

United States
Department of
Agriculture




Forest Service

The Early Warning System *for* **Forest Health Threats** **in the United States**



FINAL DRAFT



The cover photos were taken from the ForestryImages.org Web site at <http://www.forestryimages.org>

(Background) Southern pine beetle damage in slash stand
Photographer: Erich G. Vallery, USDA Forest Service

(Middle right) Coast live oak infected by Sudden Oak Death
Photographer: Joseph O'Brien, USDA Forest Service

(Bottom right) Southern pine beetle—adult male
Photographer: David T. Almquist, University of Florida

(Middle left) Asian gypsy moth—frontal view of adult female
Photographer: USDA APHIS PPQ Archives

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Executive Summary

In response to direction contained in Title VI of the Healthy Forests Restoration Act of 2003 and the increased focus on environmental threats, the USDA Forest Service, working in conjunction with Federal State, Tribal, and private partners, has developed the Early Warning System (EWS), a comprehensive monitoring framework for early detection and response to environmental threats to forest lands in the United States. The EWS is based upon four key steps necessary to detect and respond to environmental threats:

- 1) Identify Potential Threats
- 2) Detect Actual Threats
- 3) Assess Impacts
- 4) Respond

Environmental threats that may be addressed by the Early Warning System include potential catastrophic threats such as insects, diseases, invasive species, fire, weather-related risks, and other episodic events.

Uses of the Early Warning System include:

- Education - as an aid to understanding the crucial elements involved in early detection and response to environmental threats.
- Analysis and Improvement - as an aid to help identify and remedy weaknesses in the current system of early detection and response, eliminate unnecessary redundancies, and increase cooperation among EWS participants.
- Planning and Decision-Making – as an aid for strategic planning and resource allocation.

This document contains both a general overview of the Early Warning System and a detailed application of the EWS framework to forest insect and disease threats. It includes EWS model diagrams and brief descriptions of the EWS functional components as they apply to insects and diseases. These descriptions include listings of key resources (activities, organizations, programs, or databases) along with short descriptions and associated URL web site links. Also provided are several case histories illustrating various real-life applications of the EWS, and a list of insect and disease EWS resources.

Early Warning System Overview

The EWS consists of an ordered series of individual functional components that are grouped and arranged in loose chronological sequence according to four key steps of early detection and response. Each step contains four functional components, arranged as follows:

- 1) Identify Potential Threat
 - Identify Nature of Specific Threat
 - Identify Mode of Spread
 - Identify Environmental Influences
 - Identify Vulnerable Ecosystems
- 2) Detect Actual Threats
 - Surveillance and Reporting
 - Systematic Detection Surveys
 - Special Detection Surveys
 - Verification and Notification

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- 3) Assess Impacts
 - Evaluate Extent, Severity, Potential Impact
 - Conduct Regulatory and Quarantine Assessments
 - Evaluate and Develop Treatment Options
 - Assess Potential Response Actions
- 4) Respond
 - Consult and Coordinate Actions
 - Implement Appropriate Treatments
 - Monitor Treatment Effectiveness
 - Restore Affected Areas

Each component represents the group of EWS resources that carry out its specific function. Although most EWS components can be applied to a variety of environmental threats, a few apply only to invasive species. Only a subset of the total number of components is activated in most situations. The order in which various components become activated varies depending on the threat and particular circumstances. More than one component may be active at any given time. The EWS model depicts a considerably streamlined version of the huge number of processes and actions involved in actual situations.

EWS Model Application to Insect and Disease Threats

- The Early Warning System for insects and diseases integrates a wide array of existing resources and activities belonging to a variety of organizations and groups. These organizations and groups form an EWS network of Federal, State, Tribal, and private cooperators.
- The effective functioning of this network depends to a very large extent upon good coordination and communication among EWS cooperators and stakeholders.
- Overall coordination and support for the insect and disease EWS will be provided by the USDA Forest Service Forest Health Protection program and an EWS Steering Committee comprised of representatives from key organizations.
- Initial financial support of the Early Warning System will be provided by base program funds of each EWS organization.
- Case histories of the Asian gypsy moth in the Pacific Northwest (a potentially invasive insect), the southern pine beetle (a native insect), and sudden oak death (a previously unknown invasive pathogen) demonstrate the varied nature of Early Warning System response to differing sets of circumstances, and serve to illustrate the flexibility and capacity of the EWS for dealing with a wide range of potential threat situations.

The Early Warning System helps to ensure that a comprehensive approach is taken when dealing with environmental threats, and that all relevant resources are considered. It plays a vital role in maintaining and restoring healthy and resilient forest ecosystems across America.

Table of Contents

Introduction	5
Background.....	5
Overview.....	5
Purpose	6
Model Diagram of Early Warning System for Forest Health Threats.....	7
Model Diagram of Early Warning System for Insect and Disease Threats.....	8
EWS Framework Applied to Insects and Diseases.....	9
Program Organization and Management.....	9
Financial Support.....	9
Components and Resources of the Early Warning System for Insect and Disease Threats	9
Identify Potential Threats	9
Identify Nature of Specific Threat.....	10
Identify Mode of Spread.....	12
Identify Environmental Influences	13
Identify Vulnerable Ecosystems.....	14
Detect Actual Threats	15
Surveillance and Reporting.....	15
Systematic Detection Surveys	16
Special Detection Surveys	17
Verification and Notification	19
Assess Impacts.....	22
Evaluate Extent, Severity, and Potential Impact	22
Conduct Regulatory and Quarantine Assessments	23
Evaluate and Develop Treatment Options	22
Assess Potential Response Actions.....	24
Respond.....	25
Consult and Coordinate Actions.....	25
Implement Appropriate Treatments.....	25
Monitor Treatment Effectiveness	26
Restore Affected Areas.....	27
Applying the Early Warning System	29
Case History – Asian Gypsy Moth	29
Case History – Southern Pine Beetle.....	30
Case History – Sudden Oak Death.....	31

Conclusion.....	32
Glossary.....	33
Appendix A - List of EWS Resource Web Sites	35

Introduction

The Early Warning System (EWS) is a comprehensive monitoring framework for early detection and response to environmental threats to forest lands in the United States. Based upon four key steps necessary to detect and respond to environmental threats, the EWS model (Fig. 1) provides a universal structure for early warning that can be applied to all environmental threats. In this document we present the Early Warning System framework, focusing its application to forest insect and disease threats to forest health (Fig. 2). Distinct systems of detection and response for various other environmental threats (e.g., invasive weed species, fire) that are being developed by other groups are not specifically described in this document.

Background

In recent times, significant increases in the movement of humans and trade goods among world ecosystems have coincided with the transport of native plant and animal species to new ecosystems where they often proliferate to damaging levels. At the same time, our natural forest ecosystems have grown less resilient and increasingly susceptible to undesirable alteration following disturbance events.

Timely, well-coordinated efforts can minimize the incidence and rate of undesired ecosystem change caused by environmental threats. To this end, vigilance and early action are extremely important. Systematic planning and preparedness is necessary to make sure we are ready for the next invasive species, catastrophic insect or disease outbreak, wildfire, or weather event.

In the face of mounting pressure from environmental threats, a need exists for enhanced protective measures such as those provided by a coordinated national early warning system. The basis and direction for development of a formalized early warning system for forest health threats is contained in Title VI, Section 601 of the Healthy Forests Restoration Act of 2003 (HFRA). Section 601 (c) specifies development of a “comprehensive early warning system for potential catastrophic environmental threats to forests.”

Responding to HFRA direction and the increased focus on environmental threats, the USDA Forest Service, working in conjunction with Federal, State, Tribal, and private partners, developed the Early Warning System (EWS). This effort parallels efforts to develop early warning systems for native pests and invasive species in other systems, such as agricultural systems and [coastal marine ecosystems](#). The EWS is patterned on the [Early Detection and Rapid Response System for Invasive Plants](#) (EDRR) developed by the Federal Interagency Committee for the Management of Noxious and Exotic Weeds (FICMNEW). Key processes and resources involved in early detection and rapid response to environmental threats have been identified, categorized, and linked together in a systematic fashion to create an umbrella framework of interconnected key functional areas.

Overview

Environmental threats that may be addressed by the Early Warning System include potential catastrophic threats such as insects, diseases, invasive species, fire, weather-related risks, and other episodic events. The wide diversity and varied natures of potential environmental threats span a broad array of scientific disciplines and require a networked system of integrated activities with different detection and response systems in place simultaneously. The ultimate

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goal of the EWS is to prevent damage from new threats and reduce to acceptable levels the impacts of existing threats.

The Early Warning System (Fig. 1) is based upon four key steps necessary to detect and respond to environmental threats:

- 1) Identify Potential Threats
- 2) Detect Actual Threats
- 3) Assess Impacts
- 4) Respond

Success of the Early Warning System depends upon timely completion of these steps. Each step is subdivided into four functional areas (represented by component blocks in the model diagram). Although most functional areas apply to a variety of environmental threats, a few apply only to invasive species. In Figure 2, key resources (activities, organizations, programs, or databases that carry out a particular EWS function) have been identified for each functional area.

Note that the EWS component model depicts a streamlined version of the many processes and actions involved in any scenario of detection and response; in actuality there are a huge number of interactions occurring “below the surface” of the model. The order in which the various functional components of the EWS are activated depends on the threat and particular circumstances (see Figs. 3-5), and simultaneous activation of more than one functional component sometimes may occur.

Purpose

The EWS serves several purposes. It organizes the national effort against catastrophic environmental threats to forest health into a logical, systematic framework. This framework can illustrate to forest managers, specialists, and practitioners the necessary components of early detection and rapid response, and facilitate the practical consideration and inclusion of important elements during planning and management activities. It can be used to identify gaps, weaknesses, and unnecessary redundancies in the national system of detection and response, focusing research efforts to address gaps and weaknesses, and enabling significant improvements in information, processes, coordination, networking, and organizational structures. It also can highlight opportunities for increased cooperation and collaboration and serve as an aid for prioritizing proposed projects, management emphases, or available resources.

Figure 1. Diagram of the Early Warning System for forest health threats in the United States.



