WEATHER-BASED PEST RISK MAPPING PROJECT

2010

FINAL REPORT

This report fulfills the deliverable of requirement
for a final project report for year 2010.

**Edited by Roger Magarey, Dan Borchert,
and Jessica Engle**

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**Cooperative agreement 10-8100-0862-CA
between NCSU and
USDA-APHIS-PPQ-CPHST-PERAL/ NCSU**

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Executive Summary

This document is the annual report for the 2010 NCSU-APHIS Cooperative Agreement **10-8100-0862-CA** "Weather-Based Mapping of Plant Pests," Turner Sutton, NCSU, Principal Investigator.

Highlights of 2010

- Updates CAPS Top 50 pest risk maps, including improved commodity and forest inventory data and the addition of maps for Puerto Rico, Hawaii and Alaska.
- Completion of Pareto summary risk maps for Top 50 pests.
- Development of Global Analyst tool for improved climate matching.
- Improved speed and functionality for NAPPFAST-OBS, including the Exotic Pest Targeting Tool.
- Migration of old modeling tools from the old NAPPFAST system to the new NAPPFAST-OBS system. This change enabled phasing out of the old NAPPFAST system.
- Acceptance of paper on CAPS Risk mapping in the EPPO Bulletin.

Recommendations for future development of NAPPFAST

- The development of economic impact maps to better allow PPQ managers to better target pest detection programs.
- The creation of a modeling building tool. This addition would allow modelers to create more complex and adaptable models that can predict pest epidemiology and impacts beyond that of the existing model templates. A committee featuring experts on population modeling, epidemiology, and pest dispersal should be formed to develop standards for model design including inputs and outputs.
- The creation of a data management role to provide online tools for cleaning and improving phytosanitary and pest distribution data sets.
- Creation of a NAPPFAST public page to allow users to see pest risk maps in an interactive online GIS format.
- A tool for allowing code developed in the statistical package R to be run as an executable file in NAPPFAST. This would enable researchers developing models such as wavelets or pathway models to use NAPPFAST as online tool to run models.

The above recommendations will be considered for incorporation into future NAPPFAST work plans.

Project Staff and Cooperators

Principal Investigator
Dr. Turner Sutton, Professor of Plant Pathology
North Carolina State University
Don E. Ellis Building 201, Box 7405
Raleigh, NC 27695
Telephone: 919 515-6823, Fax: 919 515-8795

Project Staff at NCSU
Dr. Roger Magarey, Senior Researcher
Dr. Jessica Engle, Plant Pathologist, NCSU
Scott Chanelli, Student Assistant

Project Staff at APHIS-PPQ-CPHST
Dr. Daniel Borchert, Risk Analyst
Dr. Glenn Fowler, Risk Analyst
Mr. Dan Fieselmann, National Science Program Leader for Survey and Detection

Project Staff at ZedX, Inc.
Dr. Joseph Russo, Agricultural Meteorologist
Dr. Joseph Pietrowicz, Meteorological Data Manager
Mr. Jay Schlegel, Meteorological Specialist
Mr. Brian Holderman, Programmer
Mr. Nathan Gerber, Programmer
Mr. Eric Hudish, Programmer
Ms. Julie Golod, Database Manager (PSU)

Cooperators from Pathways Risk Mapping Group
Dr. Manuel Colunga-Garcia, Michigan State University
Dr. Frank Koch, U.S. Forest Service/NCSU
Dr. Denys Yemshanov, Canadian Forest Service
Dr. Andy Tatem, University of Florida
Ms. Anna Szyniszewska, University of Florida
Ms. Marla Downing, U.S. Forest Service.

Part 1 – NCSU Deliverables

1. Risk maps

The 2010 CAPS Pest Matrix has been completed with the following updates.

New states and territories

The states of Hawaii and Alaska have been added as additional pages of the host, NAPPFAST, and Final Risk maps. After consultation with stakeholders, the Puerto Rico territory was also added as an additional page to the maps.

Host maps

The updated host maps have nearly all commodities surveyed in the 2007 census of agriculture, for a total of 127 possible hosts. The forestry data were also updated to create 49 forestry layers based on forest species. Species in *Quercus*, *Populus*, and *Ficus* were grouped by genus.

Climate match maps

Climate matching is used for weeds and mollusks where laboratory data on growth and development are not available. The climate match was based on a pest's observed distribution and the BAMM 1.0 algorithm (http://www.nappfast.org/usermanual/BAMM_doc_2009_1019.pdf). The climate match maps have been updated with an improved version of the algorithm (Fig. 1.1). The new maps provide much more specific predictions of pest distribution than the old ones. Documentation for climate match risk maps is in progress.

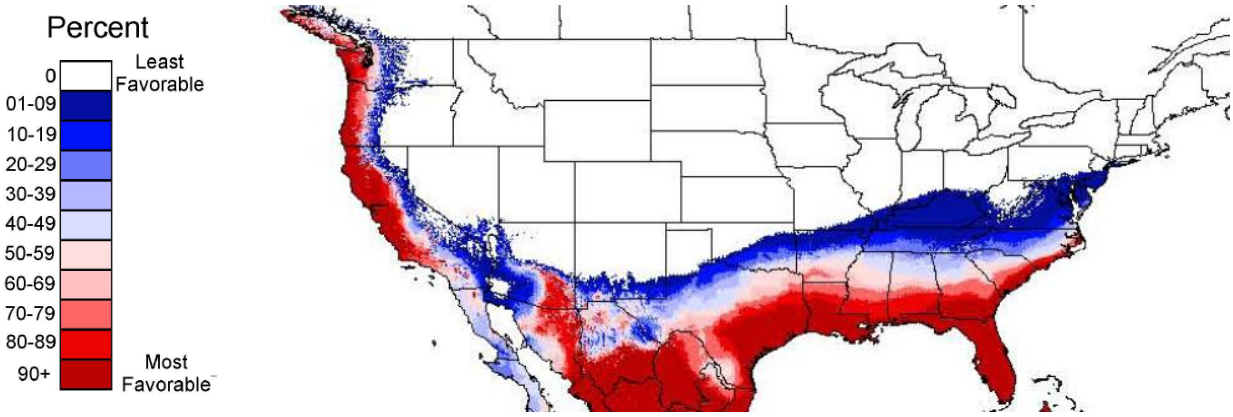


Figure 1.1. Climate match map for the invasive plant *Vitex rotundifolia*.

Pathway risk maps

Pathway Risk maps (Importation point maps) have been constructed for the Cooperative Agriculture Pest Survey (CAPS) Analytic Hierarchy Process (AHP) Top 50 Pests of 2009. More details on the procedure used to develop these maps are available in the NAPPFAST 2009 Annual report.

Pareto risk maps

The host, NAPPFAST, and importation point maps have been combined to create a Pareto Summary risk map (see Fig 1.2). The Pareto maps were

constructed by Denys Yemshanov (Canadian Forest Service) with help from Frank Koch (North Carolina State University/U.S. Forest Service) and data provided by NAPPFAST staff. Pareto is a more defensible foundation for incorporating the tradeoffs between multiple risks. Other approaches such as multiplicative or additive weights were tried, but did not produce maps that represented the most optimal survey need.

The Pareto approach does not require prior experts' beliefs and the preferences of individual risk components. The final ranks are ordinal and can be used directly to prioritize surveillance and regulatory efforts. They can also be easily rescaled to a desired range (e.g., 0-10). The Pareto maps were completed in the fall of 2010.

