

United States
Department of
Agriculture



Economic
Research
Service

Program of Research on the Economics of Invasive Species Management

Fiscal 2003-2006 Activities



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Program of Research on the Economics of Invasive Species Management Contacts

Elizabeth Ashley, Report Coordinator
Craig Osteen, Program Co-Leader
William Hahn, Program Co-Leader
Janet Perry, ERS Invasive Species Co-Manager
Utpal Vasavada, ERS Invasive Species Co-Manager

Phone: (202) 694-5547
Fax: (202) 694-5775
E-mail: PREISM@ers.usda.gov
Website: <http://www.ers.usda.gov/Briefing/InvasiveSpecies/>

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Program of Research on the Economics of Invasive Species Management

Fiscal 2003-2006 Activities

Chapter 1

Program of Research on the Economics of Invasive Species Management

In 2003, USDA's Economic Research Service (ERS) initiated the Program of Research on the Economics of Invasive Species Management (PREISM) to examine the economics of managing invasive pests in increasingly global agricultural markets. PREISM is national in scope and focuses on decision-making related to species of agricultural or USDA program significance.

Invasive species are defined broadly to include any vertebrate, invertebrate, weed, fungus, plant disease, livestock disease, or other organism that meets the following criteria:

- Is nonnative, alien, or exotic to the ecosystem where it exists or potentially could be introduced – including agricultural, range, and forest ecosystems; and
- When introduced, causes, or is likely to cause, economic or environmental harm.

Invasive species can inflict losses on U.S. agriculture by reducing crop and livestock production, increasing food prices faced by consumers, or undermining export potential, and they can damage environmental or resource values. Faced with this issue, crucial public policy questions have arisen:

- How should resources be allocated among exclusion, surveillance, control, and mitigation programs?
- Which pests should be excluded or controlled?
- What combination of exclusion or control approach (such as monitoring, eradication, containment, or long-term areawide management programs) should be used?
- When and where should the approach be used?
- What type of practice (such as inspection, pesticide, or biological control) should be used?
- When should the program or use of a practice be terminated?

Research Mission and Program Principles

PREISM's mission is economic research to support the broader effort within USDA to efficiently prevent and manage invasive species for the sake of the competitiveness, safety, and security of the U.S. food and fiber system. PREISM's goal is to build a high-quality, multidisciplinary research

program to provide analytically based principles, guidelines, and criteria for invasive species policy and program decisionmaking, as well as economic information, modeling systems, and other tools that support the decision-making.

The following program principles ensure the integrity, reliability, and usefulness of PREISM research:

- Research that meets the needs of USDA, other Federal and State agencies concerned with invasive species, Congress, and the public.
- Direct involvement of a broad array of public and private entities in research, evaluation, and review efforts that provides diverse insights into what issues to address and which methods to use.
- Development, implementation, and accomplishment of research projects that address USDA needs; concurrently, ERS staff gain access to cutting-edge methods and expertise.
- Scientifically rigorous studies with verifiable and unbiased results.
- Wide distribution of research findings.

Program at a Glance

Under PREISM, ERS supports and conducts research to improve the economic basis of decision-making concerning invasive issues, policies, and programs. Since the inception of PREISM, program themes have included international dimensions of invasive species prevention and management; development and application of methods to analyze important invasive species issues, policies, and programs; and analysis of economic, institutional, and behavioral factors affecting decisions to prevent or manage invasive species.

Funding for Invasive Species Research

A fiscal year 2003 budget initiative established ERS' annual invasive species funding at \$2 million. With this funding, ERS seeks to build national capacity for analysis of USDA invasive species program management through extramural research and internal capacity development. PREISM has allocated \$4.9 million in fiscal years 2003-06 through its competitive extramural program: \$1.6 million in fiscal year 2003, \$1.1 million in 2004, \$1.1 million in 2005, and \$1.1 million in 2006. In addition, PREISM has allocated \$640,000 over fiscal years 2003-2006 for eight commissioned studies to address USDA program needs not covered by competitively submitted proposals and to build the capacity of 1890 Institutions to address invasive species issues. Funding for intramural research has supported management of the PREISM extramural program, as well as other ERS-initiated research activities. PREISM activities that have strengthened USDA's internal analytical capability include research targeted toward specific program agency needs, such as estimation of price elasticities (demand and supply) and the development of analytical models.

Interactions With Other USDA Agencies

Program priorities have been selected annually through extensive consultation with the Animal and Plant Health Inspection Service (APHIS), the Office of Budget and Program Analysis (OBPA), and other USDA agencies responsible for program management.

ERS researchers have met with staff from other agencies to share research findings and identify possible topics for collaborative research. For example, ERS economists worked with APHIS, Agricultural Research Service (ARS), and Cooperative State Research, Education and Extension Service (CSREES) researchers on the economic and policy implications of windborne entry of soybean rust into the United States. ERS researchers subsequently analyzed the economic value of USDA's coordinated soybean rust network. Also, annual workshops where PREISM awardees discuss their progress and results provide opportunities for intensive discussions between researchers and staff from APHIS, USDA's Office of Risk Assessment and Cost-Benefit Analysis (ORACBA), ARS, CSREES, the Environmental Protection Agency (EPA), and various Department of Interior agencies.

To strengthen Federal coordination of invasive species research, ERS convened an informal committee of economists analyzing invasive species issues from USDA and other departments, including the Forest Service (FS), APHIS, Natural Resources Conservation Service (NRCS), ORACBA, U.S. Geological Survey (USGS), and EPA. Quarterly meetings since May 2003 have provided a forum to discuss ongoing activities and present current analyses. This committee is now managed by the Forest Service.

Research Dissemination and Outreach

PREISM uses numerous outlets to disseminate research findings to diverse audiences. Final extramural project reports may be made available on the ERS website (www.ers.usda.gov). The findings of some extramural projects, as well as reports of intramural research, may be included in ERS reports or in articles in *Amber Waves*, ERS's flagship publication. ERS staff will develop a series of briefs to present important project findings.

Results of PREISM extramural and intramural research targeted to narrower, technical audiences are published in professional journals. Researchers also present preliminary results of many extramural and intramural projects at professional meetings and symposia concerning the economics of invasive species.

PREISM's outreach strategy includes a briefing room on the ERS website (<http://www.ers.usda.gov/Briefing/InvasiveSpecies/>). Topics include invasive species and their effects on agriculture; exclusion and eradication programs to manage agricultural invasive pests, including trends in APHIS program and USDA's emergency program expenditures; and Federal and international programs and policies that affect agricultural invasive species. The briefing room showcases ERS research, including the economic implications of windborne entry of soybean rust, the value of USDA's coordinated soybean rust framework, and timely updates on the PREISM competitive grants program. In addition, the ERS website highlights analyses of animal disease issues,

such as the market effects of Bovine Spongiform Encephalopathy (BSE) cases found in Canada and the United States (<http://www.ers.usda.gov/Publications/LDP/2006/06Jun/LDPM14301/>).

Key Accomplishments

PREISM intramural and extramural research has provided critical data, developed decision tools for ranking policy and program priorities, and conducted economic analysis to inform policy and management decisions.

USDA Policy and Program Issues

ERS economists and PREISM-funded researchers are addressing several USDA program needs.

Soybean Rust: Impacts and Value of Surveillance. ARS, APHIS, and CSREES conducted major studies to prepare for the windborne entry of Asian soybean rust into the United States. ERS consulted with plant pathologists and other scientists from these agencies and with universities as part of a study linking economic and biological data on soybean rust, including data reflecting South America's experience with outbreaks of soybean rust. This multidisciplinary and cross-institutional effort helped establish reasonable assumptions about the implications of Asian soybean rust on agricultural production. ERS disseminated study findings to senior USDA policy officials and congressional staff through a series of briefings.

The ERS study showcases essential elements of an economic risk assessment for any pest or disease. It considers the likelihood of a pest reaching U.S. agricultural production regions through natural means, uncertainties surrounding the effects on agricultural yields and production costs upon arrival of a pest in the United States, varying U.S. regional susceptibilities to pest establishment, effects on commodity prices, and producer and consumer adjustments to changing markets.