USDA Forest Service Early Warning System for Forest Health Threats Component Model

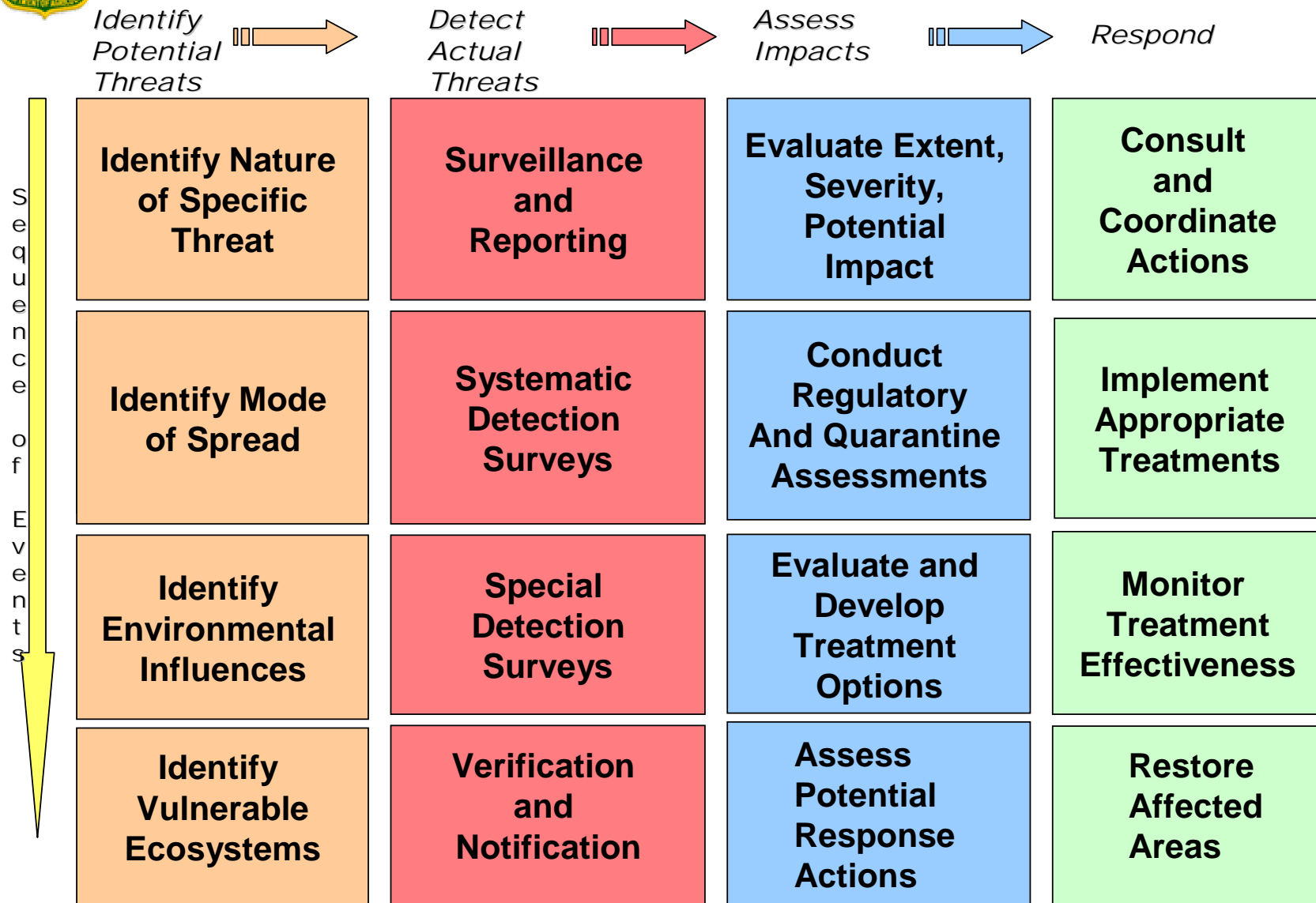
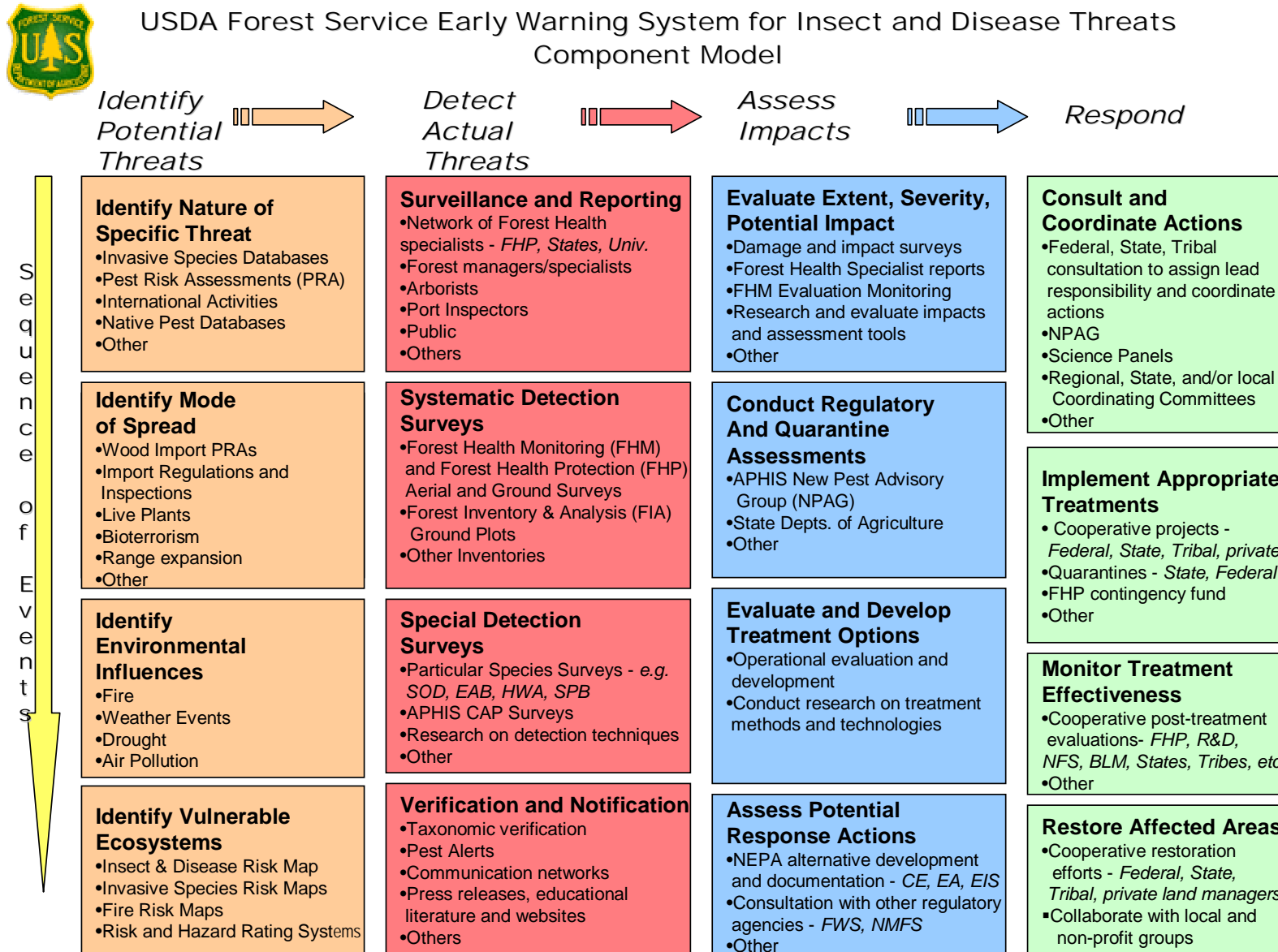


Figure 2. Diagram of the Early Warning System for insect and disease threats in the United States.



The Early Warning System references contained in the remainder of this document are specific to forest insects and diseases. The following description should not be viewed as an exhaustive treatise, but rather as a comprehensive representation of the EWS that is likely to change over time with improvement and additional detail.

EWS Framework Applied to Insects and Diseases

Relying heavily on partnerships, the Early Warning System for insect and disease threats integrates existing resources, programs, and jurisdictions belonging to a variety of Federal, State, Tribal, and private agencies and organizations (Fig. 2). Most of the agencies and organizations forming the EWS operate as independent entities with disparate funding sources and missions. While some routinely cooperate on various aspects of identification, detection, inventory, monitoring, or response, others tend to operate with no or relatively few linkages to other EWS groups. Thus the EWS essentially is a network of cooperating entities and sub-systems, without central control or hierarchy, that depends upon good communication and coordinated actions by local, State, Tribal, regional, and national partnerships.

Program Organization and Management

National coordination of the Early Warning System for insects and diseases is provided by the USDA Forest Service Forest Health Protection (FHP) program. The Forest Service will form an EWS insect and disease Steering Committee comprised of representatives from key organizations and agencies to strengthen the functioning of the EWS.

Financial Support

Initial financial support of the Early Warning System will be provided by base program funds of each EWS agency or organization. The EWS Steering Committee will develop a strategy and action plan to identify future direction and resource needs.

Components and Resources of the Early Warning System for Insect and Disease Threats

Short descriptions of Early Warning System elements as they apply to insect and disease threats are provided in the following section. Each description contains web links (if available) to more detailed information on specific programs. Appendix A provides an alphabetical listing of EWS groups and web links.



Identify Potential Threats

The first step in the EWS is to identify potential and existing threats to forest health so that detection activities may be planned and implemented. Identification of potential threats entails gathering, analyzing, and organizing pertinent information in ways that facilitate awareness and detection of potential threats.

Identify Nature of Specific Threat

Invasive organisms pose one of the most significant threats to forest health. Identifying potential invasive organisms before they invade new ecosystems allows us to target effective early detection surveys to likely areas of introduction and initial establishment. Similarly, identifying existing invasive organisms in areas where they have already become established permits research to develop survey and monitoring programs to track trends and assess impacts. Native pest responses to weather events or forest conditions that are outside of historic ranges can sometimes threaten ecosystem health and viability. Identifying potential native organism threats to forest ecosystems allows us to design effective surveys for early outbreak detection.

- **Invasive Species Database: North American Exotic Forest Pest Information System (EXFOR)** - Exotic forest insect and disease organisms introduced from other continents pose an increasing threat to the forests of North America. Information on their management often is not readily available to pest management specialists, regulatory officers, research scientists and the public. The Exotic Forest Pest Information System for North America (EXFOR) was developed in partnership with Canada and Mexico through the North American Forestry Commission (NAFC). It concentrates hard-to-find information assessing an exotic forest insect or pathogen's risk of establishment and spread and on their management. EXFOR records include risk assessments regarding potential for pest establishment, spread, economic damage, and environmental damage, along with potential and probable pathways of introduction. EXFOR is a scientifically-based Internet database for more than 130 exotic insect pests and disease pathogens. This information enables land managers to design rapid detection systems for specific exotic organisms. See <http://spfnic.fs.fed.us/exfor/>.
Lead: NAFC - <http://www.fs.fed.us/global/nafc/welcome.html>
- **Invasive Species Database: National Agricultural Pest Information System (NAPIS)** - The purpose of the National Agricultural Pest Information System is to facilitate data management coordination for the plant pest survey data gathered on a national, regional, and/or state scale as part of the Cooperative Agricultural Pest Survey (CAPS) program sponsored by USDA Animal and Plant Health Inspection Service (APHIS). NAPIS provides the capabilities for entering, storing, processing, summarizing, managing, retrieving, graphing, and distributing plant pest survey data to the participants of the CAPS program and to other interested parties. NAPIS currently houses 1.3 million records on more than 3800 different organisms covering such diverse areas as insects, pathogens, weeds, and biological control organisms. NAPIS contains data that describes the results of a wide range of plant pest surveys and observations conducted throughout the United States. Emphasis is given to surveys for exotic pests, pests that may impact export of US agricultural products, and regulated pests and biological control agents. See <http://ceris.purdue.edu/napis/>.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
- **Pest Risk Assessments (PRAs)** - Pest Risk Assessments evaluate the likelihood that a specific invasive organisms or group of organisms may be introduced and established in new forest ecosystems and the potential economic and environmental consequences. Regulatory officials use PRAs to determine the need for quarantine regulations. Ideally PRAs are conducted prior to introduction of an invasive organism, however they also may occur following an introduction; this is especially

true when the invasive is previously unknown, as was the case with sudden oak death. Examples of several PRAs of the sudden oak death pathogen, *Phytophthora ramorum* can be found at <http://www.suddenoakdeath.org>

Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

- **International Activities** - Trade agreements, the ease of travel between countries, and increased demands worldwide for forest resources, all result in increased potential for introduction of exotic pests. The USDA Forest Service conducts international activities to identify potential exotic pests, identify biological control options, develop detection and control technology, and share forest health technology and expertise worldwide (see sidebar below). USDA Forest Service Research and Development (R&D) researchers cooperate closely with researchers in other countries to study potential pests in their native environments before they are introduced into the US, investigating such matters as the potential for a species to become invasive, detection methods, and possible control treatments. Information provided by international R&D activities is used in pest risk mapping and invasive pest databases such as EXFOR.

