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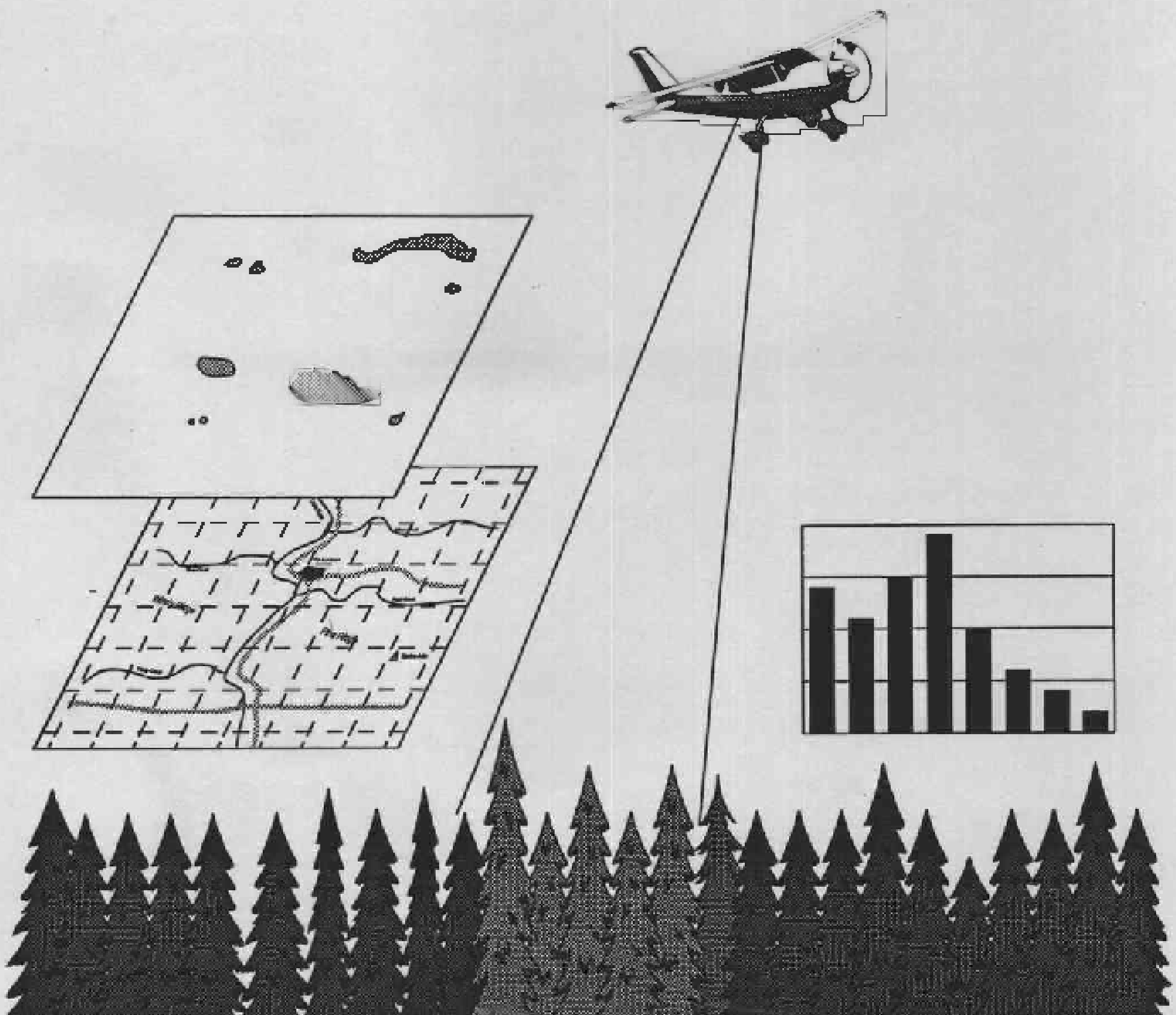
Aerial Pest Detection and Monitoring Workshop



Proceedings

Aerial Pest Detection and Monitoring Workshop

April 26-29, 1994
Las Vegas, Nevada

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INTRODUCTION

The first recorded use of an airplane to survey "pest" damage was done in Quebec and Ontario, Canada in 1920 (Swaine 1921), over an extensive spruce budworm infestation. In 1931, F.P. Keen, head of the Portland Forest Insect Laboratory and C.S. Cowan, Chief Fire Warden of the Washington Forest Fire Association, conducted the first recorded aerial survey in Washington and Oregon, delineating hemlock looper defoliation in Pacific County, Washington (Wear and Buckhorn 1955). Annual aerial surveys began in the late 1940's on a regular basis in many parts of Canada and the United States. By the late 1950's most all USDA Forest Service, Forest Pest Management (FPM) units across the country were conducting aerial surveys on an annual basis. The aerial survey technique has now become a common method of remote sensing because it is an economical and efficient means of gathering data about forest conditions over large areas.

Although programs differ around the country, due to topography, seasonal changes, different insects and diseases, budgets, personnel, available aircraft, etc., most techniques needed to perform this type of survey are common to all personnel and these techniques have been previously developed over the past 50 years. In the late 1980's, advances in the quality, portability, and affordability of video equipment were developed and video technology was adapted for use in aerial detection and monitoring surveys. Since then, many FPM units purchased and integrated airborne video systems into their existing survey programs. This workshop provided an opportunity to share methods, techniques, philosophies, priorities, safety concerns and problems associated with the responsibilities of conducting various forms of aerial surveys.

The goal of this workshop was "To provide a forum for information sharing and technology transfer to people involved in all aspects of aerial insect and disease detection and monitoring surveys." That goal was met. And from the workshop attendees came the unanimous vociferation for additional training for those people responsible for conducting aerial surveys. Most all Regions share the problem of a diminished cadre of qualified observers and increasing detection and monitoring responsibilities due to increased forest health awareness. No formal training course addressing flight safety and operations has ever been provided to aerial observers or videographers, yet the problem is of National concern. Hopefully, from this workshop, the people responsible for conducting aerial surveys, who need additional or even basic training, will be provided the tools to conduct a safe, efficient and quality aerial detection survey to supply land managers and the public with valuable forest disturbance information.

Acknowledgements

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AERIAL PEST DETECTION AND MONITORING WORKSHOP
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First I want to acknowledge the attendees from Canada and Kenya. We have a long-standing, excellent relationship with our Canadian couterparts. I am also pleased to see visitors from Kenya. In March, the Chief signed a long-term agreement with Kenya for exchanges in forest health. We hope to learn much through working together.

I plan to discuss five topics: surveys, exotic pests, ecosystem management, forest health monitoring and reports.

Surveys. I am glad to see here our state cooperators who participate in the Cooperative Forest Health Program. State specialists, together with our FPM specialists, are the trained observers on whom we all rely. No one else is responsible and no one else conducts systematic examinations of the Nation's forest resources for insect and disease epidemics. Although others may look, you are the ones who know what to look for and how to interpret what you see. The surveys that you annually conduct over millions of acres produce information that is highly valued and important. As we move toward ecosystem management, I am convinced that the information you provide will be even more highly valued. It will increasingly be used for interpreting the condition of our forest ecosystems.

Exotic Pests. Exotic pests continue to threaten forest ecosystems worldwide. With greater international commerce, despite the best efforts of regulatory agencies, the threat will increase. Examples of exotic insect and disease problems are Asian gypsy moth in the Pacific Northwest and now in North Carolina, white pine blister rust, dogwood anthracnose in the Southeast, and Cinara aphid in Kenya. The best way to deal with exotics is to keep them out in the first place. Working with APHIS, Agriculture Canada, and Resources Canada, we have together made major headway in the last 3 years to improve safeguards against exotic pest introductions. APHIS will soon issue the first ever regulations for the U.S. for importation of raw wood products. These regulations are based in large measure on pest risk assessments conducted by FPM and its cooperators. Canada is considering similar regulatory measures. Through the North American Forestry Commission we are developing a list of exotic pests worldwide that potentially threaten North American forest ecosystems. This list will help us plan and take proactive measures instead of only reacting after an introduction. An Asian gypsy moth monitoring system is established around Russian far eastern ports for early detection of outbreaks. This system was put in place in cooperation with APHIS, the Russian government and with the help of FPM Regional staffs. We are working with APHIS, the American military, and German officials to try to reduce the risk of further introductions of Asian gypsy moth from that country. We have to recognize that whatever we do may not be enough. Safeguards are far from perfect. Exotic pests are often widely distributed before they are detected, e.g., European pine shoot beetle on Christmas trees. As surveyors, you may be the first to spot unusual or unexpected damage that could indicate an exotic. The quicker we can detect exotics, the more we can do to respond.

Ecosystem Management. Understanding and protecting ecosystems requires information on the occurrence of insect and disease epidemics, the information you collect. I strongly believe that the success or failure of ecosystem management will be determined by how well resource managers understand and apply what is known about the combined and interacting rōles of insect and disease epidemics, wildfire, and weather events in ecosystems. The information you provide is critical to this understanding. The Directors of Fire and Aviation Management, Forest Pest Management, Forest Fire and Atmospheric Sciences Research and Forest Insect and Disease Research have agreed to work together because of the significance of these factors in shaping ecosystems. We are working together to help develop national policies. To focus our work, we are using the ecological term, "Disturbance." This new, integrated approach helps us take a fresh look at how our programs are implementing ecosystem management and helps us identify realignments and new directions.

Forest Health Monitoring. FPM has significant responsibilities within the Forest Health Monitoring Program. We are responsible for "off-plot" detection monitoring and for evaluation monitoring. The Program is now in 14 states with further expansion dependent on increased budgets. This Program would not exist without the strong support and leadership of the State Foresters. When fully implemented, the Program will provide standardized data on long-term trends in the health of our Nation's forests. Canada and most European countries already have similar programs in place. I was glad to see the Forest Health Monitoring Program on your agenda. The surveys you conduct will help us meet our responsibilties in this Program. In the east and south, states have welcomed the program and the accompanying standardization of survey data. For the first time they can compare forest health data across political boundaries. We do not have to wait until the Program expands to begin to standardize data collection in other sections of the country. A new Program brochure has just been printed. It is excellent. Copies will be distributed.

- ***Reports.*** This year, for the first time, we will have a nation-wide forest health report. It is entitled, "America's Forests: 1994 Health Update." The report is written in non-technical language and includes brief summaries of the several forest health problems which are currently of greatest national concern. The report includes many of the forest health problems that you are surveying and reporting. Where appropriate, the report describes the things being done to deal with the problem. The report will enable anyone with a little reading time to gain a quick overview of the nation-wide situation. We are also revising the Insect and Disease Conditions report to make it more useable and readable. Among other things, we will be including historical defoliation and other damage records on major pests for the first time so that long-term trends are apparent and the current epidemic and damage levels can be seen in perspective. Some Regions have excellent aerial survey records extending as far back as the late 1940's. We believe the display of this data will be particularly useful in better explaining the role of insects and diseases in ecosystems and understanding the current and future condition of ecosystems. The data you collect and the resulting records are, and will continue to be, essential for these reports.

What you are doing is important and essential. Keep up the good work.

AIRBORNE VIDEO FROM THE BEGINNING

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With the advent of Project 615 at hand, the Forest Service is now committed to considering remote sensing as an integral component of its information management effort, especially as a source for land cover layers. Field data collection will always remain important. However, time constraints for making decisions sometimes preclude collecting data in traditional ways. Existing databases can quickly become obsolete because of their singular purpose or narrow focus (Lachowski et al. 1992). Airborne videography is but a single remote sensing tool. In conjunction with traditional aerial photography and satellite imagery, it can provide historical, cost-effective imagery for large diverse areas which, when combined with field data, can contribute consistent and accurate vegetation information for GIS databases. Videography is a relatively new, easy-to-use remote sensing tool available to resource managers. It's readily apparent advantages are:

1. The immediate availability of imagery; film development is not needed.

2. live imagery can also be viewed by the operator as it's taken. In fact, new technological advances now make it possible to view imagery being taken in the aircraft while sitting at your office.

3. Audio tracks on video tape permit voice notation.

4. Airborne video provides a straight forward pathway from video tape to digital format for computerized image processing.

5. Video cameras and tape are cheaper then conventional aerial photo equipment.

6. Airborne videography improves the success rate of capturing temporal imagery occurring in narrow time frames.

7. Video cameras are able to efficiently operate in low light conditions.

8. Video is useful in foreign countries where aerial film and processing may be difficult to obtain.

9. Field-level personnel with little or no experience in remote sensing can be trained quickly to use the equipment efficiently (Myhre 1992).