ERS followed the soybean rust impact study with an analysis of the value of USDA's Coordinated Framework for soybean rust surveillance. The Coordinated Framework provides real-time, county-level forecasts of soybean rust in the United States—forecasts that can be used by farmers as they make decisions about whether to apply fungicides to their fields. The study found that the information provided by Federal, State, industry, and academic partners increased U.S. soybean producers' 2005 profits by between 16 cents and \$4.12 per acre (depending on assumptions), or \$11 million to \$299 million.

Risk Mitigation in International Trade: The Case of Mexican Avocado Imports. As part of a PREISM-funded project, a Virginia Polytechnic Institute and State University research team collaborated with APHIS to reconsider the agency's avocado trade regulation, as applied to importation from approved orchards and packers in the Mexican State of Michoacán. The team's modeling approach was used to assess, under the assumption of negligible risk, the effects of expanded Mexican access. The economic model, analysis, and responses to public comments were published with the new regulation [Federal Register, Nov. 30, 2004 (Vol. 69, No. 229), Rules

and Regulations, pp. 69747-69774, FR Doc 04-26336]. The findings of this project were also presented in a Contractor and Cooperator Report available on the ERS website (<http://www.ers.usda.gov/publications/ccr25/>).

Pest Ranking Tool. In 2003, ERS developed a decision tool for APHIS to rank plant pests by program priority. In this tool, pair-wise ranking criteria enable analysts to apply their informed judgments as to how and which factors, such as trade or environmental factors, influence the severity of infestation risk for individual species. APHIS used the tool to identify pests targeted for surveillance and detection on the 2004 and 2005 Federal-State Cooperative Agricultural Pest Survey (CAPS).

ERS Database and Model Development. To meet the needs of APHIS and other agencies for current estimates of parameters for regulatory impact assessment models, ERS commissioned research in fiscal years 2003 and 2004 to estimate supply and demand price elasticities. ERS developed a list of targeted elasticities in consultation with APHIS and focused on horticultural products where the availability of estimates was limited. Findings will be posted on the ERS website via an interactive data product that allows analysts to search for parameters by various criteria.

Potential Policy or Program Implications

PREISM-funded studies are addressing invasive species issues and decisions that have elicited interest from Federal and State policymakers, program managers, and researchers. Examples include:

Managing Invasive Plants in National Forests. Bruce Maxwell's team at Montana State University is developing a Geographic Information Systems-based decision support tool to prioritize and improve the efficiency of invasive plant management. The tool will use predictive models and economic tradeoff analysis to quantify invasion potential and the effects on diverse National Forest management objectives. This team produced maps of the potential occurrence of invasive weeds that Gallatin National Forest authorities used to assess weed distribution risk associated with road creation and improvement. The maps have also been incorporated into risk assessment by the Montana Department of Transportation. (Examples of the maps can be seen at tansy.msu.montana.edu/NCSSF/ncssf.phtml?ViewRegion=422900,90608,513960,158303.) The Nature Conservancy adopted, in 2006, invasive species inventory/survey methods developed by the team for use on two of their landholdings in Montana.

Cheatgrass Management on Public Lands. Dennis King and Lisa Wainger of the University of Maryland worked with natural resource managers to incorporate economic analysis into decisionmaking at various levels of government concerning this invasive weed. At the Federal level, they collaborated with Bureau of Land Management (BLM) staff to analyze costs of the Emergency Stabilization and Rehabilitation Project. Members of this PREISM team also worked with the Idaho Twin Falls BLM district to evaluate the cost-effectiveness of the BLM Burned Area Rehabilitation Program. Collaboration has extended to a variety of managers and scientists throughout the West, including Forest Service, BLM, and USGS personnel and academic scientists, all of whom participated in a workshop conducted

with the goals of better characterizing benefits from agro-ecosystems and identifying where there exist conflicts and natural alliances among users.

Researching Invasive Weeds: Tools for Policymakers. The Council on Food, Agricultural, and Resource Economics (C-Fare) and the Weed Science Society of America (WSSA) invited Munisamy Gopinath and Bruce Maxwell to discuss their PREISM-funded projects in two briefings in Washington, DC: one for congressional staff at the Rayburn Office Building and another at the Cooperative State Research, Extension, and Education Service. Dr. Gopinath discussed the role of stakeholders' interest and input in explaining differences among States in noxious weed seed regulations, while Dr. Maxwell discussed the decision support tool his research team is developing for prioritizing management of invasive plants on Federal land.

Invasive Species in Hawaii. James Roumasset and Kimberly Burnett of the University of Hawaii and Brooks Kaiser of Gettysburg College examined control strategies for *Miconia calvescens*, an invasive plant established in Hawaii, and the integration of prevention and control strategies for the brown tree snake. The researchers have met with APHIS, the Coordinating Group on Alien Pest Species (CGAPS), an advisor to Hawaii Governor Linda Lingle, the Brown Tree Snake Technical Committee, and Hawaiian county invasive species committees to discuss economic issues related to these invasive species. This research team has discussed the effects of management strategies for these organisms in several journal articles (cited in the fiscal year 2006 outputs in this document).

Environmental Assurance Bonding. Michael Thomas of Florida A&M University demonstrated for the Florida Department of Environmental Protection how the use of environmental assurance bonding and a review protocol can significantly reduce the risk of accidental release of nonindigenous species by individuals or firms engaged in aquaculture. The project focuses on the release of black carp to protect commercially grown catfish by eating snails carrying trematodes that infect the catfish. The release practice is under review by the Fish and Wildlife Service.

California Pesticide Regulation. This University of California-Davis project, led by Colin Carter, analyzed the effects on resistance management of restrictions on insecticides to control whiteflies on California strawberries. The California Department of Pesticide Regulation and the California Department of Food and Agriculture have expressed strong interest in the results.

Infectious Wildlife Disease Management. Michigan State University's Richard Horan and Christopher Wolf researched the economics of bovine tuberculosis in Michigan white-tailed deer and cattle. This project tackles a highly relevant policy issue with a new, innovative framework and has high-quality, academic output. With researchers and managers at the Michigan Department of Natural Resources, Horan and Wolf worked to better understand the problem and available management strategies, and their findings may improve the cost effectiveness of managing the disease.

Foreign Animal Diseases. This project, led by Philip Paarlberg at Purdue University in collaboration with APHIS-Veterinary Services, links a U.S.

agricultural sector model to a disease spread model to estimate the impacts of foreign animal diseases on U.S. livestock and related markets. The study examines control strategies and recovery of export market share after the expiration of trade bans, with a focus on three important diseases: foot-and-mouth disease, classic swine fever, and highly pathogenic avian influenza. Upon completion, APHIS will have a model that rapidly estimates the market impacts of disease-related animal cull, export market disruption, or adverse consumer reaction, and can be used in rule-making and evaluation of alternative control and surveillance procedures.

Crop Insurance, Hurricanes, and Citrus Canker. This University of California-Davis project, led by Daniel Sumner, examines how farm programs and crop insurance affect invasive species policies, drawing on three case studies: citrus canker, karnal bunt, and foot-and-mouth disease. The research team completed a paper on the effect of hurricanes on the economics and spatial dynamics of citrus canker eradication. The team has discussed this issue with APHIS, which in 2006, decided that hurricanes had spread citrus canker so extensively that the disease could not be eradicated.

Expanding the Economic Literature on Invasive Species Management

PREISM-funded researchers have written many journal articles and presented results at professional meetings, including contributions to special issues of academic journals, books, and conference sessions addressing the economics of preventing and managing invasive species.

Choices. Rachel Goodhue, of the University of California-Davis, and Gregory McKee, of North Dakota State University, were guest editors for a set of four articles relating to invasive species in the third quarter, 2006 issue of *Choices*, an online magazine addressing the economics of food, farm, and resource issues (<http://www.choicesmagazine.org/>). All the articles drew from research projects that PREISM funded in 2003. The primary theme for the articles is that critical mistakes in policy choices can result without information on relevant economic and biological relationships. Topics included modeling the depth of bioeconomic integration, integrating prevention and control policies, value of information and methodological choices in bioeconomic modeling, and institutional uncertainty and bioeconomic systems.

