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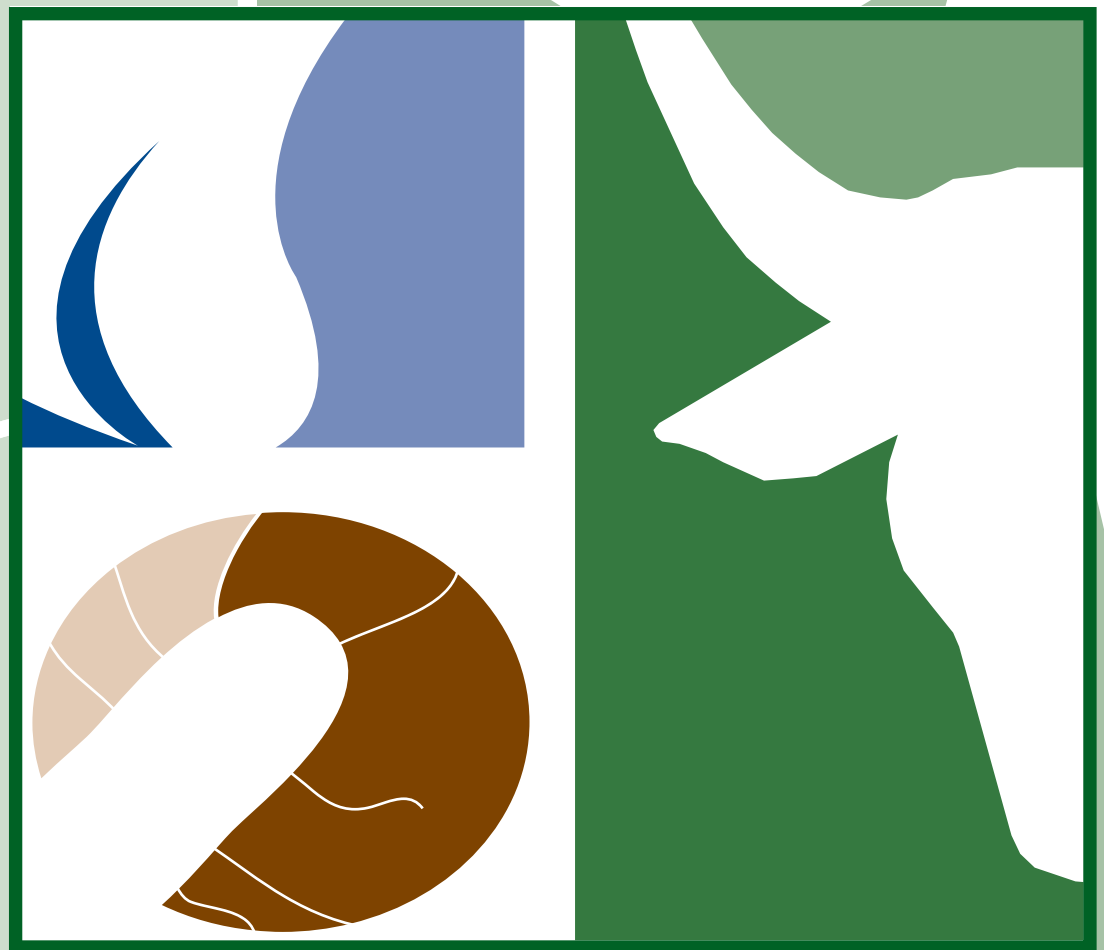
United States
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Agriculture



Economic
Research
Service

Program of Research on the Economics of Invasive Species Management

Fiscal 2003-2011 Activities



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Program of Research on the Economics of Invasive Species Management

Fiscal 2003-2011 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 threat, 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 approaches (such as monitoring, eradication, containment, or long-term areawide management programs) should be used?
- When and where should each approach be used?
- What type of practices (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 to support economic research contributing to 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 decisionmaking.

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

ERS seeks to build national capacity for analysis of USDA invasive species program management through extramural research and internal capacity development through PREISM. PREISM allocated \$6.82 million in fiscal years 2003-08 through its competitive extramural program: \$1.6 million in fiscal year 2003; \$1.1 million each in 2004, 2005, and 2006; \$950,000 in 2007; and \$970,000 in 2008. In addition, PREISM allocated \$640,000 over fiscal years 2003-2008 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. Extramural funding for competitive and commissioned research totaled about \$7.46 million. Funding for intramural research 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 were 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 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, renamed the National Institute of Food and Agriculture, NIFA, in 2008) 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, NIFA, 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. 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 researchers have begun developing a series of economic briefs summarizing 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 addressed several USDA program needs.

National Academy of Sciences Review of Light Brown Apple Moth Classification. APHIS and the State of California initiated quarantine and eradication of light brown apple moth (LBAM) populations after detection in 2007. Objections to the quarantine/eradication effort were raised by many homeowners and some researchers. Two groups petitioned USDA and California to declassify LBAM as an actionable pest subject to quarantine and eradication. In response, APHIS requested the National Academy of Sciences to review the classification. Of the 10 experts on the review panel, four were associated with PREISM-funded projects: all three economists—Sean Cash (University of Wisconsin), Rachael Goodhue (University of California, Davis), and L. Joe Moffitt (University of Massachusetts)—and forest entomologist Robert Venette (FS). The expert panel criticized aspects of APHIS analysis, communication, and response, but concluded that APHIS was within its authority to classify LBAM as an actionable pest, in a report released on Sept. 14, 2009 (<http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12762>). APHIS responded to the report, requested public comments, retained the actionable pest classification, determined that eradication was infeasible, but maintained a control program (http://www.aphis.usda.gov/plant_health/plant_pest_info/lba_moth/index.shtml).

Integrating Invasive Species Prevention and Control Policies. Previous research recognizes the interdependence of policies designed to limit the introduction of invasive species (prevention) and those designed to reduce or eradicate domestic populations of invasive species (control), as well as the practicality of designing such policies simultaneously and harmoniously. This ERS study <<http://www.ers.usda.gov/Publications/EB11/>> synthesizes recent PREISM-funded and other research, highlighting the information and data required when developing policies (for government decisionmakers) or deciding on a course of action (for agricultural producers and homeowners). Especially important to consider are the biological characteristics of the invasive species, ecological characteristics of potentially invaded agroecosystems, the relative costs and benefits of prevention and control policies, the ways in which the actions of regulators and citizens combine to influence management outcomes, and whether the costs of prevention are borne domestically or abroad.

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 developed a general framework to analyze the value of pest surveillance information and applied it to 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 (Virginia Tech) 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, pairwise 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.

APHIS Outreach. ERS, with assistance from the Farm Foundation, supported briefings and other activities to inform APHIS staff about the implications of PREISM-funded studies for invasive species programs and ways to improve analyses for decisionmaking:

- **APHIS Livestock Compensation Symposium:** Keith Coble (Mississippi State University), Ben Gramig (Purdue University),

and Chris Wolf (Michigan State University) discussed results of PREISM-funded projects at the Veterinary Services' (VS) Centers for Epidemiology and Animal Health Symposium and Workshop on Livestock Compensation, organized by Stephen Ott, on July 23, 2010. Other speakers included Barry Barnett (Mississippi State University) and Tom Vukina (North Carolina State University), while William Hahn represented ERS. The symposium was a video conference that included VS headquarters and its eastern regional office.

- **Emerald Ash Borer:** Jonathon Bossenbroek (University of Toledo) presented a seminar on the findings of his PREISM-funded project addressing emerald ash borer control at APHIS' Center for Plant Health, Science, and Technology (CPHST) in Raleigh, NC, on Dec. 9, 2009. He met with program specialists after the presentation.
- **Sanitary Regulations for U.S. Livestock and Germplasm Exports:** On November 18, 2009, Philip Paarlberg (Purdue University) presented "Costs of Regulations Facing U.S. Cattle, Swine, and Ovine Exports" to APHIS staff at Riverdale, MD. He discussed the results of his PREISM-funded collaboration with Ann Hillberg Seitzinger (APHIS/VS) to develop a database of sanitary regulations for live animal and germplasm exports and to evaluate the costs.
- **Economic Modeling:** Caesar Cororaton, at Virginia Tech, conducted a 1-day training session for selected Policy and Program Development staff on economic modeling on June 19, 2009, as well as followup training sessions (under a cooperative research agreement between Virginia Tech and APHIS). The training material was based on the avocado pest risk and mitigation model that Everett Peterson and David Orden developed, with PREISM support (http://www.gii.ncr.vt.edu/docs/Training_materials_Avocado_Model_2009.pdf).
- **Decision Support Modeling:** Craig Osteen and Utpal Vasavada, from ERS, served on the APHIS/CPHST expert panel convened to review "Economic Models for Decision Support" developed for the APHIS Administrator, from December 2008 to February 2009. The panel also included economists and scientists from APHIS, the Office of the Chief Economist (OCE), and ORACBA.

ERS Data Products

ERS analyzed data and assembled products that can be used for analysis of import rules, regulations, and other policies related to the prevention and management of invasive species.

Phytosanitary Regulation of Fresh Fruit and Vegetable Imports into the United States. ERS publishes an annual data set on its website at <http://www.ers.usda.gov/Data/FruitVegPhyto/> that identifies which countries, under the phytosanitary rules of USDA's Animal and Plant Health Inspection Service, are eligible to export to the United States the fresh fruits and vegetables that are most important in the American diet. Data on the absolute and relative importance of these countries in international production and trade, individually and in aggregate, are also included. Having access to information on countries that are eligible to export these products to the United States can

underpin analyses of the market effects of existing import rules and potential changes in these rules. This data product can also facilitate economic analyses of other programs and policies related to trade in fresh fruits and vegetables that are of interest to market participants, international trade and standards organizations, and development agencies. The data product was featured in the April 2008 issue of *Amber Waves* (<http://www.ers.usda.gov/amberwaves/april08/datafeature/>).

ERS Elasticities Database. The ERS website < <http://www.ers.usda.gov/Data/Elasticities/> > provides price and income elasticities of demand for a large number of commodities and foods from academic and government studies that can be used in economic research and analysis. In addition, 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.

Potential Policy and 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.

Foreign Animal Diseases. This project, led by Philip Paarlberg at Purdue University in collaboration with Ann Hillberg Seitzinger, APHIS-VS, 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. This study examines the consequences of regulations facing bovine, porcine, and ovine exports from the United States by integrating searchable databases of trade regulations with the quarterly U.S. agricultural sector model developed under a previous PREISM project. This research complements earlier PREISM-funded research by focusing on economic impacts of livestock disease-related regulations facing U.S. exports. The project demonstrates the use of the quarterly U.S. agricultural sector model to assist in prioritizing bovine, porcine, and ovine regulations facing U.S. exports.