In the early 1980's, the development and availability of cameras sophisticated enough to employ as components in airborne video image acquisition pioneered the beginnings of this technology. By the mid-1980's, significant improvement in image quality, affordability, and portability in video equipment increased the feasibility of utilizing it in remote sensing applications. In 1986, a joint project with the USDA Forest Service

(FPM/MAG) and the University of Minnesota/Remote Sensing Lab tested the operational feasibility of utilizing a color infrared video camera for forest health monitoring. Two conclusions became apparent from the project. First, it was noticed that the degree of detail possible in mapping defoliation was more precise than that obtained from sketch maps and second, that accurately locating problem areas was more precise using video imagery (Hosking et al. 1992). In 1988, the MAG staff began evaluation of video components available on the market with designs to using them in airborne operations. By 1989, further technological improvements had been made to video components including solid state cameras using chip sensors. Video cameras became available in shuttered configurations that provided higher quality imagery and reduced motion blur. With the advent of S-VHS increased resolution, (400 lines horizontal resolution compared to 240 lines horizontal resolution), improved color quality, and improved signal-to-noise ratios became available. MAG offered a consolidated procurement package in 1990 and supported it with training and technical assistance (Myhre 1992).

Prior to the availability of the supported package, and in conjunction with the work MAG was doing, the NA/FPM in St. Paul, along with R-8 FPM, National Forests, and ENG/NFAP, purchased operational systems. This brought the Forest Service into the arena of using videography as a functional remote sensing tool. The basic field package consisted of a S-VHS video camera, a lens remote controller, a camera mount, a S-VHS recorder, a power adaptor, a 10-inch monitor, an electrical junction box, and a caption generator. Platforms vary, everything from the Queen air to Cessna 180/185, 182s, 206, 207, 210s, and helicopters are being utilized. Microimages, Inc. supplied MIPS (map and image processing)--a system designed for image processing, geographic data analysis and inventory, desk-top mapping, and related computer-aided design. The original MIPS was designed to run on DOS-based 286 and 386 microcomputers where it employs a dual screen set up for program interaction and image display. When the consolidated procurement package was made available R-2 FPM, R-3 FPM and Kaibab NF, R-4 FPM, NA FPM at Durham, NH, NA FPM at Morgantown W. VA., and FPM/MAG, purchased operational systems.

Concurrently, in the late 1980's and early 1990's, several other systems were developed and utilized to aquire airborne video imagery. Differing needs and budgets led to the development and utilization of specialized and/or selective component systems. In 1988-89, U.S. Fish and Wildlife was employing airborne videography to assess the availibility of plover and tern nesting habitat at varying river flows along the Platte river. A Cessna 172 with a baggage compartment camera port and $2,900 in video equipment was utilized (Sidle and Ziewitz 1990). Simple needs for basic ground truthing of satellite imagery as well as more sophisticated systems designed to tag every video frame with GPS data such that the encoded data can be automatically retrieved using software like GMATCH were developed. Airborne videography is utilized in multi-spectral imagery and split screen.displays in many places to assess crop damages. In 1991-92, in R-3 FPM and a variety of other functions began operational use of airborne videography. Numerous missions were conducted including imagery of Ips beetle outbreaks around the community of Prescott, AZ, vegetation typing for rangeland mapping on the Sante Fe NF, roundheaeded beetle outbreak on Mt. Graham, timber analysis coverage of the North Kaibab Ranger District, a roundheaded and western bark beetle outbreak on Lincoln NF, and helicopter videography of eagle habitat along the upper Verde River. Interest in utilizing airborne videography seemed to catch on rapidly as applications began to be envisioned by land managers. By late 1992, airborne videography was being employed nationwide to:

survey recreation sites,
survey riparian areas,
assess wetlands,
assess wildlife habitat,
evaluate range conditions,
do road updates,
perform snag counts,
assess forest pest damage,
assess catastrophic damages,
forest type mapping,
do forest inventory,
law enforcement,
search and rescue,
select pipeline siting (Dull et al. 1992).

Before the end of 1993, airborne videography, as developed by MAG, was demonstrated and utilized in natural resource applications in Russia, Finland, and New Zealand. Requests for videography demonstrations were received from China and Russia again.

Where does the future lie? MAG is currently evaluating the possibility of upgrading the system to tag each video frame with GPS georeferencing. Developments in SAR (synthetic aperture radar) technology enabling scientists to operate in adverse weather conditions has already been tested with the relief efforts associated with the natural disasters plaguing our own mid-west. FLIR (forward looking infrared) systems are currently being mounted and tested on Forest Service aircraft in many regions. The potential exists to offer S-VHS and FLIR imagery on a split screen display. The Boulder Public Works Department is utilizing ACCUDAT, a videography system employing an onboard 486 computer to georeference each video frame with differentiated GPS. The system platform is a Aerospatiale Gazelle helicopter capable of slowing air speeds to 40-60 mph for high quality imagery. Kodak has recently demonstrated a camera that is digital. Instead of using film, a digital file is created eliminating the need for bulky tape and video cassette recorders.

Many field units have become proficient in image acquisition. However, a rather large learning curve still confronts many of us regarding image processing and GIS. Without any defined direction due to the uncertainties created in the award of the 615 contract, many sites have utilized what analytical software is available to them to begin learning to think spatially. After all, the goal is not merely to employ a GIS as a high tech map maker, but to learn to use it as the true analytical tool it was designed as. Airborne videography will undoubtedly provide valuable data for future analysis with GIS.

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AERIAL DETECTION SURVEYS AND GEOGRAPHIC INFORMATION SYSTEMS

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How are Geographic Information Systems (GIS) incorporated into the management of forest health issues and aerial detection surveys? With GIS technology, it is possible to take paper maps and associated data and convert them to an electronic format. This electronic data is analyzed and used in the decision making process.

The GIS process can be divided into data definition and acquisition, data entry and storage, analysis, and display of results. All four parts are important in providing accurate and timely products to the decision makers.

Aerial survey data falls into the data definition and acquisition category. The process starts with the aerial detection survey. The sketch mapper interprets the damage onto a paper map. Airplanes allow the mapper to cover large areas and delineate many types of insect and disease damage. The data is then ready to be entered into the GIS.

Data entry and storage includes:

1. Good registration,
2. Edge matching input sheets,
3. Vertical integration,
4. Stable materials (mylar),
5. Verifying output (hard copy and attribute checks),
6. Storing each theme as a layer,
7. Clipping data to useful boundary,
8. Developing procedures for updating.

Because sketch mappers have little experience with GIS technology, problems can occur that reduce the quality of the electronic data. For example, I have received folded source maps bearing wide magic marker lines, no registration to associate with existing data sets, mislabeled polygons, and edges that did not match between quad sheets. These problems made it difficult to ensure an acceptable level of accuracy. Aerial detection specialists work hard to accurately define problem areas and it is important to build on that accuracy when the data is transferred to an electronic format.

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Data acquisition is the most expensive and important component of a GIS. You need a vision of where you want to go and how to get there. The Information Needs Assessment (INA) process can help you formulate a plan to reach your goals. The process involves identifying your present and future data needs, products, and priorities. Input is gathered from all the groups that utilize your data. This is important because you can reduce costs by sharing data. You may also find that you are duplicating efforts. Contact your local GIS specialist for more information on the INA process.

An example of why planning is important can be found in an analysis that was recently attempted by Region 8 Forest Health. They wanted to look at 1993 Gypsy Moth defoliation for the Commonwealth of Virginia and identify success rates of spray projects. The defoliation data was collected at a 1:50,000 scale using a combination of aerial photography and sketch mapping. Defoliation was lumped into areas greater than 40 acres. The spray block data was captured at 1:24,000 scale. When the two data sets were combined and the data enlarged to the county level, it appeared as if there were many spray block failures. The county cooperators became very excited when they saw the map products. When the defoliation data was mapped, areas less than 40 acres were lumped into larger polygons. Most of the spray blocks in Virginia were smaller than 40 acres. There was no intention to use the data in this manner when it was captured. One of the problems with GIS technology is that it will allow you to make these comparisons and they look accurate. If you do not understand the limitations of the data, it is possible to generate invalid conclusions. A proper INA could have prevented this problem.

Why do we need to make this data electronic? Aerial detection has been a consistent tool for mapping damage to forests throughout the United States. GIS technology makes it possible to look at changes and trends in the forest over time. The turn-around time can be fast, and the ability to look at complex combinations of forest conditions is remarkable. For example, with GIS technology it is possible to determine hazard ratings or risk factors for land not currently damaged. This can help land managers be proactive as they implement ecosystem management. The technology helps track the progression of problems over time and predict the probability of damage in the future.

The real power behind GIS technology resides in the ability to perform analysis functions. The attributes, scale, intensity of survey, original source, and method of collection of the database will determine the quality and accuracy of the analysis. Examples of analysis functions are buffering (roads, streams, spray blocks, wildlife nests), statistical information, nearest neighbor and viewshed analysis, networking, and three-dimensional modeling. For more information on spatial analysis, consult the proceedings from the Spatial Analysis and Forest Pest Management Workshop (General Technical Report NE-175, June 1993).

I believe that we will soon move out of the dinosaur age and into the information age, leaving our paper maps and color pencils behind. We can provide the land use managers with quality data, quick turnarounds, and useful and accurate analysis. The analysis capabilities are the backbone of why this technology is so important in our future. The products we generate will help managers make informed and timely decisions, inform the public about proposed projects, facilitate the coordination between agencies, and provide specialists with the information they need to model pest problems.

PACIFIC NORTHWEST REGION COOPERATIVE ANNUAL AERIAL INSECT DETECTION SURVEY

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In the Pacific Northwest Region, we conduct a cooperative annual aerial insect detection survey of all the major forested lands. This survey covers approximately 54 million acres and is conducted in July and August. In Oregon we fly in the Oregon Department of Forestry's Partenavia, a high wing, twin-engine aircraft, with the Department's pilot and State observer. In Washington we utilize a contracted Partenavia and pilot and have an observer from both the Forest Service and the Washington Department of Natural Resources. In Washington, about 30 percent of the flying is contour flying and 70 percent is grid flying. In Oregon, virtually all survey is grid flying.

Each observer maps the insect activity on his side of the aircraft and from these maps a master is made. The polygons and attributes from the masters are hand transferred onto mylar and scanned into the GIS and then edited in the GIS. The GIS prints the polygons and attributes onto a cronoflex from which paper copies are made and sent to the Federal, State and private land managers. In GIS, we import the data into Paradox and prepare data tables which are also made available to the land managers, and are used to track insect activity, and to prepare reports.

AERIAL PEST DETECTION OPERATIONS IN THE INTERMOUNTAIN REGION

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Aerial pest detection surveys (ADS) are the most widely used method for detecting and monitoring forest pests and abiotic damage in the Intermountain Region. Two types of aerial surveys are currently used: aerial sketchmapping and airborne videography. Approximately 15 million acres are annually aerially surveyed using these methods. Surveys are conducted from light fixed-wing aircraft and occasionally rotor-wing aircraft.

The host's expression to pest invasion or abiotic damage, extent of damage, and management priority determines the appropriate aerial detection technique. Generally, aerial sketchmap surveys are used as the initial detection tool to locate and quantify forest pest damage. Because of the narrow swath-widths needed to obtain acceptable imagery airborne video surveys are only used over small high-priority areas with very visible pest signatures.

In the Intermountain Region symptoms of forest pathogens are difficult to detect with the exception of some needle diseases, very heavy dwarf mistletoe infections and large openings caused by root rots. Most aerially visible damage is attributed to bark beetles and/or defoliating insects. A skilled aerial observer can detect visible damage caused by these pests, estimate the degree of damage to host trees, determine probable pest involved and plot this information on a map with reasonable accuracy. Likewise a skilled video-image interpreter can accurately identify and delineate pest activity on video.

Following is a brief discussion of how aerial pest detection surveys are planned and conducted.

AERIAL PEST DETECTION SURVEYS

Planning Aerial Pest Detection Surveys

All National Forests in Region 4, National Parks, BLM state offices are contacted during April of the survey year to identify high priority ADS areas. These inputs are combined with Forest Pest Management (FPM) priority areas, such as current insect infestations or areas with a high potential of becoming infested, to develop a Regionwide survey schedule. Generally, the ADS covers major commercial timber production areas, National Recreation Areas, administrative sites and Ski areas. Low priority areas not surveyed unless specifically requested are: administrative set-asides, wilderness areas, alpine zones and extensive blocks of pinyon-juniper. Low priority areas may be surveyed on an alternate year basis.

ADS are conducted from late June through early September and insofar as possible are scheduled to coincide with optimum damage symptom expression of major forest pests and damage. Currently, FPM uses two contract aircraft and pilots, three observers to conduct surveys throughout the Region. Additionally, under a Memorandum of Understanding with the State of Idaho FPM surveys state lands intermixed with

Forest Service lands while the State of Idaho surveys Forest Service lands adjacent to state lands. Total flight time generally varies from 300 to 350 flight hours per year for Forest Service aircraft and 50 to 70 flight hours per year for State of Idaho Aircraft

Conducting Aerial Pest Detection Surveys

Aircraft: While rotor-wing aircraft make excellent survey platforms due to their slow airspeed and excellent visibility however the high hourly price of the aircraft usually precludes their use. Fixed-wing aircraft offer a cost effective and readily available aerial survey platform. Only highwing monoplanes are used because they offer acceptable downward and lateral visibility. Currently FPM uses two Cessna 206's for aerial pest detection surveys. One aircraft is equipped with a photoport for airborne videography missions.