Agricultural and Resource Economic Review. The April 2006 issue of this journal was devoted to the economics of invasive species and contains articles based on presentations at the Northeastern Agricultural and Resource Economic Association (NAREEA) Workshop on Invasive Species on June 14-15, 2005, in Annapolis, MD, cosponsored by ERS, EPA, and the Farm Foundation. Of the 16 articles in the issue, 6 reported findings from PREISM-funded extramural research projects and another 3 reported findings of ERS intramural research on invasive species topics, including soybean rust. The ARER editorial council and editors selected "Prevention or Control: Optimal Government Policies for Invasive Species Management," by C.S. Kim and others (one of the articles reporting on ERS intramural research) as the outstanding ARER article of 2006.

New Approaches to the Economics of Plant Health. This book, edited by Alfons Oude Lansink and scheduled for publication by Springer Press in 2007, is based on presentations at the Frontis Economics of Plant Health conference in Wageningen, the Netherlands, on June 1-3, 2005 (<http://library.wur.nl/frontis/>). The book addresses efficient border inspection policies and the costs, benefits, and nonmonetary effects of phytosanitary and control policies. It contains 13 chapters authored by economists from Finland, Germany, the Netherlands, the United Kingdom, and the United States; 4 chapters report findings of PREISM-funded research projects.

Euphytica. A special issue of this journal titled, “Plant Breeding and Crop Domestication as Sources of New Invasive Species,” published in March 2006, was edited by Neil Anderson and Susan Galatowitsch of the University of Minnesota (<http://www.springerlink.com/content/vn72277u2316/?p=3d80ac4032934c588fe42315b3925727&pi=12>). This issue contained 16 articles written by authors from the biological and social sciences. Two articles based on PREISM-funded research, one by Brooks Kaiser and one by Edward Barbier and Duncan Knowler, provided economic perspectives to the discussion.

Economic Impacts of Aquatic Invasive Species. In July 2005, the EPA held a workshop to obtain participants’ views on conceptual frameworks and bioeconomic tools for estimating market and nonmarket impacts of aquatic invasive species. Several PREISM-funded researchers participated in the workshop, including Rick Horan, Brooks Kaiser, Lars Olson, Jason Shogren, David Finnoff, and Brian Leung.

PREISM, Today and Tomorrow

Since its inception in 2003, PREISM has conducted and supported research to improve the economic basis of program and policy decisionmaking that concerns invasive species of agricultural and USDA-program significance. PREISM will continue to integrate intramural research with its extramural program, enhance the capacity to analyze invasive species issues and related decisionmaking, and disseminate policy-relevant research that informs decisionmakers and the public. The program will seek input from key constituencies, such as policy officials and program and research leaders in USDA agencies, to identify and prioritize research needs and policy issues concerning the prevention and management of invasive species.

Chapter 2

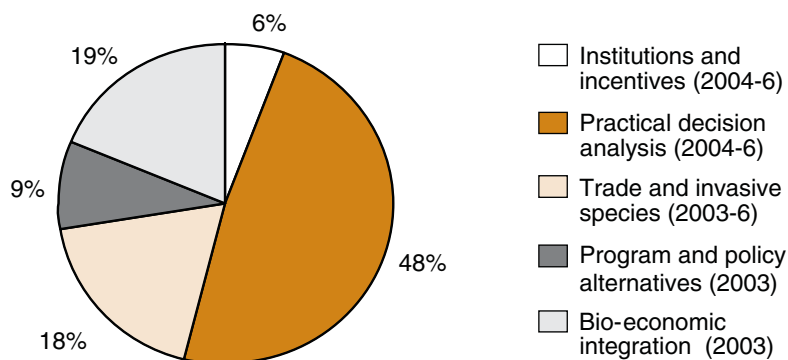
Extramural Research Funding, Fiscal Years 2003-2006

In fiscal years 2003-06, PREISM requested proposals that focused on economic research and/or decision support system development to address USDA invasive species policy and program decisionmaking. Applicants were encouraged to incorporate scientific and technical expertise into their analyses and to have a strong component addressing the economic aspects of space, dynamics, risk, uncertainty, irreversible effects, and institutional frameworks.

The requests for proposals (RFPs) identified priority research areas developed in consultation with agencies concerned with invasive species problems, including the Animal and Plant Health Inspection Service (APHIS), Agricultural Research Service (ARS), Forest Service (FS), Office of Risk Assessment and Policy Analysis (ORACBA), and Office of Budget and Policy Analysis (OBPA). Priority research areas changed each year to address new issues identified in those consultations, as well as previously identified issues not addressed by funded projects. Researchers submitted proposals for consideration under specific priority research areas, but many proposals addressed more than one priority research area. Under the competitive funding process, the proposals were peer reviewed by experts from public and private universities and colleges, government agencies, and private research groups. PREISM research priorities, as well as the technical reviews, provided the basis for selecting proposals for funding.

There have been five major priority research areas in PREISM’s history, although emphases and names changed from year to year: “Institutions and Incentives for Efficient Invasive Species Prevention and Management” from 2004-2006 (called “Stakeholders and Incentives for Efficient Invasive Species Prevention and Management” in 2004), “Practical Decision Analysis for Invasive Species Management” from 2004-2006 (called “Practical Decision Tools for Invasive Species Management” in 2004), Trade and Invasive Species from 2003-2006 (called “International Dimensions of Invasive Species Management” in 2005-06), “Resource Implications of Invasive

Share of competitive funding, by priority research area*



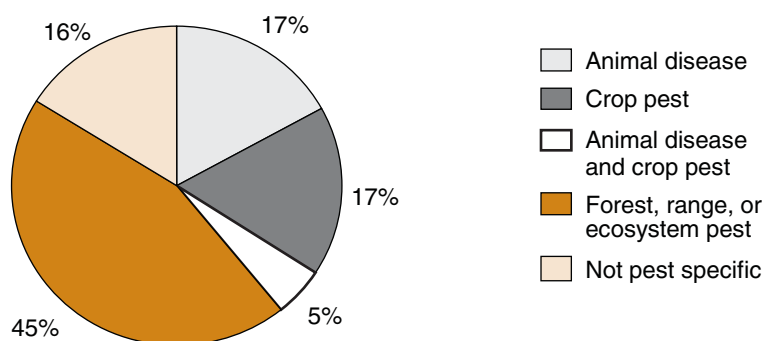
*As identified by applicants; names of areas vary by year.

Species Program and Policy Alternatives” in 2003, and “Bio-Economic Integration and Risk Assessment” in 2003.

While PREISM-funded projects focus on the economics of invasive species prevention or management, many also address specific pest or invasive species problems. During the 4 years of the program, about 45 percent of the funds were allocated to projects addressing issues related to invasive species of forests, rangeland, and ecosystems; 17 percent to projects addressing animal diseases; another 17 percent to projects addressing crop pests; and 5 percent to projects addressing animal disease and crop pests. Approximately 16 percent of funds were allocated to projects addressing border inspection, trade policy, risk assessment, and conceptual topics that are not pest-specific.

PREISM has funded 33 projects through its competitive award program from 2003 to 2006, with 7 new agreements in 2006. In addition, PREISM has commissioned eight studies, including three new studies funded in 2006, to address USDA program needs not covered by competitively submitted proposals and to build the capacity of 1890 Institutions to address invasive species issues. Study topics include risk management in the context of uncertainty and ambiguity, insurance rates for programs to indemnify losses from soybean rust, estimation of supply and demand elasticities for horticultural crops, compilation of sanitary and phytosanitary regulations affecting U.S. exporters, development of a framework for determining the level of compensation for livestock producers for disease eradication and containment, and assessment of the potential use of assurance bonds to manage the risk of intentional release of exotic species. Extramural funding for competitive and commissioned research has totaled about \$5.5 million, with \$1.4 million awarded in 2006.

Share of competitive funding, by pest type



Chapter 3

Extramural Research Activities, Fiscal Year 2006

In fiscal year 2006, ERS accepted economic research proposals in three areas of importance to USDA's invasive species policies and programs.