Lead: USDA Forest Service International Programs (IP) - <http://www.fs.fed.us/global/aboutus/welcome.htm>

Native Species Profiles: Forest Insect and Disease Leaflets (FIDLs) - This ongoing series of publications contains succinct, scientifically-based information on the biology and management of more than 170 native and established non-native

International Activities



In 1993 a cooperative program was initiated by Russia and the United States to develop an early warning system to alert ports in the US, New Zealand, Canada, Australia, and Chile of increasing forest pest populations in Russia's Far East. This effort focuses on reducing the risk of potential invasive pest introductions to the US and other cooperating countries. Monitoring protocols developed through this program are used to track Lymantriid moth populations near Russian ports, and allow regulators to identify high risk periods for ship infestation. The monitoring information also is used to trigger mitigation measures such as ship exclusion, decreased ship and port lighting (attractive to egg-laying female moths), and suppression treatments in nearby forests. APHIS and FHP cooperate in this program, which is administered through the International Forestry-Forest Pest Exclusion Program.



Asian Gypsy Moth



Nun Moth



Pink Gypsy Moth

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insect and disease pests. To view a listing of available FIDLs, go to http://www.na.fs.fed.us/spfo/pubs/fth_pub_pages/fidlpage.htm.

Lead: FHP - www.fs.fed.us/foresthealth

- **Native Species Databases: Regional FHP web sites** - Regional FHP websites provide a consolidated source of information on the most important forest pests found in various areas of the United States. To access regional FHP websites, go to http://www.fs.fed.us/foresthealth/regional_offices.html.

Lead: FHP - www.fs.fed.us/foresthealth

Identify Mode of Spread

The likelihood of any particular invasive organism becoming established can be significantly reduced by anticipating probable pathways (carriers and event sequences), and then acting in a timely manner to obstruct the identified pathways and to detect and eradicate new introductions. Trade in raw wood and live plants are major pathways for pests to enter the United States.

- **Wood Import PRAs** – At the request of APHIS, a series of PRAs for wood imports and packing materials as pathways for invasive species have been completed by the FHP Wood Import Pest Risk Assessment and Mitigation Evaluation Team (WIPRAMET) for unprocessed wood imports from Russia, New Zealand, Mexico, South America and Australia, and for solid wood packing from all sources:
 - *Pest risk assessment for Importation of Solid Wood Packing Materials Into the United States.* See <http://www.aphis.usda.gov/ppg/pr/swpm/intro.pdf>.
 - *The Unmitigated Pest Risk Potential for the Importation of Pinus and Abies Logs from all States of Mexico.* See <http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr104.pdf>.
 - *Pest Risk Assessment of the Importation into the United States of Unprocessed Eucalyptus Logs and Chips from South America.* See <http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr124.pdf>.
 - *Pest Risk Assessment of the Importation into the United States of Unprocessed Logs and Chips of Eighteen Eucalypt Species from Australia.* See <http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr137.pdf>.

Lead: FHP - www.fs.fed.us/foresthealth

- **Import regulations and inspections** - Import regulations and inspections of wood imports, wood packaging, and live plants identify and target potential pathways of invasive species. They help prevent the unintentional transport of invasive species and provide a means to intercept invasive organisms before they are introduced into the United States. Quarantine regulations for live plants are currently being revised by APHIS.

Leads:

APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

US Department of Homeland Security (DHS) - <http://www.dhs.gov/dhspublic/index.jsp>

- **Live Plants** - Live plants serve as important pathways for invasive pests coming into the US, and for spread of invasive pests across the country. Invasive pests such as emerald ash borer and sudden oak death have spread within the US on nursery stock. Live plant pathways need to be adequately considered in early detection

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activities, especially during pathway analyses, pest risk mapping, and development of special detection surveys.

Leads:

APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

State Departments of Agriculture - <http://www.nasda-hq.org/>

- **Bioterrorism** - Deliberate introduction by humans with malicious intent is a potential pathway for invasive organisms.
 - The National Plant Diagnostic Network (NPDN), administered through DHS and established by USDA Cooperative State Research, Education, and Extension Service (CSREES) in cooperation with APHIS and State Departments of Agriculture, is a national network formed to enhance national agricultural security by quickly detecting, identifying, and reporting introduced pests. The National Plant Diagnostic Network links Land Grant University plant pest diagnostic facilities across the US and allows Land Grant Universities, State Regulatory personnel, and first detectors to communicate in an efficient and timely manner regarding identification of detected pests. NPDN consists of five regional plant pest diagnosis centers and NAPIS. See <http://npdn.ppath.cornell.edu/default.htm>.
- **Lead:** DHS - <http://www.dhs.gov/dhspublic/index.jsp>
- **Range expansion from a neighboring country** - Invasive organisms introduced and established in neighboring countries can spread across national borders into the United States. Good communications with regulatory officials and natural resource managers in Mexico and Canada are necessary to foster awareness and timely response to imminent threats.
Lead: NAPPO - http://www.nappo.org/menu_e.shtml
- **Other currently unidentified pathways** - Consideration should be given to unusual pathways such as art objects, home decorations, etc.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

Identify Environmental Influences

Other environmental factors frequently interact with insects and pathogens in a synergistic manner. Identifying these factors and their potential interactions before damage occurs allows proactive planning and management.

- **Fire** - In some geographic areas, interactions among insects, diseases, and fire can result in catastrophic damage to forest ecosystems. An integrated approach to management problems in these locations requires consideration of fire regime, history, condition class, and risk. Existing coarse-resolution fire regime condition class (FRCC) maps based on historic fire regimes and current vegetation conditions provide a starting point for assessing current degrees of departure from historical ranges (see http://www.fs.fed.us/rm/pubs/rmrs_gtr87.html). The LANDFIRE project builds and improves upon these existing maps to project fire risk and other associated variables at the sub-watershed scale. LANDFIRE products are scalable to regional and national levels (see <http://www.landfire.gov/>).
- **Leads:**
USDA Forest Service (USFS) - <http://www.fs.fed.us/>
US Geological Survey (USGS) - <http://www.usgs.gov/>

DRAFT

- **Weather Events** - Windthrow, ice storms, tornados, and hurricanes can lead to insect or disease outbreaks. Forest land management agencies are the primary skill repositories for damage assessment, recovery project planning and implementation, and landowner assistance following major weather events. See *“Restore Affected Areas”* for web link to a recent response to a major weather event in the Northeastern United States.

Leads:

FHP - www.fs.fed.us/foresthealth

USDA Forest Service National Forest System (NFS) -

<http://www.fs.fed.us/aboutus/meetfs.shtml> and

http://www.fs.fed.us/land/staff/lar/definitions_of_terms.htm

State Departments of Forestry - <http://www.stateforesters.org/SFlinks.html>

- **Drought** – Drought can place increased stress on forest stands, making them more vulnerable to insects and pathogens and foster conditions favorable for wildfire. Accurate forecasts and evaluations of climatic trends enable forest pest specialists and land managers to correctly assess problematic situations and formulate appropriate and adaptive management solutions.
 - US Drought Monitor, National Drought Mitigation Center (a consortium of federal agencies and non-governmental organizations) - <http://www.drought.unl.edu/dm/monitor.html>
 - USGS Drought Watch - http://water.usgs.gov/cgi-bin/dailyMainW?state=us&map_type=dryw&web_type=map
 - USDA Natural Resources Conservation Service (NRCS) National Water and Climate Center - <http://www.wcc.nrcs.usda.gov/wcc.html>
 - US Department of Commerce (DOC) National Oceanic and Atmospheric Administration (NOAA) Drought Information Center - <http://www.drought.noaa.gov/>

Leads:

National Drought Mitigation Center - <http://www.drought.unl.edu/index.htm>

NOAA - <http://www.noaa.gov/>

NRCS - <http://www.wcc.nrcs.usda.gov/>

USDA Forest Service Research and Development (R&D) -

<http://www.fs.fed.us/research/>

Universities – various web sites

- **Air pollution** - Air pollution causes a variety of adverse effects on forests, including reduced tree vigor, growth, and resistance to insects and pathogens. Air pollution effects on forests in the United States are monitored using air pollution bioindicators (air pollution-sensitive plants) during systematic surveys by the USDA Forest Service. See also *“Systematic Detection Surveys.”*

Leads:

Forest Health Monitoring Program (FHM) - <http://www.na.fs.fed.us/spfo/fhm/index.htm>

R&D, Forest Inventory and Analysis Program (FIA) - <http://fia.fs.fed.us/about.htm>

Identify Vulnerable Ecosystems

Knowing which ecosystems are at risk facilitates timely, efficient, and effective management actions. Numerous risk and hazard rating systems have been developed for use at regional and local scales. Risk maps can display vulnerable ecosystems at a variety of scales. In recent years, national risk maps have become important tools useful for communication, strategic planning and decision-making, and resource allocation.

- **Insect and Disease Risk Map** - Identifies areas at risk to increased mortality caused by forest insects and pathogens and highlights areas of concern. See http://www.fs.fed.us/foresthealth/risk_maps/risk_maps.html
Lead: FHP - www.fs.fed.us/foresthealth

- **Invasive Species Risk Maps** - Identify areas at risk to invasion by non-native species; separate maps are developed for individual invasive species. Examples:
 - **Sudden Oak Death Risk Map** - <http://www.na.fs.fed.us/spfo/fhm/sod/images/riskmap.pdf>
 - **Emerald Ash Borer Risk Map** – not available on the Internet.**Leads:**
FHP - www.fs.fed.us/foresthealth
R&D - <http://www.fs.fed.us/research/> and <http://www.fs.fed.us/research/vmpr.html>

- **Fire Risk Maps**
Landscape level fire risk is being mapped by the LANDFIRE project. See <http://www.landfire.gov/>.
Leads:
FAM - <http://www.fs.fed.us/fire/>
R&D - <http://www.fs.fed.us/research/>

- **Risk and Hazard Rating Systems** - Identify conditions, often at the stand or watershed levels, associated with increased hazard or risk to insects, diseases, or fire. Risk and hazard rating systems may be found in the scientific literature and at many FHP regional websites (*access FHP regional websites at http://www.fs.fed.us/foresthealth/regional_offices.html*).
Leads:
FHP - www.fs.fed.us/foresthealth
FAM - <http://www.fs.fed.us/fire/>

Detect actual threats

The second step of the EWS is detection of actual threats. The goal of this step is early detection of 1) invasive organisms before they become established, or if already established, before populations expand to previously unoccupied areas or build to harmful levels, 2) native pests before populations build to harmful levels, or 3) any disturbance phenomenon that threatens forest ecosystem function or sustainability.