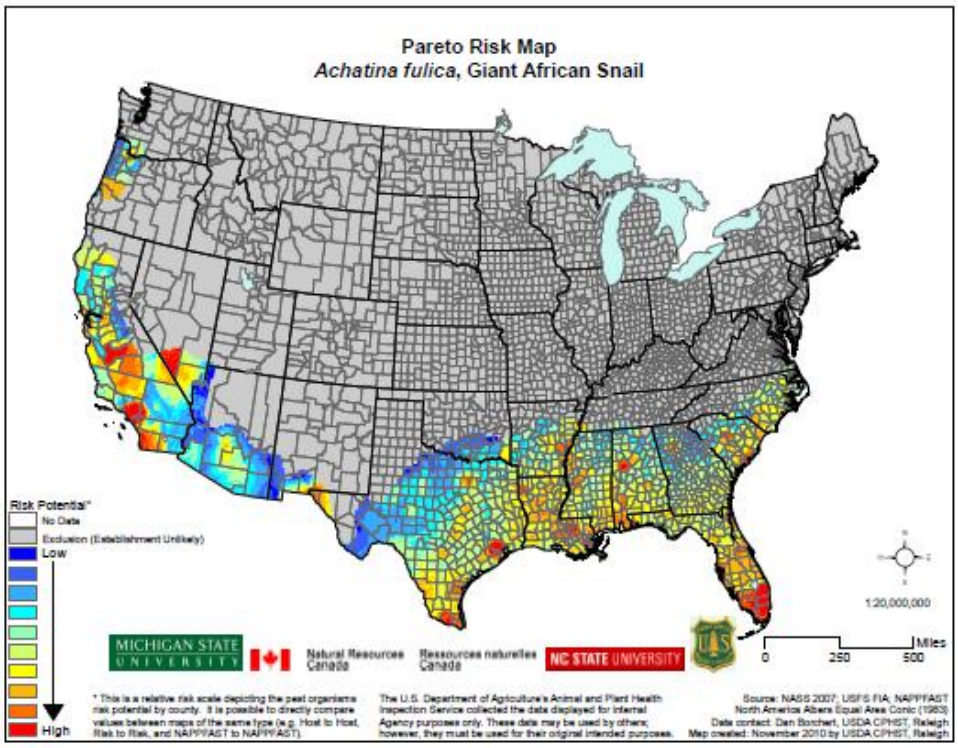


Figure 1.2. Pareto risk map for the exotic land snail *Achatina fulica*

CAPS 2011 pest targets

New models and NAPPFAST climate maps were developed for *Diaphania perspectalis*, *Geosmithia* sp., and *Gymnosporangium yamadae*. New models have been developed for *Pseudomonas syringae* pv. *aesculi*, *Eupoecilia ambiguella*, and *Fusarium oxysporum* f. sp. *cubense* with maps in progress.

Publication of risk mapping methods

A paper detailing the risk mapping procedure used to develop host, climate, pathways, and Pareto risk maps has been accepted by the EPPO Bulletin and will be published in the April edition (Magarey et al., 2011). Roger Magarey, Dan Borchert, Jessica Engle, Manuel Colunga-Garcia, Frank Koch and Denys Yemshanov authored the paper.

2. Economic models

Please see the section on economic analysis in Part 3 of the report.

3. Training of CAPS cooperators

In early February 2010, Dan Borchert provided training on NAPPFAST to pest survey specialists at the Professional Development Center in Frederick, Maryland.

4. International and national cooperation

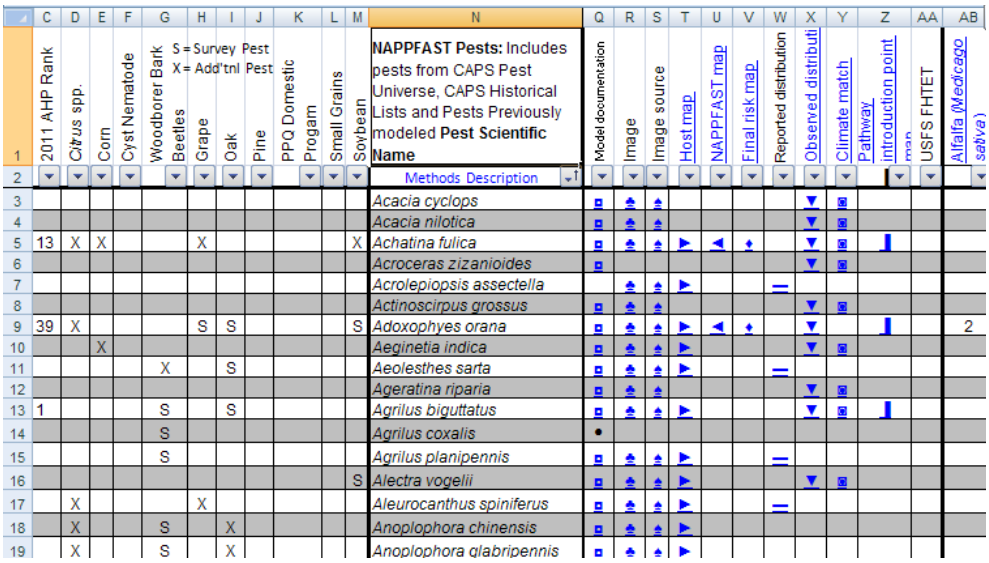
NAPPFAST staff participated in the International Pest Risk Mapping and Modeling (IPRM&M) workshop. They presented a paper on "A Framework for Modeling and Mapping Economic Impacts." One important effort led by Darren Kriticos, Commonwealth Scientific and Industrial Research Organisation (CSIRO), is to create a Good Practice Manual for use by scientists working in the field. The manual will include sections on model types, selection and use of models, uncertainty, and sources of data. Other topics at the 2010 meeting will include self-organizing maps and development of a group website. A proposed 2011 meeting may focus on economics.

Roger Magarey was the 2010 chair of the NCERA-213 (formerly 148) Migration and Dispersal Committee. The committee is planning to develop training materials for international researchers in pest migration and dispersal in the following areas: NAPPFAST, aerobiological modeling, population genetics, practical aerial sampling, aerobiology/meteorology 101, insect ecology, and pathways.

5. User manuals and websites

The NAPPFAST.org website received a substantial upgrade this year. The most important upgrade was the CAPS 2010 pest matrix (Fig. 1.3). The matrix includes new introduction point risk maps and improved climate match risk maps. The matrix has been greatly improved in terms of its functionality and ease-of-use. For example, a sort function allows users to select pests that are assigned to each of the CAPS commodity surveys or to select pests that attack a National Agricultural Statistics Service commodity. The documentation for these risk maps was also updated, including a description of methods used to create the pathway risk maps. Additional research information on pathway risk mapping is now available from Michigan State University cooperator Dr. Manuel Colunga-Garcia's website, www.metroinvasive.info.

CAPS 2010 matrix



	C	D	E	F	G	H	I	J	K	L	M	N	Q	R	S	T	U	V	W	X	Y	Z	AA	AB
1	2011 AHP Rank	*Citrus* spp.	Corn	Cyst Nematode	Woodborer Bark Beetles	S = Survey Pest X = Add'tnl Pest Grape	Oak	Pine	PPQ Domestic Progam	Small Grains	Soybean	**NAPPFAST Pests:** Includes pests from CAPS Pest Universe, CAPS Historical Lists and Pests Previously modeled **Pest Scientific Name**	Model documentation	Image	Image source	Host map	NAPPFAST map	Final risk map	Reported distribution	Observed distributi	Climate match	Pathway introduction point	USFS FHTET	Alfalfa (*Medicago sativa*)
2												Methods Description												
3												*Acacia cyclops*												
4												*Acacia nilotica*												
5	13	X	X			X					X	*Achatina fulica*												
6												*Acroceras zizanioides*												
7												*Acrolepiopsis assectella*												
8												*Actinoscirpus grossus*												
9	39	X				S	S				S	*Adoxophyes orana*												2
10			X									*Aeginetia indica*												
11					X		S					*Aeolesthes sarta*												
12												*Ageratina riparia*												
13	1				S		S					*Agrilus biguttatus*												
14					S							*Agrilus coxalis*												
15					S							*Agrilus planipennis*												
16											S	*Alectra vogelii*												
17		X				X						*Aleurocanthus spiniferus*												
18		X			S		X					*Anoplophora chinensis*												
19		X			S		X					*Anoplophora glabripennis*												

Figure 1.3. View of 2010 CAPS Pest Matrix.