Institutions and Incentives for Efficient Invasive Species Prevention and Management

Projects in this area examine the interactions between the public sector and groups and individuals in the private sector who act to prevent and manage invasive species; factors that motivate each party to act or fail to act in particular ways; and the incentives created by alternative programs, organizations, or rules. Relevant questions include:

- What is the effect of public and private institutions on invasive species prevention and management?
- What is the effect of strategic behavior on invasive species prevention and management?
- What are the efficiency and equity effects of current and alternative USDA invasive species funding mechanisms?
- How should invasive species regulations be written and enforced, given that contraband can harbor and distribute invasive pests?

Practical Decision Analysis for Invasive Species Management

Projects in this area adapt and apply economic and data management tools and techniques to aid, guide, and inform USDA decisions and actions related to invasive species prioritization, detection, monitoring, management, and regulation. Relevant questions include:

- How can economic concepts and decision support models be applied to invasive species problems?
- How can USDA evaluate alternative regulations and research investments in a more useful and timely manner, in spite of methodological challenges?

International Dimensions of Invasive Species Management

Significant increases in international trade, travel, transport, and tourism over the past decades have created the potential for increased transmission of invasive species. Countries use different approaches to mitigate trans-boundary risks arising from these activities. Strategies include extra-territorial efforts to control pests and diseases, the regulation of commercial imports by source and product, and border inspections. A network of international organizations, including the Food and Agriculture Organization of the United Nations (FAO) and other international groups, provide, coordinate, and/or finance regional or multilateral efforts to control invasive species, which complement or supplement national efforts. International negotiations have resulted in trade agreements that govern the use of national sanitary and phytosanitary (SPS) regulations that affect trade. The

World Trade Organization (WTO), North American Free Trade Agreement (NAFTA), and other trade regimes set out different options for regulating trade-related risks from invasive species, with different distributions of costs and benefits across importing and exporting countries. These invasive species policy choices made by national and international authorities affect, and are affected by, production and investment decisions made by firms and private individuals participating in international food and agricultural product markets. Research in this area focuses on economic evaluations of trade-related invasive species risks, as well as firm-level, national, and international strategies for controlling these risks. Relevant questions include:

- What are the international public goods related to invasive species management and how might their underprovision be corrected?
- What are the effects of public enforcement of trade-related invasive species regulation?
- What are the firm-level effects of trade-related invasive species risks, regulations, and responses?

Table 1

PREISM competitive awards, fiscal year 2006

Research Project	Objective	Award
<i>Practical Decision Analysis for Invasive Species Management</i>		
A Decision Model for Controlling Buffelgrass (<i>Pennisetum ciliare</i>) Invasion in an Urban-Wildland Interface Combining Dynamic Programming with the Analytical Hierarchy Process George Frisvold <i>University of Arizona</i>	Develop a web-based decision support system that enables government agencies and private land managers to provide pest information and identify cost-effective strategies for managing buffelgrass in Arizona, focusing on the desert-urban interface. The system will solve a dynamic programming problem with user inputs and provide user-friendly displays that include maps of management strategies. Buffelgrass is a non-native perennial grass introduced for livestock forage, but has become invasive and contributes to fire hazards in natural and urban-fringe areas.	\$119,000
Bioeconomics of Managing Multi-Host Diseases Richard Horan and Christopher A. Wolf, <i>Michigan State University</i>	Investigate the economic effects of policies to manage diseases transmitted between livestock and wildlife by incorporating producer incentives, recent ecological developments on multi-host species-pathogen dynamics, and pathogen co-evolutionary processes into a bioeconomic framework. The researchers will examine such diseases as bovine tuberculosis, brucellosis, and John's disease.	\$117,000
Evaluating the Economic Costs and Benefits of Slowing the Spread of the Emerald Ash Borer in Michigan and Ohio, Jonathan Bossenbroek <i>University of Toledo</i>	Investigate the ecological and economic effects of emerald ash borer, a high-priority pest for USDA agencies, on ash forestry and amenities in Ohio and Michigan. Using a regional computable general equilibrium model, the researchers will estimate the current distribution and spread rate of emerald ash borer, the economic value of ash trees, and economic losses due to the pest. They will use estimates of costs and effectiveness of control methods to find a socially optimal control strategy.	\$250,000
Landscape-Level Decision Support for Invasive Species Management Woodam Chung <i>University of Montana</i>	Build a user-friendly decision support system to help weed managers in the U.S. Forest Service and other land management agencies to identify efficient strategies for a wide variety of weed species. The researchers will develop a heuristic solver for complex temporal and spatial weed management problems, which evaluates a large number of alternative strategies to select the most efficient one. The system will use information on the spatial distribution of weeds, the dynamics of weed growth and spread, and the cost-effectiveness of control methods. It will be applied in the Bitterroot and Nez Perce National Forests and will incorporate Forest Service priorities and resource constraints.	\$209,000
Modeling and Evaluation of Effectiveness of Avian Influenza Mitigation Options Levan Elbakidze <i>Texas A&M University</i>	Examine the economic effectiveness of available mitigation strategies against avian influenza, focusing on the Texas poultry industry. The researchers will use an integrated epidemiological-economic model and will consider characteristics of the regional poultry industry to investigate the tradeoffs among preparedness, prevention, response, and recovery activities, and to provide guidance on the efficient allocation of resources to those activities.	\$150,000
Spatial Decision-making Tools for Efficient Allocation Strategies in Invasive Species Management Frances R. Homans <i>University of Minnesota</i>	Develop a spatially explicit decision support system that considers ecological and economic factors, time, and uncertainty to efficiently allocate resources to prevention, detection, and control for a variety of invasive species. The system will be applied to invasive species in Minnesota, to be identified during the study, and the results compared to current practices.	\$106,000

Table 1

PREISM competitive awards, fiscal year 2006—Continued

Research Project	Objective	Award
<i>International Dimensions of Invasive Species Management</i>		
Welfare Impacts of Invasive Species on Livestock Trade Thomas Marsh <i>Washington State University</i>	Examine the economic and trade effects of animal disease outbreaks in U.S. and global markets and of individual and multi-country responses to those outbreaks. The research will derive theoretically consistent welfare measures for estimating the economic effects and develop a dynamic bioeconomic model of livestock and invasive species that includes the U.S., Canada, Mexico, and Australia. The study will focus on hypothetical foot-and-mouth disease outbreaks in North America and Australia.	\$119,000
<i>Commissioned Research</i>		
A Feasibility Analysis of Indemnification Plans for the Management of Soybean Rust Barry K. Goodwin and Kenrett Jefferson-Moore <i>North Carolina State University and North Carolina A&T University</i>	Construct empirical models to estimate actuarially fair insurance or checkoff rates for indemnification programs that could compensate producers for losses induced by soybean rust infection. These rates would be set in accordance with expected losses, such that the resulting risk management program would operate on an expenditure-neutral basis (abstracting from program administration costs). Such “self-help” programs place the burden of funding on the affected producers in accordance with each individual producer’s risks.	\$82,000
Managing Invasive Species Risks Joseph E. Aldy and W. Kip Viscusi <i>Resources for the Future and Vanderbilt University</i>	Examine risk management issues for invasive species at different stages of the policy process in the context of uncertainty and ambiguity, using mad cow disease (bovine spongiform encephalopathy) as a case study. Important issues include the assessment of risk (probabilities); estimation of the effectiveness and benefits of such policies as surveillance, prevention and interdiction, information collection/provision, and eradication; and prioritization of risks and selection of policies when information is limited.	\$157,000
Reducing Sanitary and Phytosanitary Hazards in International Trade: Incentives, Measurement, and Financing of an International Public Good Laurian Unnevehr <i>University of Illinois</i>	Examine the existence of international spillovers related to the mitigation of sanitary and phytosanitary (SPS) risks in imported agricultural products, the links to monitoring at the border by Federal agencies, and to the allocation of technical assistance to food exporters. This project will build a knowledge base for understanding which food and hazard pairings most frequently occur. The results and policy implications will be interpreted using an international public goods framework, which identifies incentives and institutions for internalizing spillover benefits from mitigating SPS risks, when costs of improvement are incurred in one country for benefits in another country.	\$75,000

PREISM-Supported Publications and Other Outputs

The following is a list of outputs from projects funded by PREISM during fiscal year 2006. Three categories are listed: monographs and journal articles; conference presentations; and working papers, discussion papers, and theses.

