Update

FOREST HEALTH TECHNOLOGY
ENTERPRISE TEAM UPDATE

USDA FOREST SERVICE, STATE AND PRIVATE FORESTRY, FOREST HEALTH PROTECTION, FOREST HEALTH TECHNOLOGY ENTERPRISE TEAM SPRING/SUMMER 2001

Geospatial Web Technology

This new technology is makes it possible to customize and view complex maps, on-line.

Consider this: If you remove the E-commerce quotient from the on-line equation, the fastest growing sector on the Internet is geospatial imaging, or mapping. That is, more mapping technology is being developed for, and tested on, the Web than anything else.

It makes sense. Maps have been available on the Web for years. But until very recently, Web users had to make do with static imagery, meaning they could only view maps on-line that had been created from pre-determined data sets. If the website did not host a map containing the precise data the user needed, the user was out of luck. Likewise, any changes to a static map had to be made off line by the map's designer, and the revised map had to be uploaded to a website's files either by the designer or programmer. Hence, the process made it impossible to make dynamic, real-time changes.

Technology is rapidly redefining that process. Software has been developed that allows a Web user to select raw data, and produce and manipulate a map from it, on-line, in real time.

In mid-2000, FHTET began to consider developing Websites that would enable users to use this new technology to generate dynamic maps, on-line. But after considerable study, FHTET determined it was still a bit too early in the technology's development, and opted to wait.

However, technology develops at light speed when it comes to Web-based applications. To wit, FHTET determined early in 2001 that over just a few month's time, sufficient progress and improvements to the technology had been made to warrant testing a couple Web-based pilot projects, including the development of the National Aerial Survey Spatial Database (NASSD), an FHP clearinghouse, and a Southern pine beetle hazard and risk mapping application at FHTET, Fort Collins.

At the heart of this and FHTET's other Web-based mapping projects is a commercially available software product called ArcIMS. Developed by ESRI (Redlands, CA), ArcIMS simplifies things for Web developer and user, alike. The Forest Service plans to include ArcIMS in its suite of software products in Fiscal Year 2002. (*See* About ArcIMS, *page 3*.)

More about Geospatial Web Technology, pages 2, 3, 5, 7

Facts:

- *Mapping technology is now the number one development push in Web technology*
- *Web users can select raw data, and produce and manipulate a map from it, on-line, in real time*
- *FHTET's pilot projects include a National Aerial Survey Spatial Database, an FHP Clearinghouse, and a Southern Pine Beetle Risk Mapping Aplicaton*
- *Contact--**Loren Iverson** (FHTET - Fort Collins) (970) 295-5844 liverson01@fs.fed.us*

What's in the Update. . .

National Aerial Survey Spatial Database

According to plan, NASSD will come on-line in 2002, and provide map users with access to the world's largest, interactive, Web-based archive of spatial data.

In 1999, Forest Service aerial sketchmappers looked out their aircraft windows and sighted tens of thousands of discolored, telltale patches of insect and disease infestation in the forests below. While still in the aircrafts, they recorded their sightings as points and polygons on USGS topographical maps. Once back on the ground, they digitized their maps, and then forwarded the digital data to FHTET Contract Image Processing Specialist **Jeanine Paschke** (INTECS Int'l., Fort Collins).

Paschke's task is to check the data for errors and compliance with the standards established in the *Aerial Survey Geographic Information System Handbook* (1999), and then add the files to a national aerial survey spatial database, the largest database of its kind in the US.

According to Paschke, on average she posted 70,000 records each year since 1996, the year the project started. She said data for year 2000 is still coming in and will likely exceed the 90,000 records sent in 1999.