The website received other upgrades, including updated presentations, reports, and user manuals. The website now includes 2010 presentations made by Roger Magarey at the University of Florida's Colloquium on Plants of Regulatory Significance series and Glenn Fowler at the North American Plant Protection Organization pathway risk analysis symposium. A user manual for the BAMM climate match tool written by Jay Schlegel of ZedX has also been placed online.

Video manuals

A decision has been made to create future user manuals using video screen capture technology. Camtasia software is being used by ZedX to create videos with narration describing the NAPPFAST website. The following videos have been completed and have been or soon will be posted on the restricted access website. :
1) NAPPFAST Fundamentals – site access,
2) Exotic Pest Targeting Tool; and
3) Data upload tool.

6. Model validation

Work continues on model validation. NAPPFAST phenology models for *Helicoverpa armigera* (old world bollworm) and *Thaumatotibia leucotreta* (false codling moth) are being validated with flight observations from South Africa. A study comparing the number of generations observed in the field with those predicted by NAPPFAST for 21 arthropod pests has been extensively revised and is now available at NAPPFAST.org.

Part 2 – NAPPFAST Deliverables

The following NAPPFAST deliverables saw progress during the first six months of the project period.

1. Project planning

Prepare a project planning document to schedule and track deliverables.

The completed planning document specifies dates of delivery, roles, and responsibilities to ensure orderly completion of the tasks listed below. The planning document is used to generate weekly tasks for the programming team.

2. Tool improvement

Improve upon the performance of the Program Planning, Global Risk Analyst, Risk Analyst and Modeler roles based upon user (program managers, survey specialists and risk analysts) feedback.

Exotic Pest Targeting tool

The Exotic Pest Targeting Tool (EPTT) allows a user to combine risk maps, dynamic pest models, and pest data in an online interactive GIS environment. The EPTT was substantially reworked to make maps and other products load quickly in Internet Explorer 7, PPQ's standard browser. For example, the product data navigation pane was redesigned to display additional map products including pathway risk maps. Product display is now customizable from the Program Management tool in the Administration role.

Updated 2010 NAPPFAST risk maps have been loaded into the system. The requested digital images from the National Agricultural Image Program are now largely completed, with coverage for a large part of the United States. A zoom-out tool has been added to the navigation pane to allow users to zoom out quickly to the global extent. Additional work to display pathway risk data (see Fig. 2.1 below) is in progress. For example, reference layers for ports, airports, and border crossings have been added.

Global Analyst

The Global Analyst tool is in progress. The Global Analyst role consists of four components: Data Analyst, GBIF Upload, Venn tool and the BAMM tool. The Global Anlayst tool is expected to be rolled out to Canadian stakeholders on February 22, 2011.

Global Risk Analyst tool

The Data Analyst tool, which allows a user to view and edit GBIF data, is largely completed. Pests are displayed using the Species 2000 phylogenies. Users can select observations for editing. The GBIF Upload tool allows a user to upload GBIF data in CSV format is also finished but requires debugging following testing behind the firewall.

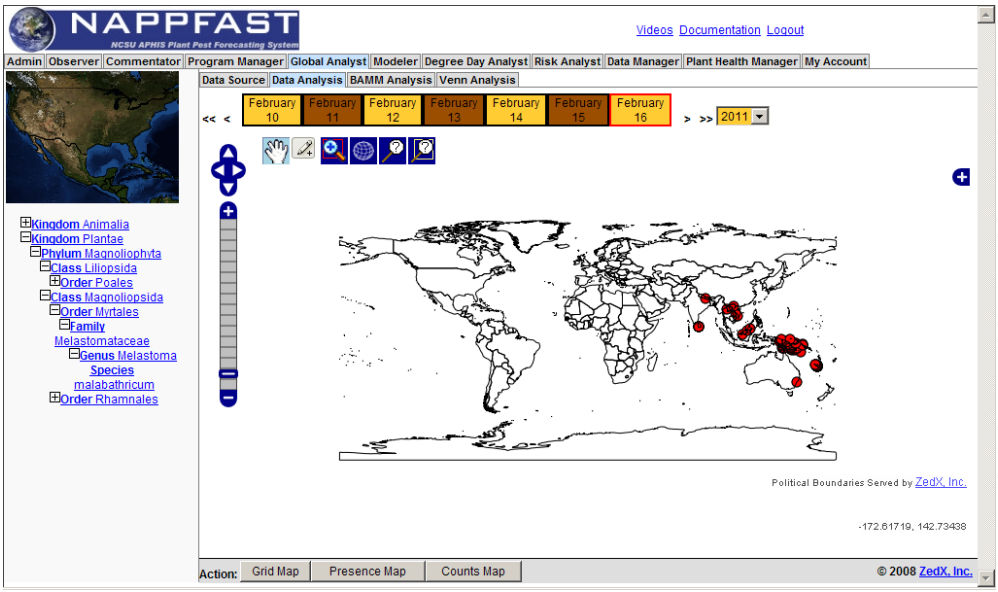


Figure 2.1. View of the Data analyst tool showing the selection of *Melastoma malabathricum*, an exotic plant.

Venn tool

The Venn tool is now available online (Fig 2.2). The tool allows users to select data layers, such as custom drawn areas, elevation, plant hardiness zones (10 year), growing degree days (10°C/50°F), Koppen classes (Peel et al., 2007), Landuse and annual precipitation. For each layer users can select class zones by either clicking on the map or on a legend class. For numerical layers, users can also enter their own lower and upper limits. After selecting two or more layers, users can create union or intersection maps from selected classes. Users are also be able to select from product maps–for example, pest risk maps created in the NAPPFAST modeling tool. The power of the tool is that it can enable a risk analyst to create specialized and summary risk map products for a given country, pest, or host. Over time, the Venn tool working environment is expected to grow richer as additional data products are added.

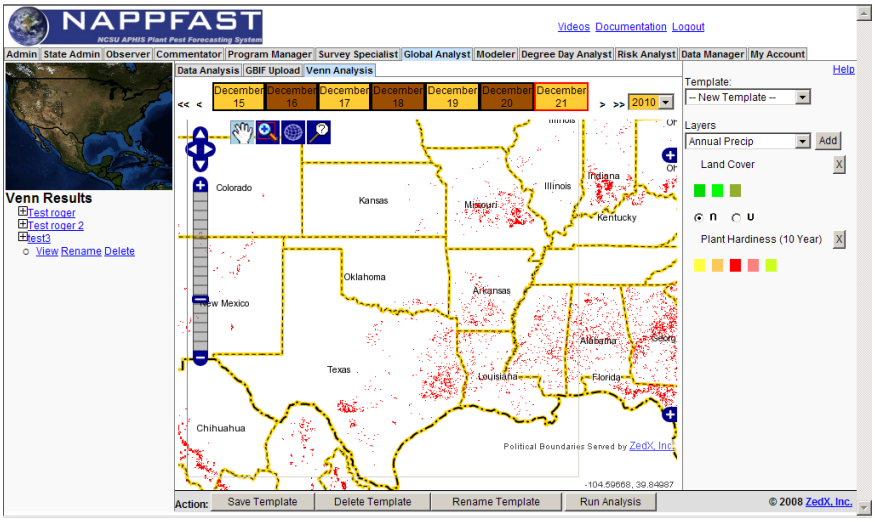


Figure 2.2. View of the Venn tool showing the intersection (red areas) of two specified classes of land cover and plant hardiness data layers.

BAMM tool

The BAMM tool has undergone a second version to make the tool more useful for pest surveillance. Instead of sending a configuration file to ZedX, users will soon be able to run BAMM on-line (see Fig 2.3 for a storyboard of the design). Users will be able to select which GBIF observarions are used in the run. Users will also be able to run BAMM for a smaller domain, for example North America, instead of having to run the whole world.