Monographs and Journal Articles

Acquaye, Albert K.A, Julian M. Alston, Hyunok Lee, and Daniel A. Sumner. "Hurricanes and Invasive Species: The Economics and Spatial Dynamics of Eradication Policies," in *New Approaches to the Economics of Plant Health*, Alfons Oude Lansink, ed., Wageningen UR Frontis Series, vol. 20, Springer: Dordrecht, forthcoming, 2007, 208 pp. (http://library.wur.nl/frontis/plant_health/07_acquaye.pdf).

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Costello, Christopher J. "Unintentional Biological Invasions: Does Risk Vary By Trading Partner?" Triangle Resource and Environmental Economics Seminar, Duke University, Research Triangle Park, NC, November 2005; International Agricultural Trade Research Consortium, San Diego, CA, December 2005.

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Chapter 4

Extramural Research Activities, Fiscal Years 2003-2005

Priority Research Areas, Fiscal Year 2005

In fiscal year 2005, ERS requested proposals in three broad areas. “Institutions and Incentives for Efficient Invasive Species Prevention and Management” encompassed such topics as collective action and property rights, the economics of contraband, and moral hazard in public and private sector interaction on invasive species management. “Practical Decision Analysis for Invasive Species Management” emphasized the application of economic concepts or decision support models to resource allocation issues and the design/implementation of invasive pest programs/policies, and the development of evaluation methods to evaluate invasive species strategies under tight deadlines. “International Dimensions of Invasive Species Management” included economic analysis of international public goods related to invasive species management, economic evaluation of public enforcement of trade-related invasive species regulation, and firm-level analysis of trade-related invasive species risks, regulations, and responses.

Table 2

PREISM competitive awards, fiscal year 2005

Research Project	Objective	Award
<i>Institutions and Incentives for Efficient Invasive Species Prevention and Management</i>		
Strategic Behavior, Incentives, Heterogeneity and Invasive Species Management Janie M. Chermak <i>University of New Mexico</i>	Examine ranchers' incentives for invasive species prevention and management and evaluate potential effectiveness of public prevention and management strategies implemented prior to a critical level of establishment. The project develops a spatial, game theoretic model to examine institutions and incentives surrounding Russian knapweed and yellow starthistle in New Mexico.	\$200,000
<i>Practical Decision Analysis for Invasive Species Management</i>		
Insect Derivatives: Managing Insect Risk with Financial Instruments Timothy Richards <i>Arizona State University</i>	Examine the use of market-traded instruments, known as insect derivatives, as a market-based approach for mitigation of the economic risk of insect damage and as a complement to insurance or public programs. The case study considers whitefly infestation in U.S. cotton.	\$104,000
The Economics and Ecology of the Risk of Invasive Plant Establishment from the Horticultural Trade in North America Edward Barbier <i>University of Wyoming</i>	Develop an integrated economic and ecological analysis of the costs and benefits associated with the risk of invasive plant establishment, where the source of the accidental introduction is the commercial horticultural industry and horticultural trade. The project evaluates policies to reduce the risk of accidental introduction, including self-regulation by the industry, taxing or banning the sale of exotic species, and policy coordination between the U.S. and Canadian Governments.	\$207,000
Value of Animal Traceability Systems in Managing Contagious Animal Diseases Ted Schroeder <i>Kansas State University</i>	Construct an intertemporal, spatially disaggregated model of the U.S. beef sector to analyze and simulate responses to an outbreak of foot-and-mouth disease. The project measures benefits, costs, and market impacts of animal identification and traceability programs.	\$152,000
<i>International Dimensions of Invasive Species Management</i>		
Border Enforcement, Importer Behavior, and Trade-Related Invasive Species Risks David Zilberman <i>University of California-Berkeley</i>	Apply an agent-based model to examine how inspection protocols affect export firms' incentives to control or eliminate pests versus their incentives to avoid inspections or hide problems. The theoretical model will incorporate a port selection problem for both inspectors and export firms.	\$132,000
Seed Trade and Invasive Species Risk: Identifying Arbitrary SPS Regulations, Their Cost and Impact on Trade and Welfare John Beghin <i>Iowa State University</i>	Investigate how other nations' SPS regulations affect U.S. seed exports. The project identifies SPS regulations that do not meet international standards, determines the cost associated with the tests, and estimates the effects of removing arbitrary SPS regulations on U.S. seed exports.	\$136,000
Strategic Policy for Prevention of Invasive Species in Dynamic International Trade Relationships Lars Olson <i>University of Maryland</i>	Examine the types of import rules and regulations that would induce exporting firms to voluntarily reduce the risks of exporting exotic species to the United States and the circumstances under which domestic trade policy is required to induce foreign governments to regulate exports. The project uses a game theoretic approach to examine interactions between private producers in exporting countries and governments of importing countries and between governments of importing and exporting countries.	\$157,000

Table 2

PREISM competitive awards, fiscal year 2005—Continued

Research Project	Objective	Award
<i>Commissioned Research</i>		
The Effects of Foreign Invasive Species Regulations on Markets for U.S. Agricultural Products: Data, Measurement, and Methods Everett Peterson <i>Virginia Polytechnic Institute and State University</i>	Develop a database of SPS regulations, as they relate to invasive species, for selected products in international trade of interest to U.S. stakeholders. Since such regulations currently must be obtained from the importing countries, the compilation in a common format will facilitate monitoring and analysis of SPS measures, as well as analysis of SPS policy options.	\$200,000
Optimal Compensation Schemes for Invasive Species Eradication and Containment in Livestock Andrew Muhammad <i>Mississippi State University</i>	Provide mechanisms for determining the level of compensation to producers for reporting disease outbreaks in the livestock sector. The project develops a theoretical model of compensation for pest eradication and containment, apply the model to case studies in the cattle sector, and develop guiding principles and rules for compensating producers in various circumstances.	\$25,000

Priority Research Areas, Fiscal Year 2004

In fiscal year 2004, ERS requested proposals in three broad areas. “Stakeholders and Incentives for Efficient Invasive Species Program Management” encompassed such topics as collective action and property rights, the economics of contraband, and moral hazard in public and private sector interaction on invasive species management. “Practical Decision Tools for Invasive Species Management” emphasized developing multi-criteria decisionmaking tools, applying standard tools and techniques of economic analysis to the design and implementation of invasive pest programs and policies, and valuing ecological services likely to be affected by invasive agricultural pests of forest, range and agricultural ecosystems. “Trade and Invasive Species” included economic evaluation of national invasive species regulations on trade in international agricultural markets, economic analysis of international rules and governance frameworks for invasive species regulations, and firm-level analysis of trade-related invasive species risks, regulations, and responses.

Table 3

PREISM competitive awards, fiscal year 2004

Research Project	Objective	Award
<i>Stakeholders and Incentives for Efficient Invasive Species Program Management</i>		
Determinants and Welfare Implications of Federal and State Noxious Weed Regulations Munisamy Gopinath <i>Oregon State University</i>	Evaluate the impact of noxious weed lists on interstate trade, with a focus on the ecological and economic factors determining which species appear on Federal and State lists and why these vary substantially across jurisdictions.	\$85,000
<i>Practical Decision Tools for Invasive Species Management</i>		
Developing and Integrating Tools for Assessing the Impacts of Invasive Plants for Prioritization of Management on Federal Lands Bruce D. Maxwell <i>Montana State University</i>	Develop a Geographic Information Systems (GIS)-based decision support tool to help land managers prioritize across invasive plant populations, taking into account tradeoffs among ecosystem indicators and control costs. U.S. Forest Service land managers are actively engaged in the project as providers of expert opinion and as prospective users of the tools.	\$238,300
A Risk-Based Approach to Manage Intentional Introduction of Nonnative Species James J. Opaluch <i>University of Rhode Island</i>	Develop a risk-based framework to balance potential benefits of intentional introduction of nonnative species for commercial purposes against the risks that the species become invasive and cause harm. Research focuses on the case of Asian oysters in the Chesapeake Bay.	\$219,880
Spatial Management of Invasive Alien Species: An Application to Cheatgrass Management in the Great Basin James N. Sanchirico <i>Resources for the Future</i>	Develop a stochastic, spatial, and intertemporal bioeconomic model for comparing the costs and benefits of targeting invasive species management actions (such as exclusion, surveillance, control, and mitigation) at various times and locations. The researchers simulate control policies, using cheatgrass in the Great Basin as an example.	\$190,860
Economic Impacts of Foreign Animal Disease Philip L. Paarlberg <i>Purdue University</i>	Quantify the economic impacts of diseases that pose a threat to U.S. livestock and poultry industries. The project focuses on consumer and international trade responses to the presence of such diseases and alternative disease control strategies.	\$169,000
Robust Inspection for Invasive Species with a Limited Budget L. Joe Moffitt <i>University of Massachusetts, Amherst</i>	Construct a decision tool to develop efficient border protection protocols for potentially damaging species under conditions of extreme uncertainty and limited budgets. The project suggests revisions to the inspection processes in the USDA/APHIS Agricultural Quarantine Inspection Monitoring Handbook, focusing on agricultural inspection at northeastern U.S. ports of entry.	\$125,400
<i>Trade and Invasive Species</i>		
The Regulation of Invasive Species Introduced Unintentionally Via Maritime Trade Amitrajeet A. Batabyal <i>Rochester Institute of Technology</i>	Analyze economic issues associated with the design and operation of two pest exclusion policy options—port-of-entry inspections and pre-export certifications—used by USDA.	\$74,000