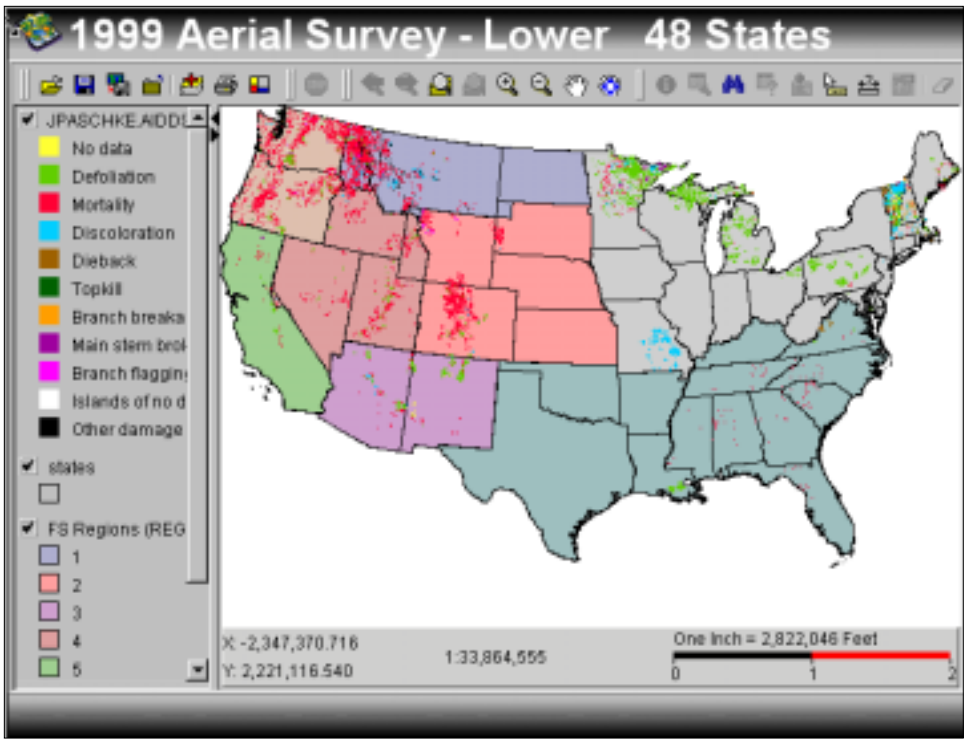
The data are used to create maps of mortality, defoliation, bark beetle activity, and other damage types, and to produce maps for the annual *Forest Insect and Disease Conditions Report.*

Data are stored in a spatial database that uses ESRI's Spatial Database Engine (SDE) and Oracle. They are accessible using ArcInfo 8 desktop tools, such as ArcMap and ArcCatalog, and ArcView 3.2.

Using the current system, someone who needs a map must contact Paschke in Fort Collins, provide her with the parameters for the map, and then wait for it. With the introduction of ArcIMS, the data will be available through the Web, and will empower users to create their own maps, view them on-line, download the map data, and print them locally.

Facts:

- *Over 70,000 records have been posted to the system annually since 1996*
- *Users will be able to create their own custom maps from data accessed over the Web*
- *Data is accessible using ArcInfo 8 desktop tools, such as ArcMap,ArcCatalog, and ArcView 3.2*
- *Contact -- **Jeanine Paschke** (INTECS-FHTET) (970) 295-5865 jpaschke@fs.fed.us*



More about Geospatial Web Technology, pages1, 3, 5, 7

Forest Health Protection Geospatial Database Clearinghouse

Expertise in the Alaska (R10) office is helping to drive development for this FHP/FHTET pilot project

FHTET is working with the FHP offices in the Northern (R1), Intermountain (R4), and Pacific Northwest (R6) regions on a pilot project to learn the system, network, and developer requirements involved in building and maintaining a Web-based, national geospatial data clearinghouse for FHP data.

The website will use ESRI's ArcIMS as its internet map-server tool, which will provide users with an interactive access to data, and enable them to create their own maps.

The project is based on the Geospatial Data Clearinghouse developed and maintained by the USGS in Alaska. The Alaska (R10) FHP Office has been a major contributor to the development and use of this clearinghouse since its inception. FHP's decision to investigate the creation of a geospatial clearinghouse was based in large part on R10's experience with the Alaska clearinghouse.

Initially, the website will be accessible to the FHP offices in the western regions, with the initial objectives being to determine how useful the system is, and provide insight into the costs and benefits involved in providing full public access to the site. Only a relatively small set of spatial coverages and attribute data will be available in the beginning. FHTET will fine tune the site and add more data as demand increases.

Cooperators in the project include: **Gregg DeNitto**, **Larry Stipe**, **Jim Byler** (FHP – R1); **Dayle Bennett**, **Dick Halsey**, **Leon LaMadeleine** (FHP – R4); **Julie Johnson** (FHP – R6).

Facts:

- *ArcIMS will become part of Forest Service office suite software in 2002*
- *FHP-FHTET prototype is based on the Geospatial Data Clearinghouse developed and maintained by the USGS in Alaska*
- *GIS Professionals will be able to download and manipulate data, and produce custom maps, off line.*
- *Contact--**Loren Iverson** (FHTET - Fort Collins) (970) 295-5844 liverson01@fs.fed.us*

About ArcIMS

At the heart of each National Aerial Survey Spatial Database (NASSD) project is a commercially available software product called ArcIMS. Developed by ESRI (Redlands, CA), ArcIMS simplifies things for Web developer and user, alike.