The new version of BAMM includes the option for users to choose from a confidence interval and a tolerance interval. The confidence interval is a measure of the range of values about a distribution parameter, such as the mean, of a sample population for a stated level of confidence. The tolerance interval is a measure of the proportion of a population that is represented by a sample for a range of values and a stated level of confidence.

In addition, the BAMM database has been upgraded from the NCEP reanalysis II supplemented with ISH station data to the NCEP Climate Forecast System Reanalysis (CFSR) database. The new database provides substantial improvements in data quality and resolution (Compare Fig. 2.4a with Fig 2.4b for an invasive weed, cogon grass). Saha et al. 2010 makes a detailed comparison between the two data sets (See Table 1 in their BAMS publication).

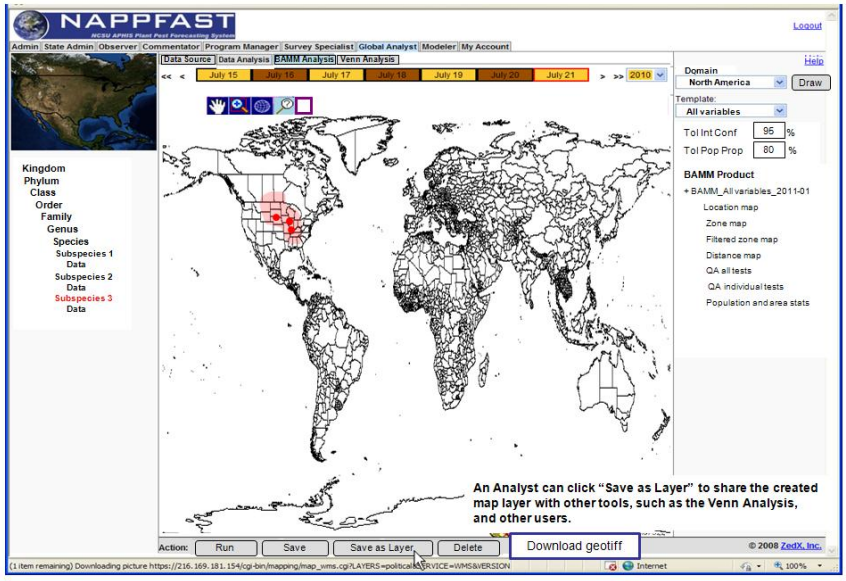
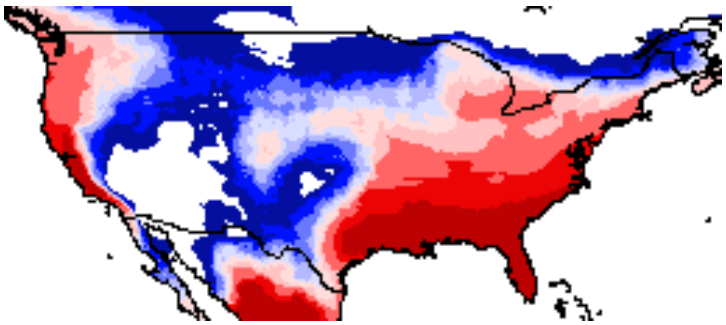
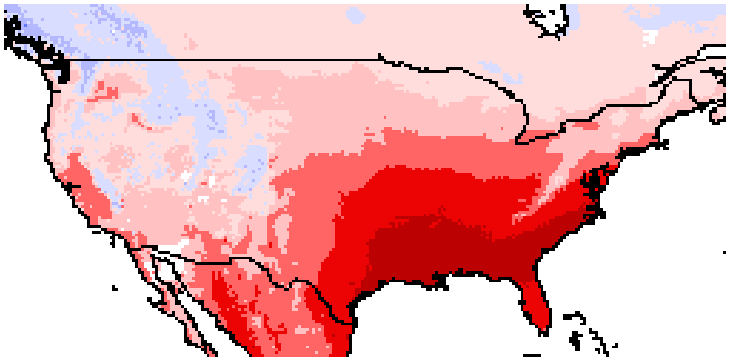


Figure 2.3. Storyboard for BAMM tool.



Old dataset: NCEP reanalysis II supplemented with ISH station data

Figure 2.4a. BAMM prediction map for the invasive grass *Imperata cylindrica* with the old (NCEP reanalysis II) data set.



New dataset: NCEP Climate Forecast System Reanalysis (CFSR)

Figure 2.4b. BAMM prediction map for *Imperata cylindrica* with the new (CFSR) data set.

Risk Analyst tool

The Risk Analyst tool consists of a Pathway Upload tool and a Pathway tool.

The Pathway Upload tool is completed but still requires additional testing. The tool enables any type of pathway or risk point data to be uploaded using common data fields, including data source, observation date, data type, data resolution, commodity host family, commodity host, pest family, pest scientific name, trade (HS code), quantity data, location data, entry port, shipment date, and origin location data. NCSU staff are working to clean up specific data sets for uploading into NAPPFAST. The cleaning process will result in standardization of host and pest names and quantities. Data are uploaded at the spatial resolution of zip code, state, or port. No personally identifiable information (PII) data is uploaded.

The Pathway tool (near completion) will allow risk analysts to create a specific view of the uploaded data sets—for example, the potential risk of exotic wood bark borers. The risk analyst will be able to select specific data sources including pest interceptions (PestID), commodity inport data (PPQ 280), imported plant data (PPQ 264), emergency actions (PPQ 523), and commercial sales databases (Salesgenie). Next the risk analysts will be able to filter or limit the data sets to specific hosts, pests, and commodity types. The resultant data layer view can then be saved and viewed by program

managers and survey specialists in the Exotic Pest Targeting Tool. According to these selections, zip codes will be colored by risk level and users will be able to query an individual zip code to query and identify risk elements.

3. Migrate modeling tools

Migrate the modeling tools from the old version of NAPPFAST to the new version.

Specifications

The migration of modeling tools from the old version of NAPPFAST to the new version has been completed. The migration includes the model set-up, model run, and model view (see Fig. 2.5). It also includes an administration tool (Copy models) to allow models (excluding maps) to be copied from the old NAPPFAST site to the new. A second administration tool allows assignment of users to modeling work groups. Currently, modelers also have a share button at the bottom of the Model Set-Up page. This function allows models to be shared from one workgroup to another.

Model set-up tool

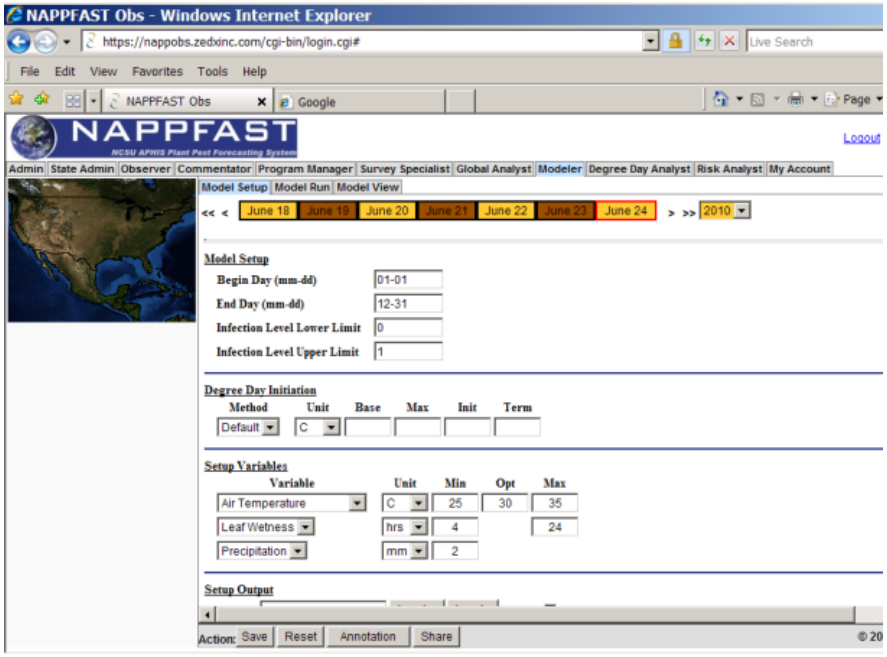


Figure 2.5. View of the modeler tool in the new NAPPFAST system.