Flying Height: For both aerial sketchmap and airborne video surveys optimum flying altitude above ground level (AGL) varies with terrain and pest activity but usually is 1,000-2,500 feet above ground level for aerial sketchmap surveys and 1,000 -3,000 AGL for airborne video surveys. We attempt to fly as high as possible while still being able to accurately identify pest activity since the greater the altitude the greater the ground coverage (with both aerial sketchmapping and airborne videography) and hence productivity. Higher elevation flight increases flight safety by increasing the glide distance in the event of an engine failure.

Airspeed: Airspeed dependent on the level of pest activity and topography but always is above 80 miles per hour at all times. Conversely, with aerial sketchmap surveys airspeeds greater than 120 miles per hour results in the aircraft passing over the ground too quickly to accurately locate and identify pest activity. Airborne video missions are generally conducted at airspeeds of 100-120 miles per hour.

Time of Flight: Because of the steep highly dissected terrain in the Intermountain Region shadows on west and north facing slopes can obscure pest activity before 0900. After 1400 hours thermally heated air can become very turbulent and make identifying and mapping observed pest activity difficult. Airborne video surveys are conducted in a narrower flight window than aerial sketchmap surveys, usually from 1000 hours to 1400 hours due to the systems sensitivity to shadowed areas and turbulence.

Flight Patterns: The topography to be surveyed, level of accuracy, and intensity of pest activity will determine the flight pattern. Two flight patterns are generally used: contour and grid.

Grid--Grid flight patterns are used when topography is generally flat with few distinguishing features. Predetermined flight lines are plotted on the flight map and while the aircraft travels down these lines two observers map pest activity from their respective sides of the aircraft. Flight lines range from one to three miles apart depending on the level of accuracy desired. Electronic navigation systems are used with grid flight patterns. Airborne video missions are conducted using grid flight patterns with swath-widths from 1/8 to 1/2 mile.

Contour--Steep, well-defined topography requires a contour flight pattern. The aircraft, usually with one observer, travels up and down major drainages in a clockwise flight pattern. Travelling up the drainage the pilot is close to the left side of the drainage allowing the aerial observer to map pest activity to the right of the aircraft. When the top of the drainage is reached the aircraft turns around and travels down the opposite side of the drainage and the observer maps pest activity on the opposite side of the drainage. Occasionally, contour flight patterns are used on airborne video missions when it is necessary to monitor pest activity along roads, streams, etc.

In many instances a combination of grid and contour flight patterns are used to effectively survey an extensive area.

Damage symptoms which cannot be readily attributed to specific pests are plotted on sketch-maps as being of questionable cause. Location of such damage may also be entered into the aircraft's LORAN-C or GPS navigation system. These geodetic coordinates used to aid in pinpointing the ground location of tree damage during followup ground evaluations to determine causal agents.

When ADS and followup ground evaluations of each forest or survey unit are completed, information is replotted onto a single 1/2 in or 3/8 in per mile forest base map, which is then digitized into ARC/INFO Geographical Information System for data summation and map reproduction.

SAFETY/FLIGHT COORDINATION ACTIVITIES ASSOCIATED WITH AERIAL PEST DETECTION SURVEYS IN THE INTERMOUNTAIN REGION

Time	*Duty*	*Comments*
Week before flight	Call RO dispatch and inform them of week's general flight plans.	Emphasize that our plans frequently change and we are giving them a tentative schedule.
At least 24 hours before flight	Call appropriate dispatch office(s) and inform them of flight plan and aircraft manifest, check on frequencies, inquire on fire activity and aircraft on Forest. **Get name of person you talked to.**	*Flight plan*: time due on Forest, mission (pest detection), type of flight-contour or grid, starting location and general are of flight. *Manifest*: aircraft number, type of aircraft, pilot, passenger(s), color of A/C.
Day of flight	Call dispatch and repeat above, inform them of any changes in your flight plan.	
Before take-off	Radio check with dispatch, inform them of destination.	If at a controlled airport let disptch know you will be talking to the tower and you will talk to them when leaving the TCA or ARCA.

After take-off	Radio dispatch and let them know you are off the ground and enroute.	If you are ferrying to a different Forest or area, have dispatch call with your ETA.
Every 15 minutes	Radio dispatch with location and direction or "working upsteam or down-stream" in drainage.	
After landing	Radio dispatch that you are on the ground.	If you are taking a break inform dispatch of ETD. If survey is completed inform dispatch that you are ceasing flight operations.
PM	Call with next days flight plan as above.	

PACIFIC SOUTHWEST REGION AERIAL DETECTION SURVEY PROGRAM SUMMARY

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The Pacific Southwest Region (R-5) resumed aerial detection surveys in 1992 using National Forest personnel to conduct the surveys. One National Forest was flown during 1992, four during 1993, and we are anticipating flying 10 National Forests during 1994. Forest Pest Management provides the funding and survey standards and the Forests are responsible for the aerial surveys and sketch mapping. Flights are conducted between June and July by either helicopter or fixed-winged aircraft. Aircraft type varies between Forests; however, all aircraft and helicopters have been contracted.

Standardized mortality categories are used Regionwide and are based on percent of dead trees within a polygon. Mortality polygons are overlayed in GIS onto the Forest vegetation layer to determine the number of acres in each timber strata within each polygon. The number of dead trees and the volume associated with them is estimated using a Lotus 1-2-3 spreadsheet with the data for the appropriate timber strata. All maps are created on the Data General system and using LTPLUS on a PC.

R-5 has the complete airborne video package (MAG). Airborne video has been used for two projects: Modoc budworm defoliation survey and for Port-Orford-cedar root disease management. TNT MIPS version 4.4 (on an x-windows system) is available in the Region for video processing.

AERIAL DETECTION SURVEYS IN THE NORTHEASTERN AREA

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Aerial pest detection surveys have been conducted throughout the Northeastern Area for decades. There are maps and records of aerial surveys conducted by the Forest Service dating back to the 1950's. Through the 1960's, 1970's, and into the 1980's, most aerial pest detection surveys had been driven by requests from the National Forest System or a need to assess pest conditions before or after control projects. Since the late 1980's and through the 1990's, the aerial survey programs in the Northeastern Area have been driven by a growing concern for general forest health and ecosystem conditions, and a growing appreciation for the historic value of a complete record of major pest events.

A variety of strategies are used throughout the Northeastern Area to conduct aerial pest detection surveys. Most of the States in the Northeastern Area have pest specialists, planes, and pilots available for aerial pest detection surveys. With the cooperation and coordination between Northeastern Area State and Private Forestry personnel, National Forest personnel, and State pest specialists, aerial pest detection surveys and reporting are conducted and completed in a timely and effective manner throughout the Northeastern Area. The three field offices in the Northeastern Area (St. Paul, MN field office (SPFO), Durham, NH field office (DFO), Morgantown, WV field office (MFO)) take different approaches in assuring that pest detection surveys are completed on federal lands and throughout their areas. While the federal lands in the MFO area are flown by State specialists, the DFO has a technician permanently assigned to surveying the two National Forests in their area as well as other federal lands, and the forester in the SPFO is responsible for completing the aerial surveys on the ten National Forests in their area as well as numerous National Parks, Indian Reservations, and other federal holdings. All three of the field offices rely heavily on State personnel to provide aerial survey information for State and private holdings. A network of State and National Forest personnel provide insect and disease development information which is invaluable for planning the timing of the various surveys.

The DFO and the SPFO follow Forest Service flight-following regulations while conducting aerial surveys. The DFO uses contract planes equipped with radios capable of contacting Forest dispatchers, and the SPFO uses Forest Service owned airplanes equipped with Forest Service radios, and flown by experienced Forest Service pilots who are familiar with flight-following procedures and with wilderness flying. Most of the Forests in the Northeastern Area have contracts with FAR 135 Forest Service approved private planes and pilots to fly surveys and fire patrol. These aircraft are also equipped for flight following and the pilots are usually experienced in flying surveys. These planes and pilots are usually available to fly aerial pest detection surveys.

The DFO and the SPFO both have experienced sketchmappers in charge of their aerial survey programs, but often times inexperienced, untrained personnel are used to complete the survey crew. This can create problems with the quality of information obtained on the surveys. Greater effort must be made to assure that aerial pest detection surveys are conducted by well-trained, experienced personnel.

With the increased interest in national and regional forest health, there has been a push to standardize aerial surveys and establish minimum pest damage reporting standards. As this effort continues, aerial pest detection survey data collected by different agencies within the Northeastern Area will become more compatible and, therefore, more reliable. With the increased amount of time and money being spent collecting pest damage information, greater effort must be taken to assure that aerial survey personnel are properly trained, and that experienced personnel are available to train and mentor inexperienced surveyors.

AERIAL SURVEY OF FOREST INSECT AND DISEASE ACTIVITY IN ALAKSA

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Alaska is a vast area with approximately 130,000,000 acres of forest land. Each year, the Alaska Region (Region 10) Forest Health Management Group conducts aerial surveys that cover as much as 32 million acres of Alaska's boreal and coastal forests. Surveys are conducted across all ownerships including federal (Forest Service, Park Service, BIA, BLM, Fish and Wildlife, Department of Defense etc.), state, and private (e.g., native corporation) lands. Surveys are conducted in three segments, covering interior, south-central and southeast Alaska. Surveys begin around mid-July and depending on weather, may continue through the end of August. With limited resources, all of the forested area in Alaska cannot be surveyed in a single year. Therefore, resource managers are polled annually in order to set priorities to obtain the most valuable survey information possible.

Aerial forest pest detection surveys in Alaska have had a "colorful" history. The earliest documented surveys occurred in southeast Alaska, where wide-scale timber management activity first began. Systematic aerial surveys to detect forest insect activity began in interior and southeast Alaska in 1956 and 1952, respectively. For many years, surveys were conducted by research entomologists. State and Private Forestry (FPM) later assumed survey responsibilities following a period of cooperative survey implementation with PNW.

Survey Techniques

Because of rough terrain and often inclimate weather patterns, aerial surveys in Alaska (with the exception of the Kenai Peninsula) are not conducted on a grid pattern. In interior, forests tend to follow narrow bands along river valleys and thus, the survey entails flying many of the major drainages, often in a single pass. Southeast Alaska is made up of a narrow strip of mainland and many islands. Some of the islands rise from sea level to elevations over 3,500 feet. Most of the commercial forest lands in southeast Alaska are located within 2 miles of salt water, the exceptions being some river drainages. Thus, the survey in southeast Alaska can take on a meandering pattern in island areas when ceilings are low.

Survey aircraft vary, but typically include a Cessna 206 amphib or a DeHavilland Beaver. Amphib capabilities are especially beneficial, as refueling sites are often on land or water, but not necessarily on both.

Flying height varies, but is normally from 1,000 to 1,200 feet. For safety reasons, an altitude of 500 feet above "the deck" (water or land) is maintained at all times. Airspeed also varies, depending on survey aircraft and conditions.

Forest pest activity is sketch mapped on 1:250,000 scale maps. Original maps include detail on flight line location and direction.

Defoliator Sampling

In conjunction with the aerial survey of southeast Alaska, periodic stops are made at pre-designated sites (beaches with float plane access) to collect information on western hemlock defoliator species and abundance. This defoliator trend information has been collected during the annual aerial survey since 1971. Approximately 50-60 sites are visited within a 2-week period.

GIS and Airborne Video Application

During the last 2 years, airborne video technology has been deployed to remotely sense spruce beetle activity. This technology is obviously not being used during the entire annual survey, but has proven valuable as a sampling tool. The current airborne video acquisition system is deployed aboard an amphib Dehavilland Beaver that has a pre-existing belly hatch.

In 1993, a cooperative effort between the Forest Service (Forest Health Management) and the Alaska State Division of Forestry was initiated to include annual state-wide insect activity in an ARC INFO database. The information is available to anyone with comparable GIS technology.

Future Work

International Cooperation

Because Alaskan forests have much in common with our neighbors in Canada, there are opportunities to coordinate and share information. Spruce beetle activity northwest of Haines (southeast Alaska) is a prime example, where spruce mortality occurs on both sides of the border.

Aerial Survey and Ecosystem Management

Aerial surveys in Alaska have long included documentation of insect and disease activity among commercial and non-commercial forests alike. As we begin to take an ecosystem level approach in forest management, survey data for all components of forest vegetation will no doubt be elevated in importance. Our historical survey data may provide some baseline information as we begin to look more closely at the ecological role of "non-traditional" forest insects and diseases. In fact, we may determine in many cases that the term "pest" is inappropriate.