Priority Research Areas, Fiscal Year 2003

PREISM identified three priority research areas for fiscal year 2003. “The Economics of Trade and Invasive Species” encompassed economic evaluation of tariff and nontariff barriers to trade in international agricultural markets and analysis of international rules and governance frameworks for invasive species regulation. “Resource Implications of Invasive Species Policy and Program Alternatives” included the following avenues of research: deriving economic implications of alternative approaches to invasive pest exclusion, surveillance, management, and/or compensation; illuminating tradeoffs and informing resource allocation options in the multiprogram context; and exploring the political economy and welfare implications of invasive species regulation. “Bioeconomic Modeling and Risk Analysis” sought to encourage advances in the art and science of bioeconomic modeling; the analysis of externalities, public goods and nonmarket valuation in relation to invasive species; and the incorporation of risk and uncertainty into economic decisionmaking concerning invasive species.

Table 4

PREISM competitive awards, fiscal year 2003

Research Project	Objective	Award
<i>The Economics of Trade and Invasive Species</i>		
Design of Systems Approaches to Invasive Pest Risk Management David Orden <i>Virginia Polytechnic Institute and State University</i>	Formulate an evaluation methodology for regulations that adopt a “systems approach” to reducing invasive pest risks associated with imports. This project is developing a means for determining regulations that achieve appropriate levels of risk protection.	\$108,000
Modeling the Effects of Invasive Species on the International Trade of Forest Products Jeffrey P. Prestemon and Joseph Buongiorno <i>USDA Forest Service and University of Wisconsin, Madison</i>	Examine the economic effects of trade regulations aimed at preventing the accidental importation of potentially forest-damaging invasive species. The research considers the losses incurred by producers and consumers due to timber inventory reductions and supply shifts caused by invasive species, both in the absence of regulation and under phytosanitary regulations that protect forest resources but restrict trade.	\$101,981
Controlling Exotic Species Introductions: Trade-Related Policies and Exposure Christopher J. Costello and Carol McAusland <i>University of California-Santa Barbara</i>	Develop theoretical and empirical models to analyze the physical and economic tradeoffs and complementarities between various ex ante policy tools—such as trade bans, port inspections, and pre-export certifications—designed to mitigate the risks associated with invasive species introduced via international trade.	\$68,000
<i>Resource Implications of Invasive Species Policy and Program Alternatives</i>		
Integrating Prevention and Control of Invasive Species: Lessons from Hawaii James Roumasset and Brooks Kaiser <i>University of Hawaii and Gettysburg College</i>	Examine the allocation of scarce resources between exclusion and control strategies for different types of pests and provide information to Federal and State decisionmakers. The project employs a dynamic optimal control methodology to examine exclusion and control strategies for three representative pests: an established invader (<i>Miconia calvescens</i>), a potentially explosive invader not yet introduced (red imported fire ant), and an eradicable or controllable invader (brown tree snake).	\$200,000
Commodity Programs, Distorted Markets and Economic Consequences of Invasive Species Policies Daniel A. Sumner <i>University of California-Davis</i>	Examine the economic implications of invasive species policy within the context of trade and agricultural policies, such as commodity programs and crop insurance. The framework is applied to three invasive pests of particular interest to U.S. agriculture: citrus canker, foot-and-mouth disease, and karnal bunt.	\$150,000
Tradeoffs and Resource Allocation Effects for Alternative Invasive Species Management Policies Thomas I. Wahl <i>Washington State University</i>	Compare the benefits from trade and potential costs resulting from the establishment of an invasive species. The analysis addresses the economic consequences of alternative response strategies, including prevention and/or control activities carried out in foreign countries, at U.S. ports of entry, and within the United States.	\$100,000
<i>Bioeconomic Modeling and Risk Analysis</i>		
Integrating Economics and Biology for Bioeconomic Risk Assessment/Management of Invasive Species in Agriculture Jason Shogren <i>University of Wyoming</i>	Extend bioeconomic modeling frameworks in order to improve risk assessments for and policy responses to invasive species that affect U.S. agriculture, with an application to leafy spurge.	\$185,000

Table 4

PREISM competitive awards, fiscal year 2003—Continued

Research Project	Objective	Award
Comparing Cost, Risk and Benefit Tradeoffs Under Uncertainty: Cheatgrass Case Study Dennis M. King and Lisa Wainger <i>University of Maryland, Cambridge</i>	Illustrate practical and credible components of decision support tools to be used in prioritizing regional responses to invasive plants on agricultural and natural lands. The project examines the role of human alteration of landscapes in invasive species diffusion and assesses the potential for spatial (GIS) databases to be used in an analysis of invasions and their potential irreversibility.	\$175,000
Feasibility of Indemnification and Check-off Funded Programs to Manage Invasive Species Risks in Agriculture Barry K. Goodwin <i>North Carolina State University</i>	Evaluate economic issues associated with voluntary insurance and mandatory checkoff programs that provide risk management assistance for agricultural producers facing the threat of invasive species. The project includes statistical modeling of the risk associated with three case studies: karnal bunt, Asiatic citrus canker, and Canadian thistle.	\$158,000
Biology and Economics of Invasive Species: Spatial and Temporal Interactions Colin A. Carter <i>University of California-Davis</i>	Examine the spatial and temporal links between agricultural markets and invasive species infestations, using greenhouse whitefly infestations of California strawberries as a case study.	\$145,000
Economics of Managing Infectious Wildlife Disease When Livestock Are at Risk Richard D. Horan <i>Michigan State University</i>	Create a modeling framework to account for biological and economic factors that jointly determine how invasive species, wildlife and livestock ecosystems, and human economic activities interact. An empirical application examines economic tradeoffs associated with bovine tuberculosis (TB) control options on and off the farm and compares social incentives with private (that is, farmer and deer hunter) incentives for investing in TB control options and making decisions that affect disease transmission risk.	\$129,000
Randomly Introduced Biological Invasions: The Economics of Prevention and Control Lars J. Olson <i>University of Maryland, College Park</i>	Consider the tradeoffs between prevention, control, and eradication efforts as elements of invasive species policies. This study employs a dynamic optimization framework that incorporates ecological conditions, potential economic damages, and the costs of prevention and control.	\$119,000
<i>Commissioned Research</i>		
Assurance Bonds as Tool to Manage Risks Associated with Intentional Releases of Exotic Species Michael Thomas <i>Florida A&M University</i>	Assess the potential to use assurance bonds to manage the unintended negative economic and environmental impacts of intentional releases of exotic species into the environment. The project examines the release of black carp to protect commercially grown catfish from infectious trematodes.	\$50,000
Estimating Supply, Demand, Import, and Export Elasticities Gary D. Thompson University of Arizona	Develop methods, obtain data, and estimate elasticities for citrus and other selected specialty crops.	\$28,500
Estimating Import and Export Demand for Specialty Crops James L. Seale <i>University of Florida, Gainesville</i>	Develop methods, obtain data, and estimate import expenditure and price elasticities for selected products imported into the U.S. and export expenditure and price elasticities for U.S. products in selected countries. Crops include tomatoes, bell peppers, oranges, grapefruit, apples, bananas, and grapes.	\$22,500

PREISM-Supported Publications and Other Outputs, Fiscal Years 2003-2005

The following is a list of outputs from projects funded by PREISM during fiscal years 2003-05. Three categories are listed: monographs and journal articles, conference presentations, and working papers, discussion papers, and theses.