Benefits

The migration is significant for several reasons, including allowing for greater processing speeds in the new NAPPFAST environment, which is based upon a distributed grid processing environment rather than being limited to a single server. A system is now in place to share products from the modeler role to the Exotic Pest Targeting Tool (EPTT). First, modelers have a release button on the bottom of maps in the Model view tool. Once a modeler chooses to release a map it will be available for sharing to other roles (e.g. Program manager) by the administrator using the Product Management tool (Fig. 2.6). The administrator can give products a unique display name and also control in which pests programs the products are

displayed.

Product management tool

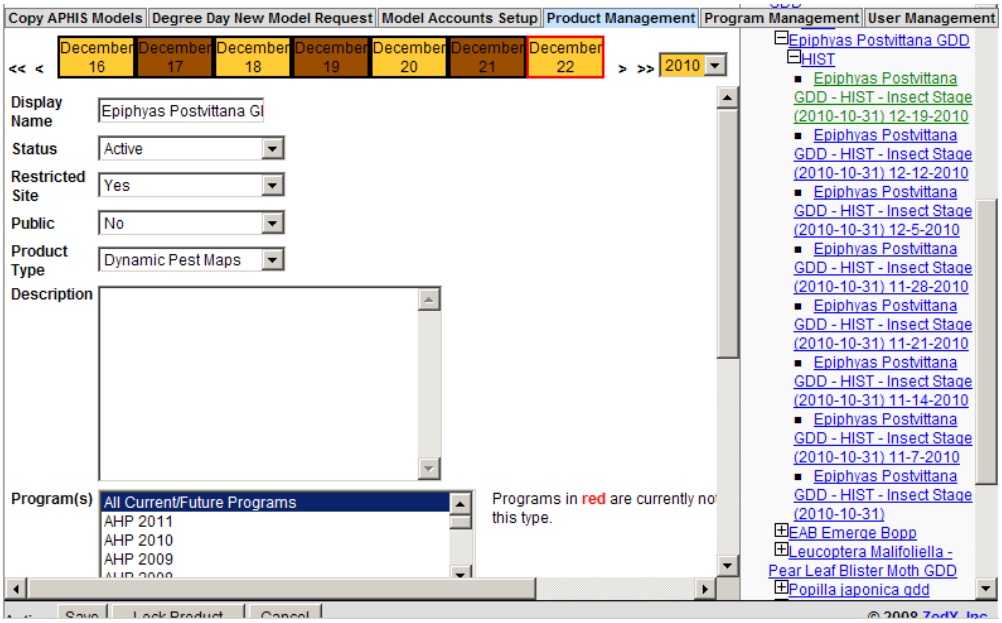


Figure 2.6. View of the Product Management tool

4. NAPPFAST Public Page

The Public Page will be an unrestricted version of the program planning tool that will allow the public to view static risk maps, dynamic maps, and metadata. The Public Page will supplement the CAPS Top 50 matrix on NAPPFAST.org and will have greater spatial capabilities and functionality.

Work on the NAPPFAST Public Page has not commenced beyond the design phase. The NAPPFAST Public Page is expected to look like the Exotic Pest Targeting Tool, except that it will not include data sets and products of a sensitive nature.

5. Model building tool

Create a graphical model building tool to be known as the "Build Template Tool."

Progress has been made on a preliminary redesign of this tool. The proposed diagrammatic flow chart design was considered to be too complex for routine use by risk analysts so we are investigating the possibility of developing a dashboard modeling approach (Fig. 2.7). The dashboard control chart would allow users to parameterize individual model components for example growth or mortality rates. The dashboard would guide users step-by-step through the model building process using a color coding scheme to show which components are completed and which ones require user input. The model building tool would keep track of inputs and output variables. One proposed advantage of this design is it would allow users to calculate damage functions resulting from the interaction between host phenological susceptibility and pest life stages.

Preliminary design

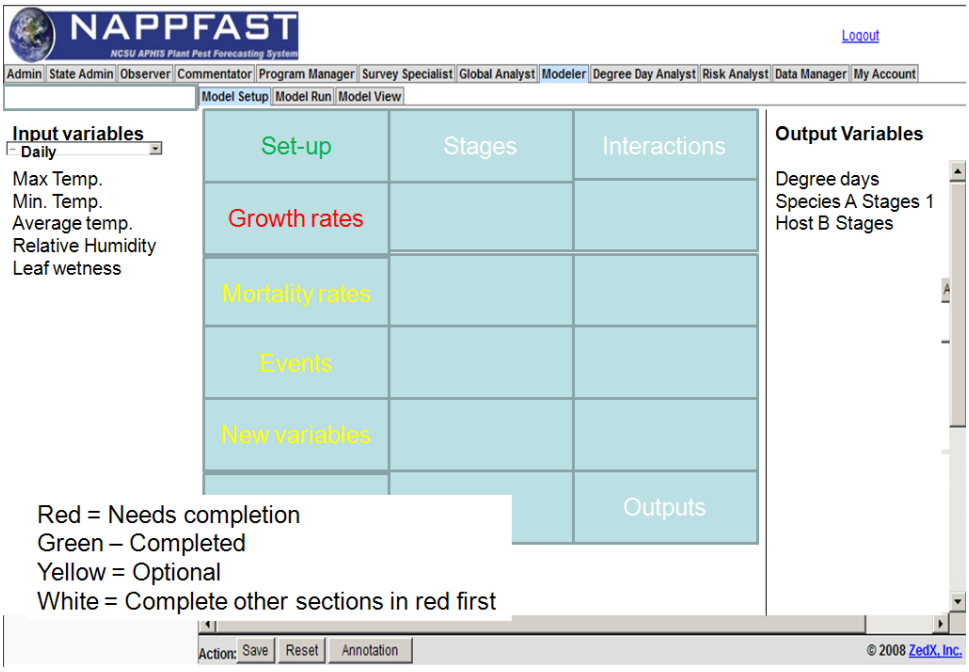


Figure 2.7. Preliminary design for a model building tool based on a dashboard design.

6. Improve run model tool

Improve the Run Model tool with the following features.
c) Create an event prediction tool to calculate quarantine exclusion periods.

Work is in progress to allow users to graph predicted dates for pest phenologies (for example, predicting future generation emergence dates for validating exclusion periods during an eradication program). This work mainly involves the preparation of climatological and forecast weather data to extend the map or graph request 18 months into the future. The remaining tasks will be scheduled for 2011.

7. Pest dispersal function

Incorporate a pest dispersal function into the Habitat Match tool, which is available to the Global Analyst and Risk Analyst roles. The dispersal function will be used to create map based products delimiting areas with a suitable climate and a high likelihood of finding undetected pest invasions that were dispersed from infested areas.

A basic dispersal function has been created. The dispersal function calculates the cumulative distance from location points were the pest has been observed. An example is shown for *Agrilus* sp. in the United States (Fig. 2.8). The power of this map is that it could potentially be overlaid with climate match and host map in the Venn tool. This three way combination map would show areas that are suitable for the beetle and the beetle has most likely already infested. The dispersal function is now a standard product in BAMM and so a dispersal map can be created every time the climate match model is run.

Location map for *Agrilus* sp.