AERIAL SURVEY METHODS USED IN THE SOUTHERN REGION

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In the Southern Region, which covers 13 states, our aerial survey program relies heavily on the sketch mapping survey method. Aerial photography in the 9 x 9 format is currently our second most-used method. Airborne videography is becoming very popular with our clients on both National Forest lands and other Federal lands. Our state cooperators are also very interested in the use of videography for documentation of insect and disease occurrences and storm damage.

Our current uses of the aerial sketch map method are:

1. Southern pine beetle (SPB) surveys.
   a. Annual reconnaissance surveys of areas adjacent to known outbreaks or areas having a previous history of SPB activity, for documentation of bark beetle activity.

   b. Detection surveys are usually a 25 percent sketch map survey where numerous active spot infestations were observed during a reconnaissance survey. Detection surveys are also conducted when a land manager reports numerous multiple-tree spot infestations from ground surveillance. On all our aerial sketch map surveys, we estimate spot infestation size by estimating the number of red and fading trees present in the spot. We also use other key codes such as "F" for spots with fading trees and "R" for older spot infestations with only red or brown-colored tree crowns and other helpful codes.

   c. Forest Health Evaluation surveys for SPB are either 50 percent or 100 percent aerial sketch map surveys. Spot size is estimated during evaluation surveys also.

The procedure above is currently used by the Asheville, North Carolina Field Office. The Pineville, Louisiana Field Office relies very heavily on their National Forest Ranger Districts to conduct almost all their aerial sketch map surveys for the SPB. The Asheville Field Office also uses District aerial sketch map surveys where and when possible, especially during continuing suppression projects or where we have trained personnel on the Ranger Districts. For suppression projects on Federal lands, National Forests, and Other Federal, pre-suppression flights are conducted bi-weekly or at least once every 3 weeks.

Our state cooperators conduct two 20 to 25 percent sketch map surveys annually for SPB and other bark beetle detection. Aerial surveys for evaluating outbreak areas are usually 50 to 100 percent surveys. Pre-suppression aerial sketch map surveys are conducted monthly during a cooperative suppression program.

In Region 8, we encourage our Federal land managers to cooperate with State personnel and vice-versa in sharing their aerial sketch map survey results with each other.

2. Gypsy Moth Surveys - Aerial sketch mapping for the detection of gypsy moth defoliation in Region 8 is one of the primary sources for compiling an annual database that depicts the amount and severity of defoliation related to this pest. The data from these surveys are used to form national and regional defoliation maps used in determining the location of new infestations, post-treatment evaluations, amount and severity of defoliation and movement of gypsy moth populations.

3. Other pests surveyed in Region 8 with the aerial sketch map method are:

   a. Other defoliator (pine and hardwood)
   b. Storm damage (tornado, hurricane, ice, etc.)
   c. Oak wilt (Texas and North Carolina)
   d. Littleleaf disease of shortleaf pine
   e. Annosum root rot
   f. Introduced plant species
   g. Balsam woolly adelgid
   h. Hemlock woolly adelgid
   i. Beech bark disease
   j. Air pollution
   k. Fire surveillance
   l. Oak decline
   m. Spruce fir type mapping (etc.)

Current uses of color or IR photography are:

1. Southern pine beetle infestations in special use situations are areas such as wilderness areas when they are threatening bordering state and private lands, or threatened and endangered species their habitat or nesting areas. An example in our Region would be the red-cockaded woodpecker (RCW) its colonies, cavity trees and habitat.

2. Gypsy moth use of aerial photography. The format used for detection of gypsy moth defoliation is either high altitude color infrared or connectional color 9- x 9-inch prints or transparencies of various scales. These photos are used to delineate areas of gypsy moth defoliation. sketch mapping is used to fill in the gaps not covered by photography and the combined results are then entered into a GIS system to produce defoliation maps.

3. Other pests surveyed with aerial photography are:

   a. Oak decline
   b. Oak wilt
   c. Storm damage
   d. Pest in special use areas
   e. Pests threatening T&E species
   f. Balsam woolly adelgid
   g. Hemlock woolly adelgid
   h. Air pollution

We are also making use of satellite imagery and other quads.

Airborne videography is currently used for the following:

1. Monitoring SPB spot infestations in wilderness areas and other special use areas, to determine the rate of spot growth and to document the distance of the individual spot infestations to bordering state and private lands or RCW colonies and cavity trees. The National Forests in Texas and Mississippi are currently using their own aerial videography systems for these purposes. They also have the map and image processing (MIP's) system and GPS. Our field offices also have complete aerial videography and MIP's system.

2. Other planned uses are:

   a. For gypsy moth
   b. Hemlock woolly adelgid
   c. Oak decline
   d. Beech bark disease
   e. Storm damage
   f. Air pollution
   g. Balsam woolly adelgid

ROCKY MOUNTAIN REGION AERIAL SURVEY PROGRAM

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Approximately 5 years ago, the Rocky Mountain Region decided to curtail much of its regular aerial survey program primarily because of concerns about safety relative to the value of the information to the land manager. Flying at low altitudes over the Rocky Mountains entails problems of sudden downdrafts and hazards of box canyons. Most Forests in the Rocky Mountains require contour flying. We have had to rely on pilots and aircraft that were contracted on a daily basis and often were unfamiliar with the type of flying required to do pest detection surveys. It was often difficult to get the same pilot two days in a row. We use Forest Service dispatchers for flight following, but sometimes have trouble with personnel not being there when we want to start, even after giving them information about our flight plans in advance. We normally must quit flying around noon because the turbulence gets to be too much.

For the past 5 years, each of the three Service Centers in the Region has planned and conducted its own aerial survey program. The Black Hills National Forest (served by the Rapid City Service Center) is surveyed each year primarily for mountain pine beetle damage. The elevation changes are less dramatic in the Black Hills than in the mountainous terrain of most of the rest of the National Forests in the Rocky Mountain Region and can be flown in a grid pattern. Also, the Black Hills National Forest has the largest timber program of any Forest in the Region. Other Forests are surveyed on an as-needed basis, often when an outbreak has already been detected by other means and an estimate of area or volume of damage and extent of infestation is needed. Primary pests of interest are mountain pine beetle, Douglas-fir beetle, western spruce budworm, and spruce beetle. We occasionally survey for infrequent defoliators such as pine sawfly and pine tussock moth. Recently, much of the area surveyed in southern Colorado (served by the Gunnison Service Center) has been prompted by outbreaks of western spruce budworm or bark beetles. The Lakewood Service Center has not conducted any aerial surveys in recent years.

To date, the survey work conducted by Forest Health Management personnel in the Region has entailed sketch mapping. Color and infra-red photography is contracted when needed. For sketch mapping, we use dot symbols to indicate groups of dead trees of various sizes up to 25 trees for bark beetles. We outline larger spots of defoliation and bark beetle damage, including the estimated number of trees killed. Dot symbols are counted and multiplied by an estimate of associated acreage for each symbol type. Acreage of larger, outlined areas is determined using a planimeter. Acreages are then totalled by ownership type (Forest Service, Other Federal, State and Private) to meet national reporting requirements. For bark beetles, estimates of numbers of trees killed are derived by using a sum of the number of each type of dot symbol times a mean number of trees for the corresponding dot symbol, then added to the total estimated number of trees in larger outlined spots.

Conversion factors that vary by tree species and forest are used to estimate volume killed from number of trees killed. Copies of the aerial survey maps are made by hand and sent to affected land management units.

For special project areas, we can generate a computer copy of the sketch map using MIPS software on the PC at the Regional Office. So far, we have not done much digitizing of our aerial survey maps.

A few months ago, a Cessna 206 acquired by Region 2 was outfitted with airborne video equipment. Forest Health Management personnel have yet to use this newer technology. However, the MAG unit in Fort Collins has flown some airborne video projects for Region 2, Forest Health Management in the past couple years. Results were disappointing in that bark beetle (Douglas-fir beetle) damage was not readily discernible on the film. There may be value for its use in recording conditions on permanent plots included in the Forest Health Monitoring program; however, film shot for this purpose has not yet been viewed and interpreted. The availability of the Cessna 206 is likely to improve the aerial survey program for sketch mapping in Region 2 in addition to providing a new technology for our use.

CANADIAN AERIAL SURVEYS FOR PEST DAMAGE ASSESSMENT

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To complete annual regional and national overviews of forest pest conditions and their implications, the Canadian Forest Service's Forest Insect and Disease Survey (FIDS) has for many years monitored the incidence and damage of insects and diseases in the nation's forests. Aerial reconnaissance and sketch mapping have been a major component of these surveys, especially for mapping some types of defoliation and tree mortality. Across Canada, six similar survey units housed at the federal regional forest centres constitute the national FIDS program. Through cooperation and coordination, regional and national surveys and reports are completed.

At the Pacific Forestry Centre, the 17-member FIDS unit includes field technicians responsible for both ground and aerial surveys throughout the region (British Columbia and Yukon). They are supported by professional and technical diagnostic staff and a geographic information system manager. All are under the general leadership of the Survey Head. Each year more than 225 hours of flying time, much of it in cooperation with the B.C. Ministry of Forests and forest industry, are completed for detection and first-stage mapping of pest-caused damage. Generally, recent bark beetle-killed trees and major defoliator infestations are the specific reasons for the flights, but climatic injury, animal damage, some foliar diseases, or unusually heavy cone crops can often be identified.

The purpose of the aerial survey is to complete a regional and national uniform estimate of yearly changes in pest types, location, area affected and damage intensity. Also of concern are timelines, continuity during and between outbreaks, and support to research and to subsequent more detailed surveys of areas of specific or operational interest.

Aerial Survey and Mapping Methods

Aerial surveys for detection and mapping of forest pests have been quite regular since 1960 and were conducted for selective problems since the late 1940's. Although there are records of aerial mapping from hydroplanes of hemlock looper and mountain pine beetle in British Columbia as early as 1927, most of the earlier cartographic records of infestations were largely limited to mapping from vantage points. For provincial and national overviews, aerial sketch mapping is still the most time and cost-effective procedure for conducting a detection and initial survey over vast areas on a yearly basis. Currently, sketch mapping for a first-stage overview is mostly on 1:100,000 scale maps, occasionally at larger scales and, if necessary because of map availability throughout the region, at smaller scales up to 1:250,000.

Flying is usually best done in late July or August, by which time field staff have a good knowledge of current conditions and can plan the most efficient coverage of known and historically likely outbreaks. Also, the discoloration or loss of foliage caused by bark beetles or defoliators is usually at its most consistent and visible stage for ease of detection and distiction. With bark beetle-killed pine, experienced observers can usually differentiate between previous year's and older mortality.

There are usually two observers, preferably with the senior observer having at least 5 year's experience. With attention to the plane's altimeter, map contours and natural features, the location, relative size, severity and damage, and probable cause are delineated on topographical maps. If small, the estimated mumber of currently damaged trees is recorded; otherwise, severity classes are assigned. In mountainous terrain, contour flying is most efficient with one or more passes through the watershed depending on its size and the light conditions. Observers seated in tandem may be best if several passes are made through a drainage, while one on each side of the aircraft is best if only a single pass is made or if a grid pattern is flown.

High-winged aircraft are selcted for safety, ease of forward and lateral visibility (bubble windows greatly improve viewing almost directly below), adequate cruising range and for speed and good performance when mapping is done at elevations of 300 to 500 meters above ground level (depending on terrain) and an air speed of 150 to 175 kph. For best concentration and comfort, individual flights should not greatly exceed 3 hours' duration. The time of day affects lighting and ease of damage detection, especially on north slopes, so mid-morning flights are usually best. Some observers find that amber IR/UV- filtered sunglasses provide better contrast of color changes.

For provincial and national overviews, our preferred map scale is the provincial 1:100,000 topographical series which is currently available for about 40 percent of the province. Alternatives are 1:125,000 or 1:250,000 scale maps. Pre-flight preparations such as lightly marking the previous year's infestation allow staff to check for errors, increases consistency from year to year, improves the accuracy of locating continuing infestations, enables the expansions and changes over time to be checked and better identified, and ensures that major infestations are reflown.

Some oblique, hand-held photography or video is usually obtained for a visual record, a training guide, and sometimes to refine the sketch maps and the assessment of damage. Other photographic and remote sensing techniques have been evaluated (Gimbarzevsky et al., 1992), but it was felt they could not provide as timely, cost effective and complete an overview as the basic sketch mapping procedure. The operating costs for the aerial survey (excluding staff salaries) is about 10 cents per km2 (1/10 of a cent per hectare).

Geographic Information System Outputs - Annual infestation maps and summaries

Development of GIS capabilities has been underway in FIDS at Pacific Forestry Centre (PFC) since 1984. The GIS software used since November 1991 is Environmental System Resource Institute's (ESRI) ARC/INFO. It operates on a Sun Sparcstation 2 platform {32 megabyte (MNB memory, 16-inch colour monitor, 424 MB internal disk drive, 3.5" 1.44 MB floppy disk drive, and Sun Operating System (Sun OS)}. Peripheral hardware used includes an Altek AC30 Digitizing Table, a 150 Mb 1/4" SCSI Cartridge Tape Drive, a 1.2 gigabyte (Gb) Wren VII Disk drive, a 758 Hewlett Packard (HP) Pen Plotter, and a QMS-PS 410 Laser Printer. Similar work stations or personal computer-based systems are in place at each of the other Canadian Forest Service laboratories and through the network and cooperation, nation-wide maps can be produced at the Petawawa National Forest Institute.