Surveillance and Reporting

Everyday observation by numerous individuals is an important mechanism for early initial detection of insect and pathogen threats. Many significant problems are first noticed by concerned citizens who contact forest managers or forest health specialists to voice their concerns or curiosity. This component of the EWS is very dependent upon informed awareness and ease of communication among the key groups listed below:

- **Forest Health Specialists** - Forest Health Specialists represent the first line of response to forest health threats. This group is comprised of a tight network of over 300 FHP and State specialists, University specialists, and others trained to identify,

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monitor, assess and respond to forest health threats. *Communication linkages - among FHP units, States, and Universities.*

Leads:

FHP - www.fs.fed.us/foresthealth

States - <http://www.stateforesters.org/SFlinks.html>

- **Forest managers and specialists** - Private, State, Tribal, and Federal forest land managers and natural resource specialists comprise this large and diverse group. They work mostly in wildland and wildland-urban forest environments. *Communication linkages - through FHP, States, Cooperative State Research, Education and Extension Service (CSREES).*
- **Arborists** - Arborists are a highly specialized group of professionals skilled in individual tree care. They work mostly in urban environments. *Communication linkage - International Society of Arboriculture (ISA) - <http://www.isa-arbor.com/home.asp>*
- **Port Inspectors** - Port inspectors work to intercept and prevent accidental introductions of invasive organisms at overseas trade points-of-entry. *Communication linkage - through DHS.*
Lead: US Department of Homeland Security (DHS) - <http://www.dhs.gov/dhspublic/index.jsp>
- **Public** - Often a first line of detection for forest health threats, members of the public are a resource of the EWS because they are numerous, widespread, observant, and curious. *Communication linkages - through CSREES, FHP, Federal land managers (FLMs), States.*

Systematic Detection Surveys

Systematic aerial and ground detection surveys are the backbone of environmental threat detection. These surveys are repeated in a consistent manner on regular, periodic schedules. Their goal is detection and documentation of the general array of damaging agents occurring throughout (usually) broad geographical areas. Systematic detection surveys can detect new outbreaks of native and established invasive pests, new introductions of some invasive organisms, and provide reliable data for periodic overviews of forest health and long-term trend projections.

- **Forest Health Monitoring (FHM)** - Forest Health Monitoring is a national program designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. Managed by USDA Forest Service Forest Health Protection and conducted in cooperation with USDA Forest Service Research and Development, The National Forest System, and the National Association of State Foresters (NASF), the FHM program uses data from ground plots and surveys, aerial surveys, and other biotic and abiotic data sources and develops analytical approaches to address forest health issues that affect the sustainability of forest ecosystems. FHM covers all forested lands through partnerships involving USDA Forest Service, State Foresters, and other state and federal agencies and academic groups. Aerial detection surveys cover more than 700 million acres annually mapping tree mortality and defoliation. See <http://www.na.fs.fed.us/spfo/fhm/index.htm>.
Lead: FHP - www.fs.fed.us/foresthealth

DRAFT

- **Forest Inventory and Analysis (FIA)** - Forest Inventory and Analysis is the Nation's forest "census," sampling forests on all forest lands within the US. FIA reports on status and trends in forest area and location; in the species, size, and health of trees; in total tree growth, mortality, and removals by harvest; in wood production and utilization rates by various products; and in forest land ownership. The FIA program includes information relating to tree crown condition, lichen community composition, soils, ozone indicator plants, complete vegetative diversity, and coarse woody debris. It is managed by the Research and Development organization within the USDA Forest Service in cooperation with State and Private Forestry and National Forest Systems. The FIA program is implemented in cooperation with a variety of partners including State forestry agencies and private landowners who grant access to their lands for data collection purposes. See <http://fia.fs.fed.us/about.htm>.
Lead: R&D - <http://www.fs.fed.us/research/>

- **Federal land management agency and Tribal land inventories** - Many NFS and USDI Bureau of Land Management (BLM) units and Tribal agencies collect data on insects, pathogens, and fire during periodic forestland inventories.
Lead: FLMs, e.g. USDA Forest Service Natural Resource Information System (NRIS) at <http://www.fs.fed.us/emc/nris/>.



Special Detection Surveys

The goal of special detection surveys is early detection of particular pest species. Special detection surveys for potential invasive species target likely locations of introduction and initial establishment. For native and established invasive species, special detection surveys focus on areas at high risk for outbreaks or significant damage.

- **Invasive Species Surveys** - Following are examples of some special detection surveys for invasive organisms:
 - **Sudden Oak Death (SOD) Detection Surveys** - Cooperative surveys among Federal and State agencies in areas not yet infested with the disease. See http://www.na.fs.fed.us/spfo/fhm/sod/sod_natnl.pdf.
Lead: Forest Health Monitoring - <http://www.na.fs.fed.us/spfo/fhm/index.htm>
 - **Emerald Ash Borer (EAB) Detection Surveys** - Cooperative surveys among Federal and State agencies in areas not yet infested with the insect. See <http://www.na.fs.fed.us/spfo/eab/index.html>.
Lead: FHP - www.fs.fed.us/foresthealth
 - **Gypsy Moth Surveys** - Cooperative annual surveys among Federal and State agencies in areas not yet infested with the insect. See <http://www.fs.fed.us/ne/morgantown/4557/gmoth/isolated/isolated.html>.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
 - **Hemlock Woolly Adelgid (HWA) Surveys** - Cooperative surveys among Federal and State agencies in areas not yet infested with the insect. See <http://www.fs.fed.us/na/morgantown/fhp/hwa/hwasite.html> and <http://www.ceris.purdue.edu/napis/pests/hwa/>
Lead: FHP - www.fs.fed.us/foresthealth

- **Rapid Detection and Response Program (RAPDET)** - This program currently is piloting tests for detection of invasive bark beetles and moths near points of entry throughout the US. Its ultimate purpose is to develop the framework for and implement a national interagency detection, monitoring and response system for non-native invasive species (see sidebar below). See also http://www.fs.fed.us/foresthealth/briefs/Rapid_dect_response_prq.htm
Lead: FHP - www.fs.fed.us/foresthealth
- **Native Pest Detection Surveys** - Following are examples of some special detection surveys for native pest organisms:
 - **Douglas-fir Tussock Moth Early Warning System** - Cooperative annual survey program among Federal and State agencies in high risk areas of the Western US and Canada. See http://www.fs.fed.us/r6/nr/fid/dftmweb/biology/dftm_ews.htm.
Lead: FHP - www.fs.fed.us/foresthealth
 - **Southern Pine Beetle (SPB) Detection Surveys** - Cooperative annual surveys among Federal and State agencies in high risk areas of the Southern US.
Lead: FHP - www.fs.fed.us/foresthealth
 - **Pine Mortality Surveys in Southwestern US** - Aerial survey program to map pine mortality (primarily pinyon and ponderosa pine) caused by a complex of factors including bark beetles and drought.
Lead: FHP - www.fs.fed.us/foresthealth

Special Detection Surveys Discover A Previously Unreported Pest



Since 2001, The RAPDET program has coordinated pilot tests for the detection of invasive bark beetles and the nun moth in high-risk locations throughout the USA. The RAPDET program places traps at selected sites and sends unknown captured specimens to an insect taxonomist for identification. In April 2003, the banded elm bark beetle, *Scolytus schevyrewi*, a Siberian species previously unreported in North America was first collected and identified in 2 western states. By August 2003, additional RAPDET trapping had detected *S. schevyrewi* in at least 13 states. Currently APHIS, State forestry organizations, and FHP are working together to map the potential range and impacts of this beetle.

Photo by Whitney Crenshaw, courtesy of Forestry Images.

DRAFT

- **Cooperative Agricultural Pest Survey (CAPS)** - State surveys coordinated by APHIS. See <http://ceris.purdue.edu/napis/caps.html>.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
- **Conduct research and development of detection technologies** – Specialized information, protocols, and tools usually are required to implement effective detection programs for invasive and native pests. Systematics research is needed to develop more rapid and effective techniques for identifying insect and disease threats (e.g. PCR tests giving immediate confirmation of *Phytophthora* are needed). Research is also needed to facilitate the incorporation of new technologies into existing methods as they become available. See also “Conduct research on treatment methods and technologies.”
Leads:
R&D - <http://www.fs.fed.us/research/> and <http://www.fs.fed.us/research/vmpr.html>
USDA Agricultural Research Service (ARS) - <http://www.ars.usda.gov/AboutUs/AboutUs.htm>
Universities - various individual web sites
FHP - www.fs.fed.us/foresthealth

Verification and Notification

The identity of the causal organism must be ascertained before potential impacts can be accurately assessed and appropriate response actions developed. In addition, rapid and accurate information flow between those who may initially detect and verify environmental threats and those having response authorities is crucial to successful eradication or suppression treatment. The State Plant Regulatory Officials (SPROs) and APHIS State Plant Health Directors (SPHDs) should be notified immediately following any confirmations of new invasive pests. They are responsible for disseminating further information. Land managers and owners need to develop networks for gathering advance information regarding environmental threats, obtaining verification of detected pests, and notifying appropriate regulatory officials. Conversely, regulatory officials and others involved with detection programs and response need to furnish land managers, landowners, and the public up-to-date information on status, identification, and impacts of environmental threats.

- **Taxonomic verification** – Taxonomic verification by taxonomic specialists or laboratory procedures is necessary when the identity of the causal agent is uncertain or cryptic to normal sensory observation. Critically important, taxonomic verification determines whether a detected pest is a new introduction. At the present time, most of the forest insect and pathogen taxonomic expertise in the US resides at Land Grant Universities, State Departments of Agriculture, APHIS Plant Protection and Quarantine (PPQ), and USFS Forest Products Laboratory (FPL).
 - Regional Centers of the National Plant Diagnostic Network (NPDN) provide diagnostic services, share information among laboratories, and provide training to diagnosticians and first detectors. For additional information, go to <http://npdn.ppath.cornell.edu/default.htm> (See also “Identify Potential Pathways for Invasive Organisms”, “Bioterrorism”).

Leads:

APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>


DHS - <http://www.dhs.gov/dhspublic/index.jsp>

USFS Forest Products Laboratory (FPL) - <http://www.fpl.fs.fed.us/>

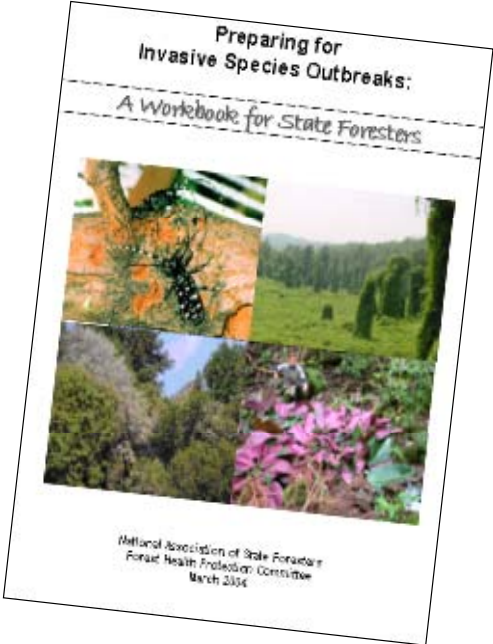
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- **Pest alerts** – Pest alerts for invasive species of forest ecosystems usually are brief memos describing recent introductions. They typically contain important information on the identification and biology of the introduced species, and how and where to report sightings. Their purpose is to provide timely notification to a wide audience regarding a new introduction or likely potential introduction.
 - FHP maintains a national listing of pest alerts for invasive insects and diseases that threaten forest ecosystems.
See <http://www.fs.fed.us/na/morgantown/fhp/palerts/palerts.htm>.
Lead: FHP - www.fs.fed.us/foresthealth
 - APHIS PPQ provides pest alerts for invasive species that have been recently detected in the US or in neighboring countries.
See http://www.aphis.usda.gov/ppq/ep/emerging_pests.html.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
 - CSREES-supported programs often provide pest alerts for invasive species of forest ecosystems of significance to regional, state, or local areas.