Bovine tuberculosis. Chris Wolf and Richard Horan at Michigan State collaborated with Philip Paarlberg's team at Purdue to analyze bovine tuberculosis eradication program options for APHIS/Vs personnel. The analysis combined models from two PREISM projects: Horan and Wolf's models of disease spread and economic consequences, and the Paarlberg team's model of welfare effects, which was particularly useful in assessing the trade implications of disease spread and the loss of disease-free World Organization for Animal Health (OIE) accreditation. The analysis considered interactions between cattle herds and deer populations and the effects of imported Mexican cattle.

Risk of Invasive Plants in North America. Duncan Knowler and Sarah Reichard, co-investigators on Edward Barbier's project at the University of Wyoming, provided technical information about the economic and ecological risks of invasive plants to the North American Plant Protection Organization (NAPPO). Duncan Knowler is an expert panel member of a

technical working group convened to review elements of the NAPPO process. Sarah Reichard reviewed and provided comments in the preparation of the “Screening Imported Plants for Invasiveness” discussion paper to the Invasive Alien Species Technical Advisory Group of NAPPO.

Controlling Buffelgrass in Arizona. Members of George Frisvold’s team at the University of Arizona actively participated in efforts to provide information about buffelgrass issues and control efforts to public and private organizations. The team members participate in the Buffelgrass Working Group that provided much of the interagency planning for the buffelgrass control effort in Pima County, Arizona. They provided technical support on the role of economics in designating priority treatment areas to the Southern Arizona Buffelgrass Coordination Center’s Tucson Basin Buffelgrass Assessment (<http://216.104.181.187/drupal-6.16/sites/default/files/Final%20Tucson%20Basin%20Report%200526-2010.pdf>). Also, the team provided technical advice and text for Congressional Appropriations filed by the Arizona-Sonora Desert Museum and were contributors for the publication, “Southern Arizona Buffelgrass Strategic Plan,” (http://www.desertmuseum.org/invaders/splan/buffelgrass_strategic_plan.pdf).

Emerald Ash Borer in Ohio. Davis Sydnor and Sakthi Subburayalu, members of Jonathan Bossenbroek’s team at the University of Toledo, met with community volunteers in 2008 in Xenia and in Monclova Township, Ohio, to provide tools for data collection and explain plant identification techniques to inventory public street trees. The appropriate identification technique helped home owners and urban planners inventory trees for better management of tree resources and emerald ash borer. Additionally, in Lucas County, Bossenbroek’s team is mapping ash trees using ortho photos, soil survey data, and other data. The team also produced a summary report evaluating the economic costs and benefits of slowing the spread of the emerald ash borer.

Managing White Pine Blister Rust in High-Elevation Forests. This research team, led by Craig Bond at Colorado State University (CSU), actively participates in the Central Rocky Mountains White Pine Health Working Group. The Working Group is the coordinating committee of researchers and regulatory, outreach, and management professionals who address such white pine health issues as the spread, intensification and impacts of white pine blister rust over large landscapes. Team members Dr. William Jacobi, a forestry pathologist at CSU, and Dr. Anna Schoettle, an ecophysiologist with the U.S. Forest Service, are part of the Working Group leadership. In addition to CSU and FS, participants include Federal and State agencies such as the National Park Service, Colorado State Forest Service, and the Washington Department of Natural Resources, and universities, such as the University of Colorado, University of Wyoming, and Oregon State. The group meets annually in Ft. Collins, CO, to involve stakeholders in planning research and management priorities related to high-elevation forests, including input into model updates and management options. To date, four separate presentations reported PREISM-supported research results and solicited feedback. In addition, many team members participated in The High-Five Symposium: The Future of High-Elevation Five-Needle White Pines in Western North America, June, 2010, in Missoula, MT.

Managing Oak Wilt in the North Central States. Frances Homans's team at the University of Minnesota modeled the spread of the oak wilt fungus on a spatially heterogeneous landscape to predict tree mortality and resulting economic costs in the Midwest. The North Central States Oak Wilt Task Group—comprising representatives from Departments of Natural Resources in States where oak wilt is an issue (MN, MI, WI, TX, and CO)—see this research as a valuable contribution to their efforts to manage the spread of this invasive pest. Robert Venette, a member of the research team, is a standing member of the Oak Wilt Task Force and communicated project updates. The analysis of oak wilt spread revealed a greater economic impact from oak wilt than managers had realized. Managers intend to use these results as a focal point for educational campaigns to local governments and landowners. In addition, the research team is drafting a white paper for the Oak Wilt Task Force and other managers concerned about oak wilt. The team also provided information during a regional stakeholder meeting/webcast organized by the State and Private Forestry division of the U.S. Forest Service.

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 effects of plants on diverse National Forest management objectives. The invasive species probability of occurrence maps produced for PREISM were incorporated into the Hebgan Lake District of the Gallatin National Forest Transportation Plan, as well as the grazing management plan, 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. The Nature Conservancy adopted, in 2006, invasive species inventory/survey methods developed by the team for use on two of their landholdings in Montana. Gallatin and Park Counties in Montana have also incorporated the methods of inventory/survey and monitoring of invasive plant species. These maps and predictive models are available online at: <http://tansy.msu.montana.edu/NCSSF/ncssf.phtml?ViewRegion=422900,90608,513960,158303>.

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 cheatgrass—an 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 organized to better characterize benefits from agro-ecosystems and identify potential 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 invited Munisamy Gopinath (Oregon State University) and Bruce Maxwell (Montana State University) 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, 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. 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.

Crop Insurance, Hurricanes, and Citrus Canker. A University of California-Davis project, led by Daniel Sumner, examined 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.

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 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.

Journal of Environment Management. The December 2008 special issue of this journal compiled papers focusing on the economics of invasive species prevention and management. Of the seven articles in the issue, two reported findings from PREISM-funded research projects. Moffitt et al. designed an economic model for robust border inspection protocols that address the uncertain introduction of invasive species, while Grimsrud et al. used a bioeconomic model to examine incentives for ranchers to manage yellow starthistle.

Journal of Agricultural & Applied Economics. The October 2007 special issue of this journal includes papers focused on the economic impact of invasive species in tropical and subtropical regions. Of the 11 articles in the issue, 4 reported findings from PREISM-funded extramural research projects, while another reported findings of ERS intramural research. In general, this issue examined the economic effects of invasive species in the public and private sectors, evaluation of management strategies, and the application of models to invasive species problems.

New Approaches to the Economics of Plant Health. This book, edited by Alfons Oude Lansink and published 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.

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 include 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.

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.

Workshop on Invasive Species Management. On October 9, 2007, Michigan State University held a workshop that presented a number of economic and biological modeling studies of invasive species management. Four PREISM-funded researchers participated in the workshop—Carolyn Fischer, Brooks Kaiser, David Finnoff, and Rick Horan.

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.

Chapter 2

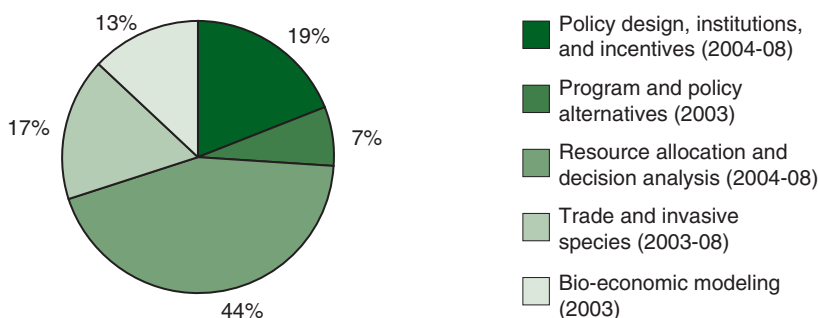
Extramural Research Funding, Fiscal Years 2003-2008

In fiscal years 2003-08, PREISM requested proposals focusing 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 identified priority research areas developed in consultation with agencies concerned with invasive species problems, including APHIS, ARS, FS, ORACBA, and OBPA. Priority research areas changed each year to address new issues identified in the 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.

PREISM funded 45 projects through its competitive award program from 2003 to 2008. In addition, PREISM commissioned eight 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. Study topics included 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. Some projects will continue through 2011, and many projects continue to generate publications after all research funding is spent.

PREISM competitive funding by priority research area, fiscal years 2003-08*



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

Source: USDA, Economic Research Service, based on PREISM data.

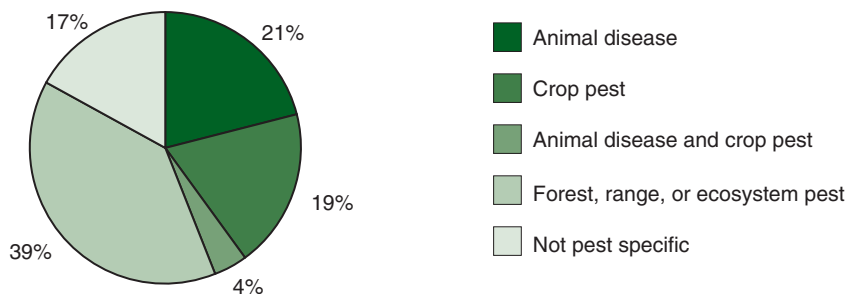
There were five major priority research areas in PREISM’s history, although emphases and names changed from year to year:

- “Policy Design, Institutions, and Incentives for Efficient Invasive Species Prevention and Management” from 2004 to 2008 (called “Institutions, and Incentives for Efficient Invasive Species Prevention and Management” in 2005-06 and “Stakeholders and Incentives for Efficient Invasive Species Prevention and Management” in 2004);
- “Resource Allocation and Decision Analysis for Invasive Species Management” from 2004 to 2008 (called “Allocation of Government Resources for Efficient Invasive Species Prevention and Management” in 2007-08, “Practical Decision Analysis for Invasive Species Management” in 2005-06, and “Practical Decision Tools for Invasive Species Management” in 2004);
- “Trade and Invasive Species” from 2003 to 2007 (called “International Dimensions of Invasive Species Management” in 2005-08);
- “Resource Implications of Invasive Species Program and Policy Alternatives” in 2003; and
- “Bio-Economic Integration and Risk Assessment” in 2003.

Many studies can fit in more than one category. For example, even though “Bio-Economic Integration and Risk Assessment” (bio-economic modeling in the chart) was discontinued after 2003, many studies under other categories include bio-economic modeling to address a problem. Policy design or resource studies can address trade and invasive species issues, as well.