Upon completion of the aerial surveys each year in August or September, the field technicians return to PFC and enter into the GIS the current infestations by digitizing the polygons and assigning attributes of pest, severity, year, forest region and map reference. From these data, searches or compilations, of any combination of desired attributes can be made.

Also, during digitizing, the current and previous year's infestations can be viewed on the screen and any differences are corrected or accepted by the technician before entry into the database. With the field technicians responsible for input of their own data, errors of missing labels, placement, etc. can be detected and corrected.

Maps are then computer-produced at various scales and distributed to cooperating provincial forest service and forest industry staff, and are available to parks and others. By combining 20 to more than 100 maps, regional and provincial maps are available for review, planning meetings and reports. Using report generators, area and polygon tallies can be derived for selected areas, map sheets, administrative regions or the entire province.

Accuracy of Aerial Sketch Mapping

Aerial sketch mapping is widely used and accepted as an initial survey technique especially for damage by defoliators and bark beetles throughout Canada and the United States. The accuracy of the results is often difficult or costly to assess. Also, the general purpose of the different surveys should not be forgotten. Too often, in the absence of more detailed information, sketch map results are extrapolated beyond reasonable limits and expectations. Conversely, time and effort is often spent on detailed surveys when a simple sketch map would have been just as useful.

With experienced mappers, the detection and location of infestations is generally accurate to the scale of map used. For individual trees or small groups, direct observation can even provide better detection than most overview photography. Our own periodic reviews, as well as Aldrich et al. (1958) with southern pine beetle, have found aerial sketch map detection and location results to compare very favorably with more careful spot checks or complete surveys.

In sketch mapping, the size of infestation is frequently exaggerated, especially when many small pockets are mapped, but the counts of dead trees are usually low. In comparison to aerial photographs obtained for a portion of selected outbreaks, Harris and Dawson (1979) found the total area sketch mapped was 34 percent larger than measured on photographs. An over-estimation of the area affected was also noted by Gimbarzevsky et al. (1992) in an extensive comparison of results from ground plots, aerial sketch mapping and numerous scale and types of remote sensing.

National Standards and Training

While a national workshop such as this one has not been held in Canada (it would be an excellent idea), each regional unit of FIDS has operation manuals (e.g., Forest Insect and Disease Survey 1984) with sections on aerial surveys and safety procedures. Separate manuals exist for the ARNEWS/biomonitoring program

(Magasi 1988). Although national aerial survey standards have not been developed, there is national uniformity in coding and recording forest insect and disease based on procedures established for the computerized database of more than 1.6 million ground-based samples gathered over the last 5 decades (Forestry Canada 1991). GIS data standards and a policy for data sharing still need to be developed.

While each region has its own set of training photos and pest signatures, unfortunately these have not been formalized and there has been too little inter-regional standardization. To partly overcome this, DESTIMAS (defoliation estimation system), a personal computer-based training aid for tree and branch damage assessment has been completed this year (Thomson and Van Sickle 1994) and will be tested. While not intended to replace field or aerial workshops, it does introduce and test the observer's ability to visualize random and known patterns and levels of defoliation or damage as simulated for various tree types.

Conclusion

A large national and regional historical database has been created from ground and aerial surveys over several decades, but only recently has the computer capability of relational database management and geographic information systems enabled fuller analysis. To guide and assist forest protection research and management, the database can be interrogated. A wide range of maps can be stored and produced, and maps can be overlaid, analyzed and summarized in association with pest distribution and history, forest inventory, ecological vegetation zones, administrative boundaries or climatic and other records.

While we continue to seek improved and efficient techniques for timely, annual surveys, we expect that aerial sketch mapping will remain a basic overview method and we will continue to work on improving its consistency and accuracy.

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USE OF AERIAL SURVEY FOR MONITORING CYPRESS APHID DAMAGE IN KENYA

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1. *Introduction*

For the best decisions to be made in regards to a forest pest, the extent and magnitude of the damage must be determined. Aerial sketchmap surveys, followed by ground truthing are the most efficient way to obtain good information. In Kenya, an aerial survey became desirable when the cypress aphid outbreak was noticed in 1991 on Mexican cypress plantations.

Detection is done by:

(a) Using a light aircraft to fly over forested areas and sketchmap the locations of damage, and
(b) Ground detection to identify the host, the damage, and the causal agent.

The aerial sketchmapping becomes the only quick way to cover large tracts of remote forest areas in a short period of time.

(a) *Advantages*

(1) Quick assessment of forest damage
(2) Costs per hectare are lower when large areas are involved

(b) *Disadvantages*

(1) Needs highly trained manpower which is expensive to obtain
(2) Sometimes finding a suitable aircraft and a qualified pilot is difficult

(c) *Uses of Aerial Surveys*

Aerial survey is used in detecting and monitoring the location, extent, and intensity of forest damage by a forest pest. The damage is sketchmapped on maps of various scales and then a summary can be made back in the office. Summary information includes the station, block, sub-compartment, age of stand area, and stand volume. This information will quantify the resources at stake and an economic threshold can be determined. The determination of an economic threshold is important as it will tell us how much we can expect to lose in comparison to how much we are going to spend on controlling the pest.

2. *References and Guidelines*

Guidelines for aerial surveys were prepared in February 1992, by Mr. J.G. Denny Ward, FAO/TCP Project Consultant, in collaboration with the project coordinator, Professor Joe Mwangi, and the, then, Deputy Project Coordinator, Mr. J.N. Maina. These guidelines have served as reference material for the execution of aerial surveys in Kenya.

3. Data Used in the Aerial Survey

Data used in the aerial survey in Kenya was developed by the relevant branches of the Forest Department and the Kenya Forest Research Institute (KEFRI). This included the following:

(a) Summary of plantation information from Forest Inventory Branch showing:
- o District
- o Station
- o Block
- o Sub-compartment No.
- o Age
- o Area
- o Volume of wood in each sub-compartment and the total monetary values

(b) Plantation maps of scales 1:250,000 prepared by the Forest Survey Branch showing the details as above, but without volumes.

(c) Some topographic maps were also brought from the Survey Department of Kenya after several requests and vetting was done by the Defense Department.

4. Techniques of Aerial Surveys

Aerial surveys fall under various categories and the technique for each one will depend on the category. The main categories of aerial surveys are:

(a) *Reconnaissance Aerial Survey*

This is a quick survey covering the whole country. The important issue in this kind of survey is that since very large areas are covered every day, small scale maps are desirable. The ideal map scale is 1:250,000 or 1:500,000. The limitation here is that plotting damage accurately is difficult since only a dot on the map will mean several thousands of hectare. Fixed-wing aircraft are used.

(b) *Intensive Operational Aerial Survey*

This is an aerial survey aimed at getting information that can be used for operational purposes, namely spraying, salvaging, biological treatments of stands, silvicultural activities, etc. The map scales used are large scales like 1:10,000, 1:25,000, and 1:50,000. The information is plotted accurately and verification of the same information can be done by spot checking if a helicopter is used in this survey. Helicopters are used in this survey because of the slow speeds required for accurate plotting.

(c) *Post-Treatment Aerial Survey*

This survey is done to determine the effectiveness of a specific treatment done to a stand. This is a site-specific survey and aims to check on mortality or recovery. Both large-scale maps and small-scale maps can be used since the aim is a quick assessment of the results of treatment.

In all the cases, the aerial survey starts with the following:

- o Appropriate scale for the purpose.
- o All forested areas--marked in green.
- o Predetermine flightlines on the maps and drawing them up with appropriate flight intervals and alignment.

At this planning stage, there are numerous considerations to be done; e.g.:

- o The type of aircraft that is going to be used (its suitability, carrying capacity, its power, weather conditions, and the financial resources available).

A certified aerial surveyor would require 100 hours of flying time to master the job. There are numerous factors which influence the accuracy of an aerial survey. These factors form a wide subject of discussion and will not be discussed here in this seminar.

After the aerial survey is completed the crew comes back to the office and compiles the following information:

- o Date of the flight
- o The areas flown
- o The block, compartment, sub-compartment, area, age, and volume of stands
- o The aerial survey crew--by names
- o The aerial survey team leader who signs the document

The aerial survey team leader has several responsibilities which he must ensure that he strictly follows.

5. *Global Positioning Systems (GPS)*

This is a very important instrument fitted to the aircraft. It is used for navigating both on the ground and in the air, to locations of interest. GPS can be used as an efficient means of updating our GIS database on the cypress aphid.

6. *Airborne Videography (ABV)*

ABV is an alternate to aerial sketchmapping but it requires highly trained personnel. This is a procedure in which a small video camera and video tape are used in the aircraft to record the desired information. These can be viewed in the office and important features noted. Airborne videography is more accurate than manual sketchmapping. Preservation of the video tapes can be done for many years and stand conditions at the spot can be compared frequently.

7. *Aerial Survey Results*

The First Aerial Survey

In February 1992, FAO hired a consultant to assist the Kenyan counterparts in developing guidelines for aerial surveys and train the aerial survey crew. The training was done in a seminar held in Muguga and a crew of four people was thoroughly trained in theory and practice. After the training an aerial survey was done. An actual sketchmapping revealed that about 46,000 ha. of cypress plantations had been severely infested by the aphid. The determination and classification of foliar conditions had been done earlier by Dr. Odera of KEFRI and the sketchmapping was based on this classification.

The conditions of the crown were classified as:

0	healthy
1-25%	light damage
26-50%	moderate
51-75%	heavy
76-100%	severe

The sketchmapping was mainly based on the two conditions: heavy and severe. As the aphids infest the crown from the bottom upwards, it was difficult to register effects in the light and moderate categories.

Maps were developed in the office showing the locations of the severe aphid damage and information was plotted on a GIS in Atlanta, Georgia, U.S.A.

The Second Aerial Survey

The second aerial survey has shown that about 10,000 ha. range between severe effect and mortality. Out of the 10,197 ha., 6,367 ha. have been salvaged, 3,830 ha. have actual mortality, and 1,220 ha. are in the severe state. This means that the area actually needing urgent salvaging is 1,610 ha. These constitute the plantations of 29 years up to 46 years. The figures above are the most recent figures collected from a ground confirmation survey done by the ground survey crew. The reasons given for these plantations not being harvested are:

(a) Inaccessibility
(b) Insecurity, especially in Mt. Elgon
(c) Unavailability of sawmilling industry in certain areas
(d) Political reasons.

8. Ground Survey

In February 1992, after the aerial survey, a ground confirmatory trip was organized and undertaken in April to confirm the aerial survey results. This trip covered Nakuru District, Kericho, Uasin Gishu, Baringo, Nyeri, and Meru. As there were not enough funds, the other Districts were not covered. In July, another trip was organized and covered Kakamega, Nandi, Uasin Gish, Baringo, Nyandarua and Laikipia. Some districts were repeated because the first one was done during the rainy season and it was necessary to compare the information after the long rains. In June and July 1993, two ground surveys were done--one west of the Rift and the other one east of the Rift. This trip was organized to confirm the results of the second aerial survey. The previous data was derived from this confirmatory trip. The trip covered the whole country and all the districts with host materials were visited, apart from Keiyo Maragwet and Kiambu Districts where a trip is now being organized.

During the survey in western Kenya, intensive sampling was done for mortality counts and most plantations had substantial mortality and the evaluation showed that about Kshs.8 million would be lost in only the 29 plantations that were sampled. This mortality, spread over the whole country, would mean a substantial loss of revenue if the materials are not harvested in time.

Some of the plantations sampled showed that some trees had severe heart rots and the sawmillers were not interesting in harvesting them. Some of the materials which dried up last year have already become unsuitable for sawmilling and many sawmillers are disliking them.

A third aerial and ground survey will be done in November or December 1994.

9. *Analysis of Aerial and Ground Survey Results*

Introduction

The first question before the aerial survey was done was:

> "What is the extent and location of the cypress aphid damage in the field?"
>
> The sketchmapping surveys showed the locations and the extent of the cypress aphid damage. The actual position of stands severely damaged has been transferred to GIS-generated maps which are now available at the Forest Health Management Centre at Karura.

The second question was:

> "Is the information marked on the maps true?"
>
> This question prompted surveys to be undertaken. The ground survey verified that about 35% of the plantations marked on the map still existed or were harvested due to excessive mortality caused by the aphid or due to the normal harvesting age. It should be noted that the plantation list which was prepared after the aerial survey was used as a checklist and an updated one was produced.
>
> A point worth noting also is that the updated list needs reviewing after six months since the plantations indicated in the previous list are being continuously harvested.

The third question was and is:

"What is the amount of volume loss through mortality?"