The product is quite complex, but that aside, it performs three functions crucial to successful, on-line map building. First, it significantly reduces the amount of coding required by developers to build Web-based, ArcView-like interface and map display systems. Second, it enables Web users not only to select the specific data sets they need to generate dynamic maps, on-line, but generate and view those maps on-line, as well. Third, ArcIMS enables users to download the raw data sets they need and manipulate the data, off line.

What makes this last feature particularly attractive to GIS Professionals and ArcView users is that it enables users to merge data acquired through the Forest Service and FHTET geospatial database, and utilize it (merge and/or layer it) with data collected elsewhere.

The Forest Service plans to include ArcIMS in its suite of software products in Fiscal Year 2002.

More about Geospatial Web Technology, pages 1, 2, 5, 7

Tim McConnell is new Aviation Safety and Aerial Survey Manager

Tim McConnell will join the FHTET (Fort Collins) staff on July 23, as Forest Health Protection's (FHP) first national program manager for aviation safety and aerial survey.

Tim has been an aerial sketch mapper for 23 years. Growing up in Seattle, he started in forestry with the Washington DNR in 1975 and began flying aerial survey in 1978. He began his Forest Service career in the Pacific Northwest Region at Portland, Oregon, in 1979.

Tim has served for the past nine years as the Northern Region's aerial survey program manager in Missoula, Montana. During that time, he worked with many surveyors and forest health and aviation management specialists to improve the safety and quality of aerial sketchmapping surveys. Tim was lead author of *A Guide to Conducting Aerial Sketchmapping Surveys*, a recent FHTET publication that describes the general procedures used by experienced aerial survey specialists to collect forest health data via sketchmapping. He has assisted with aerial survey training and technology transfer in Canada, Israel, and Mexico.

By establishing this new position and hiring Tim, FHP recognizes the importance of a national manager who can focus on coordinating and supporting the field in the safe and efficient use of aviation resources. In the Forest Service, FHP is second only to Fire in the use of aircraft. FHP's most significant aircraft use is by the cooperative aerial survey program, which includes over 200 state and Federal observers, who survey over 500 million acres each year, nat-ionally. In ad-dition, FHTET and several FHP field units use aircraft for op-erational remote sensing and technology develop-ment.

In addition to emphasizing safe and efficient aviation activities, Tim will help ensure national standards are met when collecting high quality

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Conferences

- Southern Forest Insect Work Conference (SFIWC), July 23 – 26, 2001. Jekyll Island, Georgia. http://www.sfiwc.org
- Society of American Foresters Convention, September 13-18, 2001. Denver, Colorado http://www.safnet.org/calendar/natcon.htm
- The 2nd Forest Vegetation Simulator (FVS) User's Conference. February 12 - 14, 2002. Fort Collins, Colorado. Call for papers is out. http://www.fs.fed.us/fmsc/fvs/fvs_conference2.htm
- Bark Beetle Technical Working Group (BBTWG) meeting. October 23 - 25, 2001. Taos, New Mexico. Reservations must be made by September 21st, under the group name of Bark Beetle Technical Working Group. For more information contact **Carol Randall**, crandall@fs.fed.us.
- The Western International Forest Disease Work Conference (WIFDWC). September 10 – 14, 2001. Carmel, California. Registration due by August 24, 2001. http://www.fs.fed.us/foresthealth/technology/wif.

There's an easy way!!

You don't need to copy down a link. Simply point your internet browser to http://www.fs.fed.us/foresthealth/technology/news.htm navigate to, and click on, the ***Spring 01 Update***. This will launch the ***Update*** in PDF format. All links on all pages are active; click on a link to open the Web page.

Southern Pine Beetle Hazard and Risk Mapping: Interactive Mapping on the Internet

Users will be able to conduct interactive risk analysis and mapping based on criteria they select from the SPBIS database

FHTET is developing a prototype Website that will enable users to do hazard and risk analyses for Southern Pine Beetle (SPB) infestations, and produce maps of areas at risk, on-line. The site should be accessible for beta testing in late FY2001.

This site will feature an interactive interface through which users can "customize" their risk criteria, conduct risk and hazard analyses, and generate maps on-line. Initially, to test the concept and procedures, the data on the site will cover only one ranger district.