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 6 years of the program, about 39 percent of the funds were allocated to projects addressing issues related to invasive species of forests, rangeland, and ecosystems; 21 percent to projects addressing animal diseases; 19 percent to projects addressing crop pests; and 4 percent to projects addressing both animal disease and crop pest cases. Approximately 17 percent of funds were allocated to projects addressing border inspection, trade policy, risk assessment, and conceptual topics that are not pest-specific.

PREISM competitive funding by pest type, fiscal years 2003-08



Source: USDA, Economic Research Service, based on PREISM data.

Chapter 3

Extramural Research Activities, Fiscal Years 2003-2008

Priority Research Areas, Fiscal Years 2007-08

In fiscal years 2007 and 2008, ERS requested economic research proposals in two areas of importance to USDA's invasive species policies and programs.

Efficient Prevention and Management of Invasive Species

Projects in this area adapted and applied economic and data management strategies and techniques to aid, guide, and inform government agencies' decisions and actions related to invasive species prioritization, resource allocation, detection, monitoring, management, and regulation. Also, some projects examined the interactions between the public and private sectors in preventing and managing 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. Two relevant topics were: "Allocation of Government Resources for Efficient Invasive Species Prevention and Management," and "Program, Policy, and Institutional Design To Encourage Private Sector Invasive Species Prevention and Management." Some general questions included:

- How can economic concepts, methods, and models be applied to invasive species prevention and management decisions and the allocation of government resources?
- How can government evaluate alternative policy decisions, regulations, and research investments in a more useful and timely manner, in spite of methodological challenges?
- What is the effect of program, policy, and institutional design on private sector invasive species prevention and management decisions, and how do private sector responses affect the outcomes of government actions?

International Dimension 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 transboundary 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 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 regulations that affect trade. The World Trade Organization, North American Free Trade Agreement, 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 focused on economic evaluations of trade-related invasive species risks, as well as firm-level, national, and international strategies for controlling these risks. Two relevant topics were: “Government and Firm Responses to Trade-Related Invasive Species Risk and Policies,” and “Economic Analysis of International Public Goods Related to Invasive Species Management.” Some general questions included:

- What are the effects of trade-related invasive species risks and policies on government and firm-level decisions?
- What are the effects of public enforcement of trade-related invasive species regulations?
- What are the international public goods of invasive species prevention and management and what arrangements might facilitate their provision across international boundaries?
- How can economic analysis and risk assessment be integrated for pest and disease exclusion decisions?

Table 1

PREISM competitive awards, fiscal year 2008

Research Project	Objective	Award
<i>Efficient Prevention and Management of Invasive Species</i>		
Cost-Sensitive Machine Learning Algorithms for Invasive Species Decision Support, Risk Analysis, and Policy John Drake <i>University of Georgia</i>	Develop cost-sensitive decision support tools to aid risk analysis of potentially invasive, imported ornamental plant species, using information about taxonomy, ecology, and biological features gained prior to importation. Use the characteristics of successful plant invaders and the potential economic effects of such invasions to develop algorithms and visual decision trees that aid risk classification.	\$173,000
Economics of Discovery Alternatives for Emerging Animal Diseases L. Joe Moffitt <i>University of Massachusetts</i>	Investigate the structural characteristics of a surveillance network for emerging animal diseases that will be most robust in early discovery of unknown or undetected diseases while adhering to performance and cost criteria. Address network structure, speed of information flow, and the effects of severe uncertainty about disease spread and surveillance networks.	\$147,000
Efficient Management of White Pine Blister Rust in High-Elevation Ecosystems: A Dynamic Modeling Approach Craig Bond <i>Colorado State University</i>	Analyze economic tradeoffs of proactive and reactive management strategies for white pine blister rust in high-altitude, non-timber pine forests. Consider nonmarket values and attitudes of recreational users when evaluating management options for affected and threatened areas.	\$178,000
Institutional Design for Resource Allocation and Risk Sharing Among Private and Public Sector Agents To Manage Invasive Grasses and Wildfire in the Great Basin Kimberly Rollins <i>University of Nevada, Reno</i>	Examine contractual mechanisms to encourage ranchers to preemptively manage weeds, such as cheatgrass, that induce wildfire in the Great Basin. Investigate tradeoffs between preemptive and restorative weed management policies, and efficiency gains from coordinating allocation of weed and wildfire risk management resources across multiple agencies and private entities.	\$178,000
Market-Based Instruments for the Optimal Control of Invasive Insect Species: <i>B. Tabaci</i> in Arizona Timothy J. Richards <i>Arizona State University</i>	Compare mechanisms, such as Pigouvian taxes, marketable invasion permits, and performance bonds, that could encourage growers to use integrated pest management to combat a potential pest invasion, focusing on the pesticide-resistant whitefly on Arizona cotton. Estimate relationships between infestations, crop yield and quality, and control costs to achieve a pest population level below acceptable injury levels.	\$124,000
<i>International Dimensions of Invasive Species Management</i>		
Risk Factors for Invasive Pest Introductions in Commodity Imports Erik Lichtenberg and Lars Olson <i>University of Maryland</i>	Investigate the effect of alternative phytosanitary policies, such as pre-clearance, pre-treatment requirements, and World Trade Organization (WTO) notifications, on invasive pest risks in imports and the implications for allocating surveillance resources. Analyze risk factors for pest introductions in imports of fruits and vegetables, cut flowers, and propagative plant materials, using APHIS inspections data and information on phytosanitary policy from the U.S. Code of Federal Regulations and the WTO notification database.	\$172,000

Table 2

PREISM competitive awards, fiscal year 2007

Research Project	Objective	Award
<i>Efficient Prevention and Management of Invasive Species</i>		
Efficient Institutions for Encouraging Private Sector Cooperation in Preventing Unintended Imports of Invasive Species in Agricultural Commodities Linda Fernandez and Glenn Sherif <i>University of California-Riverside and Columbia University</i>	Examine mechanisms that may prevent the import of invasive species in agricultural commodities by encouraging foreign, private-sector exporters to reveal information about the presence of invasive species in cargo. Such mechanisms include random inspections, compensatory payments, early warning systems, and offshore preclearance. The research method is applied game theory, deriving perfect Bayesian equilibria for dynamic games of asymmetric information between a government agency and a group of private exporters with information hidden from the agency.	\$196,000
Economic Efficiency and Equity of Alternative Government Programs for Invasive Species: A Decision Model of Government Action for Avian Influenza and Exotic Newcastle Disease in Poultry Keith Coble <i>Mississippi State University</i>	Conceptually and empirically evaluate circumstances under which government agencies could use indemnification, insurance, and/or assistance with management programs to address animal disease outbreaks, focusing the analysis on avian influenza and exotic Newcastle disease in poultry. The researchers are using a moral hazard model of behavior, subjective probabilities from industry experts and producers, and anticipated economic costs of infestation to delineate government responses and simulate likely outcomes.	\$180,000
Encouraging Cooperation Between Commercial Producers and Residential Users of an Invasive Species Host: Designing Collective Pest Management Institutions for the Olive Fruit Fly in California Rachael Goodhue <i>University of California-Davis</i>	Use a bio-economic model to examine the economic efficiency of alternative management strategies for the olive fruit fly, a pest spreading in California. The project considers pest mobility between commercial groves, abandoned groves, and ornamental trees on public and private property, as well as markets for olives and olive oil. The researchers also examine the incentives that regional organizations create for homeowners and commercial growers to effectively manage pests.	\$175,000
Micro-behavior and the Spatial-Dynamics of Invasions James Wilen <i>University of California-Davis</i>	Develop spatial-dynamic models of bioinvasions linked to spatially explicit economic models of agent behavior for people whose land is invaded or about to be invaded by weeds. The researchers use the models to identify optimal patterns and the extent of control efforts for yellow starthistle in California, and evaluate institutions or incentives for optimal levels, location, and timing of control. Ranchers, public agencies, and road managers are surveyed to characterize factors influencing land managers' control decisions.	\$135,000
Efficient Management Strategies for a Contagious Animal Disease Outbreak: Probability Distributions of Economic Impacts from Foot-and-Mouth Disease Dustin Pendell <i>Colorado State University</i>	Analyze the selection of economically efficient contingency plans for control and management of foot-and-mouth disease, given probability distributions of economic value from alternative plans. The research team determines the study region beyond which 95 percent of outbreaks would not spread, estimates the effects of disease outbreaks under alternative scenarios with disease spread models, develops distributions of welfare measures with an equilibrium displacement model, and shows preferred strategies by analyzing the distributions of welfare measures using stochastic efficiency with respect to a function.	\$142,000
<i>International Dimensions of Invasive Species Management</i>		
Prioritization of Sanitary Restrictions Facing U.S. Exports of Bovine, Porcine, and Ovine for Determination of Surveillance Needs Philip Paarlberg <i>Purdue University</i>	Quantify the effects of sanitary requirements facing U.S. exports of live animals, breeding stock, and germplasm, and prioritize disease surveillance efforts for export purposes. The researchers use an export requirements database developed by APHIS, a quarterly U.S. agricultural sector model focusing on livestock, and results of other economic studies. APHIS epidemiologists collaborating with the project evaluate its scientific merit and the probability of sanitary barriers being imposed.	\$121,000

Priority Research Areas, Fiscal Year 2006

In fiscal year 2006, 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 and implementation of invasive pest programs and policies, and the development of methods to evaluate invasive species strategies under tight deadlines. “International Dimensions of Invasive Species” 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 3

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 solves a dynamic programming problem with user inputs and provides 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 project examines such diseases as bovine tuberculosis, brucellosis, and Johne'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 are estimating the current distribution and spread rate of emerald ash borer, the economic value of ash trees, and economic losses due to the pest. They 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 identify efficient strategies for a wide variety of weed species. The researchers 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 uses information on the spatial distribution of weeds, the dynamics of weed growth and spread, and the cost-effectiveness of control methods. It is being applied in the Bitterroot and Nez Perce National Forests and incorporates Forest Service priorities and resource constraints.	\$209,000

Table 3

PREISM competitive awards, fiscal year 2006—Continued

Research Project	Objective	Award
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 use an integrated epidemiological-economic model and 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 Decisionmaking 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 is being applied to oak wilt in Minnesota, with the results compared to current practices.	\$106,000
<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 derives theoretically consistent welfare measures for estimating the economic effects and develops a dynamic bio-economic model of livestock and invasive species that includes the U.S., Canada, Mexico, and Australia. The study focuses 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 are 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 builds a knowledge base for understanding which food and hazard pairings most frequently occur. Results and policy implications are 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

