

Proposal for a Base Evaluation Monitoring Project (Sept. 28, 2007)

TITLE: Probabilistic Commodity-Flow-Based Focusing of Monitoring Activities to Facilitate Early Detection of *Phytophthora ramorum* Outbreaks.

LOCATION: The researchers supported by this grant will be located in Northfield, Minnesota. The subjects of the grant are forests throughout the eastern United States, with an emphasis on forests in the Appalachian region.

DURATION: Year 1 of a 1-year project.

FUNDING SOURCE: Base Plan

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PROJECT OBJECTIVES: Through the use of trace-forward information regarding the shipment of *P. ramorum* infected nursery stock provided by the USDA Animal and Plant Health Inspection Service (APHIS), supplemented by commodity flow data from the US Departments of Commerce and Transportation, the analytical techniques and software developed by this project will allow forest health managers to focus their limited resources on areas with the greatest likelihood of new *P. ramorum* infestation and thus, more quickly identify newly infested areas, increasing the likelihood of successful intervention before the pathogen crosses the urban-forest interface.

JUSTIFICATION: Although *P. ramorum* has only been detected in natural forests in California and Oregon, there is concern that the pathogen may be accidentally introduced elsewhere in the country, particularly in oak-dominated portions of the eastern United States. A potential pathway of introduction is transfer of the pathogen from infected nursery plants to susceptible understory forest species (e.g., *Rhododendron* sp.) at the forest-urban interface. Despite current federal restrictions, the interstate shipment of West Coast nursery stock remains a serious risk, as is evident from the detection of infected plants in nurseries in Indiana, Maine, and other states in 2006. The USDA Animal and Plant Health Inspection Service (APHIS) and the USDA Forest Service have ongoing national *P. ramorum* survey programs; these programs can be made more efficient by identifying locations throughout the U.S. that are most likely to receive infected nursery stock.

This project addresses three of the nine areas of interest specifically mentioned in the RFP for Base Evaluation Monitoring proposals.

- Tree mortality. Sudden Oak Death (SOD), caused by the *P. ramorum* organism, poses a serious threat to oak species throughout North America. If *P. ramorum* becomes endemic to eastern forests, oak mortality is expected to be widespread, leading to a significant change in the species composition of these forests.
- Insects and Diseases. It appears that the disease SOD, and the causative parasite *P. ramorum*, are well on their way to becoming endemic in the western US. The objective of this project is to support efforts to isolate *P. ramorum* in its current range while effective eradication techniques are being developed.
- Validating or filling data gaps in insect and disease risk models. The primary activity to be funded under this proposal is the extension of an existing probabilistic risk assessment model to more robustly utilize commodity flow information and trace-forward data of confirmed discoveries of *P. ramorum* infected plants within the eastern US.

DESCRIPTION:

The funding sought under this grant proposal will support a summer undergraduate research student for a period of 10 weeks during the summer of 2008, along with ancillary support for office supplies and general overhead. Saint Olaf's matching funding will consist of six weeks of faculty salary as well as software and computer hardware support.

- a. Background: Some important progress has already been made in our effort to use probabilistic modeling to identify likely sites of *P. ramorum* in eastern forests based on nursery stock inspections. The commodity flow network relevant to *P. ramorum* transmission has been created by Frank Koch. A simple Bayesian model has been implemented under the assumption that a single source is responsible for all newly discovered infestations. Independence assumptions have been made regarding infestation patterns and the role of shipment levels in assessing the risk of infesting a previously pristine site. A paper based on these results, "*Predicting Movement of Nursery Hosts Using a Linear Network Model*," has been accepted for publication in the Proceedings of the Third Sudden Oak Death Science Symposium held on March 5-9, 2007, in Santa Rosa, California.

This summer additional research, funded under an omnibus grant to Saint Olaf College by the Howard Hughes Medical Institute (HHMI), resulted in a more robust probabilistic model that eliminates the assumption of a single infection source. A Java-based software package implementing this model has been developed and delivered to the USDA Forest Service. The next step in this project is to consider independence assumptions made in the existing model and to incorporate the APHIS trace-forward data. Unfortunately, the HHMI grant that supported this summer's research is set to expire at the end of this academic year, leaving us to search elsewhere for funding support for this project.

- b. Methods: The current state of the probabilistic analysis is hampered by a series of independence assumptions. The different types of nursery stock flow are not accounted for in the probabilities of infection calculated within the existing model. The existing analysis can also be strengthened using the valuable trace-forward information available from APHIS. The methods used in the proposed project will be the standard techniques of model building. A careful reconsideration of the precise problem definition, the

identification of data to be used in the model, the development of strategies to identify surrogates for the inevitable data items that are desired but not readily available. Standard Bayesian probabilistic techniques will be used. Techniques from optimization, graph theory and numerical analysis may also play an important role in the project's completion.

- c. Products: The proposed project will result in two deliverables, a technical paper describing the probabilistic techniques used in the analysis along with a comprehensive list of data sources. Examples of the application of the model will also be included.

The second deliverable will be an open source software package, written in the Java programming language for portability across hardware and software platforms, that implements the model. Full documentation of the software will be included.

Under the direction of the Project Leader, the summer research student will extend the existing infection model to incorporate probabilistic analysis using APHIS trace-forward data, identify new data needs/sources and design and write the computer software and accompanying documentation and user's manual.

- d. Schedule of Activities: Research activities will be conducted during the summer months of 2008 and possibly during the first (fall) semester of the 2008-09 academic year. The summer session will be focused on incorporating more detailed commodity flow and APHIS information into the existing probabilistic model. Software development and related documentation will be done during the summer or fall. The funding being sought under this RFP is to support stipends for one undergraduate summer research student and for faculty salary during the summer and fall terms. The faculty salary for time spent on this project represents the Saint Olaf College matching contribution to the funding sought from the USDA Forest Service.
- e. Progress/Accomplishments: The accomplishments already achieved in this project, including software development and a manuscript accepted for publication, have been documented elsewhere in this proposal.

COSTS:

	Item	Requested FHM EM Funding	Other- Source Funding	Source
Administration	Salary and Housing (Student)	\$5329	\$0	
	Salary (Professor, 6 Weeks)	\$0	\$8262	Saint Olaf College
	Overhead	\$2077	\$0	
	Travel	\$0	\$0	
Procurements	Contracting	\$0	\$0	
	Equipment	\$0	\$0	
	Supplies	\$150	\$0	
Totals		\$7556	\$8262	