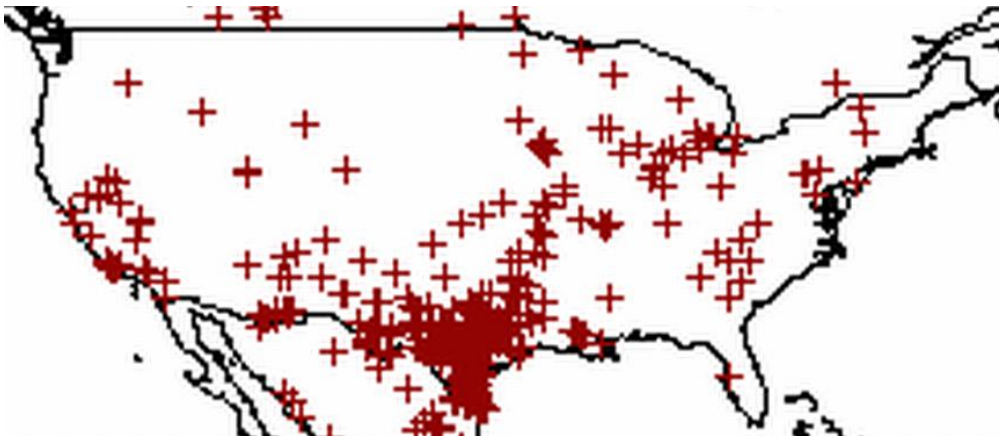


Figure 2.8. Locations where *Agrilus* sp. woodboring beetles have been reported.

Distance map for *Agrilus* sp

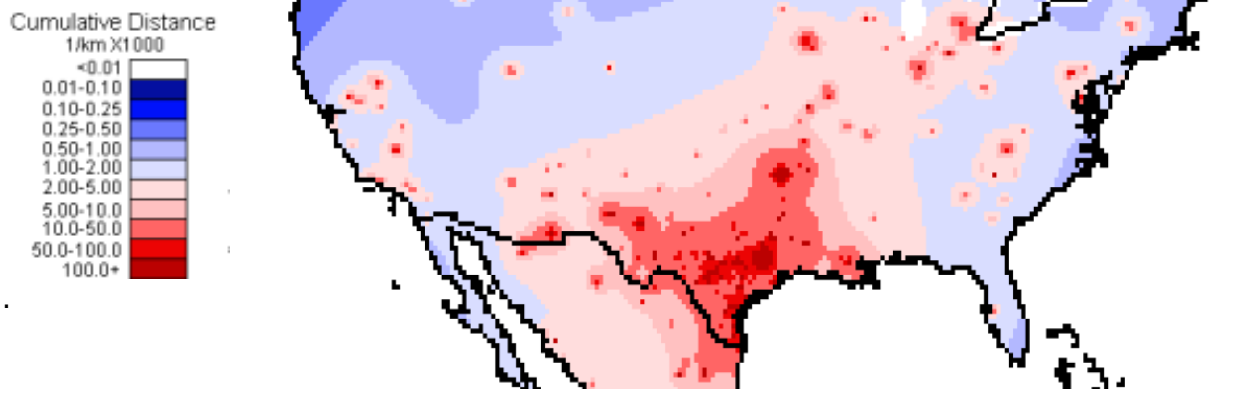


Figure 2.9. Cumulative distance function for *Agrilus* sp.

8. Climate databases

Provide online user access to comprehensive North American and Global weather databases as part of the New NAPPFAST. User access would have the following components.

a) Static or dynamic 3-D interpolation of global databases to 10 km^2 and North American databases to 1 km^2,

Degree day products

A new tool has been created in NAPPFAST called the Degree Day Analyst that allows users to download degree day maps for the conterminous 48 U.S. states (Fig. 2.10). The maps are daily degree geotiff maps for 32, 41, 42, 45, 48, 50, 52, 54, and 57°F. The 1-km geotiffs can be imported into a Geographic Information System such as ArcMap and customized for distribution to users.

Method for deriving 1k maps

The daily degree day accumulations at a 1-km resolution were generated for the conterminous United States using the following steps:

- Minimum and maximum daily temperature grids were derived from hourly, 5-km resolution Realtime Mesoscale Analysis (RTMA) grids.
- The 5-km minimum and maximum temperature grids were interpolated to a 1-km (1/120-degree) resolution using a bilinear method. Prior to the bilinear interpolation, RTMA-derived minimum and maximum temperatures were adjusted to sea level using local, date-specific, adiabatic lapse rates calculated from grid-centered temperature and mean elevation values for cells within a radius of 17.5 km. Following the bilinear interpolation, grid temperature values were readjusted to the mean elevations of the 1-km cells using locally determined lapse rates calculated prior to the interpolation.
- Daily degree days were computed using the interpolated minimum and maximum temperatures for each 1-km grid by applying the "Allen" method. (Allen, J.C. 1976. A modified sine wave method for calculating degree days. Environ. Entomol. 5:388-396).
- Accumulated daily degree day grids were created by summing the computed daily degree day grids for a requested period.
- Accumulated daily degree day grids were converted for distribution in a GeoTIFF format using a geographic projection. (North American datum of 1983, GRS 1980 spheriod, EPSG 4269).

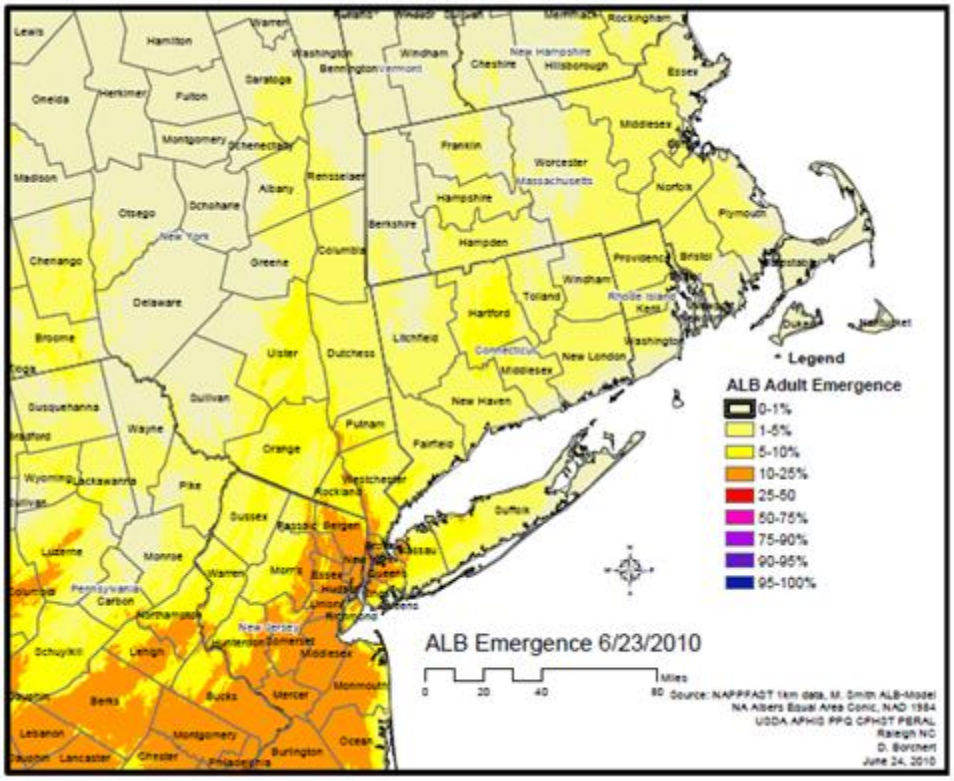


Figure 2.10. View of an emergence map as of June 23, 2010 for Asian longhorned beetle created with the 1-km data set.