The Website will use one basic layer of geospatial data, assembled from stand-coverage data from the FSVeg database, to develop stand hazard maps based on established algorithms. The user can then use the hazard maps to interactively conduct risk analysis and mapping based on criteria he/she selects from the Southern Pine Beetle Information System (SPBIS) database (*See* FSVeg and SPBIS, *this page*.)

Once fully operational, the plan is to expand the database to include other insect species and geospatial data (road networks, etc.), and develop a Website for the Southern Region (R8) through which the data can be accessed, on-line.

Forrest Oliveria, FHP Southern Region (R8), Pineville, LA, is the cooperator for this project.

Facts:

- *Beta testing is slated to begin this year.*
- *Site will feature interactive interface for customized research*
- *Website can access both FSVeg and SPBIS data*
- *Contact - **Forrest Oliveria** (FHP-R8) (318) 473-7294 foliveria@fs.fed.us*

FSVeg and SPBIS Databases

FSVeg is an Oracle database used to store data from grid-based strategic inventories, permanent re-measured inventory plots, and operational inventories, such as stand examinations and range status inventories. The database is composed of tables of information about plot setting, tree measurements, cover measurements, downed woody debris, ecological and site productivity classification, insect and pathogen observations, ownership, and treatment history. FHTET will add layers and ranger districts as testing progresses.

The Southern Pine Beetle Information System (SPBIS) is an Oracle database that has been operational since the mid 1980s, and was created to help monitor, predict and manage the Southern Pine Beetle (SPB), a major insect pest in the Southern Region (R8). SPBIS has been built from data input by districts throughout R8, and is used to track changes in, and generate status reports on, SPB "spots." There are scores of attributes (types of data) collected, on thousands of spots, annually, including: The number of spots monitored; the number of spots requiring control; trees cut and removed/left; and acres sprayed.

More about Geospatial Web Technology, pages 1-3, 7

Tim McConnell, continued from page 4

aerial survey data. Also, he will play a key role as an adviser to the FHP Washington Office and Regional/Area Directors on aviation issues and opportunities.

Tim will work closely with FHTET Fort Collins Director Andy Mason, the Aerial Survey Working Group and Forest Service Aviation Management staff.

FHP and FHTET look forward to Tim's arrival in Fort Collins.

Look for more information about the Forest Health Aviation program in the FHTET *Program of Work for Fiscal Year 2002* to be released this fall.

Eco-physiology Model Ready for Release and Evaluation

This model integrates the Stand-BGC bio-chemical cycles process model into the Forest Vegetation Simulator

FHTET and it's cooperators at the University of Montana and Rocky Mountain Research Station have done something quite novel that ultimately will give forest managers a more complete look at 21st Century forest health conditions. They have integrated a BioGeochemical Cycles process model, called Stand-BGC (Milner et al. 1996), into the Forest Vegetation Simulator (FVS), the Forest Service's standard stand growth model. The result, FVS-BGC, is a more powerful and complete approach for simulating growth, vigor and stress conditions of individual trees and stands.

This "marriage" of BGC and FVS is a big plus for future technology transfer, since FVS is already available to users at their desktops nationwide and FVS's geographical variants address most of the major forest types in the United States.

By itself, FVS can only be used to estimate stand competition values based on basal area and Stand Density Index. FVS-projected basal area and Stand Density Index are functions of tree growth, which assume average growth conditions, over a five- or ten-year period. FVS-BGC uses specific environmental factors to simulate both the trees' physiological functions and tree growth within the stand, and simulate variations in growing conditions on a daily, seasonal and annual basis.

Specific environmental factors include climate (weather), soil conditions, and tree competition for light and water. FVS-BGC uses climate and soil conditions to model changes in stand leaf area, and to project the stand's photosynthetic activity. FVS-BGC simulates water conditions by taking into account precipitation, soil water-holding capacity, evaporation, and water use (evapotranspiration) by trees and other vegetation.

The current version of FVS-BGC has been linked and tested with FVS's Central Rockies and North Idaho geographical variants. (The site data needed to run FVS-BGC is widely available, much of it on the Internet.) Weather information, including temperature, humidity, and rainfall, is available on-line from national climate databases. Some soil information, including type, depth, and water-retention capacity, is available on-line, too.