Monographs and Journal Articles

Acquaye, Albert K.A., Julian M. Alston, Hyunok Lee, and Daniel A. Sumner. "Economic Consequences of Invasive Species Policies in the Presence of Commodity Programs: Theory and Application to Citrus Canker," *Review of Agricultural Economics*, 27(3): 498-504, 2005.

Batabyal, Amitrajeet A. "A Research Agenda for the Study of the Regulation of Invasive Species Introduced Unintentionally Via Maritime Trade," *Journal of Economic Research*, 9: 191-216, 2004.

Batabyal, Amitrajeet A., Hamid Beladi, and Won W. Koo. "Maritime Trade, Biological Invasions, and the Properties of Alternate Inspection Regimes," *Stochastic Environmental Research and Risk Assessment*, 19(3): 184-190, 2005.

Finnoff, David, and Jason F. Shogren. "Endogenous Risk as a Tool for Nonindigenous Species Management," *Weed Technology*, 18: 1261-1265, 2004.

Finnoff, David, Jason F. Shogren, Brian Leung, and David Lodge. "Risk and Nonindigenous Species Management," *Review of Agricultural Economics*, 27(3): 1-8, 2005.

Horan, Richard D., and Christopher A. Wolf. "The Economics of Managing Infectious Wildlife Disease," *American Journal of Agricultural Economics*, 87(3): 537-551, 2005.

Horan, Richard D., Christopher A. Wolf, Eli P. Fenichel, and Kenneth Mathews, Jr. "Spatial Management of Wildlife Disease," *Review of Agricultural Economics*, 27(3): 483-490, 2005.

Leung, Brian, David Finnoff, Jason F. Shogren, and David M. Lodge. "Managing Invasive Species: Rules of Thumb for Rapid Assessment," *Ecological Economics*, 55(1): 24-36, 2005.

McAusland, Carol, and Christopher J. Costello. "Avoiding Invasives: Trade-Related Policies for Controlling Unintentional Exotic Species Introductions," *Journal of Environmental Economics and Management*, 48(2): 954-977, 2004.

Moffitt, L. Joe, John K. Stranlund, and Barry C. Field. "Inspections to Avert Terrorism: Robustness Under Severe Uncertainty," *Journal of Homeland Security and Emergency Management*, 2(3) (<http://www.bepress.com/jhsem/vol2/iss3/3>).

Olson, Lars J., and Santanu Roy. "On Prevention and Control of an Uncertain Biological Invasion," *Review of Agricultural Economics*, 27(3): 491-497, 2005.

Sumner, Daniel A., Jose E. Bervejillo, and Lovell Jarvis. "Public Policy, Invasive Species and Animal Disease Management," *International Food and Agribusiness Management Review*, 8(1), January 2005.

Conference Presentations

Batabyal, Amitrajeet A., and Hamid Beladi. "International Trade and Biological Invasions: A Queuing Theoretic Analysis of the Prevention Problem." Eastern Economic Association 30th Annual Conference, Washington, DC, February 2004; Economics of Invasive Species Workshop, Fargo, ND, April 2004; Canadian Economics Association Annual Meeting, Ryerson University, June 2004; Canadian Agricultural Economics Society-Northeastern Agricultural and Resource Economics Association Annual Meeting, Halifax, NS, June 2004; American Agricultural Economics Association Annual Meeting, Denver, CO, August 2004.

Batabyal, Amitrajeet A., Hamid Beladi, and Won W. Koo. "Maritime Trade, Biological Invasions and the Properties of Alternate Inspection Regimes." Economics of Invasive Species Workshop, Fargo, ND, April 2004; Social Science Research Network (SSRN) Working Paper, August 2004 (<http://ssrn.com/abstract=572661>).

Buongiorno, Joseph. "Modeling and Forecasting the International Wood Supply, Forest Stock, and Forest Area (Results for France)." Laboratoire d'Economie Forestiere Seminar on Forest-Wood Sector Modeling, Nancy, France, May 26, 2005.

Buongiorno, Joseph. "An Economic Model of International Wood Supply, Forest Stock, and Forest Area Change." International Faustmann Symposium, Baton Rouge, LA, April 20-21, 2005.

Burnett, Kimberly. "Weaker Link Public Goods." Northeastern Agricultural and Resource Economics Association Invasive Species Workshop, Annapolis, MD, June 14-15, 2005; Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Burnett, Kimberly, Brooks A. Kaiser, and James A. Roumasset. "Optimal Public Control of Invasive Species: Preventing the Brown Tree Snake (*Boiga irregularis*) from Invading Hawaii." Poster presentation: Hawaii Conservation Conference, Honolulu, HI, June 2004.

Costello, Christopher J. "Marine Exotic Species: An Emerging Threat in California." California Ocean Economic Summit, Long Beach, CA, July 2005.

Costello, Christopher J., Carol McAusland, Andrew Solow, and Michael Springborn. "International Trade and the Risk of Biological Invasions." Association of Environmental and Resource Economists, Jackson, WY, June 2005.

Diaz, Ricardo, Thomas Wahl, and Zishun Zhao. "The Economic Implications of Invasive Species in International Trade: The Chile – US Fresh Fruit Market." Asia-Pacific Economic Cooperation Study Centers Consortium Meeting, Valparaiso, Chile, May 26-29, 2004.

Dougher, Frank L., Lisa J. Rew, and Bruce D. Maxwell. "Scale Effects in the Evaluation of the Spatial Distribution of Non-Native Species in Wild-land Ecosystems." *Western Society of Weed Science*, Vancouver, BC, Canada, March 2005.

Fenichel, Eli P., and Richard D. Horan. "Jointly-Determined Ecological Thresholds and Economic Trade-offs in Wildlife Disease Management." Seventh Annual BioEcon Conference on "Economics and the Analysis of Ecology and Biodiversity," Kings College, Cambridge, England, September 20-21, 2005; Seventh Annual Heartland Environmental and Resource Economics Workshop, Iowa State University, Ames, IA, September 18-19, 2005.

Fenichel, Eli P., and Richard D. Horan. "Understanding Ecological and Economic Interactions in Wildlife Disease Management." Midwest Fish and Wildlife Conference, Grand Rapids, MI, September 2005.

Fenichel, Eli P., Richard D. Horan, and Christopher A. Wolf. "Wildlife Disease Management Policies Based on Sexual Dimorphism: An Economic Argument." The Wildlife Society, Calgary, AB, Canada, September 18-23, 2004.

Fenichel, Eli P., Richard D. Horan, and Christopher A. Wolf. "The Role of Sexual Dimorphism in the Economics of Wildlife Disease Management." American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Gramig, Benjamin M., Richard D. Horan, and Christopher A. Wolf. "A Model of Incentive Compatibility under Moral Hazard in Livestock Disease Outbreak Response." American Agricultural Economics Association, Providence, RI, July 2005 (http://www.msu.edu/user/gramigbe/papers/Gramig+Horan+Wolf_AAEEA2005.pdf).

Horan, Richard D., and Christopher A. Wolf. "The Economics of Managing Wildlife Disease: Bovine TB in Michigan Deer Populations." American Agricultural Economics Association, Montreal, Canada, July 27-30, 2003.