Be Prepared for Invasive Pests



A useful tool for forest managers and landowners is the booklet, "Preparing for Invasive Species Outbreaks: A Workbook for State Foresters," which contains general guidelines for how to create networks, locate resources, and develop a strategy for rapid response to detection of an invasive species. This workbook was developed by the Forest Health Protection Committee of the National Association of State Foresters
<http://www.stateforesters.org/pubs/InvasivesWorkbook.pdf>



National Association of State Foresters
Forest Health Protection Committee
March 2004

DRAFT

Cooperative Extension at Land Grant universities and colleges.

See <http://www.csrees.usda.gov/qlinks/extension.html>.

Regional Pest Management (IPM) Centers. See <http://www.pmcenters.org/>

Lead: CSREES - <http://www.csrees.usda.gov/about/background.html>

- Phytosanitary Alert System (PAS) - The Phytosanitary Alert system gathers, repackages, and disseminates information on emerging invasive species of significance to North American Plant Protection Organization (NAPPO) countries: Canada, Mexico, and the USA. Information is provided in the form of official reports, pest alerts, and news stories. The ultimate goal of this comprehensive, web-based information system is to provide timely, significant, and reliable alerts to enhance pest exclusion capabilities and result in fewer invasive pest outbreaks in NAPPO countries. See <http://www.pestalert.org/main.cfm>.

Lead: NAPPO - http://www.nappo.org/menu_e.shtml

▪ **Communication Networks**

- **Regulatory agency networks** - APHIS and State Departments of Agriculture have primary regulatory responsibilities for invasive pests. Regulatory officials such as State Plant Regulatory Officials (SPROs) and APHIS State Plant Health Directors (SPHDs) utilize communication networks to quickly disseminate and receive information regarding invasive pest threats. The APHIS PPQ “Emergency Programs Manual” outlines notification protocols for invasive plant pest interceptions. To view the manual, go to http://www.aphis.usda.gov/ppq/manuals/pdf_files/epm.pdf.

Leads:

APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

State Departments of Agriculture - <http://www.nasda-hq.org/>

- **Land management agency networks** - Good communication within and among land management agencies are important for detection and timely notification of environmental threats. Agencies having responsibility for detecting and responding to invasive pests include FHP, State Departments of Forestry, State Departments of Agriculture, NFS, BLM, and Tribes (*see sidebar on previous page*).
- **State Cooperative Research, Education and Extension networks** - Private land managers and landowners working directly with forest resources sometimes may be the first to detect environmental threats. Their ability to recognize and report potentially significant problems is enhanced by advance information and knowing how to contact responsible authorities. State cooperative research, education, and extension offices work directly with private land managers and land owners, bringing agricultural and forestry research, information, and expertise to the local level.
- **Extension Disaster Education Network (EDEN)** - The Extension Disaster Education Network links Extension educators from across the US and various disciplines. Supported by USDA Cooperative State Research, Education and Extension Service (CSREES), EDEN is designed to reduce the impact of disasters by facilitating communication and resource-sharing among Extension educators. See <http://www.agctr.lsu.edu/eden/default.aspx>.
- **Regional and local Cooperative Extension programs and networks** - Commonly the first line of contact for private landowners and managers are regional and county Cooperative Extension offices. In addition, Extension programs such as the Master Gardener and Master Tree Farmer programs provide networking opportunities for invasive species communications.
- **Professional and Trade Organizations** - Communication venues and networks maintained by forestry-related professional and trade organizations for purposes of

DRAFT

interacting with their membership could be used to notify specialized groups working in forestry and forestry-related sectors of invasive species information.

- International Society of Arboriculture (ISA) - <http://www.isa-arbor.com/home.asp>
- American Nursery and Landscape Association (ANLA) - <http://www.anla.org/>
- Society of American Foresters (SAF) - <http://www.safnet.org/who/whoweare.cfm>

- **Press releases, educational literature and web sites** - Public notification of insect and disease threats often is accomplished through press releases, educational literature and web sites. This group plays an important role in detection and management of forest health threats. At times they may unknowingly contribute to the spread of invasive species; in other instances they may be the first to detect one, or to notice an early outbreak of a native pest.

Leads:

State Plant Regulatory Officials (SPROs) and APHIS State Plant Health Directors (SPHDs) are responsible for public release of information regarding new introductions of invasive species:

SPROs - <http://www.aphis.usda.gov/npb/npbmemb.html>

SPHDs - http://www.aphis.usda.gov/travel/aji_pop/sphdlist.html

Public information for other insect and disease threats is managed by the various responsible agencies, including:

FHP - www.fs.fed.us/foresthealth

FLMs - various agency web sites

States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>

Assess Impacts

The third step of the EWS is impact assessment. This step encompasses all processes and programs related to the evaluation of potential impacts caused by environmental threats, including developing quarantine restrictions for invasive organisms and treatment options. Careful impact assessment is an essential prelude to appropriate response actions.

Evaluate Extent, Severity, and Potential Impact

Once the causal agent is verified, the scope of current and potential damage can be determined based on available information, professional knowledge, and research.

- **Damage and impact surveys** - Damage surveys, especially aerial surveys and special ground impact surveys, contribute pertinent information for defining the current extent, severity, and potential impact of damage caused by insect and disease threats; this is particularly true for native pests.

Lead: FHP - www.fs.fed.us/foresthealth

- **Forest Health Specialist Reports** - Biological Evaluations (BE) of pest problems and Pest Risk Assessments prepared by FHP and State forest health specialists evaluate the current status and potential impacts of forest insect and pathogen pests.

Leads:

FHP - www.fs.fed.us/foresthealth,

States - <http://www.stateforesters.org/SFlinks.html>

DRAFT

- **FHM Evaluation Monitoring projects** - Through a competitive grant program called Evaluation Monitoring, FHM funds projects clarifying the extent, severity, and causes of undesirable changes in forest health identified through FHM detection surveys. See <http://www.na.fs.fed.us/spfo/fhm/index.htm>
Lead: FHP - www.fs.fed.us/foresthealth
- **Research and evaluate impacts and assessment tools** - Research and evaluation defines potential impacts where little information is currently available, such as for wildlife, fish, or riparian areas. Research and evaluation also develops and improve risk/hazard classification systems, which can be used to predict potential impacts of forest health threats.
Leads:
R&D - <http://www.fs.fed.us/research/>
FHP - www.fs.fed.us/foresthealth

Conduct Regulatory and Quarantine Assessments

Regulatory agencies prepare invasive organism assessments, which serve as the basis for regulatory response to new or potential introductions.

- **APHIS New Pest Advisory Group (NPAG)** - NPAG assesses new and potential introductions of exotic pests of plants into the USA in order to recommend the appropriate course of action. See <http://www.cphst.org/npag/>
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
- **State Departments of Agriculture** - Individual State Departments of Agriculture conduct state-level assessments of new and potential introductions of invasive organisms into their state. See <http://www.nasda-hq.org/>
Lead: States - <http://www.nasda-hq.org/>

Evaluate and Develop Treatment Options

Ideal treatment options are effective, cost-efficient, site-specific, and minimize undesirable effects.

- **Operational evaluation and development** - During field operations and in special working groups, work conferences, and staff meetings, forest health specialists from agencies responsible for responding to forest health threats continually evaluate available treatment methods and tools and work to develop better treatment options.
Leads:
FHP - www.fs.fed.us/foresthealth
States - <http://www.nasda-hq.org/>, and <http://www.stateforesters.org/SFlinks.html>
- **Conduct research on treatment methods and technologies** - Research develops new technologies and improves existing treatment methods and tools. Cooperators in this effort include R&D, FHP, Federal Land Managers (FLMs), States, and Universities. Research provides information on how to identify areas for treatment, and where to best apply various treatment methods and technologies. Research Centers can advance development of solutions to problems caused by environmental threats by focusing scientific work and available resources on forest health topics.
 - **Vegetation Management and Protection Research (VMPR)** - Part of a coordinated Federal effort to address problems associated with invasive and native insect,

DRAFT

disease, and weed pests, VMPR research addresses pest prevention, detection, response, restoration, and associated disturbances including weather and climate patterns, fire, and forest operations. VPMR researchers develop treatment and monitoring methods and technologies, and play an important role in the development of risk maps and strategic maps for invasive pests. See

<http://www.fs.fed.us/research/vmpr.html>

Lead: R&D - <http://www.fs.fed.us/research/>

- **Agricultural Research Service (ARS)** - The ARS is the in-house research arm of the US Department of Agriculture. ARS scientists conduct agricultural research, collaborate with scientists from other institutions and other countries, and provide research support to other federal agencies. Broad in scope with an emphasis on agriculture, ARS research sometimes covers topics pertaining to forest health threats, e.g. [SOD symptomatology and host range research project](#). For more information about the ARS, go to <http://www.ars.usda.gov/aboutus/>
- **Forest Health Technology Enterprise Team (FHTET)** - Sponsored by Forest Health Protection, FHTET develops and delivers forest health technology as well as forest health technology support to field personnel in public and private organizations. FHTET provides support to the Forest Service in the arena of forest health protection. It focuses on development of intermediate-term (3-5 years) technology development and development of pioneering technology (5+ years). The group has an entrepreneurial component that provides services on a cost-reimbursable basis. FHTET also administers FHP's Special Technology Development Program (STDP) (see <http://stdpweb.fs.fed.us/stdp/bkgrnd.asp>), a competitive grant program that funds technology development projects led by Forest Service employees responsible for delivery of FHP programs. For more information on FHTET, go to <http://www.fs.fed.us/foresthealth/technology/>

Lead: FHP - www.fs.fed.us/foresthealth

Assess Potential Response Actions

Potential treatment options are designed around project objectives (e.g., eradication or suppression) and may consist of one or more treatment methods (e.g., aerial pesticide application) or tools (e.g., type of insecticide used). The National Environmental Policy Act of 1969 (NEPA) applies to treatments on federal lands and certain federally funded projects on non-Federal lands, requiring development of treatment alternatives and evaluations of potential impacts prior to project decision-making and implementation.

- **Determine and develop appropriate NEPA documentation** - Treatment projects are analyzed according to specified NEPA requirements at one of three analysis levels: Categorical Exclusion (CE), Environmental Assessment (EA), or Environmental Impact Statement (EIS). Title I and Title IV of the Healthy Forests Restoration Act provides special authorities for expedited NEPA analyses of insect and disease-related treatments, applied silvicultural assessments, and research studies of 1,000 acres or less.

Leads:

FHP - www.fs.fed.us/foresthealth

FLMs - various agency websites

States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>

- **Consultation with other regulatory agencies** - The Endangered Species Act (ESA) requires formal consultation with regulatory agencies such as the US Fish and Wildlife Service (FWS) or NOAA Fisheries National Marine Fisheries Service (NMFS) for

proposed treatments potentially affecting endangered and threatened (listed) species. Individual states also may have their own consultation requirements for state listed species, designated natural areas, etc.

Leads:

FWS - <http://www.fws.gov/>

NMFS - <http://www.nmfs.noaa.gov/>

States, link to "State-by-State Environ. Guides" - <http://www.nasda-hq.org/>



Respond

The fourth step of the EWS is response to environmental threats. Timely response and followup is crucial to prevent or ameliorate unacceptable environmental damage from environmental threats. When new infestations of regulated invasive species occur, responses are coordinated by State Plant Regulatory Officials (SPROs) and APHIS State Plant Health Directors (SPHDs).