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 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 4

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 incorporates a port selection problem for both inspectors and export firms.	\$132,000

Table 4

PREISM competitive awards, fiscal year 2005—*Continued*

Research Project	Objective	Award
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' sanitary and phytosanitary (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
<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 sanitary and phytosanitary (SPS) regulations, as they relate to invasive species, for selected products in international trade of interest to U.S. stakeholders. Since such regulations must be obtained from the importing countries, the compilation in a common format facilitates 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, applies the model to case studies in the cattle sector, and develops 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 the effect 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 5

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 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 provide expert opinion and serve 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

Table 5

PREISM competitive awards, fiscal year 2004—Continued

Research Project	Objective	Award
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” focused on 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” encouraged 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 6

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 developed 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 considered 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>The Economics of Trade and Invasive Species</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 employed 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

Table 6

PREISM competitive awards, fiscal year 2003—*Continued*

Research Project	Objective	Award
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 was 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 addressed 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
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 examined the role of human alteration of landscapes in invasive species diffusion and assesses the potential for spatial databases to be used in an analysis of invasions and their potential irreversibility.	\$175,000
Feasibility of Indemnification and Checkoff-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 included 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 examined 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 among prevention, control, and eradication efforts as elements of invasive species policies. This study employed a dynamic optimization framework that incorporates ecological conditions, potential economic damages, and costs of prevention and control.	\$119,000

Table 6

PREISM competitive awards, fiscal year 2003—Continued

Research Project	Objective	Award
<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 examined 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 <i>University of Arizona</i>	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 2003-11

The following is a list of outputs from projects funded by PREISM. 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, 208 pp., 2007.

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.

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- Gramig, Benjamin M., and C. Wolf. “Estimating Within-Herd Preventive Spill-overs in Livestock Disease Management.” Principal paper, annual meetings of the American Agricultural Economics Association, Portland, OR, July 2007.
- Gramig, B., R. Horan, and C. Wolf. “Using Livestock Disease Indemnification Policy to Align Public and Private Incentives.” Alternative Methods for Livestock Compensation Workshop. USDA-APHIS. Fort Collins, CO. July 23, 2010.
- Grannis, Jennifer, Kamina Johnson, Ann Hillberg Seitzinger, Philip L, Paarlberg, and John G. Lee. “Mitigation Trade Disruptions due to Disease Outbreaks in Integrated US and Canadian Swine and Pork Markets.” Western Agricultural Economics Association, Anchorage, AK, June 28-29, 2006.
- Grimsrud, Kristine, Janie Chermak, Jason Hansen, Jennifer Thacher, and Kate Krause. “A Two-Agent Dynamic Model with an Invasive Weed Diffusion Externality: An Application to Yellow Starthistle (*Centaurea Solitialis*) in New Mexico.” Southern Economics Association Annual Conference (AERE Session), Washington, DC, Nov. 2008.
- Grimsrud, Kristine, Janie Chermak, Kate Krause, and Jennifer Thacher. “A Game Theoretic Model of Rancher Responses to Diffusing Weed Infections,” AAEA & ACCI 2009 Joint Meeting, Milwaukee, WI, July 26-28, 2009.
- Grimsrud, K., J. Chermak, J. Hansen, J. Thacher, and K. Krause. “A Two-Agent Dynamic Model for an Invasive Weed: Can an Invasive Species Problem be Nipped in the Bud?” Southern Economic Association Annual Meeting, Washington, DC, Nov. 20-23, 2008; Southwestern Economic Association Annual Meeting, Albuquerque, NM. March 16, 2007.
- Gwatipedza, Johnson, and Edward B. Barbier. “A General Monopolistic Competition Economic Model of the Horticultural Industry with a Risk of Harmful Plant Invasion.” Paper presented at the Western Economic Association International 83rd Annual Conference, Waikiki, HI, June 29-July 3, 2008.

Haight, R., S.V Mehta, T. Horie, D.J. Smith, R.C. Venette, F.R. Homans, and A.J. Walter. "An Economic Impact Assessment for Oak Wilt in Anoka County, Minnesota." *20th U.S. Department of Agriculture interagency research forum on invasive species*, 2009, Katherine A. McManus and Kurt W. Gottschalk, eds., January, 13-16, 2009, Annapolis, MD, Gen. Tech. Rep. NRS-P-51, p. 31, U.S. Department of Agriculture, Forest Service, 2009.

Horan, Richard D. "Economics and Ecology of Managing Infectious Animal Diseases." Invasive Species Workshop, Michigan State University, Oct. 9, 2007.

Horan, Richard D. "Economics of Managing Infectious Wildlife Disease When Livestock Are at Risk." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.

Horan, Richard D., and Eli P. Fenichel. "Managing Infectious Wildlife Disease Based on Marginal Analysis." Presented at the Ecological Society of America meetings, San Jose, CA, Aug. 2007; Workshop analyzing the role of agricultural transformation and invasive species in disease emergence, sponsored by BESTnet (Biodiversity and Ecosystem Services Training Network), Diversitas, and AgTrans, June 2008.

Horan, Richard D., and Eli P. Fenichel. "Economics and Ecology of Managing Emerging Infectious Animal Diseases." Principal paper, presented at the annual meetings of the American Agricultural Economics Association, Portland, OR, July 2007.

Horan, Richard D., and Eli P. Fenichel. "A Bioeconomic Approach to Managing Multiple-Host Wildlife Diseases." Presented at the Department of Agricultural Economics and Rural Sociology, The Pennsylvania State University, Feb. 9, 2007.

Horan, Richard D., and Eli P. Fenichel. "Ecological Thresholds, Economic Trade-offs, and Targeting to Control Wildlife Disease: A Case Study of Bovine Tuberculosis in White-Tailed Deer." Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, Nov. 11, 2005.

Horan, R.D., and R.T. Melstrom, "No Sympathy for the Devil: Comparing Test-and-Removal versus Test-and-Translocation Strategies for Disease Management." World Congress of Environmental and Resource Economists, Montreal, Canada, June 2010.

Horan, Richard D., Jason F. Shogren, and Benjamin M. Gramig. "Wildlife Conservation Payments to Address Habitat Fragmentation and Disease Risks." American Agricultural Economics Association, Long Beach, CA, July 2006.

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, Aug. 1-4, 2004.
- Horan, R.D. and A. Xepapadeas, "Coevolution of Livestock Diseases and Management Choices." Workshop of the National Institute for Mathematical and Biological Synthesis (NIMBioS) working group for Synthesizing and Predicting Infectious Disease while Accounting for Endogenous Risk (SPIDER), Montreal, Canada, June 2010.
- Horie, Tetsuya, "Optimal Strategies for Surveillance and Control of Invasive Forest Pathogens." 1st Congress of East Asian Association of Environmental and Resource Economics, Hokkaido University, Sapporo, Japan, Aug. 18-19, 2010; 52nd Annual Conference on Great Lakes Research, Toledo, OH, May 2009; Annual Conference of the Society for Environmental Economics and Policy Studies, Japan, Sept. 2009.
- Horie, Tetsuya, and Frances Homans. "Optimal Detection Strategies for an Established Invasive Forest Pest." Selected paper, American Agricultural Economics Association Annual Meetings, Portland OR, 2007 (<http://purl.umn.edu/9695>).
- Iverson, Louis R., A. Prasad, J. Bossenbroek, D. Sydnor, and M. Schwartz. "Modeling Potential Movements of a Ash Threat: The Emerald Ash Borer." Advances in Threat Assessment and Their Application to Forest and Rangeland Management Conference, Boulder, CO, July 2006.
- Iverson, Louis R., A. Prasad, J. Bossenbroek, D. Sydnor, and M. Schwartz. "Modeling potential movements of a killer: the emerald ash borer." International Association for Landscape Ecology, San Diego, CA, Mar. 2006.
- Iverson, Louis R., A.M. Prasad, D. Sydnor, J.M. Bossenbroek, and M.W. Schwartz. "Modeling potential EAB spread through GIS/cell-based/gravity models with data bolstered by web-based inputs." Emerald Ash Borer (EAB) Annual Review and Research Planning Session, Pittsburgh, PA, Sept. 15, 2005.
- Jayasinghe, Sampath, John Beghin, and Giancarlo Moschini. "Determinants of World Demand for U.S. Corn Seeds. The Role of Trade Costs." Selected paper, American Agricultural Economics Association Meetings, Orlando FL, July 27-29, 2008; presentation at the University of Sydney Agricultural Economics workshop, April 9, 2008.
- 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. "Spatial Consideration for Economic Analyses of Invasive Species." Invasive Species Workshop, Michigan State University, Oct. 9, 2007.

Kaiser, Brooks A. "Spatial Economic Analysis of Early Detection and Rapid Response Strategies for an Invasive Species." Environmental Protection Agency's Valuation for Environmental Policy: Ecological Benefits Workshop, Washington, DC, April 23-24, 2007 (<http://yosemite.epa.gov/ee/epa/erm.nsf/vwRepNumLookup/EE-0505?OpenDocument>).

Kaiser, Brooks A. "Searching Under the Lamppost: Optimal Interdiction and Removal of the Brown Treesnake in Hawaii." BIOECON Conference at Kings College, Cambridge, England, Aug. 29-30, 2006.

Kaiser, Brooks. "The Economics of Prevention and Control of Invasive Species." Containing Invasives: Closing Pandora's Box, Kings Gap Environmental Education and Training Center, Carlisle, PA, March 15, 2006.

Kaiser, Brooks, and Kimberly Burnett. "Economic Impacts of Coqui Frogs in Hawaii." Ecological Society of America, Merida, Mexico, Jan. 8-12, 2006; Interdisciplinary Environmental Association's 12th International Interdisciplinary Conference on the Environment, Kona, HI, June 22-24, 2006.

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.

Kaiser, Brooks, and James Roumasset. "Avoiding and Catching Brown Tree Snakes in Hawaii." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.

Keane, R. and A.W. Schoettle. "Strategies, Tools, and Challenges for Sustaining and Storing High-Elevation Five-Needle Pine Forests in Western North America." High-Five Symposium: The Future of High – Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.