This question prompted us to conduct ground surveys to sample the plantations that were viewed from the air as having mortality to determine how many trees were dead due to aphid damage per ha. and per plantation, and the trees' volumes.

Some work has been done on this and the results computed. The ages of the stands sampled ranged from 16 to 46 years and there were numerous gaps in the age ranges. This means that if enough funds were available, sampling could be done in all the stands from age 5 to 46 years to correlate the aphid damage with age. The amount of volume loss has been computed in the test samples and the volumes equivalent to revenue which could accrue if the trees are harvested in time calculated.

B. *Sampling Method*

The sampling method used in this study was the nearest neighbor method. The main advantage of this method is that stratified sampling is done and sample size will depend on the total area of the plantation to be sampled. This means the larger the area, the greater the number of sample plots--up to 20 plots. This method also limits the number of trees to be assessed to 5 trees per plot and at least 20 plots per plantation so that 100 trees are assessed per plantation.

The trees are assessed by classifying them as:

		0	crown foliar damaged	healthy trees
1	-	25%	crown foliar damaged	light attack
26	-	50%	crown foliar damaged	moderate
51	-	71%	crown foliar damaged	heavy
76	-	100%	crown foliar damaged	severe
Whole tree dried up				dead

When observing mortality it is important to note that other causal agents were noted, e.g., animal damage, human damage, fire damage, and other tree stressors that may have caused the death of the trees.

The fourth question was:

"Is it true that the older the trees the greater the severity of the cypress aphid damage?"

We have tried to prove this by interpolating the figures from the field by comparing severely affected trees in percentages (%) with actual mortality percentages. The trend seems to indicate that the older the tree the greater the effect of the cypress aphid. It is recommended that sampling be done for the whole country and for trees of all age classes to come up with good figures to show the actual relationship between age and damage.

This will also assist in helping us draw up salvage guidelines for the severely affected stands. A decision will be made on which salvage method will be appropriate at what age.

Salvaging can be done in two ways:

(1) Incorporating the harvesting in the usual thinning schedule--selective salvaging.

(2) Salvaging in total: harvesting the whole plantation that is affected.

The advantage of selective salvaging is that the dangers of soil erosion on the salvaged lands is eliminated. There is a tendency of the land on which salvaging has been done to be eroded during the rains before natural regeneration takes place. This is true in stripe slopes.

The disadvantage is that the volumes may not be great enough for money to be made by the sawmillers, so no one would bid on the job.

C. *Recommendations*

We would recommend that whenever the funds are available, monitoring and appraisal of the stand status be done at regular intervals so that stand changes can be registered and the information can be used by managers and decision makers.

AERIAL SURVEYS, THE GOOD, THE BAD, THE BUMPY

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I started to learn aerial surveys in the mid-seventies from Ladd Livingston. When I started, it all sounded really neat. I would sit in the back of a Cessna 182, on the passenger side. We sub-contracted a fire patrol aircraft from the Forest Service out of Coeur d'Alene, which contracted from Felts Field Aviation in Spokane, Washington. For the first couple of years, I was just trying to learn to identify the tree species and to locate myself on the maps and keep from getting sick. When I first got started, I can clearly remember that what I saw on the maps was not how it always looked from the air. The maps are large so you had to fold them several times. They have not changed very much over the last 20 years. They are still very large and it is always fun to try to refold them, in a short period of time in these small planes.

Air speed and elevation, with sharp turns at the head of every drainage, were another thing I had to get used to. The first couple of years, sitting in the back seat, was not that easy. You would be looking out the window, then turning your head to look down at your map, then turning your head to look out the window, always trying to keep your location on the map. When you would see a group of dead trees, your head would be going back and forth, back and forth. What tree species is that, how many trees in that group, what is the code for that species? Then, trying to draw a nice little polygon on the map, in perfect location, with a code and a estimated number of dead trees, which was not always right and as you tried to erase the first group or numbers, there came another group of dead trees and another and another. "Oh no, I put it in the wrong spot," or just as you're about to write, the plane hits a turbulence, your head hits the roof of the plane and your pencil hits the map, either making a hole in your map or drawing a long line all over it. In my years of back-seat flying, I can remember trying to map in every dead tree, even the single ones. I would remember having to take motion sickness pills and how they would make me sleepy in the warm afternoons. Trying to keep my concentration as the day wore on, was always hard. Even more so after I got lost on the map.

Usually it would be a different pilot each morning. I would have to get the maps out, explain the procedure, air speed, elevation above the tree tops, staying always on the left side of every drainage, going to the top of the ridge, turning around with a sharp turn, then back down the drainage staying on the left side again, so the bottom of the main drainage was always in view. Then I could see the side drainages coming out of the main drainage and then up the next one. Always going in a clock-wise rotation, so what I wanted to see is always on the right side of the airplane. As I remember, the pilot did some kind of check in; we had no head sets to help keep the noise down. If we had ear plugs, we were lucky. Trying to direct the pilots in the direction I wanted them to go has always been fun in a noisy airplane. I had to make up my own sign language and then hope they were looking when I gave it.

At first, I can remember, if it was cloudy or windy at all, we would not go because of the shadows. It had to be an almost perfect day (not any more). I can remember in the early years I would get pilots who would smoke and would not know where they were or how to get there. They would always have to ask what our location was. They would be using the airplane's radio to do the check ins. The planes are noisy and small, with no place to go until we landed--usually 3 hours at a flight. After a couple of hours or less, I started to get antsy, and then 9 o'clock comes and the pilot turns on Rush Limbaugh for the next 3 hours.

Some years are always better than others. Some years, one or two of the last 20, we get lucky and the bark beetle populations are very low. The conditions are just right. There are no forest fires, no burning grass fields yet, and you have a good pilot. Most years there are plenty of insects and disease damage to keep one busy and then there forest fires, grass-burning smoke, windy - cloudy days, or something goes wrong with the radio. There seems to be something new every year--a new disease or defoliator or bark beetle. It's never the same.

NORTHERN REGION AERIAL SURVEY PROGRAM

Tim McConnell

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Introduction

Using fixed-wing aircraft to observe forest insect outbreaks in the northern Rocky Mountains began in 1948. At that time few forest access roads were aviailable to detect and monitor insect outbreaks. The post World War II aviation boom provided not only access for forest observations, but also a cost-effective remote sensing technique to observe and record major forest disturbances. Occurring at the same time across most of the northwest United States, was a large western spruce budworm outbreak. As more and more forested areas were flown, more forest disturbances were detected, including Douglas-fir beetle outbreaks and large windthrown areas. Along with the aviation boom came an intensified effort to combat several forest defoliators by using aerial spraying. Much of the "early years" of aerial detection survey mapping supported the aerial spray projects, as well as salvage opportunities for windthrown trees and Douglas-fir beetle caused mortality. These uses of the annual aerial survey are still in effect today. Along with them, is an historical record of major insects and diseases covering a span of over 40 years in some areas. As the Forest Service looks philosophically toward an Ecosystem Management approach to land management, and has a concern for change over time on the land it manages, the aerial detection survey maps have provided a long-term, broadscale record of some of the major components for forest disturbances.

The Program

The Northern Region aerial survey program is conducted annually on all 13 National Forests and one Indian Reservation (Flathead). The survey is flown intermittently on two National Parks and four other Indian Reservations. Areas of low insect disturbance are generally flown every other year due to a limited budget and available trained observers.

Three single-engine aircraft are available for survey flights provided by a private contractor. Survey pilots are the contractor's employees and are carded (certified) by the Forest Service to fly mountain reconnaissance missions. The contract aircraft available the past 6 years has been a Cessna 182, a Cessna 182 RG and a Cessna 206. The contract specifies at least two of the single-engine aircraft will be turbo charged or power boosted. This contract specification is to provide a safety margin for power when flying at the higher altitudes in mountainous terrain.

Two Forest Pest Management (FPM) observers fly approximately 90 percent of the annual survey totaling approximately 375 hours of aircraft time. One summer seasonal (high school biology teacher) and I do all the survey flying for FPM. The approximate aviation contract cost to do the survey each year is $60,000 ($160.00 per hour aircraft time). Most all forested lands are surveyed, except wilderness areas. Since there is a limited amount of dollars and observers, wilderness areas have, for several years, been dropped from the annual aerial survey. This is also due to the fact that one of the primary uses of the survey is to support the timber aspect of land management and no timber management is currently being conducted in the vast wilderness areas of Montana and northern Idaho. Approximately 26 to 28 million areas are covered by the two observers.

The Idaho Department of Lands, Bureau of Private Forestry personnel fly the other 10 percent of forested lands (4 to 5 million acres) in the Region in Idaho. They are responsible for flying a specific portion each year that is primarily state and private land. Their survey maps are included in the final Regional survey maps.

The Montana Department of State Lands, Forestry Division has a Collection Agreement with the Forest Service to provide funds to cover costs of FPM flying aerial survey on the large, contiguous forested state land holdings. This amounts to approximately $4,500 each year.

Survey Method

Timing

To capture most damage signatures of insects and diseases from the air in a single flight, the survey is conducted during the summer months of July and August. The survey begins in areas where defoliators are not expected and continue to defoliate areas because the pest signatures of western spruce budworm and Douglas-fir tussock moth generally do not show up until late July. Other defoliators such as pine tussock moth need special surveys because the defoliation occurs before the regular survey.

A typical survey day consists of approximately 5.5 to 6.5 hours of flying. The flights occur between 8:00 a.m. and 4:00 p.m. each day. A noon break is usually taken to refuel the aircraft and crew. This break is kept to a 45- to 60-minute maximum to take advantage of optimum sunlight.

Flight Method

Most all aerial surveys are conducted using the contour or drainage-by-drainage method. This method gives a single observer the most thorough view of an area of any first-stage mapping. Terrain often dictates the flying altitude, but generally it is about 1,200 to 2,000 feet above ground level. The estimate is very rough because the terrain is so mountainous.

Flight Following

Positive flight following is practiced in the Northern Region, just as it should be practiced everywhere. Whenever the survey airplane is in the air, someone on the ground knows its location, intention or destination. Flight following is down through the Forest Service dispatch system. Each National Forest has one or more dedicated FM frequency for flight following and other Forest activities. Many dispatch centers are now combined with other National Forests, Bureau of Land Management (BLM) and State agencies for wild fire response efficiency. During the aerial survey, regular check-ins are made every 15 minutes.

Radios used for flight following have been 10 watt 9600's, provided by the Forest Service, which were mounted in the aircraft's instrument panel. The new contract for aerial survey aircraft specify that the contract aircraft provide their own programmable, 5 watt minimum radio. The benefits of having a programmable radio include being able to contact any National Forest the aircraft is flying over, it offers the flexibility to change frequencies to a fire frequency or to a ground crew's radio frequency, and in eastern Montana where there is less National Forest land, a BLM, State or even wildlife refuge office may be called up for flight following or communication through them to a National Forest.

Survey Flight Maps

Most survey flight maps used for sketch mapping are printed on one side for ease of transferring polygons from the flight map to a final map on a light table. Flight maps are often done in pencil so they can be re-attributed in ink on the ground with the print oriented normally. (An observer normally reads the map oriented to the direction of flight and attributes the polygon in the same way.)

In the past, for the regular aerial surveys, the Forest series (1:126,720) half-inch scale maps were used to sketch map. This map base provides excellent drainage patterns, major grounds features, high points and easily recognizable road systems. As this map base gained additional uses for the Forest such as points of interest, recreation sites and management activity designations, while also providing less and less coverage outside the boundary of the National Forest, the half-inch map became less and less useful to the regular area survey. Since all forested lands are surveyed, a map base that offers complete coverage is necessary. Now, the USDI Geological Survey 1:100,000 scale metric topographical maps are used where needed and available.

Survey Map Processing

Upon completion of a survey map, a master map is made (hand traced) that will be digitized using software developed by our geometronics group. From the digitizing, numerical summaries are made by polygon, attribute and number of trees or intensity. Each polygon is visually checked with a hard copy map for ownership. Ownership information is then combined with the polygon data to produce a final summary by ownership and pest. Land managers are also given photocopies of the master. All surveyor originals and masters are kept on file indefinitely for reference and additional copying.

All the survey maps have been digitized each year since 1988, as well as most maximum-minimum outbreak year maps to support broad-scale analysis projects at both the Forest and Regional level. To support these and other analysis efforts, our map files are usually converted to a MOSS format.