Horan, Richard D., Christopher A. Wolf, Eli P. Fenichel, and Kenneth H. Matthews, Jr. "Wildlife and Livestock Disease Control with Inter- and Intra-Specific Transmission." American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Johnson, Mara, Lisa J. Rew, Bruce D. Maxwell, Fabian Menalled, William Grey, Matthew Kelty and Deborah McCullough. "Synthesis of the Effects of Forest Health Restoration Activities on Non-Indigenous Plant Species." Poster presentation: *Western Society of Weed Science*, Vancouver, BC, Canada, March 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Control of Invasive Species: Lessons from *Miconia* in Hawaii." Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Integrating Prevention and Control of Invasive Species: Brown Tree Snake." Brown Tree Snake Technical Committee Meeting, Honolulu, HI, April 2005; Western Economic Association Annual Meetings, San Francisco, CA, July 4-8, 2005.

Kaiser, Brooks A., Kimberly Burnett, James A. Roumasset, and Basharat A. Pitafi. "Integrating Prevention and Control of Invasive Species: Lessons from Hawaii." WEA Annual Meetings, Vancouver, BC, Canada, July 2004; Western Agricultural Economic Association Annual Meetings, Honolulu, HI, June 2004; NAREA Invasive Species Workshop, Annapolis, MD, June 14-15, 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Detecting the Invasion Potential of Non-Indigenous Plant Populations." Ecology Seminar Series, Pennsylvania State University, April 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Quantifying Invasiveness of Plant Populations." Poster presentation: *Western Society of Weed Science*, Vancouver, BC, Canada, March 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Detecting Invasiveness of Invasive Plant Species." Poster presentation: *WSSA Abstracts* 45, p. 60, Honolulu, HI, February 2005.

Maxwell, Bruce D., and Lisa J. Rew. "Plant Invasions: How Should We React?" Crown of the Continents Annual Meeting, Kalispell, MT, 2005.

McKee, Gregory J. "Insecticide Resistance and Optimal Invasive Species Management." Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND, September 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Insecticide Resistance, Population Dynamics, and the Economics of Invasive Species Management." Western Agricultural Economics Association, San Francisco, CA, July 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Economics of Greenhouse Whitefly Management: Costs of Esteem Emergency Regulations." Poster presentations: Santa Cruz County Strawberry Grower Field Day, Monterey, CA, February 2005; Ventura County Strawberry Grower Field Day, Ventura, CA, March 2005; California Agricultural Symposium: Challenges and Opportunities, Sacramento, CA, March 2005.

McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Insecticide Resistance and the Economics of Invasive Species Management." Western Agricultural Economics Association, Honolulu, HI, July 2004; Western Economics Association, Vancouver, BC, Canada, July 2004.

Opaluch, James J., James L. Anderson, Kurt Schnier, and Meifeng Luo. "A Risk-Based Approach to Managing the Intentional Introduction of Non-Native Species." Association of Environmental and Resource Economists Workshop, Grand Teton National Park, WY, June 12-14, 2005.

Paarlberg, Philip L., John G. Lee, and Ann Hillberg Seitzinger. "BSE Trade Restrictions and their Impact on Livestock and Products." American Agricultural Economics Association, Providence, RI, July 24-27, 2005.

Peterson, Everett B., Phylo Evangelou, David Orden, and Nishita Bakshi. "An Economic Assessment of Removing the Partial U.S. Import Ban on Fresh Mexican Haas Avocados." American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Pitafi, Basharat A., James A. Roumasset, and Sittidaj Pongkijvorasin. "Management of Renewable Resources Providing Stock Externalities to Other Resource Stocks." WEA Annual Meetings, San Francisco, CA, July 4-8, 2005; Hawaii Conservation Conference, Honolulu, HI, July 2005.

Prestemon, Jeffrey P. "The Forest Product Trade Impacts of an Invasive Species: Modeling Structure and Intervention Trade-offs." Northeastern Agricultural and Resource Economics Association's Economics of Invasive Species Workshop, Annapolis, MD, June 14-15, 2005.

Rew, Lisa J., and Bruce D. Maxwell. "Surveying and Predicting the Occurrence of Non-Native Plant Species." Plant Ecology Seminar, Pennsylvania State University, April 2005.

Rew Lisa J., Bruce D. Maxwell, Mark L. Taper, and Richard Aspinall. "Environmental Suitability Patterns and Scale Effects on Non-Indigenous Species Dispersion." Poster presentation, *WSSA Abstracts 45*, p. 37, Honolulu, HI, February 2005.

Rew, Lisa J., Mara Johnson, and Bruce D. Maxwell. "Wildfire Management Activities and the Potential for Establishment and Spread of Nonindigenous Plant Species." *Western Society of Weed Science*, Vancouver, BC, Canada, March 2005.

Roumasset, James A., and Basharat A. Pitafi. "The Resource Economics of Invasive Species." NAREA Invasive Species Workshop, Annapolis, MD, June 14-15, 2005; WEA Annual Meetings, San Francisco, CA, July 4-8, 2005.

Stranlund, John K. "Info-Gap Inspection." Isenberg School of Management, University of Massachusetts, Amherst, March 11, 2005.

Sumner, Daniel A., Henrich Brunke, and Marcia Kreith. "Costs and Benefits of Government Measures to Control Exotic Pests in California." California Agricultural Symposium: Challenges and Opportunities, Sacramento, CA, March 2005.

Thomas, Michael H. "Evaluating the Decision Process to Restrict Black Carp (*Mylopharyngodon piceus*) in Aquaculture: Using a Decision Protocol with Assurance Bonding for Releasing Potentially Invasive Exotics." World Aquaculture Society, Honolulu, HI, March 1-5, 2005.

Thomas, Michael H., Terrill R. Hanson, and Nick Stratis. "The Use of Environmental Assurance Bonds to Reduce the Establishment and Spread of the Invasive Black Carp." Southern Extension Research Activity, Information Group 30 (SERA IEG-30), Tallahassee, FL, May 19, 2005.

Turner, James A., Shushuai Zhu, and Jeffrey P. Prestemon. "Modeling the Impact of Exotic Pests on the New Zealand Forest Sector and its Major Trading Partners." IUFRO World Congress, Brisbane, Australia, August 8-12, 2005.

Wainger, Lisa A. "Comparing Cost, Risk, and Benefit Trade-offs Under Uncertainty: Cheatgrass Case Study." Bureau of Land Management, Boise, ID, August 24, 2005.

Wainger, Lisa A., Richard N. Mack, Elizabeth W. Price, and Dennis M. King. "Evaluating Economic Risk from Invasive Species and Prioritizing Restoration." International Plant Health Risk Analysis Workshop, Niagara Falls, NY, October 24-28, 2005.

Zhao, Zishun. "Modeling the Impacts of Alternative Invasive Species Management Policies on Perennial Fruit Production and Consumption." Pacific Northwest Regional Economic Conference, Bellingham, WA, May 19-20, 2005.

Zhao, Zishun. "Modeling the Effects of Alternative Invasive Species Management Policies." Presentation: Centers for Epidemiology and Animal Health, Veterinary Services, APHIS, USDA, Fort Collins, CO, November 11, 2004.

Zhao, Zishun, Thomas Wahl, and Ricardo Diaz. "Modeling the Impacts of Alternative Invasive Species Management Policies on Livestock Production." American Agricultural Economics Association, Denver, CO, August 1-4, 2004.

Zhao, Zishun, Thomas Wahl, and Ricardo Diaz. "Modeling the Impacts of Alternative Invasive Species Management Policies on Perennial Fruit Production and Consumption." Western Agricultural Economic Association Annual Meeting, Honolulu, HI, June 30-July 3, 2004.

Zhao, Zishun, Thomas Wahl, and Thomas Marsh. "The Government's Role in Stabilizing Beef Supply When BSE Strikes." World Trade Organization Impacts on U.S. Farm Policy, New Orleans, LA, June 1-3, 2005.

Zhao, Zishun, Thomas Wahl, and Thomas Marsh. “Modeling the Impacts of Alternative Invasive Species Management Policies on Livestock Production with an Implementation of Foot-and-Mouth Disease in the U.S. Beef Cattle Industry.” NAREA Workshop on Invasive Species, Annapolis, MD, June 14-15, 2005.

Theses

Fenichel, Eli P. *Bioeconomic Models of Bovine Tuberculosis in Michigan White-Tailed Deer: An Analysis of Ecological Thresholds and Economic Tradeoffs in Wildlife Disease Management*. M.S. Thesis, Department of Agricultural Economics, Michigan State University, 2005.

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