- Klutsch, J.G., B.A. Goodrich, and A.W. Schoettle. "Limber Pine Forests on the Leading Edge of White Pine Blister Rust Distribution in Northern Colorado." High-Five Symposium: The Future of High –Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.
- Knowler, D. "Economic Analysis of Invasive Plants Introduced by the Horticultural Industry in North America." Invasive Plant Council of British Columbia, Invasive Plant Research in British Columbia: Current Projects and Future Trends, Vancouver, BC, October 29–30, 2008.
- Knowler, Duncan. "Progress in the Economic and Policy Analysis of Invasive Plants Introduced by the Horticultural Industry in North America." Special Seminar for the Canadian Food Inspection Agency, Ottawa, Canada, Sept. 15, 2007.
- Kobayashi, Mimako, Thomas Harris, and Kimberly Rollins. "Invasive Weeds, Wildfire, and Rancher Decision Making in the Great Basin." Selected paper, AAEA & ACCI Joint Annual Meeting, Milwaukee, Wisconsin, July 26-29, 2009.
- Kobayashi, Mimako, and Kimberly Rollins. "Rangeland Management with Invasive Annual Grasses and Wildfire in the Great Basin." Western Agricultural Economics Association Annual Meeting, Kauai, Hawaii, June 24-26, 2009.
- Kobayashi, Mimako, Kimberly Rollins, and Michael H. Taylor. "Ranching, Invasive Annual Grasses, and the External Costs of Wildfire in the Great Basin: A Stochastic Dynamic Programming Approach." Selected Paper 11955, Agricultural and Applied Economics Association, 2010 Annual Meeting, Denver, Colorado. 39 pp., July 25-27, 2010. <http://ageconsearch.umn.edu/handle/61869>
- Lee, John, Ann Hillberg Seitzinger, and Philip L. Paarlberg. "Comparison of Economic and Disease Criteria for Controlling Foot-and-Mouth Disease." Western Agricultural Economics Association, Anchorage, AK, June 28-29, 2006.
- Lehnhoff, E., Bruce D. Maxwell, and Lisa J. Rew. "Disturbance Size and Propagule Pressure Influence Colonization Success of Yellow Toadflax (*Linaria vulgaris*)." Weed Science Society of America Abstracts, 46(295), San Antonio, TX, Feb. 2007, p. 57.
- Lehnhoff, E.A., Bruce D. Maxwell, and Lisa J. Rew. "Effects of disturbance and environment on yellow toadflax (*Linaria vulgaris*)." Ecological Society of America Abstracts, Aug. 2007.
- Lichtenberg, Erik, and Lars J. Olson. "Risk Factors for Invasive Species Introductions: Theory and Empirical Evidence." Agricultural and Applied Economics Association, Denver, CO, July 25-27, 2010; Fourth World Congress of Environmental and Resource Economists, Montreal, Canada, June 28-July 2, 2010.

- Lichtenberg, Erik, and Lars J. Olson. "Risk Factors for Invasive Pest Introductions in Commodity Imports." Society for Risk Analysis Annual Meeting, Baltimore, MD, Dec. 8, 2009; PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 22-23, 2009.
- Marsh, T.L. "Economic Impacts of FMD on North America and Australia." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington DC, Oct. 22-23, 2009.
- Marsh, Thomas L., E. Perevodchikov, Peter R. Tozer, and T. Wahl. "Impacts of Invasive Species on International Livestock Trade." PREISM Workshop, ERS-USDA, 2007.
- Marsh, Thomas, and Peter R. Tozer. "Invasive Species Management: FMD in the Australian Beef Sector." American Agricultural Economic Association & American Council on Consumer Interests Joint Annual Meeting, Orlando, FL, July 28, 2008.
- Marsh, Thomas L., and Peter R. Tozer. "Invasive Species Management in the Australian Beef Sector." Invited presentation, Ministry of Agriculture & Forestry, Wellington, New Zealand, June 2006.
- Marsh, Thomas L., and Peter R. Tozer. "Invasive Species Management in the Livestock Sector." Invited presentation, Department of Agriculture, Geraldton, Western Australia, May 2006.
- Maxwell, Bruce D. "Developing and Integrating Tools for Assessing the Impacts of Invasive Plants for Prioritization of Management on Federal Lands." C-FARE Briefing, USDA/CSREES, Washington, DC, May 5, 2006.
- Maxwell, Bruce D. "Plant Population Spatial and Temporal Dynamics." University of Buenos Aires, Buenos Aires, Argentina, Oct. 4, 2007.
- Maxwell, Bruce D. "Using Models for Management Decisions." National University of Bahia Blanca, Bahia Blanca, Argentina, Sept. 29, 2007.
- Maxwell, Bruce D., and Lisa J. Rew. "Detecting Invasiveness of Invasive Plant Species." Poster presentation: WSSA Abstracts 45, p. 60, Honolulu, HI, Feb. 2005.
- Maxwell, Bruce D., and Lisa J. Rew. "Detecting the Invasion Potential of Non-Indigenous Plant Populations." Ecology Seminar Series, the Pennsylvania State University, April 2005.
- Maxwell, Bruce D., and Lisa J. Rew. "Plant Invasions: How Should We React?" Crown of the Continents Annual Meeting, Kalispell, MT, 2005.
- Maxwell, Bruce D. and Lisa J. Rew. "Prioritizing Weed Management." Integrated Pest Management School, Flathead Reservation, Ronan, MT, Jan. 21, 2007.

- 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., Lisa J. Rew, and John Antle. "Developing and Integrating Tools for Assessing the Impacts of Invasive Plants for Prioritization of Management on Federal Lands." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.
- Maxwell, Bruce D., Lisa J. Rew, F. Menalled, A. Hulting, B. Bauer, and E. Lehnhoff. "Linking Spatial and Temporal Plant Population Dynamics, Forecasting and Informing Management Through the Use of Models." National University of Rosario, Zavalla, Santa Fe, Argentina, Sept. 18, 2007.
- Mayunga, Joseph S. "Border Enforcement, Importers, and Trade-Related Invasive Species Risk: Spatial Damage Function Component, Sample Results." Texas A&M, 2007.
- McClaran, M., K. Wisneski, and A. Olsson. "Buffelgrass Control Program on the Santa Rita Experimental Range." Southwest Vegetation Management Association Annual Meeting, Tucson, AZ, Oct. 26, 2007.
- McKee, Gregory J. "Insecticide Resistance and Optimal Invasive Species Management." Department of Agribusiness and Applied Economics, North Dakota State University, Fargo, ND, Sept. 2005.
- McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Modeling the Effect of Spatial Externalities on Invasive Species Management." Western Agricultural Economics Association, Anchorage, AK, June 2006.
- McKee, Gregory J., Colin A. Carter, James A. Chalfant, Rachael E. Goodhue, and Frank G. Zalom. "Spatial Externalities, Invasive Species, and Management Institutions." American Agricultural Economics Association, Long Beach, CA, July 2006.
- 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, Feb. 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, 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. "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.

Mehta, Shefali, Robert Haight, and Frances Homans. "The Value of Information in Invasive Species Management." Presented at the Agricultural Economic Society (AES) 81st Annual Conference in Reading, England, April 2-4, 2007; Selected poster, American Agricultural Economics Association Annual Meetings, Portland, OR, 2007 (<http://purl.umn.edu/8505>).

Mehta, Shefali, Robert Haight, Frances Homans, and Robert Venette. "A Needle in the Haystack: Identifying Invasive Species Detection and Control Strategies Using a Spatial Stochastic Dynamic Model." Presented at the Agricultural Economic Society (AES) 82th Annual Conference in England, March 31 - April 2, 2008; Minnesota Department of Agriculture for the GIS Working Group, May 2008.

Mehta, Shefali, Tetsuya Horie, D. Smith, Robert Venette, Robert Haight, Frances Homans, and Abby Walter. "The Economic and Ecological Impact of Oak Wilt in Minnesota." Summary and synthesis meeting for non-native invasive forest pests and pathogens: Distributed Graduate Seminar. National Center for Ecological Analysis and Synthesis, Santa Barbara, CA, Feb. 5, 2008; 2008 Forest Health Protection State Cooperators Meeting. State and Private Forestry, USDA Forest Service, St. Paul, MN, March 2008.

Meldrum, J. "Valuing the forest for the Trees or for the Future? Interpreting Nonmarket Values for Forest Invasive Species Management." Environmental Studies Graduate Student Brownbag Seminar Series, Boulder, CO, Sept. 2010.

Meldrum, J. R., P.A. Champ, and C.A. Bond. "Don't Listen to Visa Ads, We Can Put a Price on Anything." Central Rockies White Pine Health Meeting. Fort Collins, CO, April 2010.

Meldrum, J., P.A. Champ, and C.A. Bond. "Valuing the Forest for the Trees or for the Future? Interpreting nonmarket values for forest invasive species management." CU Environmental and Resource Economics Workshop 2010, Vail, CO, Sept. 2010.

Meldrum, J., C.A. Bond, P.A. Champ, and A.W. Schoettle. "Investigating the Optimality of Proactive Management of an Invasive Forest Pest." 4th World Congress of Environmental and Resource Economists, Montreal, Canada, July 2010.

Meldrum, J.R., P.A. Champ, and C.A. Bond. "Valuing the forest for the trees: Willingness to pay for white pine blister rust management." High-Five Symposium: The Future of High-Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.

Melkonyan, Tigran, and Michael H. Taylor. 2010. "Regulatory Policy Design for Agroecosystem Management on Public Rangelands." Presented at

- the Fourth World Congress of Environmental and Resource Economists. Montreal, Quebec, Canada, July 1st, 2010.
- Millock, Katrin, Angels Xabadia, and David Zilberman. "Investment Policy for New Environmental Monitoring Technologies." Third World Congress of Environmental and Resource Economists, Kyoto, Japan, July 2006.
- Min, H., M. Gopinath, S. Buccola, and P. McEvoy. "State Noxious Weed Seed Regulations: Economic or Scientific Decisions?" 2005 PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 20-21, 2005.
- Min, He, Munisamy Gopinath, Steven Buccola, and Peter McEvoy. "Rent-Seeking in Noxious Weed Regulations: Evidence from U.S. States." American Agricultural Economics Association, Long Beach, CA, July 2006.
- Moffitt, L. Joe. "Robust Inspection for Invasive Species with a Limited Budget." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.
- Moffitt, L. Joe. "Surveillance in U.S. Agricultural Biosecurity: Challenges, Research Gaps, and Opportunities." Surveillance and Uncertainty Workshop, Hobart, Tasmania, Australia, Aug.13, 2007.
- Muhammad, A. "Government Indemnification and Livestock Disease Risk." Symposium Presentation, Agricultural and Applied Economics Association Annual Meeting, Denver, CO, July 25-27, 2010.
- Nelson, C.R., I. Abrahamson, A. Jones, and K. Pennick. "Restoration and Management of High-elevation Pines: Cost and Efficacy of White Pine Blister Rust Treatments." High-Five Symposium: The Future of High – Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.
- Olson, Lars J. "Dynamic Sanitary and Phytosanitary Trade Policy." 4th World Congress of Environmental and Resource Economists, Montreal, Canada, July 2, 2010.
- Olson, Lars J. "Economic Aspects of Prevention versus Control of Nonnative Weeds Under Uncertainty." Annual Conference of the Western Society of Weed Science, Reno, NV, March 15, 2006.
- Olson, Lars J. "Economic Impacts of Aquatic Invasive Species." Invited participant, Environmental Protection Agency Workshop, Washington, DC, July 20-21, 2005.
- Olson, Lars J. "International Trade and the Economics of Invasive Species Prevention and Control." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 20-21, 2005.