Consult and Coordinate Actions

Involved parties, including federal, state, and tribal agencies, consult to assign lead responsibility and to coordinate actions.

- **New Pest Assessment Group** - NPAG assessments provide management recommendations for invasive organisms. See <http://www.cphst.org/npag>
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
- **APHIS Science Panels** - APHIS Science Panels advise regulators on science issues related to exotic pests of plants.
Lead: APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
- **Regional, State, or local Coordinating Committees** - coordinate responses to forest health threats that span administrative and jurisdictional borders.
Leads:
APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>
FHP - www.fs.fed.us/foresthealth
States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>
Tribes - <http://www.itcnet.org/>

Implement Appropriate Treatments

Potential impacts of environmental threats may be avoided or minimized by promptly implementing appropriate preventative, eradicated, or suppressive actions. Newly introduced invasive species are prevented from becoming established by rapidly implementing appropriate quarantines and eradication treatments. Similarly, damage to forest ecosystems by native forest pests or established invasive species can be reduced by prompt implementation of effective suppression treatments.

- **Cooperative treatment projects** - Cooperative treatment projects are carried out on Federal, State, Tribal, or private lands to eradicate newly introduced exotic pests such as Asian longhorned beetle, sudden oak death, and emerald ash borer; suppress native or established exotic pests such as Southern pine beetle, gypsy moth, western bark beetles, root diseases, hemlock wooly adelgid, and others; and to improve fire regime condition class (FRCC) across the landscape. Additional information regarding

DRAFT

cooperative forest health treatment projects may be found at http://www.fs.fed.us/foresthealth/forest_health_management.shtml

Leads:

SPROs - <http://www.aphis.usda.gov/npb/npbmemb.html> (*new infestations of invasive species*)

SPHDs - http://www.aphis.usda.gov/travel/aji_pop/sphdlist.html (*new infestations of invasive species*)

FHP - www.fs.fed.us/foresthealth (*established invasive and native pests*)

FAM - <http://www.fs.fed.us/fire/> (*FRCC improvement*)

- **Quarantines** - Federal quarantines are implemented by APHIS to prevent the introduction and establishment of invasive organisms into the USA. State-level quarantines are implemented by individual State Departments of Agriculture to prevent introduction and establishment of invasive organisms into a State.

Leads:

APHIS - <http://www.aphis.usda.gov/lpa/about/welcome.html>

States - <http://www.nasda-hq.org/>

- **FHP contingency fund** - Each year FHP holds a portion of its funding in reserve for “urgent” invasive insect and pathogen activities. These funds are dispersed for rapid response actions designed to limit the spread and intensification of invasive species.

Lead: FHP - www.fs.fed.us/foresthealth

- **Emergency funding from Commodity Credit Corporation (CCC)** - The Secretary of Agriculture has authority to procure emergency funding from the CCC to treat severe insect and disease outbreaks that threaten agricultural production. For additional information about the CCC, go to

<http://www.fsa.usda.gov/pas/publications/facts/html/ccc99.htm>

Lead: FHP - www.fs.fed.us/foresthealth

Monitor Treatment Effectiveness

Treatment effectiveness monitoring is extremely important to ensure that treatment objectives are met, and to provide a basis for future response actions. It is also important that possible non-target effects be monitored and evaluated, to provide information for future analyses and development of treatment options, mitigation measures, and restoration treatments.

- **Cooperative post-treatment evaluations** - Cooperative evaluations of pest population and damage reduction following treatment are carried out on Federal, State, Tribal, or private lands to assess treatment effectiveness. Possible non-target effects are also evaluated at this time.

Leads:

FHP - www.fs.fed.us/foresthealth,

FLMs - various agency web sites.

Tribes - <http://www.itcnet.org/>

States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>

Restore Affected Areas

Areas negatively affected by forest health threats can often be restored through the concerted efforts of concerned land managers, owners, and stakeholders.

- **Cooperative restoration efforts** - Cooperative projects conducted by Federal, State, Tribal, and private land managers and non-profit organizations attempt to restore areas affected by forest health threats. Following are some examples of cooperative restoration efforts:
 - Tree resistance breeding – Increasing tree resistance to particular pests through selection and breeding for desired traits is a primary strategy for restoring forest ecosystems impacted by invasive pests, especially in situations involving invasive pathogens. Resistance breeding programs have been initiated for a number of invasive diseases including chestnut blight, butternut canker, white pine blister rust, beech bark disease, and Port-Orford-cedar root disease. R&D in cooperation with FHP conducts research to develop disease resistant trees. Research development of techniques for resistance screening is a crucial component of resistance breeding programs.
 - Restoration of areas damaged by the Ice Storm of 1998 in Northeast USA (see sidebar below). See also <http://www.fs.fed.us/na/durham/ice/index.htm>;
 - Restoration of whitebark pine ecosystems affected by white pine blister rust and fire exclusion. See <http://www.whitebarkfound.org/about3.htm>;
 - Restoration of the American chestnut tree, affected by chestnut blight, to its native range. See <http://www.acf.org/About.htm>.

Leads:

FHP - www.fs.fed.us/foresthealth

FLMs - various agency web sites

- States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>



Restoring Affected Areas



A devastating ice storm struck Maine, New Hampshire, Vermont, and northern New York in January, 1998, seriously damaging trees and property on more than 17 million acres. In a prompt response effort, State and Federal forestry agencies cooperated in a highly successful regional program of forest recovery including damage assessment surveys; storm clean-up; forestry and fire mitigation grants to communities; landowner assistance; and research.

DRAFT

Tribes - <http://www.itcnet.org/>

Non-profit organizations (NPOs) - various web sites

- **Collaborate with local groups** - Many local groups are interested in participating in ecosystem restoration efforts.

Leads:

FLMs - various agency web sites

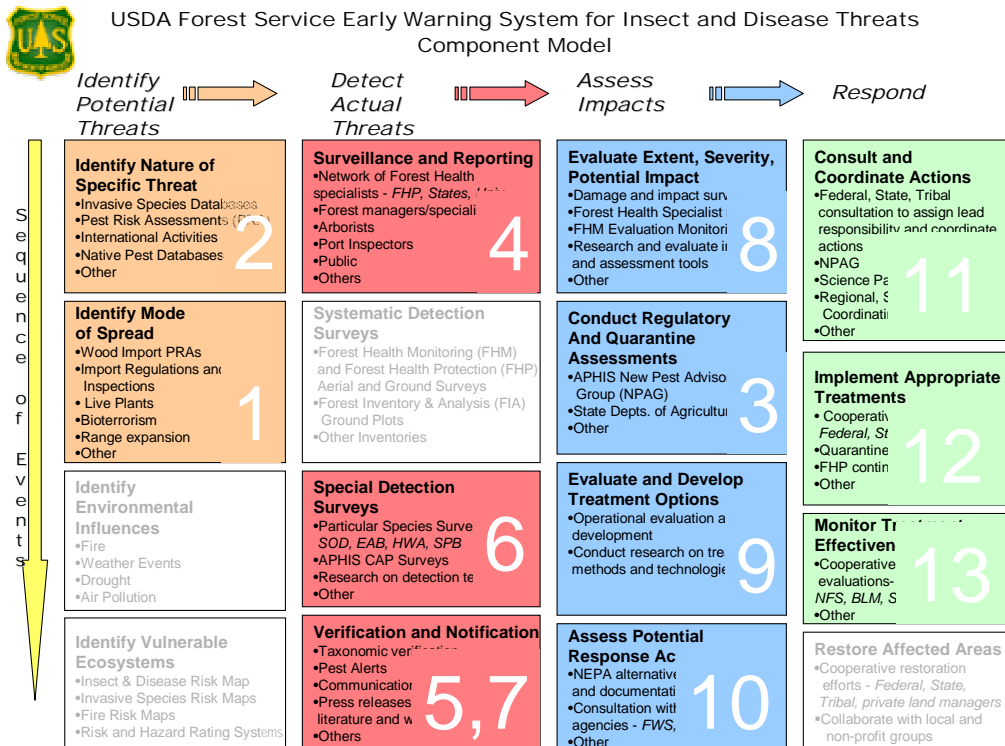
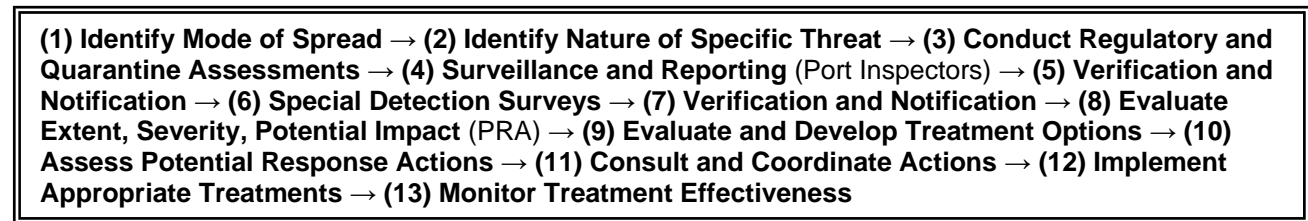
States - <http://www.nasda-hq.org/> and <http://www.stateforesters.org/SFlinks.html>

Applying the Early Warning System

Case History of the Asian Gypsy Moth in the Pacific Northwest

Native to parts of Asia, the Asian gypsy moth, *Lymptria dispar*, was identified as a potential invasive pest of forest ecosystems in the United States during the pathway assessment for logs from Russia. Logs, ships and cargo from the Russian Far East are considered significant pathways for introduction. In 1991, port inspectors on a Soviet ship docked in Vancouver, British Columbia, discovered hatching egg masses of Asian gypsy moth. Because it was feared that young larvae might have been blown onshore at this and other ports visited by Soviet ships, special detection surveys using pheromone traps immediately were initiated at port sites in northwestern North America. That year, captured gypsy moths at three trapping locations in Oregon, Washington, and British Columbia were verified as Asian gypsy moths using genetic identification techniques developed by R&D. Annual special detection surveys continued, and APHIS and USFS completed a pest risk assessment for this insect. A cooperative monitoring and suppression program was initiated in Russia in 1993 (see sidebar, p. 11). In fall, 2000, a single gypsy moth captured near shipping terminals in Portland, Oregon, was verified as Asian gypsy moth. APHIS, Oregon State Department of Agriculture, and FHP cooperated to evaluate treatment options and assess potential response actions. The following spring, over 900 acres were sprayed with an insecticide in the vicinity of the capture site to eradicate any remaining populations. Extensive trapping in fall, 2001, verified success of the eradication effort.