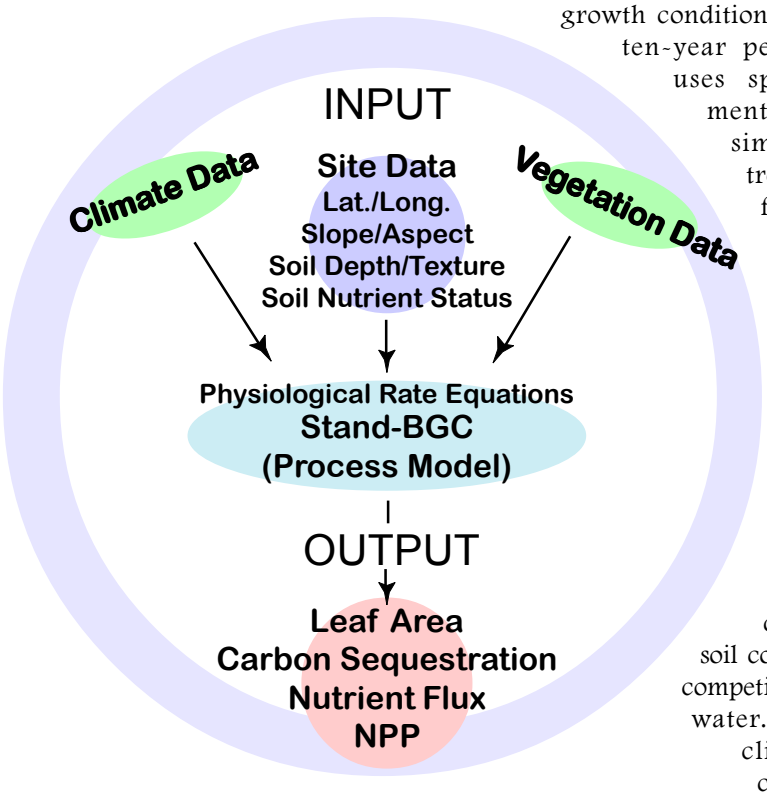
The BGC model utilizes remote sensing data from satellites to estimate leaf area; when combined with associated inventory data from FVS, FVS-BGC estimates leaf area for individual trees.

A user's manual and an evaluation version of the FVS-BGC software program will be available

Continued, page 8

Facts:

- *This integration of BGC and FVS is a big plus for future technology transfer*
- *The current version of FVS-BGC has been linked and tested with FVS's Central Rockies and North Idaho geographical variants*
- *FVS-BGC estimates leaf area for individual trees*
- *Contact--**Eric Smith** (FHTET-Fort Collins) (970) 295-5841 elsmith@fs.fed.us*



Informational Input & Output in BGC

The Web Corner

Alaska Geospatial Data Clearinghouse

http://agdc.usgs.gov

The site is straightforward with few graphics, and easy to navigate. Of particular note are the links to datasets (http://agdc.usgs.gov/data/index.html), and the tools (http://agdc.usgs.gov/AGDCgateway.html). You can download some datasets directly from the site; other datasets on other sites are available through convenient links. The Alaska Region (R10) has been a major contributor to the development of this clearinghouse since it's inception. FHTET, Fort Collins, is modeling its FHP-Geospatial Database Clearinghouse after this website.

Other Geospatial Database Websites to visit

http://fsweb.gsc.wo.fs.fed.us/ Homepage for the Geospatial Service and Technology Center. The Center coordinates its programs with a variety of partners, including: Regions and Forests, The Remote Sensing Applications Center (RSAC), Ecosystem Management Coordination, and Information Resources Management. The Center also works closely with other federal agencies such as the Bureau of Land Management (BLM) and the U.S. Geological Survey (USGS). Data, tips, programs, GIS how-to information. The site has an extensive system of links to datasets, GIS tools and maps. (You'll need Adobe Acrobat to access some reports.)
Acrobat is available free at http://www.adobe.com.)
http://www.fgdc.gov/clearinghouse/clearinghouse.html Federal Geographic Data Committee (FGDC) clearinghouse Homepage.
http://fsweb.r4.fs.fed.us/coe/index.html GIS Center of Excellence page (Intranet), Intermountain Region (R4). Includes GIS "nuts-n-bolts", downloadable programs, tutorials and help.
http://www.esri.com/library/gis/index.html ESRI's web page on GIS definitions
http://www.esri.com/software/arcims/index.html ESRI's web page on their Arc-IMS software.

Note: You don't need to copy down a link from above. Simply point your internet browser to http://www.fs.fed.us/foresthealth/technology/news.htm navigate to, and click on, the Spring 01 *Update*. This will launch the *Update* in PDF format. All links on all pages are active; click on a link to open the web page.