Olson, Lars J. “Randomly Introduced Biological Invasions: The Economics of Prevention and Control.” PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 19, 2004.

Olson, Lars J. “Valuation for Environmental Policy: Session III, Invasive Species.” Discussant, Environmental Protection Agency Workshop, Arlington, VA, April 23, 2007.

Olsson, A. “Mapping and Decision Support.” Buffelgrass Summit, Tucson, AZ, Feb. 9, 2007.

Olsson, A.D., M.A. Crimmins, B.J. Orr, S.E. Marsh, and W.J.D. van Leeuwen. “Coupling Citizen Science with Precipitation and Phenology Monitoring and Modeling to Support Invasive Species Management.” 94th Ecological Society of America Annual Meeting, Albuquerque, NM, Aug. 2-7, 2009.

Opaluch, James J. “Controlling Risks of Invasion by Intentionally Introduced Non-Native Species” University of Rhode Island, Mar. 2005 and June 2008.

Opaluch, James J., James L. Anderson, Kurt Schnier, and Meifeng Luo. “A Risk-Based Approach to Managing the Intentional Introduction of Non-Native Species” CU Environmental and Resource Economics Workshop, Vail, CO, Sept. 23-25, 2005; Association of Environmental and Resource Economists Workshop, Grand Teton National Park, WY, June 12-14, 2005 PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005; Arizona State University, April 2006; 2007 PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2007.

Orden, David, and Everett Peterson. “The Challenge of Increasing Global Trade—How to Address Linkages and Barriers.” Invited presentation in the Session, “Regulating Effectively in a Globalized World,” USDA Agricultural Outlook Conference, Feb. 22, 2008.

Orden, David, and Donna Roberts. “Food Regulation and Trade under the WTO: Ten Years in Perspective.” International Association of Agricultural Economists, Gold Coast, Australia, Aug. 2006.

Orden, David, and Everett Peterson. “Potential Fresh Apple Imports from China: A Preliminary Case Study.” Presented at USDA/APHIS/PPD, Riverdale, MD, and USDA/APHIS/CPHST, Raleigh, NC, February 26, 2010.

Orr, B. “Bridging the Gap Exploring the Barriers and Potential Solutions to Cross-jurisdictional Invasive Species Mapping, Documentation and Data Management.” Presentation to Arizona Governor’s Invasive Species Advisory Council. Phoenix, AZ, Sept. 6, 2007.

Paarlberg, Philip L. and Ann H. Seitzinger. “National Impacts of Changes in Livestock Disease Surveillance.” Western Agricultural Economics Meetings, Big Sky, MT, June 25-27, 2008.

- Paarlberg, Philip L., Ann Hillberg Seitzinger, John G. Lee, and Kenneth Mathews. "Economic Impacts of Foreign Animal Diseases." FMD Modeling Meeting, Fort Collins, CO, April 18-19, 2005; PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005; International Agricultural Trade Research Consortium, San Diego, CA, Dec. 4-7, 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.
- Pendell, D.L. "Economic Effects of a Foot- and-Mouth Disease Outbreak in Livestock: What Does a FMD Outbreak Mean." Regional Emergency Preparedness Weekend Event: Protecting the Plains, U.S. Meat Animal Research Center, Clay Center, NE, Apr. 10, 2010.
- Pendell, D.L., and A.E. Hill. "Economic impacts for alternate depopulation capacities for a FMD outbreak in the U.S." Proceedings of the 12th Symposium of the International Society for Veterinary Epidemiology and Economics meeting, Durban, South Africa: ISVEE 12, August 14, 2009.
- Pendell, Dustin L., J. Leatherman, Ted C. Schroeder, and G.S. Alward. "The Economic Impacts of a Foot-And-Mouth Disease Outbreak: A Regional Analysis." Presented at the 2007 Western Agricultural Economics Association Annual Meetings, Portland, OR, July 2007.
- Pendell, Dustin L., and Ted C. Schroeder. "Evaluation of Alternative Surveillance and Control Zone Options." Western Agricultural Economics Association Annual Meetings, Big Sky, MT, June 2008.
- Perevodchikov, E., T.L. Marsh, and P. Tozer. "Simulation of a Foot-and-Mouth Disease (FMD) Outbreak in the U.S. and Australian Beef Sectors." Poster, Washington State University Conference on Economics Issues and Outlook, Pasco, WA, 2007.
- Peters, M.P., L.R. Iverson, and T.D. Sydnor. "Emerald Ash Borer: A Classification of Tree Health and Degree of Infestation." Emerald Ash Borer Research and Development Meeting, Pittsburgh, Oct. 23-24, 2007.
- 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, Aug. 1-4, 2004.
- Peterson, Everett, and David Orden. "Integrating Risk Assessment/Scientific Information into Policy-Oriented Economic Benefit-Cost Analysis: Studies of Avocado Imports and Apples." The Center for Plant Health Science and Technology, Animal and Plant Health Inspection Service, U.S. Department of Agriculture, Raleigh, NC, July 8, 2008.
- Peterson, Everett B., and David Orden. "Linking Risk and Economic Assessments: The Case of U.S. Imports of Mexican Avocados." American Agricultural Economics Association, Long Beach, CA, July 23-26, 2006.

- Peterson, Everett B., and David Orden. "Linking Risk and Economic Assessments in the Analysis of Plant Pest Regulations." International Agricultural Trade Research Consortium, University of Bonn, Bonn, Germany, May 28-30, 2006.
- Pitafi, Basharat A., James A. Roumasset, and Sittidaj Pongkijvorasin. "Management of Renewable Resources Providing Stock Externalities to Other Resource Stocks." Western Economic Association Meetings, San Francisco, CA, July 4-8, 2005; Hawaii Conservation Conference, Honolulu, HI, July 2005.
- Pitafi, Basharat, and Sittidaj Pongkijvorasin. "Coastal Groundwater Management in the Presence of Positive Stock Externalities." Western Economic Association International, Anchorage, AK, June 29-July 3, 2006.
- Piggott, Nicholas E., Kenrett Jefferson-Moore, Barry K. Goodwin, and Anton Bekkerman. "The Economics of a Check-off to Indemnify Soybean Rust in the U.S. Soybean Industry." American Agricultural Economic Association & American Council on Consumer Interests Joint Annual Meeting, Orlando, FL, July 28, 2008.
- Pongkijvorasin, Sittidaj, Basharat Pitafi, and James Roumasset. "Pricing Resource Extraction with Stock Externalities." Third World Congress of Environmental and Resource Economists, Kyoto, Japan, July 3-7, 2006.
- Prasad, Anantha M., L.R. Iverson, M.P. Peters, J. Bossenbroek, D. Sydnor, and M. Schwartz. "Modeling the Risk of Emerald Ash Borer Spread in Ohio and Michigan." Landscape patterns and ecosystem processes: 23rd annual landscape ecology symposium, United States Regional Association of the International Association for Landscape Ecology, Madison, WI, April 6-10, 2008.
- Prasad, Anantha M., L.R. Iverson, M.P. Peters, J. Bossenbroek, D. Sydnor, and M. Schwartz. "Modeling EAB Spread in Ohio and Michigan." Emerald Ash Borer Research and Development Meeting, Pittsburgh, Oct. 23-24, 2007.
- Premashthira, S. "Quantitative Spatial Methods to Identify Foot-and-mouth Disease of Centrally-originating Potential Outbreak Area in Central United States." 11th Annual College of Veterinary Medicine and Biomedical Sciences - Colorado State University Research Day, Hilton Hotel, Fort Collins, CO, Jan. 23, 2010.
- Prestemon, J.P. 2007. "Market and Forest Policy Effects of an Exotic Forest Pest in the U.S." University of Helsinki, Helsinki, Finland, Oct. 15, 2007.
- 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., 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.
- Rew, Lisa J., E. Lehnhoff, and Bruce D. Maxwell. "Prioritizing Non-indigenous Species Management Using a Survey, Monitoring and Modeling Framework." Plant Canada 2007 Conference, Canadian Weed Science Society/Canadian Botanical Association Symposium on Ecology and Invasive Species, Saskatoon, Saskatchewan, June 13, 2007.
- Rew, Lisa J., and Bruce D. Maxwell. "Predicting Occurrence, Prioritizing Modeling, and Improving Management Efficiency." Western Society of Weed Science, Sparks, NV, March 14-16, 2006.
- Rew, Lisa J., and Bruce D. Maxwell. "Non-indigenous Species and Community Richness, Diversity and Stability: A Case Study with Leafy Spurge (*Euphorbia esula*)." Poster Presentation, WSSA Abstracts 46(97): p. 26, San Antonio, TX, Feb. 2005.
- Rew, Lisa J., and Bruce D. Maxwell. "Surveying and Predicting the Occurrence of Non-Native Plant Species." Plant Ecology Seminar, the Pennsylvania State University, April 2005.
- Rew, Lisa J., Bruce D. Maxwell, and E. Lehnhoff. "Prioritizing Noxious Weed Management: Are All Weed Populations Bad?" Big Sky Institute, Community Talk, Jan. 24, 2007.
- 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, Feb. 2005.
- Richards, Timothy J., J. Eaves, and M. Manfredo. "Bug Options: Managing Insect Risk in California Specialty Crops." Paper presented at American Agricultural Economics Association Meetings, Providence, RI, July 2005.
- Richards, Timothy J., Peter Ellsworth, Russ Tronstad and Steve Naranjo. "Market-Based Instruments for the Optimal Control of Invasive Insect Species: B. Tabaci in Arizona." American Agricultural Economics Association Meetings, Denver, CO, July 27-29, 2010.
- Roumasset, James. "Delaying the Catastrophic Arrival of the Brown Treesnake to Hawaii." European Association of Environmental and Resource Economists Annual Conference, Thessaloniki, Greece, June 27-30, 2007.
- 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.