Climate change plant hardiness maps

Two climate change scenarios were used to estimate plant hardiness zone (PHZ) changes for the current century. The source of these climate change scenarios was the International Panel on Climate Change (IPCC), which has overseen multiple simulations of climate changes, using varying assumptions of population, energy use, land use, economic development, etc. The result of these simulations varies considerably, with some scenarios showing relatively little global warming while others indicated substantial global warming. For this project, two simulations showing a relatively moderate amount of warming were used to generate PHZ maps. The PHZ maps generated for this project were the baseline 1961-90 PHZ map (Fig 2.11) and maps for 2010-19, 2020-29, 2030-39, 2040-49, 2050-59, 2060-69, 2070-79, 2080-89, and 2090-99 (Fig. 2.12). All maps are in geo-referenced tiff format. These PHZ maps in decadal increments are now available on www.nappfast.org.

Historical global plant hardiness zones 1961-90

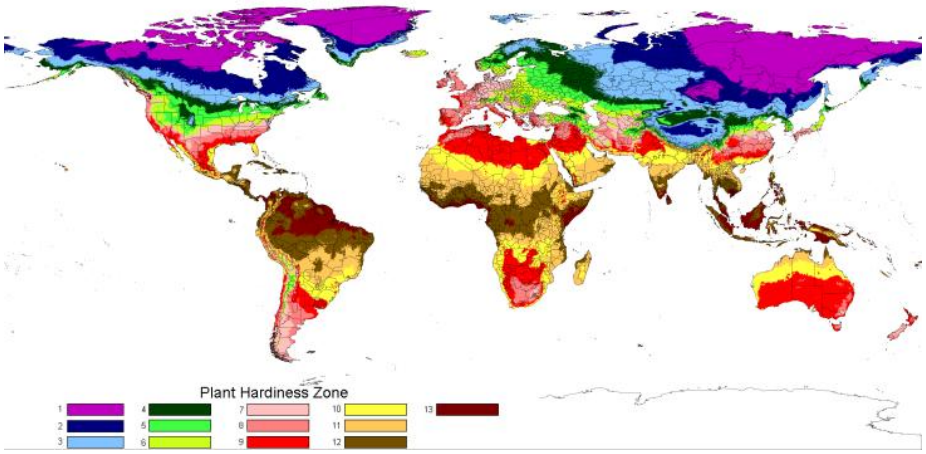


Figure 2.11. Global plant hardiness zones based for 1961-90.

Projected global plant hardiness zones in 2099

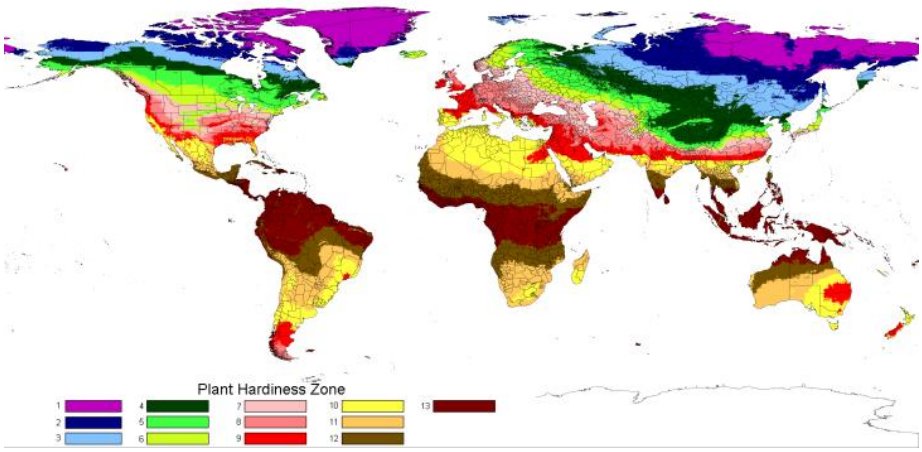


Figure 2.12. Projected global plant hardiness zones based on climate change scenarios SRA-1B (IPPC) for 2099.

b) Addition soil temperature at multiple depths to templates,

c) Online documentation of data quality and record integrity, and
d) Online documentation of data sources and data processing.

Soil temperature data not yet been added to the NAPPFAST modeler. NAPPFAST now includes online documentation. The National Agricultural Imagery Program (NAIP) document describes the year in which the background aerial images in NAPPFAST were updated. The ZedX Weather Data Documentation describes original, ZedX, and NAPPFAST weather databases sources. It also includes a list of available variables and a description of QAQC procedures. An on-line QAQC tool available from the model run tool is a web site that enables users to determine the number of weather stations that report in a user-selected region and on a given date and time.

8. Data sharing

An exchange of geo-referenced images through Web Mapping Services (WMS) has been established. The service will enable iPHIS to receive NAPPFAST products. Sample risk maps have been set up for Asian longhorned beetle and emerald ash borer. The PPQ Emergency and Domestic Programs data manager was advised of the availability of this service on August 27, 2010. Incorporation into iPHIS is pending.

Part 3 – Industry Collaboration

This project was funded under the Farm Bill section 10201 suggestion process for FY 2010.

1. **10201 Suggestion Title:** Risk Models and Data-Sharing Protocols to Promote Collaboration Between the Nursery and Seed Industries, PPQ, State Cooperators, USFS and Universities in the Early Detection, Surveillance, and Control of Exotic Pests

1. Metrics

Develop metrics to identify those exotic pests which pose the greatest immediate and future threat to the nursery and seed industries;

Metrics for exotic pest ranking

We have identified a model to rank the potential for pests to be threats to the nursery and seed industries. The quarantine significance model (QUASIMODO) model developed by David Cook (Waage et al. 2005) is an invasion-spread-control-impact model with parameters designed to allow comparison of a wide range of invasive taxa and economic/environmental pest targets. Plans to incorporate QUASIMODO into NAPPFAST are in progress. The pest-specific parameters of QUASIMDO include probability of entry, probability of establishment, costs of control, and rate of spread. The model may need to include additional parameters such as the probability of detection. Other parameters specific to the nursery and seed industry may also need to be identified with the help of stakeholders. The QUASIMODO model can be used to estimate the percent national yield reduction for a given commodity, which is the key input to the Paarlberg et al. (2005) economic model (see below). Two key scientists who developed QUASIMODO [David Cook, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia and John Mumford, (Imperial College, UK] have agreed to collaborate with us on the project in 2011, including providing relevant example spreadsheets and parameter values for test pests.

2. Industry outreach

Identify those segments of the nursery and seed industries that would be first to benefit from risk models and data sharing in terms exotic pest detection and prevention.

Past work

Project staff have met with members of the American Seed Trade Association (ASTA) Phytosanitary committee on an ongoing basis to identify the most beneficial areas for cooperation on pest risk analysis and mapping. Corn and soybean have been nominated as pilot study commodities. ASTA members are most specifically concerned about emerging endemic pests and also providing pest distribution data to APHIS to improve the phytosanitary export certification and permitting process.

Pest lists

To address these concerns we have jointly developed lists of emerging endemic pests of concern to the seed industry for both corn and soybean. An MOU has been signed by ASTA and the NAPPFAST developer to share data on survey and diagnostic observations for these pests. This data-sharing exercise will serve as test data set to demonstrate that industry cooperators can provide field observations and diagnostic data in the event of an exotic pest outbreak. To build support for the data-sharing concept among industry and university stakeholders, NCSU staff organized a two-day workshop on Southern corn rust, an emerging pest identified by ASTA cooperators. Work on identifying nursery segments is expected to be more complex and has been scheduled for later in the year.

3. Tools

Increase the functionality of NAPPFAST with new and improved tools for data sharing, risk analysis, product generation and information dissemination.

Global Risk Analysis

NAPPFAST is currently being improved with a new tool for global risk analysis. The Global analyst tool will allow a risk analyst to create predicted pest distribution maps from georeferenced pest observations, from general pest observations, and from expert opinion. The tool includes a Venn function for overlaying multiple data layers to create new products. A complete description of the tool is contained in the Section 2.

Data sharing tool

A data-sharing tool for the administrator role was not completed this year and is now scheduled for 2011. The tool will allow an administrator to share data from one organization to other. Sharing can be applied to products, data, and models. This sharing tool will allow government, industry, and university collaborators to exchange data in an online geospatial context.