More about Geospatial Web Technology, pages 1 - 3, 5

FVS-BGC Eco-Physiology Model Background

The usual five- and ten-year projection cycles did not permit linking weather conditions and treee physiology measurements to insect and disease infestation and impacts. FVS-BGC makes it happen.

Facts:

- *FVS can help calibrate and validate BGC outputs*
- *FVS-BGC can produce growth estimates from both models simultaneously*
- *Contact--**Eric Smith** (FHTET-Fort Collins) (970) 295-5841 elsmith@fs.fed.us*

FHTET's interest in applications of BioGeochemical Cycles (BGC) models developed as an offshoot of work being done on insect impact model extensions to Forest Vegetation Similator (FVS). The FVS system has been widely used by foresters and forest health specialists within the USDA Forest Service and other agencies, and abroad. It has excellent user support, which is provided by the Forest Management Service Center in Fort Collins.

Although there is an extensive body of research and observation linking weather conditions and tree physiology measurements to insect and disease infestation and impacts, the usual five- and ten-year projection cycles do not permit these measurements to be used in the existing FVS framework. Also, while the BGC family of models and similar photosynthesis-based process models have been developed and published over the last 15 years, they generally lack the institutional support of FVS and have remained primarily research tools.

The best way for FHTET to utilize BGC-type models was to integrate Stand-BGC into FVS as an extension, an approach first advocated by now-retired RMRS project leader **Dr. Albert Stage**. With BGC as an extension, the system can produce growth estimates from both models simultaneously. FVS can help calibrate and validate BGC outputs for areas and conditions where BGC has not been calibrated, and FVS management functions, such as thinning and FHP's insect and disease impact extensions, can interact with BGC simulations.

BGC-type models rarely consider the insect and disease factors which are inherent in FVS modeling. Without considering the impacts of insects and disease, process models can overestimate actual stand vigor and growth, and miss significant sources of mortality.

FHTET believes the FVS-BGC extension is a valuable tool that will provide its customers with a more complete view of future forest health conditions and help them to better understand and manage forests in the 21st century.

Eco-physiology, continued from page 6

soon as a download from FHTET's website. FHTET will be working with cooperators to evaluate FVS-BGC, further. Of particular value will be tests conducted on sites where actual insect impact or tree physiology measurements have been taken, and on data sets which previously have been used to test other models.

The FVS-BGC integration is the product of cooperative work among University of Montana Champion Professor of Forestry, **Dr. Kelsey Milner**; **Andrew McMahan**, systems analyst, INTECS International; **Nick Crookston**, operations research analyst, Rocky Mountain Research Station; and **Dr. Eric Smit**h, quantitative analysis program manager, FHTET. **Dr. Steven Running** of the University of Montana has assisted the Forest Service in developing this and other versions of BGC models.

For further information on BGC physiological modeling of tree growth, see:

Milner, K.S., S.W. Running, and D.W. Coble. (1996). A biophysical soil/site model for estimating potential productivity of forested landscapes. Canadian Journal of Forest Research 26: 1174-1186.

Running, S.W., and J.C. Coughlan. (1988). A general model of forest ecosystem processes for regional applications. Ecological Modeling 42: 125-154.

More about FVS-BGC Page 6

FHTET Steering Committee Focuses on Emerging Issues

FHTET Steering Committee on Blue Ridge Parkway near Devil's Courthouse. From left: Andy Mason, Greg Fitch, Ernest Delfosse, Eric Rudyj, Vaughn Stokes, Allan Bullard, Janet Andersen, Don Rogers, Iral Ragenovich, Scott Cameron, Bill Dickerson.

The FHTET Steering Committee held its annual meeting May 22-23 in Asheville, NC, hosted this year by Southern Research Station Director Pete Roussopoulos. The focus of the meeting was to identify emerging forest health issues and provide the Team with guidance on areas for potential future activity.

Prior to the meeting, each Committee member had prepared a list of the three key issues he/she felt would affect his/her constituency group over the next 8-10 years. These lists were compiled, grouped into categories and discussed.

