climate.

Price and Market Impacts—Outbreaks of pests and diseases can directly affect the quantities of commodities demanded or supplied. The exact impact on the market and the duration of the impact depend on several factors, including the nature of the pest or disease, market size, and demand and supply elasticities. In cases where consumer health is involved, as in the recent outbreak of bovine spongiform encephalopathy (BSE), consumers' perception about an implicated product and a country's ability to produce safe food after an outbreak or illness can have a devastating effect on marketing. In addition, a range of secondary effects may result from the multiplier effect.

Trade Impacts—The introduction and/or spread of invasive species can have major trade implications that could outweigh direct production losses. Trade impacts depend on a number of factors, including the policy response of trading partners to news about outbreaks, the importance of traded commodities, the extent of the damage, and the elasticity of demand and supply. In addition, losing a competitive advantage in the export market or premiums from supplying disease-free products negatively impacts trade. These concerns are real because unaffected countries will either prohibit the entry of commodities from the affected country or establish a set of precautionary measures. In either case, competitive trade advantages could be lost.

Food Security and Nutrition Impacts—The extent to which invasive pests and diseases reduce the domestic supply of foods directly or restrict a country's international trade could harm its food security, especially for developing countries.

Human Health and the Environment Impacts—It is difficult to assess the human health and environmental impacts of invasive pests and diseases because the impacts are not always fully understood. Available evidence suggests that the incidence of invasive zoonotic and parasitic diseases is growing and that their health and socio-economic impacts are increasingly being felt in both developed and developing countries.

Financial Cost Impacts—Measures taken at the individual, collective, and international levels to control, eradicate, or mitigate invasive pests and diseases may have budgetary implications. Such costs include inspections, monitoring, prevention, and response. Estimating this economic impact requires biological and non-biological information that involves considerable time and expense. Most studies have easily calculated financial cost impacts such as costs for control, eradication, and prevention and expected losses in enterprise productivity. However, such an approach is shortsighted since, in several cases, the indirect effects arising from (say) the trade impacts could easily outweigh production loss impacts. A recent GAO report commented on this problem in its observation that

> The scope of existing studies on the economic impact of invasive species in the United States range from narrow to comprehensive, and most are of limited use for guiding decision makers formulating federal policies on prevention and control. Narrowly focused estimates include analyses of past damages that are limited to a certain commercial activities such as agricultural crop production and simple accounting of the money spent to combat a particular invasive species. These estimates typically do not examine economic damage done to natural ecosystems, the expected costs and benefits of alternative control measures, or the impact of possible invasions by other species in the future…. In general the more comprehensive the approach used to assess the economic impacts of invasive species, the greater its potential usefulness to decision makers for identifying potential invasive species, prioritizing their economic threat, and allocating resources to minimize overall damages (U.S. GAO, 2002, p. 3).

In addition, valuing non-market impacts can be challenging because usually there is no direct market valuation. In order words, it is hard to identify any existing market, so there is no information on prices, costs, profits or quantities. Examples of non-market impacts include environmental effects and loss of biodiversity. However, as noted earlier, economists have devised and continue to refine methods to quantify such impacts. In this regard, use is made of techniques such as contingent valuation, contingent choice, contingent ranking, and conjoint analysis. These techniques utilize microeconomics, welfare economics, and econometrics in their analysis. While a description of each of these techniques is beyond the scope of this paper, suffice it is to say the main intent of these approaches is to infer the value society ascribe to such non-market goods and services.[v]

A more general measurement problem is the unavailability of data, especially when there is no disease history. Complications also may arise from the uncertainty of the scientific evidence about the probability of entry and establishment of a pest or disease, the rate at which it spread, and the extent of the damage. Closer collaboration between economists and biological scientists as well as the increased availability of computer software programs (such as the Excel @RISK program that combines dynamic simulation procedures with probability distribution) allow analysts to combine actual, but limited, data with theoretical modeling in determining potential impacts.

Modeling the Impacts of Sanitary and Phytosanitary Regulations

The need for a government to protect its citizens and environment against imported externalities (such as invasive pests and diseases) is embraced by the WTO Agreement,[vi] which promotes increased trade among countries. One way to safeguard a nation's welfare is to address legitimate externalities or other market failures through technical trade barriers. However, such measures are "welfare-decreasing" when they are imposed to isolate domestic producers from international competition. The dual nature of

SPS measures, which provide externality-based protection versus economic-based protection, adds to the importance of comprehensive economic analysis of the issues of invasive pests and diseases.

As a consequence, economists are working to develop a framework for assessing both the trade and welfare implications of trading a particular commodity under different management options when there is the potential for the introduction of an invasive pest or disease (Krissoff, et al. 1997; Sumner and Lee, 1997; Roberts, et al., 1999; Bigsby and Whyte, 2001). Developing such a framework, however, is far easier in theory than in practice. Although not insurmountable, the involvement of externalities in the form of unwanted pests and diseases, and specifically the risks and uncertainty associated with them, complicate the standard economic policy analysis.

Concluding Remarks

The invasive species problem poses a serious challenge in an era of increased globalization and trade liberalization. The problem has as much to do with economics as it does with ecology. Any solutions advanced must be firmly grounded in both science and economics. The economic discipline possesses the capability of valuing various market and non-market impacts and provides a means for assessing important trade-offs among various management alternatives, which can greatly improve the decision-making process for managing such risks. In addition, it can improve the transparency of the decision-making process by providing justifications for the measures implemented. The true value of economics should therefore not be seen solely in the precision of the numbers generated, albeit this is important, but the extent to which the discipline aids decision makers to formulate consistent and rational decisions.

Although the focus of the article was on invasive species, this is just one case of the more general issues of communication between economists and scientists. Economists and scientists must also communicate in fields of food safety, global warming and ozone protection, and nutrition.

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[i] Economist Thomas Robert Malthus was credited by biologists Charles Darwin and Alfred Russell Wallace for crucial insights leading to the discoveries of the idea of natural selection.

[ii] A notable exception is Australia, where there is a long history of bio-economic cooperation among scientists owning to the special concerns about the invasiveness in an island economy.

[iii] See Incorporating Science, Economics, and Sociology in Developing Sanitary and Phytosanitary Standards in International Trade, 2000*, Proceedings of a Conference, National Research Council*, Washington D.C.: National Academy Press. (Also available on-line at: http://books.nap.edu/openbook/0309070902/html/index.html.)

[iv] This observation is offered in the light of constructive criticism and should not be viewed as demeaning to both biological and economic scientists.

[v] The interested reader is referred to Hanley, N., J. F. Shogren, and B. White, 1997, *Environmental Economics in Theory and Practice*, Oxford, UK: Oxford University Press. Useful examples of cases where economics and biological information have been used in the decision-making framework can be found in Orden, David, Clare Narrod, and Joseph W. Glauber, 2001, Least-trade-restrictive SPS policies, in *The Economics of Quarantine and the SPS Agreement*, edited by K. Anderson, C. McRae and D. Wilson, pp. 183-215, Adelaide, Australia: Centre for International Economic Studies and Agriculture, University of Adelaide.

[vi] A separate agreement governing sanitary and phytosanitary issues, Agreement on the Application of Sanitary and Phytosanitary Measures, was negotiated during the 1986-1994 Uruguay Round multilateral trade negotiations.