- Sanchirico, James N. "Spatial Management of Invasive Species: Pathways and Policy Options." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005; University of California at Davis, Department of Environmental Science and Policy, Feb. 2007; American Agricultural Economics Association Annual Meeting, Portland, OR, July 2007; University of Minnesota Seminar in Applied Economics, Nov. 19, 2007; Environment for Development Annual Meeting, Cape Town, Nov. 7, 2007; Universidad de Guanajuato, Mexico, Economics Seminar, Oct. 12, 2007.
- Schmidt, J.P., and J.M. Drake. "Cost-Sensitive Risk Assessment for Invasive Plant Species in the United States." Ecological Society of America, 95th Annual Meeting, Pittsburgh, Pennsylvania, Aug. 1-6, 2010.
- Schoettle, A.W. "Bristlecone Pine (*Pinus aristata*): A Threatened Colorado Treasure." Colorado Native Plant Society Meeting, Denver, CO, Dec. 2009.
- Schoettle, A.W. "Sustaining High Elevation Ecosystems – Relevance to Wilderness Management." Aldo Leopold Wilderness Research Institute Workshop, Missoula, MT, April 28, 2009.
- Schoettle, A.W. "Providing the Science Foundation for Proactive Intervention to Sustain High Elevation 5-Needle Pine Populations." Central Rockies White Pine Health Meeting, Ft Collins, CO, April 2010.
- Schoettle, A.W. "Sustaining *Pinus flexilis* and *Pinus aristata* Ecosystems of the Southern Rocky Mountains in a Changing Climate." Forest and Woodland Ecosystems Program Seminar Series – RMRS, Fort Collins, CO, April 20, 2009.
- Schoettle, A.W. "Sustaining *Pinus flexilis* and *Pinus aristata* Ecosystems of the Southern Rocky Mountains in the Presence of *Cronartium ribicola* in a Changing Climate - A Cooperative Program in the Southern Rockies." Invited presentation for the Session on "Cross Linkages among agencies – how can we get cross boundary projects done?" RM-Cooperative Ecosystems Studies Unit (RM-CESU) Executive Committee and Managers of the Federal Agencies Meeting, Estes Park, CO, Oct. 16, 2008.
- Schoettle, A.W., et al. "Conserving Genetic Diversity of Limber Pine in Rocky Mountain National Park." Rocky Mountain National Park Research Conference, Estes Park, CO, Mar. 30, 2010.
- Schoettle, A.W., et al. "Mountain Pine Beetle is Adding a New Urgency to Managing White Pine Blister Rust in Limber Pine and RM Bristlecone Pine Ecosystems." Central Rockies White Pine Health Meeting, Ft Collins, CO, April 2009.
- Schoettle, A.W., et al. "Preparing the Landscape for Invasion: Accelerating the Evolution of Persistence." Poster presentation, North American Forest Biology Workshop, Logan, UT, June 23, 2009.

- Schoettle, A.W., et al. "Sustaining High Elevation White Pine Forests in the Presence of White Pine Blister Rust." Central Rockies White Pine Health Meeting, Ft Collins, CO, April 2009.
- Schoettle, A.W., M. Antolin, J. Klutsch, and S. Field. "A Population Genetic Model for High-Elevation White Pines: Projecting Ecological Outcomes of Restoration Options." High-Five Symposium: The Future of High – Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.
- Schoettle, A.W., S. Burns, and R. Snieszko. "Limitations to Rapid Adaptation to Changing Selective Pressures in High Elevation White Pine Populations – the need for proactive intervention." Western International Forest Disease Work Conference (WIFDWC), Durango, CO, July 20-24, 2009.
- Schoettle, A.W., B. Goodrich, V. Hipkins, and J. Kray. "Patterns of Genetic Variation in *Pinus aristata*, Rocky Mountain bristlecone pine." High-Five Symposium: The Future of High –Elevation Five-Needle White Pines in Western North America, Missoula, MT, June 2010.
- Schoettle, A.W., R.A Snieszko, and K.S Burns. "Sustaining *Pinus flexilis* Ecosystems of the Southern Rocky Mountains (USA) in the Presence of *Cronartium ribicola* and *Dendroctonus ponderosae* in a Changing Climate," in *Breeding and Genetic Resources of Five-Needle Pines Conference*, IUFRO Working Party 2.02.15, Yangyang, Republic of Korea, Sept. 22–26, 2008; Noshad, D., E Noh., J. King, R. Snieszko, eds.; Yangyang: Korea Forest Research Institute, pp. 63-65, 2009.
- Schoettle, A.W., R. Snieszko, S. Kegley, S. Burns, and J. Hill. "Resistance to White Pine Blister Rust in *Pinus flexilis* and *Pinus aristata* of the Southern Rockies – Initial Findings." *Proceedings of the 57th Western International Forest Disease Work Conference; July 20-24, 2009, Durango, CO*, Adams, J., ed., Forest Health Technology Enterprise Team, Fort Collins, CO, pp. 109-110, 2010. (<http://www.cnr.usu.edu/quinney/files/uploads/WIFDWC2009.pdf>)
- Schroeder, T.C. "Benefits of Animal Identification Systems." Kansas Farm Bureau Meeting, Manhattan, KS, Feb. 9, 2009.
- Schroeder, T.C. "Benefits of Animal ID and Traceability." Kansas State University Animal Sciences and Industry Guest Presentation, Manhattan, KS, Oct. 8, 2009.
- Schroeder, T.C. "Benefit Cost Analysis of the National Animal Identification System." Organized Symposium, Western Agricultural Economics Association Annual Meetings, Big Sky, MT, June 2008.
- Schroeder, T.C. "Incentives for Animal Traceability in the U.S." Presented at the 2010 International Livestock Identification Association, Calgary, AB, July 20, 2010.

- Settle, Chad, and Jason F. Shogren. "Controlling Leafy Spurge with Rangeland Management in the Thunder Basin." Southwestern Social Science Association, San Antonio, TX, April 12-15, 2006.
- Stranlund, John K. "Info-Gap Inspection." Isenberg School of Management, University of Massachusetts, Amherst, March 11, 2005.
- Sumner, Daniel A. "Economics of Exotic Pest Policy." California Workshop on Exotic Pests, Davis, CA, Nov. 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.
- Sydnor, T.D., and M. Bumgardner. "Attitudes of Residents Facing Loss of Canopy Trees from Emerald Ash Borer." Proceedings of the Society of American Foresters 2007 National Conference, Portland, OH, 2007.
- Sydnor, T.D., and M. Bumgardner. "Potential Economic Impacts of Emerald Ash Borer (EAB) on Ohio Communities." Proceedings of the Society of American Foresters 2007 National Conference, Portland, OH, 2007.
- Sydnor, T.D., and S. Subburayalu. "An Analysis of Public Tree Benefits." Presented to Xenia officials by Green County Extension, which included a workshop on Inventory Techniques to Employ for Developing a STRATUM Analysis by Volunteers, Xenia, OH; presented to Monclova Township officials by Lucas County Extension, which included a workshop on Inventory Techniques to Employ for Developing a STRATUM Analysis by Volunteers, Monclova Township, OH, 2008.
- Thacher, Jennifer, Janie Chermak, Kristine Grimsrud, and Kate Krause. "The Decision to Manage Invasive Weeds: Which Factors Matter?" AAEA & ACCI 2009 Joint Meeting, Milwaukee, WI, July 26-28, 2009; Western Social Science Association, Albuquerque, NM, April 2009.
- 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.
- Thornsby, Suzanne, and Mollie Woods. "Economic Evaluation of a Systems Approach." The 2006 Invasive Species Symposium, Michigan State University, East Lansing, MI, May 12, 2006.
- Tschirhart, John. "Comparing Modeling Approaches in Invasive Species Management." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.

- Tschirhart, John. "Nature's Oligopolists." First DIVERSITAS Open Conference on Integrating Bioscience for Human Well Being, Oaxaca, Mexico, Nov. 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." International Union of Forest Research Organizations World Congress, Brisbane, Australia, Aug. 8-12, 2005.
- Vickers, D. Angele, Sean B. Cash, Holly Ameden, and David Zilberman. "An Agent-based Model of Border Enforcement for Invasive Species Management." American Agricultural Economics Association, Western Agricultural Economics Association, and Canadian Agricultural Economic Society Joint Annual Meeting, Portland, OR, July 29-August 1, 2007.
- Wahl, Thomas I. "Dynamic Effects of Alternative Invasive Species Policies on Livestock and Perennial Fruit Production." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 2005.
- Wainger, Lisa A. "Identifying High-Payoff Areas for Restoration Investments: Assessing Spatially Heterogeneous Costs and Benefits of Ecosystem Services." The 22nd Annual Meeting of the Society for Conservation Biology, Chattanooga Convention Center, Chattanooga, Tennessee, July 16, 2008; Integration and Application Network Seminar, Annapolis, MD, May 11, 2006.
- Wainger, Lisa A. "Identifying High-Payoff Areas for Investments in Invasive Species Management: Cheatgrass (*Bromus tectorum*) Case Study." Bureau of Land Management, Washington, DC, June 22, 2006; Society for Range Management Annual Meeting, Vancouver, BC, Feb. 13, 2006.
- Wainger, Lisa A. "Assessing Spatially Heterogeneous Benefits of Ecosystem Services: Identifying High-Payoff Areas for Restoration Investments." The Society of Environmental Toxicology and Chemistry Meeting, Baltimore, MD, Nov. 14-16, 2005.
- Wainger, Lisa A. "Comparing Cost, Risk, and Benefit Trade-offs Under Uncertainty: Cheatgrass Case Study." Bureau of Land Management, Boise, ID, Aug. 24, 2005.
- Wainger, Lisa A. "Comparing Cost-Effectiveness of Restoration Strategies: Cheatgrass Case Study." PREISM Workshop, Economic Research Service, U.S. Department of Agriculture, Washington, DC, Oct. 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, Oct. 24-28, 2005.
- Wisneski, K., A. Olsson, B. Orr, and M. McClaran. "The Contribution of Geospatial Technologies to Buffelgrass Detection and Control at the Santa

- Rita Experimental Range.” Fourth Annual Research Insights in Semiarid Ecosystems Symposium, Tucson, AZ, Oct. 6, 2007.
- Wolf, C., and J. Hadrich. “Benefit-Cost Analysis of the US TB Eradication Program.” Presentation to USDA-APHIS, Washington, DC. Feb. 19, 2008.
- Wolf, C., B. Gramig, and R. Horan. “Implementing Incentive Compatible Livestock Disease Indemnities.” Alternative Methods for Livestock Compensation Workshop, USDA-APHIS, Fort Collins, CO, July 23, 2010.
- Xie, F., and Richard D. Horan. “Disease and Behavioral Dynamics for Brucellosis in Elk and Cattle in the Greater Yellowstone Area.” Selected paper, annual meetings of the American Agricultural Economics Association, Orlando, FL, July 2008.
- Xie, F., and R.D. Horan, “Optimal Control of Brucellosis in Bison in the Yellowstone National Park Area.” Selected Poster presented at the annual meetings of the Agricultural and Applied Economic Association, Denver, CO, July 27-29, 2010.
- Xie, F., R.D. Horan, C.A. Wolf, and K. Mathews, Jr., “A Gravity Model of Bovine TB in the U.S.” Selected paper presented at the annual meetings of the Agricultural and Applied Economic Association, Milwaukee, WI, July 26-28, 2009.
- 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, Nov. 11, 2004.
- 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, Z., T.I. Wahl, and T.L. Marsh. “Economic Effects of Mitigating Apple Maggot Spread.” Invasive Species Management: PREISM Workshop, USDA-ERS, Oct. 2007; Crisis in Agriculture and Resource Sectors Workshop: Analysis of Policy Response, Calgary, Alberta, Oct. 2006.
- 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 Ricardo Diaz. “Modeling the Impacts of Alternative Invasive Species Management Policies on Livestock Production.” American Agricultural Economics Association, Denver, CO, Aug. 1-4, 2004.
- Zhao, Z., T.I. Wahl, and T.L. Marsh. “Invasive Species Management: Foot-and-Mouth Disease in the U.S. Beef Industry.” International Association of Agricultural Economists, Queensland, Australia, Aug. 2006.