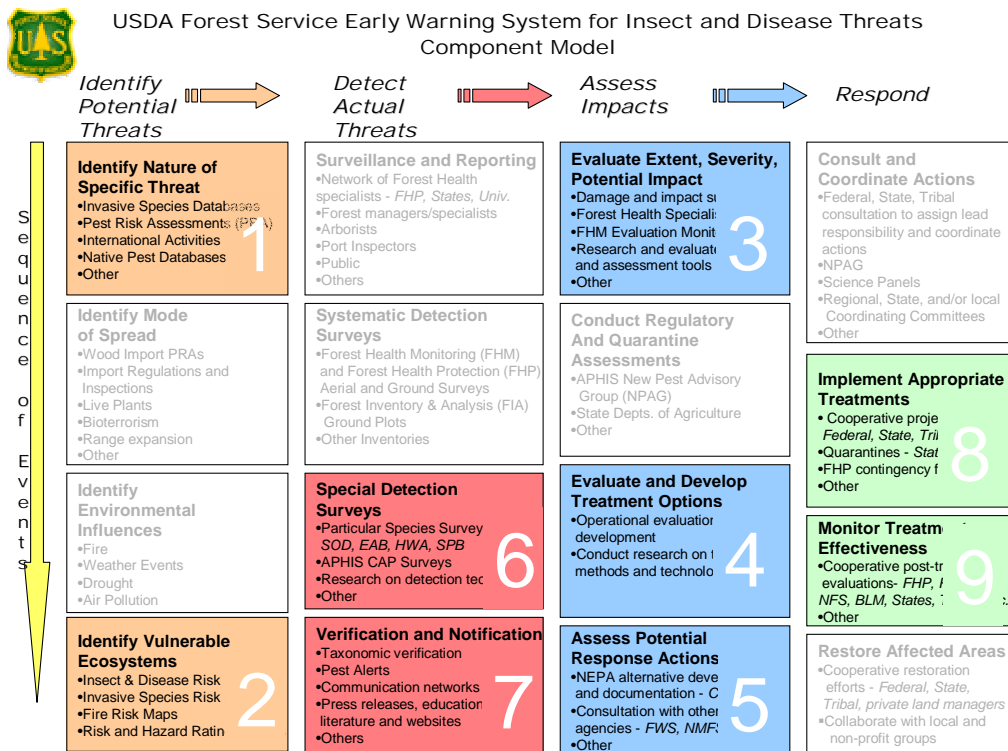
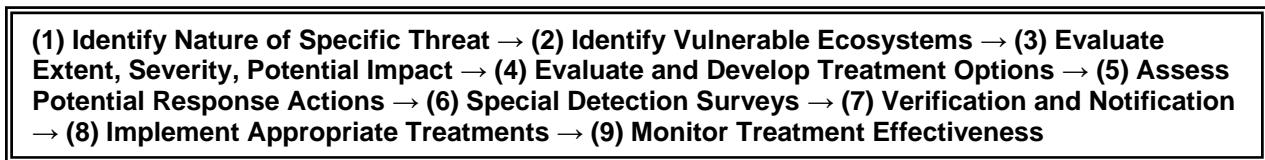
Fig. 3. Flow of detection and response to Asian gypsy moth through the EWS.



Case History of Southern Pine Beetle, a Native Bark Beetle

The southern pine beetle, *Scolytus frontalis*, is a bark beetle native to the Southern US that kills pine trees. Populations fluctuate from year to year and place to place, and reach epidemic levels in some parts of the South nearly every year. Epidemics can cause rapid, extensive, and severe tree mortality. From 1999 through 2003, heavy losses due to southern pine beetle were mostly focused in the southern Appalachian Mountains in the Southeast US. Habitat of the red cockaded woodpecker, a federally listed endangered species is threatened when excessive tree mortality is caused by southern pine beetle. Land managers and owners evaluate potential impacts and treatment options and assess potential response actions for high-risk areas. Suppressive treatment requires rapid detection and response to small spot infestations. Damage caused by the southern pine beetle is detected and evaluated on an annual basis through FHM-funded cooperative special detection aerial sketch map surveys, which are conducted by State and NFS personnel as part of the FHM program. Digital technology improves accuracy and facilitates rapid transfer of survey information to ground crews implementing suppression treatments. Treatments usually involve spot treatment of small groups of infested trees through salvage, cut-and-leave, insecticide application, and pile-and-burn operations. Treatment effectiveness is monitored with subsequent ground and aerial surveys.

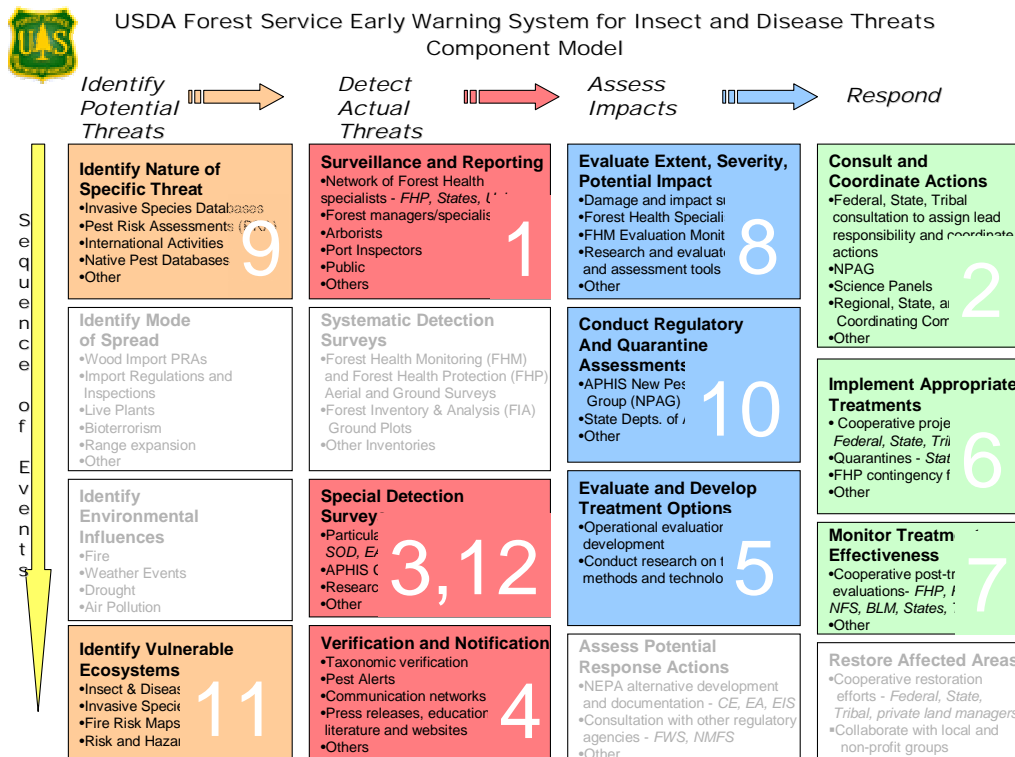
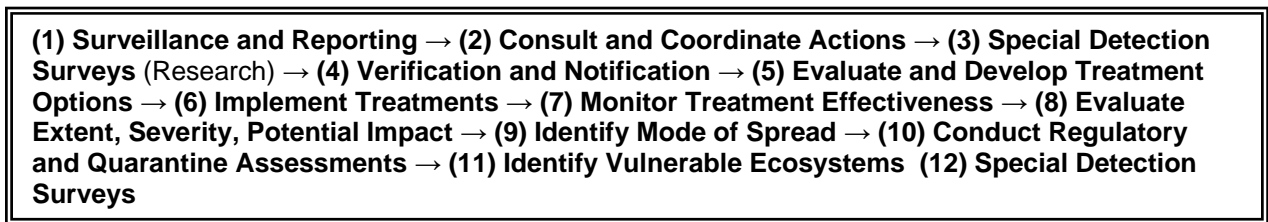
Fig. 4. Flow of detection and response to southern pine beetle through the EWS.



Case History of Sudden Oak Death, a Previously Unknown Invasive Pathogen

In 1995, forest health specialists began reporting unprecedented levels of mortality of tanoak, coast live oak, and California black oak in the coastal areas of central California. The disease associated with the oak mortality became known as Sudden Oak Death (SOD), but the causal agent was unknown. Concerned Federal and State agencies began consulting and coordinating response actions. Research was initiated to identify the pathogen, additional hosts, modes of dispersal, and to develop detection techniques. In June 2001, scientists determined that the cause of the dieoff was a previously unknown fungus, *Phytophthora ramorum*. Special surveys initiated in California, Oregon, and Washington during summer and fall, 2001, detected SOD at additional locations in California and southwestern Oregon. Eradication treatments were initiated in southwestern Oregon that same year. PRAs for SOD in the United States and in Oregon were completed in fall, 2001 and summer, 2003, respectively. A national quarantine restricting interstate movement of host plants was put into effect in February, 2002, and in 2003, a SOD Risk Map and technical protocols for detecting SOD infestations in nursery and forest environments outside known affected areas were developed and implemented. In spring, 2004, it was discovered that infected nursery stock had been shipped to nurseries in at least 13 states. Consultation and coordination regarding SOD has grown to include APHIS, all 50 States, FHP, R&D, and CSREES. Special SOD detection surveys will be conducted during 2004 at high-risk sites across the US.

Fig. 5. Flow of detection and response to sudden oak death through the EWS.



Conclusion

The Early Warning System component model described in these pages represents the conceptual framework and core resources of the EWS as it applies to insects and diseases. It has many potential applications, including education, analysis, improvement, planning, and decision-making.

The EWS aids in ensuring that a comprehensive approach is taken when dealing with environmental threats, and that all relevant resources are brought to bear upon the problem at hand. The pathway through the Early Warning System is not prescribed; rather it responds to the diverse nature of environmental threats, varying according to the particular circumstances of each application.

The next step in implementing the insect and disease Early Warning System is to form the EWS Steering Committee. The Steering Committee will help identify critical future steps, develop specific EWS action plans, and identify short and long term funding strategies and commitments. The Steering Committee can use the EWS framework to identify and remedy existing gaps or weak areas in knowledge, processes, or linkages necessary for optimal functioning of the implemented EWS, and to look for opportunities for streamlining the system by increasing cooperation and collaboration or eliminating unnecessary redundancies. The Steering Committee also may use the EWS as a tool for strategic planning when setting direction and priorities, or as a template for resource allocation to project proposals addressing various aspects of the EWS.

The effectiveness of the insect and disease Early Warning System will be greatly enhanced with improved coordination. Fully implemented with improved coordination, the EWS will enable us to prevent damage to forest ecosystems in the United States from new threats and reduce the impacts of existing threats to acceptable levels.

Glossary

ALB – Asian longhorned beetle
APHIS – Animal and Plant Health Inspection Service
ANLA – American Nursery and Landscape Association
ARS – Agricultural Research Service
BE – Biological evaluation
BLM – Bureau of Land Management
CAPS – National Cooperative Agricultural Pest Survey
CCC – Commodity Credit Corporation
CE – Categorical Exclusion
CSREES – Cooperative State Research, Education, and Extension Service
DHS – Department of Homeland Security
DOC – Department of Commerce
EA – Environmental Analysis
EAB – Emerald ash borer
EDEN – Extension Disaster Education Network
EDRR – Early Detection and Rapid Response System for Invasive Plants
EIS – Environmental Impact Statement
EPA – Environmental Protection Agency
ESA – Endangered Species Act
EWS – Early Warning System
EXFOR – Exotic Forest Pest Information System for North America
FAM – Fire and Aviation Management
FHM – Forest Health Monitoring
FHP – Forest Health Protection
FHTET – Forest Health Technology Enterprise Team
FIA – Forest Inventory and Analysis
FICMNEW – Federal Interagency Committee for the Management of Noxious and Exotic Weeds
FIDL – Forest Insect and Disease Leaflet
FLM – Federal Land Manager (e.g. NFS, BLM, NPS)
FRCC – Fire regime condition class
FWS – Fish and Wildlife Service
GISP – Global Invasive Species Program
HFRA - Healthy Forests Restoration Act of 2003
HWA – Hemlock woolly adelgid
Invasive species (organisms) - Species (organisms) that are alien to a particular ecosystem and pose a threat of economic or environmental damage.
IP – International Programs
IPM – Integrated pest management
ISA – International Society of Arboriculture (and affiliates)
NAFC – North American Forestry Commission
NAPIS – National Agricultural Pest Information System
NAPPO – North American Plant Protection Organization
NASF – National Association of State Foresters
NEPA – National Environmental Policy Act of 1969
NFS – National Forest System
NIFC – National Interagency Fire Center
NMFS – National Marine Fisheries Service