Aerial Pest Detection and Monitoring Questionnaire Results

	Aerial Sketchmap				Airborne Video			Geographic Information System	
Respondent (Organization)	No. of Aircraft	No. of hrs. flown/year	Aircraft cost/year	No. of personnel in program	No. of hrs. flown/year	No. of aircraft	Image processing (Yes/No)	Yes/No	No. of personnel used
USDA FS R-1 Forest Pest Management	3	375	$65,000	3				Yes	3
USDA FS R-3 Forest Pest Management Flagstaff, AZ	1	200	$20,000	1	40	1	No	Yes	2+
USDA FS R-4 Forest Pest Management	2	350	$55,000	3	26	1	No	Yes	2
USDA FS R-5 Forest Pest Management	2	50	$12,000	Forest personnel	20	1	Yes	Yes	5
USDA FS R-6 Forest Pest Management	2	360	$70,000	5				Yes	2
USDA FS R-8 Forest Health Management Ashville, NC	5	80	$18,000	3	60	1	Yes	Yes	2.5
USDA FS R-8 Forest Health Management Pineville, LA			$5,000		30	5	Yes	No	
USDA FS NA Forest Health Protection Morgantown, WV	6	100	$12,000	1	60	1	Yes	Yes	2
USDA FS NA Forest Health Protection Durham, NH	3	100	?	2	40	2	Yes	Yes	2
USDA FS NA Forest Health Protection St. Paul, MN	1	160		1	20	1	Yes	Yes	2

Respondent (Organization)	No. of Aircraft	No. of hrs. flown/year	Aircraft cost/year	No. of personnel in program	No. of hrs. flown/year	No. of aircraft	Image processing (Yes/No)	Yes/No	No. of personnel used
USDA FS R-10 Forest Health Management Juneau, AK	2	70	$22,000	2	30	1	Yes	Yes	2
USDA FS R-10 Forest Health Management Anchorage, AK	2	100	$35,000	2	2	1	Yes	Yes	1
Idaho Department of Lands Coeur d'Alene, ID	1	65	$12,000	2				No	
Oregon Department of Forestry	1	150	$30,000	2				Yes	USDA FS Personnel
New Mexico State University Cooperative Extension Service	1	35	$3,500	1+					
Texas Forest Service	1-12	350	$35,000	50				No	
Missouri Department of Conservation	3			2				Yes	2
Integrated Forest Pest Management Center, Kenya	1	28	$3,000	2					
TOTALS	42	2,573	$405,500	82	328	15			27.50

SURVEY FLIGHT METHODS AND LOGISTICS

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Purpose

The purpose of this talk is to briefly go over some aspects of survey flight methods and logistics necessary to conduct an aerial sketch mapping mission, as well as some things to consider before and during the actual survey. Additional information can be found in past publications on this subject.

Type of Survey to Be Conducted

Most traditional aerial surveys are considered overview or initial surveys. During some years, depending on severity of insect outbreaks, disease symptom manifestations, extreme weather effects, more extensive surveys may be warranted to address these specific conditions. The initial survey is done to obtain information on a broadscale. Even though most initial aerial detection surveys are quantitative, it should be remembered that the primary purpose is to detect disturbances across large areas. If it were to be more than that, a different map scale would be used, the survey would be flown at a slower speed, possibly a different type of aircraft would be used and a smaller area would be covered. For many land managers, the initial survey serves their needs under most situations.

To be an efficient senior aerial sketch mapper, it is important to keep in mind the type of survey being conducted. But since dollars are being spent for the aircraft, pilot, observer and ferry time, it is also important to record as much information as possible while the survey is occurring. With more and more users asking for aerial survey maps, the more important it has become for the sketchmapper to record as much information as is observed and is possible, realizing the limits of flying past the forest at 100 miles per hour with a small-scale map to record disturbances.

Survey Resource Limitations

Nature's limitation on the aerial survey is the biological window. Most conditions are only visible for a short period of time. One doesn't have all year to get the survey done. For most disturbances, it is during a 3-month period in the summer. Again, this isn't applicable to special surveys like southern pine beetle. Along with the time of year comes the time of day to fly survey. Light conditions are critical of good observations. Surveys should be conducted during the hours of the highest sun angle. Early or late day sun angle can be helpful in some areas that have an aspect facing the sun angle. For example, flying a long ridge that faces west late in the afternoon would work well, but you wouldn't want to fly that same area early in the morning.

The survey budget is an important aspect of how the survey is conducted. The budget dictates the amount of aircraft time to be used, as well as the number of observers and amount of time spent doing the survey.

Many senior observers find themselves flying the survey much faster than was done several years before to get the survey flown within the allowable time and budget.

The time allowed to fly the survey is critical to how the survey is completed. If an observer has a month to fly one National Forest, there will be plenty of time to wait for ideal weather, only fly during peak sunlight hours and fly at a slow airspeed to ensure nothing is missed. Alas, these days the observer is challenged with doing as much as possible every day to complete the survey before the season ends.

The other resource challenge that faces every observer and program manager is that there are not enough trained, qualified observers to do the flying. Most Forest Service Regions had more qualified observers fifteen years ago than currently. The need to get the survey done each year is still exist, as well as the desire to have a quality product. In the Northern Region, currently, two observers cover approximately 26 to 28 million acres annually. Ten years ago the same area was surveyed by 5 observers. This is an added pressure to any observer to complete the survey within the bio-window and budget limitations.

Aircraft

Twin versus single engine

Most aerial surveys conducted in the western United States are flown in high wing, single engine airplanes because of their cost, availability and the need for only one observer. In the Pacific Northwest Region, where 90 per cent of the survey flying technique is grid or parallel line flying, high wing ,twin engine airplanes are predominately used. The twin engines are preferred for the weight and performance safety margin since most flights carry two observers, one pilot and frequently a trainee. With four personnel aboard an airplane, doing relatively low level natural resource surveys, a twin engine is a wise idea. The only available high wing, twin (two) engine aircraft generally available to fly aerial survey are the old Cessna Skymaster (337) and the relatively new Partenavia (68B and Observer). The Aero Commander (500) is not recommended because it must fly too fast, has poor visibility and is not cost effective.

High wing

High wing aircraft offer much better lateral and downward visibility than a low wing aircraft during normal flying. Most all aircraft, with the exception of the Partenavia Observer with its clear plastic nose, causes difficulty in seeing ahead and directly under the aircraft. A low wing aircraft only makes the visibility problem worse.

Performance

Always be familiar with the performance characteristics of the your mission aircraft. Generally, a survey aircraft should not have less than 200 horse power per engine. A Cessna 172 does not have enough horse power to provide any margin of safety during normal survey flying. A Cessna 182 has 235 horse power and is an excellent single engine airplane for one observer under approximately 7,000 feet altitude (depending on temperature). A Cessna 206 is designed to carry heavy payloads and is turbo-charged, making it also an excellent single engine survey airplane. It performs well at higher altitudes, can carry an extra passenger and equipment, performs well for short take-offs and landings. Pilots only complaints are that it is heavy on the controls and is wider than a 182 making it more difficult to see out the observer's (right) side. A combination of the two is a Cessna 182 RG (retractable gear). It is not turbo-charged, but has a fuel injected type carburator giving greater horsepower at high altitudes, providing that power margin of safety required for safe high mountain flying. With the retractable landing gear, it has a much faster cruising speed making "deadhead" or ferry time more efficient. The Cessna 185 (tail dragger) is also an excellent aerial survey plane that offers slow air speed, excellent maneuverability and short airfield performance. Other high wing, single engine aircraft used include, the DeHavilland Beaver and the Cessna 210.

Flight Patterns

The two most used flight patterns are contour (drainage flying) and grid (parallel flight lines). The type of flight pattern used depends on terrain and survey resources. Flat country is often flown using the grid pattern and mountainous country is usually flown using the contour pattern. Grid pattern is often used when observers and budget dollars are limited since an area can usually be covered in less flight time. Although grid flying covers an area more efficiently, it also has limits in mountainous terrain because the topography can block or shield the observer's view.

Contour flying

Contour flying gets its name from flying survey at approximately the same altitude, while flying up and down drainages, just as contour lines appear on a topography map. This type of flying is actually drainage flying because the observer is constantly following a main drainage and then sub-drainages. Sketch mapping is done with a single observer who has the pilot fly up a drainage with the drainage bottom on the right side (observer's side) of the airplane. This provides the observer the opportunity to follow the creek or river on the ground and on the map to track their location while sketch mapping, and should give the observer a complete ground view from creek to ridge top. When the airplane reaches the head of the drainage, the pilot performs a right turn to let the observer continue to view the ground. Then, the airplane continues back down the drainage, while the observer again views from creek bottom to ridge top on the other side of the drainage that wasn't visible on the route up the drainage. It is important, that at the head (upper limits) of each drainage, the airplane turns right to go back down the drainage only after the observer is confident that all the area will be visible before and after the turn. This clockwise, systematic method gives the observer almost complete coverage of the area to be surveyed.

The topography dictates much to how contour flying is done. It should be noted that this turning to the right method is in reverse to how a pilot would normally fly in a similar situation without conducting a natural resource survey. The pilot normally flies with the ridge on the right giving the pilot an unobstructed view to a safe area to turn the airplane in case of emergency.

Safety concerns include: 1) never fly up drainages directly over the drainage bottom, because, along with reducing the observer's view, it reduces the amount of escape route space available for the pilot to turn the airplane around and back out the drainage, 2) always maintain enough altitude flying up a drainage to allow for down drafts and power emergencies, and so the airplane engine's power settings aren't pushed to the limits time and time again. It is this aspect of contour flying that requires the observer to have some basic understanding of flight, mountain flying, aircraft performance and pilot concerns. There are many more rules to flying than just staying 500 feet above the ground.

Grid flying

Grid or parallel flight line flying can be an efficient systematic method of covering a planned area. This method can provide complete coverage with the least amount of duplicated coverage. It is generally used in flat or low relief areas with poorly defined terrain. It is often used when two observers are sketchmapping at the same time out opposite sides of the airplane. Depending on the terrain, visibility, insect and disease damage, and experience of the observers, the distance between flight lines should be 4 or 5 miles. Any more space between lines makes the middle area difficult to see and may provide less than complete coverage. Care should be taken to insure that the flight lines are close enough together, so upon completion of the flight map, the flight path is not visible on the map. Inexperienced observers tend to map only what they see close to the airplane, also leaving polygon gaps in the middle between flight lines.

Although grid flying is the most efficient method of flying, limitations include lack of adequate time to see disturbances behind ridges. Crossing high ridges does not provide for low-level viewing of valley bottoms and causes a viewing gap directly under the airplane.

Cardinal directions are usually followed. Direction of flight is optional and may vary depending on time of day and terrain. Flight lines are generally predetermined and marked on the observer's map prior to the flight. Pilots differ in their method to stay on the planned flight line. Compass headings may be followed, section line markings on the ground, such as fence lines, roads and clearcuts are used to "stay on line." Give a refrence point (mountain top, lookout, snow field, ridge notch) far enough ahead to help the pilot visualize the intended path. When following compass headings, it is important to include the declination of the area, since the pilot is flying a magnetic heading (magnetic north) and the observer is following a map heading (true north) on the map. Constant corrections of the flight path can make for less than acceptable conditions for observation and mapping.

Safety concerns include, when flying in mountainous terrain, keeping a high power setting while flying across ridges and maintaining a safe margin of clearance when crossing ridges.

Survey Crew Communications

Flight following

Flight following is included in survey crew communications because the individual conducting the actual flight following on the ground should be considered an integral member of the survey team. Without this individual, the survey can not be conducted. The dispatcher or radio operator should understand the survey mission, the type of flying to be done, know the general area to be surveyed, the type of aircraft, tail number and passengers on board. This information sharing should be done in person or on the telephone prior to the flight each day.

Regular check-ins by radio should occur every 15 minutes. The primary reason for flight following is for safety, in case of an emergency, such as a forced landing. Keeping this in mind, the check-ins should include a specific landmark that would help a response team determine the search area. Another reason for the check-ins is to help the agency dispatcher manage the unit's airspace. The survey should not continue without some sort of radio comunication with someone on the ground.

The chief observer should know, or have in his/her possession, all radio frequencies that may be needed to maintain radio communication. A complete list of frequencies for the entire survey area is recommended.

Communication equipment

Attemping to fly aerial survey without adequate communication equipment can cause the survey to be inefficient, unsafe, frustrating to all involved and ineffective. Terminating the survey prematurely due to radio problems can be a costly action, both in terms of dollars and time. At a minimum, radio equipment should include a 5-watt programmable radio, an antenna mounted to the outside of the aircraft, noise attenuating aviation headsets with microphone, and an intercom system in the aircraft so all flight members can communicate with each other.

Flight crew

Your survey pilot does much more for you than just fly the airplane. The more you informed the pilot of your mission and intentions, the better team player he or she can be. Without an intercom system in the aircraft, communicating with the pilot was done with a series on hand signals, yelling and body language. Today, most survey airplanes have a built in intercom system. Portable systems are available for use in airplanes without an intercom, but often they are inadequate because they do not usually accommodate radios.

Communicating with your pilot includes, not only telling him or her which direction you want to go, but also what altitude and air speed to fly, where and when to make the turn, what kind of turn to make and where you plan to go next. And when flying a grid survey with an inexperienced pilot, you are usually requesting a slight jog to the left or right to stay on your intended course. The more you talk to survey pilots, the more you will know about the pilot's concerns, flight physics and meteorological conditions affecting the survey. An experienced pilot can also help you plan your mission when you consider such things as airports with fuel, fuel on board (maximum flight time), terrain to be surveyed (do you have the proper aircraft?), and ferry time estimates to help you decide on the most efficient overnight location.