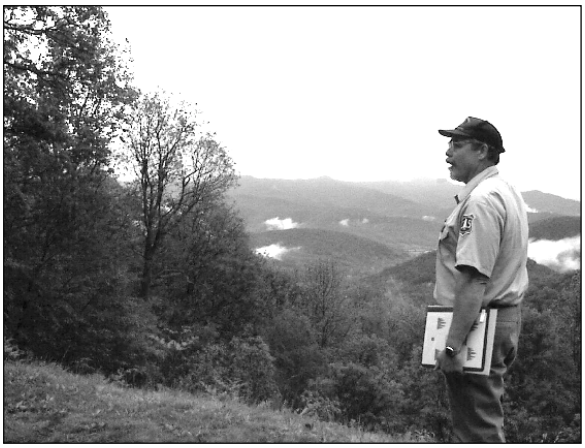
Two key areas, biotechnology and invasive species/risk analysis, were identified, along with suggestions on how they could be addressed. These two areas were then "handed over" to FHTET Directors Allan Bullard and Andy Mason to consider incorporating into long-term FHTET planning.

Other broad areas discussed as emerging issues included: communication and use of the internet; remote sensing; fragmentation of land ownership; survey and monitoring; and pesticides and pesticide application technology.

The staff from the Asheville FHP Field Office (Field Representative **Bill Carothers** along with **Rusty Rhea** and **Steve Oak**), hosted an outstanding field trip along the Blue Ridge Parkway where the Committee saw several examples of forest health problems, including: southern pine beetle damage; numerous invasive plants; oak decline; the results of the chestnut blight; and hemlock woolly adelgid and balsam woolly adelgid infestations. The trip generated a lot of discussion on how FHTET might be able to help address these and other problems.

The Committee was organized in 1996 to provide strategic guidance to the Team in program selection and direction, to provide leads on potential enterprise opportunities, and to help promote awareness of the Team's products and services.

Committee members include: Janet Andersen, EPA, Washington, DC; Bob Anderson, FHP, Atlanta, GA; R. Scott Cameron, International Paper, Savannah, GA; Ernest Delfosse, ARS, Beltsville, MD; Bill Dickerson, National Plant Board, Raleigh, NC; Greg Fitch (Chair), New Mexico Division of Forestry, Santa Fe, NM; Jeff Hardesty, The Nature Conservancy, Gainesville, FL; Dennis LeMaster, Purdue University, Lafayette, IN; Rob Mangold, FHP Director, Washington, DC; Michael Oraze, APHIS, Riverdale, MD; Don Rogers, North Carolina Division of Forest Resources, Raleigh, NC; Pete Roussopoulos, Southern Research Station, Asheville, NC; Ken Snell, Air Management and Forest Insects and Diseases, Portland, OR; E. Vaughn Stokes, FS Engineering, Washington, DC; and Tom Thompson, FS Region 2, Lakewood, CO.



Steve Oak (FHP, R-8) describing Oak Decline on Blue Ridge Parkway near Asheville, NC.

ENTERPRISE TEAM UPDATE

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New Publications

Sampling methods for Forest and Shade Tree Insects of North America, **Fettig, C., Fidgen, J., McClellan, Q., Salom, S. 2001. FHTET-2001-01.**

This first-of-its-kind Forest Service publication is a compilation of over 100 papers on 55 species of insect pests of trees in North America. Each paper is accompanied by a detailed review and an abstract of the data collected and the sampling procedure developed.

The four researchers conducted an exhaustive library search (over 3 years) and compiled a list of over 300 publications containing descriptions of sampling procedures for shade tree and forest insect pests in North America. The criterion used for selection was that the publication had to provide a procedure for making population estimates for use in pest management decision-making.

Approximately 90% of the insects covered in the publication are forest pests; the rest are common shade tree pests. However, since many of these traditional forest pests discussed could attack urban trees in an urban setting, much of what is discussed could apply to urban forests, as well.

The papers are categorized into five feeding groups:

- Bud, Shoot, and Root Insects
- Defoliating Insects
- Piercing and Sucking Insects and Mites
- Seed and Cone Insects
- Wood and Bark-Boring Insects

The target insects within each group are alphabetized by Order, Family, Genus, and species.

The abstract to each paper discusses the data collected for, and the development of, the sampling procedure. There is an introduction for each procedure; the procedures are presented in an easy to follow cookbook fashion.

The description accompanying each paper details the sampling procedure and includes any special instructions or assumptions concerning its use. The descriptions include tables and figures from the original publications or, in some cases, redrawn materials to help illustrate the procedure. There is a notes section in each description that helps put the paper in perspective with other papers for that insect, and a reference section for articles cited.

The application of the methods in the papers could reduce sampling effort and/or optimize the application of control measures. Hence, this publication should become a useful resource to forestry professionals.

Biological Control of Hemlock Woolly Adelgid in the Eastern United States. **McClure, M. 2001. FHTET-2000-08.**

Written for homeowners and pest managers, this publication provides an overview of biological control activities for the hemlock woolly adelgid, *Adelges tsugae* (Annand), as well as information on the distribution, biology and damage caused by this non-native pest.