Zhao, Z., T.I. Wahl, and T.L. Marsh. "Modeling the Effects of Mitigating Apple Maggot Spread into Apple Production Region of Washington State," American Agricultural Economics Association, Long Beach, CA, Aug. 2006.

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.

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.

Zilberman, David, Holly Ameden, and Sean B. Cash. "Integrating Location Theory with Risk Management for Invasive Species Management." PREISM Workshop, Economic Research Service, United States Department of Agriculture, Washington, DC, Oct. 2006.

Zilberman, David, Holly Ameden, and Sean B. Cash. "Invasive Species Management: Border Enforcement, Location Theory, and Risk." Invited presentation, Bren School of Environmental Science and Management, University of California, Santa Barbara, Nov. 2006.

Dissertations and Theses

Ameden, Holly. "The Economics of Invasive Species, Border Enforcement, and Firm Response." Ph.D. dissertation, University of California, Berkeley, 115 pp., Spring 2008.

Burnett, Kimberly. "Optimal Prevention and Control of Invasive Species: The Case of the Brown Tree Snake." Ph.D. dissertation, Department of Economics, University of Hawaii, 2007 (<http://www.ups.edu/facultypages/kburnett/Diss.pdf>).

Cobourn, Kelly M. "Incentives for individual and cooperative management of a mobile pest: An application to the olive fruit fly in California." Ph.D. dissertation, Department of Agricultural and Resource Economics, University of California, Davis, 2009.

Croskey, Audra. "Evaluating the costs of the emerald ash borer invasion in Ohio." M.S. Thesis, University of Toledo, 2009.

Egbenewe-Mondzozo, A. "Evaluation of AI mitigation strategies for a hypothetical outbreak in Texas." PhD Dissertation, Department of Agricultural Economics, Texas A&M University, 2009 (http://www.agecon.tamu.edu/pdf_files/graduate/Egbenewe.09c.pdf).

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.

- Gramig, Benjamin M. "Essays on the Economics of Livestock Disease Management: On-Farm Biosecurity Adoption, Asymmetric Information in Policy Design, and Decentralized Bioeconomic Dynamics." Ph.D. Dissertation, Department of Agricultural Economics, Michigan State University, 2008. (2008 *Best PhD Dissertation, Honorable Mention, Agricultural and Applied Economics Association*)
- Greathouse, B.D. "Vaccination Strategies for a Foot-and-Mouth Disease Outbreak in Southwest Kansas." M.S. Thesis, Department of Agricultural and Resource Economics, Colorado State University, 2010.
- Gwatipedza, J. "Essays on Environmental Risks, International Trade and Public Policy." Ph.D. Dissertation, Department of Economics and Finance, University of Wyoming, Spring 2010.
- Horie, Tetsuya. "Designing Optimal Strategies for Surveillance and Control of Invasive Forest Pests." Ph.D. Dissertation, Department of Applied Economics, University of Minnesota, April 2011.
- McDermott, Shana M. "Invasive Species Ecosystem Externalities." Ph.D. Dissertation, Department of Economics and Finance, University of Wyoming, Jan. 2011.
- McKee, Gregory J. "Pesticide Resistance, Population Dynamics, and Invasive Species Management." Doctoral Thesis, Department of Agricultural and Resource Economics, University of California, Davis, June 2006.
- Min, He. "Political Economy and Trade Effects of Invasive Species Regulation: The Case of Noxious Weeds." Ph.D. dissertation, Oregon State University, Aug. 2007.
- Niell, Rebecca "Spatial-dynamics, Micro-Behavior, and the Control of Biological Invasions." Ph.D. Dissertation, Department of Agricultural and Resource Economics, University of California, Davis, 2009.
- Olsson, Aaryn. "Ecosystem transformation by buffelgrass: Climatology of Invasion, Effects on Arizona Upland Diversity, and Remote Sensing Tools for Managers." Ph.D. dissertation, Arid Lands Resources Sciences, University of Arizona, 2010.
- Pendell, Dustin L. "Value of Animal Traceability Systems in Managing a Foot-and-Mouth Disease Outbreak in Southwest Kansas." Doctoral Thesis, Department of Agricultural Economics, Kansas State University, Manhattan, KS, Sept. 2006.
- Ransom-Hodges, A. "The Introduction of Potentially Invasive Alien Plant Species for Horticultural Purposes in North America: Assessing Stakeholder Perspectives and Preferences." Masters in Resource Management Degree, School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC, 2007, (<http://www.rem.sfu.ca/pubs.htm>).

Sims, Charles B. "Essays on the Bioeconomic Control of Invasive Species and Forest Pests." Ph.D. dissertation, Department of Economics and Finance, University of Wyoming, August 2009.

Vickers, D. Angele. "An Agent-Based Model of Border Enforcement for Invasive Species Management." Master's Thesis, University of Alberta, Edmonton, AB, 2008.

Working and Discussion Papers

Burnett, Kimberly, James Roumasset, and Y. Tsur. "Delaying the Catastrophic Arrival of the Brown Treesnake to Hawaii," University of Hawaii, Department of Economics Working Paper No. 07-15, 2007 (http://www.economics.hawaii.edu/research/workingpapers/WP_07-15.pdf).

Chermak, Janie, Kristine Grimsrud, Kate Krause, Jennifer Thacher, David Schimmelpennig, and Jason Hansen. "My Neighbor's Cattle: Strategic Behavior in a Spatial-dynamic Model with an Invasive Weed." University of New Mexico, Working Paper, <http://economics.thacher.us/Home/research2/workingpapers/ChermakEtAl2010.pdf/view>

Grimsrud, Kristine, Janie Chermak, Kate Krause, and Jennifer Thacher. "A Differential Game Model of Agent Response with Individually Diffusing Stocks: Invasive Weed Infestations and Ranching." University of New Mexico, Working Paper <http://economics.thacher.us/Home/research2/workingpapers/GrimsrudEtAl-submission-10-30-09.pdf/view>

Jones, G., J. Sullivan, P. Aracena, K. Krueger, W. Chung. "Weed Treatment Planner (WTP) User Guide." University of Montana, Sep. 2010. www.cfc.umt.edu/wtp.

McKee, Gregory J., Colin A. Carter, James Chalfant, and Rachael E. Goodhue. "Bioeconomic Modeling of an Invasive Species Control Problem in Agriculture." North Dakota State University, March 2006, www.ext.nodak.edu/homepages/aeddept/pdf/SimulationAR.pdf.

Millock, Katrin, and David Zilberman. "Collective Penalties and Inducement of Self-Reporting." Centre d'Economie de la Sorbonne, UMR 8174, 2006, <http://ideas.repec.org/p/mse/wpsorb/v06048a.html>.

Nogueira, L., and T. L. Marsh. "FMD in the Mexican Cattle Industry." Washington State University, 2010. <http://www.impact.wsu.edu/MarshFiles/Mexico%20FMD.pdf>

Orden, David, Lili Gao, Xiang Xue, Everett Peterson and Suzanne Thornsby. "Technical Barriers Affecting Agricultural Exports from China: The Case of Fresh Apples." GII Working Paper No. 2007-2, Global Issues Initiative, Institute for Society, Culture and Environment, Virginia Tech, December 2007. (http://www.gii.ncr.vt.edu/docs/GII_WP2007-2.pdf)

Perevodchikov, E.V. and T. L. Marsh. "FMD in the Canadian Livestock Sector." Washington State University, 2010. <http://www.impact.wsu.edu/MarshFiles/CanadaFMD.pdf>.

- Schroeder, Ted C. and Dustin L. Pendell. "Value of Animal Traceability Systems in Managing a FMD Outbreak." Kansas State University, PREISM Final Report, U.S. Department of Agriculture, Economic Research Service, 82 pp., Oct. 17, 2007, (<http://www.naiber.org/Publications/NAIBER/Value.of.Animal.Traceability.Systems.pdf>).
- Thacher, Jennifer, Janie Chermak, Kristine Grimsrud, and Kate Krause. "The Decision to Manage Invasive Weeds: Which Factors Matter?" University of New Mexico, Working Paper <http://economics.thacher.us/Home/research2/workingpapers/SEA.pdf/view>
- Tozer, P., T.L. Marsh, and E. V. Perevodchikov. "Domestic and Trade Impacts of Foot and Mouth Disease on the Australian Beef Industry." Washington State University, 2010. http://www.impact.wsu.edu/MarshFiles/Tozer%20Manuscript_170310.pdf
- Thornsbury, Suzanne, and Eduardo Romano. "Linking Risk and Economic Assessments in the Analysis of Plant Pest Regulations: The Case of U.S. Imports of Argentine Lemons." GII Working Paper No. 2007-1, Global Issues Initiative, Institute for Society, Culture and Environment, Virginia Tech, December 2007. http://www.gii.ncr.vt.edu/docs/GII_WP2007-1.pdf
- Wolf, C., J. Hadrich, R.D. Horan, P. Paarlberg, and J. Kaneene. "Economic Assessment of the US TB Eradication Program." Michigan State University, Report to the U.S. Department of Agriculture-Animal and Plant Health Inspection Service, May 2008.

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