Summary of the International Pest Risk Mapping Workgroup meeting sponsored by the Cooperative Research Program on Biological Resource Management for Sustainable Agricultural Systems

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The conference succeeded in stimulating new ideas about how to incorporate climate change, economics, and uncertainty into pest risk models and maps for invasive alien species and how to communicate these improved results to biosecurity policymakers. The full proceedings of the meeting will appear in an upcoming issue of the journal NeoBiota.

Plant biosecurity is a vital component of agricultural sustainability. The WTO Agreement on the Application of Sanitary and Phytosanitary Measures emphasizes the roles of science and transparency in decisions to protect plant health and guard against unfounded phytosanitary concerns becoming a hindrance to trade. Pest risk maps illustrate where invasive alien arthropods, pathogens, and weeds (i.e., pests) might become established and cause harm to natural and agricultural resources within an area of concern. Such maps can be powerful tools to assist policymakers in matters of international trade, domestic quarantines, biosecurity surveillance, or pest-incursion responses. The International Pest Risk Mapping Workgroup met in Tromsø, Norway from 23-26 July, 2012. Participants addressed the challenges of incorporating climate change into long-term risk projections for invasive alien species; calculating the economic effects of species invasions, and quantifying uncertainties in forecasts about future invasions. A special symposium focused on the interface between science and policy. The meeting was attended by 30 biologists, economists, and policymakers from Australia, New Zealand, Canada, the United Kingdom, Finland, Norway, the Netherlands, Hungary, France, Italy, and the United States. This document summarizes the major themes that emerged from the meeting.

Pest risk science and policy. Effective management of biosecurity risks requires close interactions between pest risk assessors (scientists) and risk managers (policymakers). Risk assessors evaluate the probability and magnitude of harm from new species incursions and may evaluate options to mitigate those risks. National biosecurity agencies and regional plant protection organizations may draw upon scientific and modeling input as they develop standards for phytosanitary measures. Pest risk assessment methods being developed or enhanced by this workgroup frequently underpin decisions about which species to survey and regulate. For example, the Norwegian Scientific Committee for Food Safety concludes that small woodboring insects in some imports of North American wood chips pose a high risk to Norwegian forests. Invariably, pest risk assessments identify uncertainties that might benefit from additional research. The establishment of the CSIRO Biosecurity Flagship in Australia exemplifies the challenges and opportunities of aligning researcher capabilities with policymaker expectations. Research economists can offer policy analysis tools that estimate the likely impacts an invasive species might have on an economy, under any number of policy scenarios. They can evaluate these impacts from a range of social, environmental and economic perspectives to determine what, if anything, should be done to mitigate these impacts. Practical constraints (e.g., information quality) and policy constraints (e.g., public comment periods) can affect assessors’ choices about which methods to use to develop pest risk maps. The challenge for pest risk assessors is to balance rigor and timeliness in their work to obtain an acceptable degree of accuracy for policymakers, and for policymakers, the challenge is to describe clearly what information is needed to support time-critical decision-making.

Pest risk and climate change. Climate change is expected to affect the distribution and phenology of pests and crops. Some invasive alien species, previously abated by cold stress, may become problematic in new regions. For example, the Asian citrus longhorned beetle could potentially cause significant damage in parks, gardens, and forests in some coastal areas of Norway if it is able to overwinter there. Process-oriented simulation models
have identified other, currently-damaging species that may become less problematic as future heat-stress increases. For migratory pests, climate change may alter the spatio-temporal synchronization of the pest and crop and affect the extent of damage such pests may cause. Furthermore, elevated levels of CO₂ may stimulate plant growth in certain crops and offset some damage from invasive alien species. **Given significant uncertainties about climate change and subsequent biological responses, adaptive management approaches, guided by models, seem prudent to address future risks from invasive alien species.**

**Pest risk and economics.** Economic analysis tools like benefit-cost analysis and break-even analysis are effective in condensing complex information into relatively simple metrics about the potential impacts from invasive alien species and the potential benefits of preventative or ameliorative actions. These tools are particularly useful when the impacts of invasive species are limited to agricultural commodities. **Methods that integrate pest spread and climate suitability models with crop productivity models have been developed to estimate economic aspects of pest risk in terms that are compatible with international standards for phytosanitary management.** These bioeconomic models may only be suitable for informing short- to medium-term risks (e.g., <30 years). Substantial uncertainties associated with future greenhouse-gas emissions, concomitant climate changes, and biological responses to these changes make longer-term forecasts difficult.

**Pest risk and uncertainty.** Uncertainty arises from a number of sources and affects the assessment of pest risk. If policymakers fail to consider uncertainty, they may make incorrect decisions. One type of uncertainty arises from a fundamental lack of knowledge. Lack of knowledge can have a major impact on decisions, for example, about which species to target during biosecurity surveillance. Risk-scoring methods exist to help prioritize species, often only requiring coarse characterizations of species traits. A new method analyzes the geographic distribution of species assemblages, often more reliable information than current ecological knowledge about a species, to estimate the relative potential of new species to become established. Another source of uncertainty arises from inherent variation in some model parameters. New analytical methods are being developed to provide formal treatments of parametric uncertainty and to address the perceived risk aversion of some policymakers. Initial investigations suggest that the incorporation of a policymaker’s risk perceptions adds credibility to pest risk maps and narrows the set of geographic locations that would need to be targeted by costly inspections and public outreach activities. Even under the best of circumstances, pest risk maps are often challenging to develop and difficult to interpret correctly. **Guidance in the form of decision support systems is being developed to address these issues, ensuring that pest risk maps are fit for purpose and contribute fully to plant health biosecurity.**

**Pest invasions, spread, and surveillance.** Biosecurity policies often strive to prevent the introduction, or slow the spread, of invasive alien species. There is a significant gap about between what we know and what we need to know about invasion pathways. Probabilistic pathway models that link the arrival of invasive organisms to existing trade flows and transportation corridors are being developed to estimate rates of pest arrivals at specific locations. Remote sensing and bioclimatic analyses are being integrated to model the distribution of forest trees at a very fine scale. Simplified spread models inform where invasive species might occur over time and the rate at which economic or other impacts might accrue. Studies are being conducted to quantify the rate at which natural selection drives adaptation to local conditions in an invading species. New geospatial data standards allow synthesis of diverse geographical data to improve pest detections in the field. New statistical treatments of survey data evaluate biosecurity strategies more rigorously, particularly when detection-surveys fail to find a targeted pest. New pest management models identify area-wide management strategies designed to maximize agricultural profitability and keep pests below economic threshold levels. **Each of these contributions helps to improve the rigor, and ensure the adequacy, of biosecurity policy decisions.**