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NOAA – National Oceanic and Atmospheric Administration
NPAG – New Pest Advisory Group (APHIS)
NPO – Non-profit organization
NPS – National Park Service
Pathway – means by which an invasive organism enters a new country or ecosystem; usually involves both a carrier and a particular sequence of events.
NPDN – National Plant Diagnostic Network
NRCS – Natural Resource Conservation Service
NRIS – Natural Resource Information System
NWCC - National Water and Climate Center
PAS – Phytosanitary Alert System
PRA – Pest Risk Assessment; a scientifically-based risk evaluation that asks how likely a pest introduction is and how bad the outcome would be if it occurred; used by regulatory officials to determine the need and nature of quarantine regulations.
PPQ – Plant Protection Quarantine
R&D – Research and Development
RAPDET – Invasive Species Rapid Detection and Response
Resources - Activities, organizations, programs, or databases that carry out Early Warning System functions.
Risk map – A map indicating the location and relative risk of damage from one or more environmental threats.
SAF – Society of American Foresters
SOD - Sudden oak death
SPHD – APHIS State Plant Health Director
SPRO – State Plant Regulatory Officer
STDP – Special Technology Development Program
US – United States of America
USA – United States of America
USDA – United States Department of Agriculture
USDI – United States Department of the Interior
USFS – United States Forest Service
VMPR – Vegetation Management and Protection Research
WIPRAMET – Wood Import Pest Risk Assessment and Mitigation Evaluation Team

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Appendix A

List of EWS Resource Web sites

Agencies:

Agriculture and Plant Health Inspection Service (APHIS) - <http://www.aphis.usda.gov/lpa/about/welcome.html>
APHIS Plant Protection and Quarantine (PPQ) - <http://www.aphis.usda.gov/ppq/>
National Oceanic and Atmospheric Administration (NOAA) - <http://www.noaa.gov/>
NOAA Fisheries National Marine Fisheries Service - <http://www.nmfs.noaa.gov/>
State Departments of Agriculture - <http://www2.nasda.org/NASDA>
State Departments of Forestry - <http://www.stateforesters.org/SFlinks.html>
USDA Agricultural Research Service (ARS) - <http://www.ars.usda.gov/AboutUs/AboutUs.htm>
USDA Commodity Credit Corporation - <http://www.fsa.usda.gov/pas/publications/facts/html/cc99.htm>
USDA Forest Service (USFS) - <http://www.fs.fed.us/>
USDA Forest Service Fire and Aviation Management (FAM) - <http://www.fs.fed.us/fire/>
USDA Forest Service Forest Health Protection (FHP) - www.fs.fed.us/foresthealth
USDA Forest Service Forest Health Technology Enterprise Team (FHTET) - <http://www.fs.fed.us/foresthealth/technology/>
USDA Forest Service International Programs (IP) - <http://www.fs.fed.us/global/aboutus/welcome.htm>
USDA Forest Service Research & Development (R&D) - <http://www.fs.fed.us/research/>
USDA Natural Resources Conservation Service - <http://www.nrcs.usda.gov/>
US Department of Commerce (DOC) - <http://www.commerce.gov/>
US Department of Homeland Security (DHS) - <http://www.dhs.gov/dhspublic/index.jsp>
US Department of the Interior - <http://www.doi.gov/>
US Geological Survey - <http://www.usgs.gov/>
USDI Fish and Wildlife Service - <http://www.fws.gov/>
USDA Forest Service R&D Vegetation Management and Protection Research (VMPR) - <http://www.fs.fed.us/research/vmpr.html>

Databases:

APHIS Regulated Pest List - <http://www.aphis.usda.gov/ppq/regpestlist/>
CAPS Target Pest List - <http://www.aphis.usda.gov/ppq/ep/pestdetection/pestlist.html>
Douglas-fir Tussock Moth Early Warning System Database - <http://www.fs.fed.us/r6/nr/fid/dftmweb/index.shtml>
Forest Insect and Disease Leaflets (FIDLs) – http://www.na.fs.fed.us/spfo/pubs/fth_pub_pages/fidlpage.htm
National Agricultural Pest Information System (NAPIS) - <http://ceris.purdue.edu/napis/>
National Alien and Invasive Species Database (NAISD) - <http://www.qisp.org/index.htm>
Natural Resource Information System (NRIS) - <http://www.fs.fed.us/emc/nris/>
New Pest Advisory Group (NPAG) - <http://www.cphst.org/npag/>
North American Exotic Forest Pest Information System (EXFOR) – <http://spfnic.fs.fed.us/exfor/>

Invasive species:

Asian Longhorned Beetle (ALB) - <http://www.na.fs.fed.us/spfo/alb/index.htm>

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Early Detection and Rapid Response System for Invasive Plants (EDRR) web site -

<http://www.invasivespecies.gov/toolkit/detection.shtml>

Emerald Ash Borer (EAB) - <http://www.na.fs.fed.us/spfo/eab/>

Gypsy Moth - <http://www.fs.fed.us/ne/morgantown/4557/gmoth/>

Hemlock Woolly Adelgid – <http://www.fs.fed.us/na/morgantown/fhp/hwa/hwasite.html>

Invasive species, Federal gateway web site– <http://www.invasivespecies.gov/>

Invasive Species Information Node, National Biological Information Infrastructure -

<http://invasivespecies.nbii.gov/>

Sudden Oak Death (SOD) - <http://www.suddenoakdeath.org>

Networks:

Extension Disaster Education Network (EDEN) - <http://www.agctr.lsu.edu/eden/default.aspx>

National Plant Diagnostic Network (NPDN) – <http://npdn.ppath.cornell.edu/default.htm>

Organizations and Groups:

American Nursery and Landscape Association (ANLA) - <http://www.anla.org/>

Cooperative Agricultural Pest Survey (CAPS) -

<http://www.ceris.purdue.edu/napis/docs/caps.html>

Federal Interagency Committee for the Management of Noxious and Exotic Weeds -

<http://ficmnew.fws.gov/>

International Society of Arboriculture (ISA) - <http://www.isa-arbor.com/home.asp>

National Invasive Species Council (NISC) – <http://www.invasivespecies.gov/council/main.shtml>

New Pest Advisory Group (NPAG) - <http://www.cphst.org/npag/>

North American Forestry Commission (NAFC) - <http://www.fs.fed.us/global/nafc/welcome.html>

North American Plant Protection Organization (NAPPO) - http://www.nappo.org/menu_e.shtml

National Association of State Foresters - <http://www.stateforesters.org/>

Society of American Foresters - <http://www.safnet.org/>

State Plant Health Directors (SPHDs) - http://www.aphis.usda.gov/travel/aji_pop/sphdlist.html

State Plant Regulatory Officers (SPROs) - <http://www.aphis.usda.gov/npb/npbmemb.html>

Pest Alerts:

APHIS Plant Protection and Quarantine (PPQ) -

http://www.aphis.usda.gov/ppq/ep/emerging_pests.html

FHP pest alerts and updates - <http://www.fs.fed.us/na/morgantown/fhp/palerts/palerts.htm> and

http://www.fs.fed.us/foresthealth/programs/FHP_News.shtml

Global Invasive Species Program (GISP) “Invasive Alien News” - <http://www.gisp.org/>

Invasive Species Council “News and Events” – <http://www.invasivespecies.gov/new/main.shtml>

NAPPO Phytosanitary Alert System - <http://www.pestalert.org/main.cfm>

Pest Risk Assessments:

Pest Risk Assessment for Importation of Solid Wood Packing Materials Into the United States -

<http://www.aphis.usda.gov/ppq/prs/swpm/intro.pdf>

Pest Risk Assessment of the Importation into the United States of Unprocessed Eucalyptus

Logs and Chips from South America - <http://www.fpl.fs.fed.us/documnts/fplqtr/fplqtr124.pdf>

Pest Risk Assessment of the Importation into the United States of Unprocessed Logs and Chips of Eighteen Eucalypt Species From Australia -

<http://www.fpl.fs.fed.us/documnts/fplqtr/fplqtr137.pdf>

The Unmitigated Pest Risk Potential for the Importation of Pinus and Abies Logs from all States of Mexico - <http://www.fpl.fs.fed.us/documnts/FPLGTR/fplqtr104.pdf>

SOD Pest Risk Assessment for Oregon -

http://oda.state.or.us/plant/ppd/path/SOD/SOD_PRA_OR_2=04.pdf

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A Pest Risk Assessment of *Phytophthora ramorum* in North America-
http://www.cnr.berkeley.edu/comtf/html/pest_risk_assessments.html#USPRA

Programs:

Cooperative Agricultural Pest Survey (CAPS) -
<http://www.ceris.purdue.edu/napis/docs/caps.html>
Douglas-fir Tussock Moth Early Warning System -
http://www.fs.fed.us/r6/nr/fid/dftmweb/biology/dftm_ews.htm
Forest Health Monitoring (FHM) - <http://www.na.fs.fed.us/spfo/fhm/index.htm>.
Forest Inventory and Analysis (FIA) – <http://fia.fs.fed.us/about.htm>
North American Exotic Forest Pest Information System (EXFOR) –<http://spfnic.fs.fed.us/exfor/>
Rapid Detection and Response Program (RAPDET) –
http://www.fs.fed.us/foresthealth/briefs/Rapid_dect_response_prg.htm
Special Technology and Development Program (STDP) -
<http://stdpweb.fs.fed.us/stdp/bkgrnd.asp>

Risk Maps:

Insect and Disease Risk Map – http://www.fs.fed.us/foresthealth/risk_maps/risk_maps.html
Coarse scale mapping of fire regime condition classes (FRCC) based on historic fire regimes and current vegetative conditions -http://www.fs.fed.us/rm/pubs/rmrs_gtr87.html
LANDFIRE project (includes fire risk mapping at subwatershed-scale) - <http://www.landfire.gov/>
Sudden Oak Death Risk Map –<http://www.na.fs.fed.us/spfo/fhm/sod/images/riskmap.pdf>

Tools:

A National Early Detection and Rapid Response System for Invasive Plants in the United States: Conceptual Design – http://ficmnew.fws.gov/FICMNEW_EDRR_FINAL.pdf
Forestry Images - <http://www.ForestryImages.org>
LANDFIRE project - <http://www.landfire.gov/>
Preparing for Invasive Species Outbreaks: A Workbook for State Foresters
<http://www.stateforesters.org/pubs/InvasivesWorkbook.pdf>
PPQ Emergency Programs Manual - http://www.aphis.usda.gov/ppq/manuals/pdf_files/epm.pdf
National Drought Mitigation Center's US Drought Monitor -
<http://www.drought.unl.edu/dm/monitor.html>
National Strategy and Implementation Plan for Invasive Species Management
http://www.fs.fed.us/foresthealth/programs/invasive_species_mgmt.shtml (not yet posted)
USDA Natural Resources Conservation Service (NRCS) National Water and Climate Center -
<http://www.wcc.nrcs.usda.gov/wcc.html>
US Department of Commerce (DOC) National Oceanic and Atmospheric Administration (NOAA)
Drought Information Center - <http://www.drought.noaa.gov/>
USGS Drought Watch - http://water.usgs.gov/cgi-bin/dailyMainW?state=us&map_type=dryw&web_type=map