Background

The hemlock woolly adelgid (HWA) is a native to Japan and China, and was first observed in the U.S. in the early 1950s feeding on hemlock in Virginia. Since then, it has spread to eleven eastern states, where it attacks two species of hemlock; the eastern hemlock, *Tsuga canadensis* (L.) Carr, and the Carolina hemlock, *Tsuga caroliniana* Engelm. It has steadily spread north and west and is now a serious threat to survival of hemlock in eastern forests. The HWA is lethal to hemlock.

There are only a few native predators in the U.S. —lacewings, syrphid flies, and cecidomyiid flies—that attack HWA, and they have yet to control HWA populations. Scientists have made good progress toward finding and studying other potential biological control agents for HWA. One, *Pseudoscymnus tsugae,* is the only non-native predator released into the environment, and results in the field have been encouraging. However, it remains uncertain if any one species will be able to control HWA populations, or if a complex of released predators will be needed.

Field Manual of Techniques in Invertebrate Pathology, edited by Lawrence Lacey and Harry Kaya, Kluwer Academic Publications (ISBN 0-7923-6269-1)

(Biopesticides and Biological Controls Program Manager ***Dick Reardon*** *contributed to two chapters in this publication.)*

The *Field Manual* provides background and instruction on a broad spectrum of techniques and their use in evaluating entomopathogens in the field. It is intended for researchers, graduate students, practitioners of integrated pest management (IPM), regulators, and those conducting environmental impact studies of entomopathogens. Although it can function as a stand-alone reference, the *Field Manual* is complimentary to the laboratory oriented *Manual of Techniques in Insect Pathology* and other comprehensive texts in insect pathology.

There are 38 chapters organized in ten sections. They discuss the tools needed to plan and implement field experiments with entomopathogens.

Section I covers the theory and practice of microbial control agents (MCAs), Section II covers statistical considerations in the design of experiments.

Section III deals with application equipment and strategies. Reardon contributed to chapter two, "Conventional Application Equipment: Aerial Application," in this section. Chapter two provides an overview of aerial applications of microbial insecticides to forests, and the development, calibration, modeling and use of aerial application equipment.

Section IV discusses major pathogen groups—virus, bacteria, protozoa, fungi, and nematodes—and special considerations for their evaluation under field conditions.

Section V describes how microbial pathogens play a vital role in the natural regulation of many important forest insects. Section VI describes the use of non-native pathogens to control non-native pests, and includes a cost/benefit analysis (costs of pesticides and other alternative control methods *versus* benefits of using non-native pathogens).

Section VII is an extensive look at the application and evaluation of MCAs in a wide variety of agricultural, forest, domestic and aquatic habitats, and includes step-by-step instructions on handling inoculum, designing _field experiments and experimental plots, and applying and assessing the efficacy of MCAs. Reardon contributed to chapter nine, "Forest Defoliators," in this section. This chapter focuses on Spruce budworm and gypsy moth, but covers jackpine budworm, wetern spruce budworm, hemlock looper and pine sawflies, as well.

(Note: Due to the uncertain future availability of organophosphates and other conventional chemical insecticides, MCAs will play increasingly important roles in insect pest management.)

Section VIII discusses the evaluation of *Bt* transgenic plants. Section IX deals with methods to manage insect pathogen resistance. Section X establishes guidelines for evaluating effects of MCAs on nontarget organisms.

Remote Sensing in Forest Health Protection, Cisela, Wm., FHTET and the Remote Sensing Applications Center (RSAC, Salt Lake City, UT). 2000. FHTET 00-03

William Ciesla's *Remote Sensing* illustrates the use of remote sensing in forest pest detection efforts around the world. Examples are given from five continents.

The first few chapters cover the fundamentals of remote sensing—the color spectrum, spatial and temporal resolution, and what to consider when selecting a particular remote sensing technique—plus a discussion of damage signatures and their application to forest damage analysis.

There is a section on mission planning, data collection, and accuracy assessment, and a discussion of techniques in sketchmapping and aerial photography used by the Forest Service to estimate tree damage.

Remote Sensing details the preparations, equipment, and flight patterns commonly used in sketchmapping, and discusses cameras, films, photography mission planning, and photointerpretation of aerial photographs.

Remote Sensing also covers still and video photography and equipment, and image processing and interpretation, and offers a brief history of the satellite in diagnosing forest damage.