4. Industry access

Establish NAPPFAST industry access to allow users from the nursery and seed industries to view selected products, data and reports.

Basic functionality

The basic online functionality to create NAPPFAST industry access has been or is nearly completed. Completed tools include the user and program management tools. Nearly completed components include the Plant Health Manager role and Plant Pest Tracking tool. Pests will be organized by commodity and host type using scientific names. Data must currently be uploaded using NAPIS codes but scientific names or European and Mediterranean Plant Protection Organization (EPPO) codes will also be an option. Users will have access to pest observations uploaded by ASTA members, risk maps shared by APHIS, weather

products, and data sheets (Fig 3.1). Weather products include precipitation, surface radiation, relative humidity and wind speed from the National Center for Environmental Prediction's (NCEP) Global Forecast System (GFS) and the North American Mesoscale (NAM) Models. A preliminary version of the tool was reviewed by ASTA cooperators on November 16. Two industry programs have been set-up one for exotic corn pests and one for emerging corn pests. Data uploaded by industry cooperators is searchable by geographic hierarchy. The industry access will also allow users to upload pest observation data by excel spreadsheet or though an online form. Preliminary test data has been uploaded for Southern Corn rust (*Puccinia polysora*) and Goss'wilt (*Clavibacter michiganensis*).

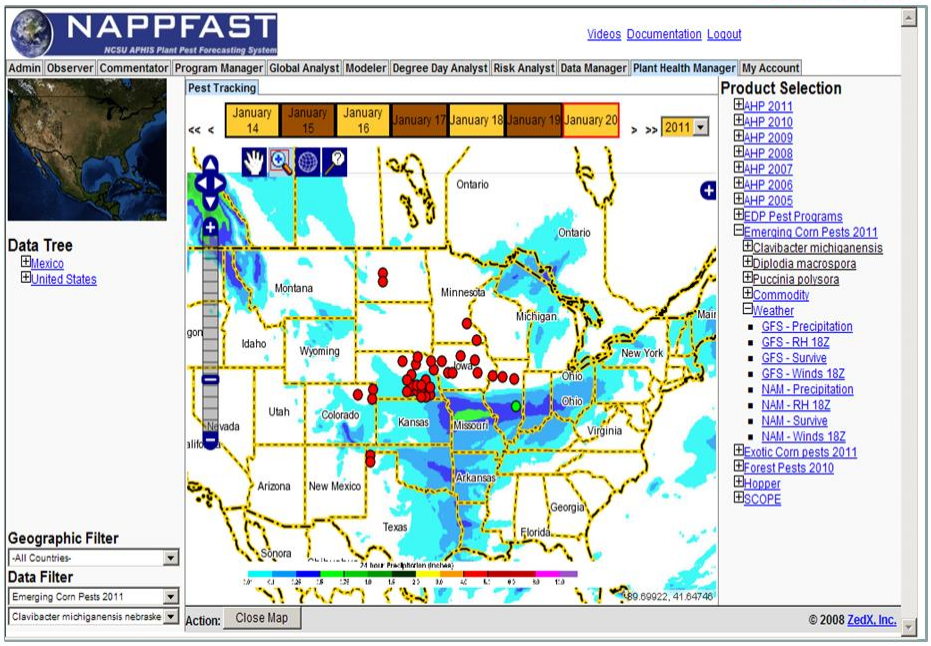


Figure 3.1. View of the Pest Tracking tool in the Industry Plant Health Manager showing observations for Goss' wilt overlaid on GFS precipitation.

Next steps

As of December 31, the following steps required completion to customize the industry role: addition of EPPO codes, display of pest data by country centroid, addition of data sheets and minor changes to legends and modification of the commentary tool. A webinar on February 8, 2011 led by an ASTA agronomist will be used to promote the tool to ASTA members. In 2011 it is hoped to collect more observation data for emerging pests in corn and soybean.

5. Economic analysis

Develop an economic analysis tool within NAPPFAST to assess the commercial impact of identified exotic pests on nursery and seed industries.

Small grains case studies

An economic model originally constructed for the livestock industry is being adapted by Paarlberg and Seitzinger to simulate economic shocks caused by exotic pests of importance to small grains. The partial equilibrium model includes both supply and trade shocks and runs with quarterly economic data for a five-year period following pest detection. Simulations have been completed for two case studies: maize late wilt, which is caused by *Harpophora maydis*, and the UG99 (TTKS) strain of wheat stem rust (*Puccinia graminis*). Two generic case studies were conducted for a slow and rapidly spreading insect pest. A final project report has been completed and the results will be published in a peer reviewed journal.

Seed and nursery economic models

Plans are in progress to adapt the small grains model to represent economic factors relevant to the seed industry. This work began in September 2010 and will continue through August 2011. As part of this effort, Trang Vo (APHIS-PPD) will begin work on defining the criteria for building an economic model to simulate the nursery industry. This will include the definition of relevant nursery sectors and a survey of available historical economic data from government and industry sources.

6. & 7. Other work

Work has not commenced on deliverables 6 and 7 to develop outreach materials and performance measures.

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Appendix 1. NAPPFAST published papers, presentations, reports, and training sessions in 2010

Published Papers

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Koch, F.H., Yemshanov, D., Colunga-Garcia, M. Magarey, R.D. and Smith, W.D. (2011). Potential establishment of alien-invasive forest insect species in the United States: where and how many? Biological Invasions.

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Colunga-Garcia M., Haack, R.A., Magarey, R.D. and M.L. Margosian. (2010). Spatial establishment patterns of exotic forest insects in urban areas in relation to urban tree cover and propagule pressure. Journal of Economic Entomology. 103:108-118.

Magarey, R.D., Dolezal, W.M., and Moore, T.J (2010) Worldwide monitoring systems. The need for public and private collaboration. IN U. Gisi et al. (eds.), *Recent Developments in Management of Plant Diseases,* 349 Plant Pathology in the 21st Century 1, DOI 10.1007/978-1-4020-8804-9_24, Springer Science Business Media B.V. 2010

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Magarey, R.D., Russo, J.M. and Colunga-Garcia, M. 2010. Biosecurity Cyberinfrastructure for Surveillance, Modeling and Risk Analysis. Global Biosecurity 2010. March 1, 2010. Brisbane, Australia.

Magarey, R.D. 2010. NAPPFAST: A tool for risk analysis of exotic plant pests. 3rd Annual Meeting of Midwest Weather Working Group Charlotte Convention Center, Charlotte, NC Friday, August 6, 2010.

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Magarey, R.D. and Russo, J.M. 2010. Economic Models in Researcher, Modeler and Economic Analyst Roles in NAPPFAST. NCERA-213 Migration and Dispersal of Agriculturally-Important Biota, Washington, DC, October 26, 2010

Magarey, R.D. 2010.NAPPFAST. CABI Plantwise Wokshop. Harvest Choice/University of Minnesota. December 13, 2010.

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Fowler, G., Takeuchi, Y., Sequeira, R., Lougee, G., Fussell, W., Simon, M., Sato, A. and Xu, Y. 2010. Pathway analysis of the likelihood of AGM movement to the United States on maritime shipments. National Gypsy Moth Management Board. 2010 Gypsy Moth Review. November 2, 2010. Durham, North Carolina.

Fowler, G. and Magarey, R.D. 2010. Pathway analysis applications of the NCSU APHIS Plant Pest Forecasting System (NAPPFAST). USDA-APHIS-PPQ-CPHST-PERAL. NAPPO Pathway Risk Analysis Symposium and Workshop. May 12, 2010. Raleigh, NC.

Fowler, G. and Magarey, R.D. 2010. Risk analysis applications of the NCSU APHIS Plant Pest Forecasting System (NAPPFAST). European Food Safety Authority. Science supporting risk surveillance of imports. February 10, 2010. Seville, Spain.

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