Prior to each flight, all personnel on board the airplane should know the intended plan of the chief observer. Anyone riding in the back seat of a small aircraft should know the approximate length of flight and area to be surveyed. Keeping everyone informed helps reduce surprises for crew members and provides an opportunity for them to be more effective participants.

Navigation

Tracking

Keeping track of the aircraft's exact location is expected of all observers during sketch mapping. One must know his/her location to accurately map forest disturbances. This can present one of the major challenges to new aerial sketch mappers. Each sketch mapper has his/her own method of tracking. Looking ahead, both on the map and on the ground, helps the observer anticipate ground features to be seen. Keeping one's finger moving along the flight path on the map can help track the flight path. Drawing the flight path on the map can help avoid repeating an area. Major land features easily seen from the air, such as lookouts, communication towers, certain mountain peaks and landing fields, should be highlighted on the map prior to the flight to help both the pilot and observer keep track of their location and heading. Loran and GPS technology to determine one's latitude and longitude can be helpful to mark a survey ending point for later return and for the observer who is helplessly lost, but it should not be necessary during routine aerial surveys. Tracking for grid flying is often improved by marking the intended flight path on the map prior to the survey flight. Tracking for contour or drainage flying can be improved by studying the area to be surveyed on the map prior to the survey flight.

Maps

A variety of maps are used to fly initial aerial surveys. Quality of the survey map directly affects the sketch mapper's ability to accurately place polygons and points on the map. Maps good for ground naviation may not be good for aerial navigation. Large-scale maps may be good for detail, but cumbersome in the cockpit due to size. The more political, recreational and transportation information on a map, the lesser the quality of the map for aerial survey purposes. Some common maps used to for sketch mapping include 1:126,720 (1/2 inch equals 1 mile Forest series), 1:100,000 (USDI Geoloical Survey, scale metric topographical), and a variety of other map bases at similar scales. Smaller scale maps, like the USGS 1:250,000 maps, are used in areas where large areas are quickly covered and have few or no other maps available. This occurs in places like Alaska and Canada. A customized map base, primarily for the the use of aerial surveys, has been talked about for decades, but due to the expense and challenges of covering more than National Forest land, little has been attempted. The best maps for aerial survey include; good drainage definition, major land features, such as mountain tops, modern civilization structures easily seen from the air, grass-tree mosaic, water, and major highways. Often, too much detail only detracts from the observer's ability to place the polygon on the map.

Mission Planning

Cost effectiveness

Experience is the best tool for planning an aerial survey mission. An observer who has flown the same area for several years automatically decides where to stay overnight, which area will be flown first, how much area can be flown in one flight, which airfield to go to for fuel and when is it cost effective to stay overnight out of town. A primary consideration when planning an aerial survey is the cost of the airplane per hour versus the cost of per diem for the crew. When the cost of ferry time back to the home base is greater than per diem costs for the crew, generally it is cost effective to stay out of town. This consideration should be made on a daily and weekly basis. Ferry time to a survey area should be kept to a minimum, since it is aircraft time costs that do not contribute to the actual aerial survey. The ideal survey day requires little to no ferry (or deadhead) time. But since most surveys are done at a Regional level, this isn't possible.

Appropriate airfields

Another important aspect to mission planning is knowing all the appropriate airfields. Most survey days include a mid-day break for lunch and fuel. Again, ferry time for fuel or lunch can be time and dollar consuming. Planning each day to include the best place to go for fuel is good management. If the crew brings a lunch, fuel is the only concern. The observer should include the pilot in mission planning, since the pilot is usually very familiar with fuel needs and ferry times. Different Regions have different policies on which airfields are approved for landings. Many smaller, unpaved airfields require back country certification for pilots. Be familiar with each pilot's agency certification.

Ground transportation

Know before landing at an airfield what type of ground transportation is available. Some forms of ground transportation include commercial rental cars, agency loaner vehicles, taxis, motel shuttles or agency personnel to provide a ride from the airport. It is best to make arrangements before your arrival since the summer months are busy and rental cars may be unavailable without reservations.

Communication considerations

Always carry with you a list of all available radio frequencies that you may possibly need. It is a good idea to have a list of not only the agency flight following radio frequencies, but also other agency local frequencies, including other federal, state and law enforcement agencies. Always carry a list of phone numbers of all people you may need to contact. It is not uncommon to lose radio contact, be forced to land and call the dispatcher flight following you. A 5-watt portable, hand-held programmable radio is recommended as a back up.

Final Safety Comments

Make sure you have the appropriate aircraft for the planned mission. An underpowered airplane in the mountains is a major safety consern. Understand density altitude and how it effects your airplane. Fly low only when flying in a direction that has an escape route, like down a drainage. Never fly below 500 feet above ground level. Be aware of and understand wind turbulence in mountain flying.

Protect your hearing. Hearing loss is common with long time aerial observers. Don't let it happen to you. Always where noise attenuating headsets that seal well and are rated for approximately 24 decibels. If headsets are not available be sure to use ear plugs.

Sunglasses are an important safety item as well as a color enhancement tool. Sunglasses, first protect your eyes from bright sunlight and help reduce eye and body fatigue. A good amber to red tint can provide the observer greater contrast between green live trees and red dead trees or foliage. Sunglasses should not be so dark as to hamper the observer's ability to read the map in the cockpit of the airplane.

Weather plays a large part in the daily aerial survey operations. Weather can be and is usually the cause of changes in plans. Being flexible to complete aerial surveys is a known aspect of the job. One way to help yourself be flexible, is to always carry enough additional personal items on the plane to keep yourself comfortable when you find yourself forced to spend the night in some unscheduled town, airfield or pasture. Survival is more than just an extra tooth brush.

Never fly an aerial survey mission without proper training. Low level, aerial reconnaissance flying requires serious attention to details and should never be taken lightly. Yet, it is an excellent, cost effective method to observe forest disturbances. If all aviation safety considerations are followed, a safe aerial survey mission can be accomplished. The best way to learn how to conduct safe and effective aerial surveys is to be trained on the job by a senior observer, who has several years experience. This mentor program has been used for the past forty years, since no formal training has ever been offered.

Acknowledgements

Thanks to the mentoring of senior observer Tommy F. Gregg, during the late 1970's in the Pacific Northwest Region, I was able to understand the importance of the aerial survey mission, its daily challenges to the observer and catch his infectious enthusiasm to capture on a map what can be seen from the air. Tommy says, "Fly low and slow and don't miss anything".

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PEST/HOST INTERACTIONS AND FPM/A&FM INTERACTIONS

David R. Bridgwater

Forest Insects and Diseases, Natural Resources,
USDA Forest Service, Portland, Oregon 97208

Pest/Host Interactions

During an aerial insect detection survey, we normally, in a broad sense, find trees effected by insects, diseases, animals and abiotic factors. Trees effected by insects can generally be subdivided into bark beetles and defoliators. However, defoliation can be caused by not only our typical defoliators such as spruce budworm or tussock moth, but also by sucking insects that result in defoliation or mortality.

It is my opinion that bark beetles preferentially attack trees that are in a weakened condition. The cause of this weakened condition can be many factors or a combination of factors. Stand over stocking, drought, root disease, lightning, defoliation, soil compaction, and mechanical damage are some of the factors that can make a tree susceptible to bark beetle attack. When bark beetles successfully attack a tree, most produce a population aggregating pheromone. This chemical, or mix of chemicals, draws other bark beetles to the tree. When the number of attacks on a tree is high enough, a switching occurs, and the beetles start attacking adjacent trees, in some cases overwhelming a normally resistant tree. This action is what produces beetle spots of mortality that can involve a few trees or cover much larger areas. As the beetles enter the tree, many of them passively carry a fungi that infects the trees and blocks off the trees' conductive tissue. This, combined with the girdling effect of the beetles and/or their larvae feeding in the cambium, results in rapid tree death. This usually causes the crown to fade within 1 year. Other organisms such as root disease often kill a tree more slowly.

The classical defoliators consume the foliage, imparting an off-color to the trees or change in texture of the canopy caused by the lack of foliage. The foliage consumed can be just the new foliage, just the old foliage or both. This feeding reduces the photosynthetic ability of the tree and can result in growth loss, top-kill and mortality depending on the level of defoliation and its duration. Defoliated trees are also much more susceptible to other organisms such as bark beetles. Dry weather patterns may help defoliators by providing a more favorable climate for their larvae to grow, and some have speculated that periods of drought result in a change in the chemical composition of the leaves thereby making the leaves a better food source.

The sucking insects also cause a type of defoliation. In some cases, better growing trees are preferred as hosts. These insects suck the plant juices out of the trees. This results in an over-all weakening of the tree either by loss of plant juices, leaves being damaged to the point they stop photosynthesis and fall from the tree, or the tree's response to the feeding injury. And, can result in total defoliation, growth loss, or mortality.

Animal damage is usually the result of animals stripping the bark from trees and feeding on the cambium layer. While this can result in the tree being infested by other organisms, death is usually rapid and caused by the girdling of the tree as a result of feeding.

FPM/A&FM Interactions

The aviation programs in our land management agencies were developed primarily in response to the ever increasing use of aircraft to combat fires. As a result, most of the policies and regulations were developed to meet concerns raised by this type of activity. Other aircraft uses were either not considered or were given much less priority because of the perceived minor use of aircraft for other activities.

We, the other users of aircraft, have been fighting an up-hill battle to gain recognition as other significant aerial programs. In the Pacific Northwest Region, we have made tremendous strides. We have a person designated as a Forest Pest Management Aviation Officer. This person operates in the same manner as a Forest Aviation Officer. Some of the improvement in the relationships include:

> the Regional Aviation Staff operates more closely with us and our State cooperators than in the past,
>
> the Forest Aviation Officer is more aware of our activity,
>
> field dispatchers better understand our flight mission and why we are there,
>
> a better tie-in with airspace coordination,
>
> increased safety awareness on our part,
>
> increased input into our contracting by the Aviation Group to help us obtain the aircraft best suited to our mission,
>
> improved networking with the Forest Service aviation community which increased our knowledge of other activities and news items which may pertain to our missions.

All of this helps to have a more efficient, effective and safe aerial survey.

SOUTHWEST REGION FOREST PEST MANAGEMENT GIS SUMMARY

Michelle Frank

***Forest Pest Management, Arizona Zone Office, Southwest Region,
USDA Forest Service, Southwest Forest Sciences Complex,
Flagstaff, Arizona 86001***

At this time, May 1994, the Southwest Region (R-3) GIS capability resides in the Arizona Zone only and the New Mexico Zone hopes to have GIS in the near future.

Personnel and Responsibilities:

1 GS-404-09; Program Manager/Data capture/Analysis/Products
1 GS-404-04 or -05 (03 months/year); Data capture/Analysis/Products

Hardware and Software:

- Most data is digitized using a backlit Summagraphics Microgrid II digitizer.
- LTPlus is run on a generic 386 personal computer with 2 hard drives, and a Bernoulli drive.
- An HP Draftmaster RX Plus plotter is used for creating map products.
- LTPlus version 2.36 is used for digitizing pest polygons.
- Arc/Info is used for analysis. We are cooperating with the Arizona State Land Department to produce the maps and conduct the analysis on their system using Arc/Info. This effort provides the State with the Federal lands pest information and FPM is able to analyze and share data with the State.

Current GIS Projects:

- Annual aerial detection survey - current year's as well as backlog.
  Current goal is to automate data back to 1974. This covers the Arizona Zone area only.
- We have discussed automating our permanent plot locations.
- The Arizona Zone is working in cooperation with the Rocky Mountain Station to automate watershed data for a project in Tapalpa, Mexico. This will include digitizing and scanning information from maps/surveys, as well as assistance with videography.

Spatial Data Layers available:

- Annual aerial detection survey data for 1988-1993.

Discussion:

Approximately 99 percent of R-3 FPM (Arizona Zone) GIS time is used for aerial detection survey data. We provide hard copy maps as well as electronic data to be used in forest planning, etc.

Over the last 18 months FPM has been working with the Regional office GIS data standards group to develop regional standards and provide review. R-3 FPM has GIS data standards in place.

INTERMOUNTAIN REGION FOREST PEST MANAGEMENT GIS OPERATION

Richard L. Halsey

Forest Pest Management, Boise Field Office, Intermountain Region,
USDA Forest Service, Boise, Idaho 84403

Personnel

Boise Field Office:

Joy Roberts - Computer Analyst/Programmer

GIS coordinator: oversees hardware/software configuration/maintenance/replacement for all State & Private Forestry and FPM computers in Region 4; performs analysis and prepares maps on a project level.

Dick Halsey - Biological Technician

GIS system manager; maintains hardware/software for GIS computers at the Boise Field Office; oversees all aerial detection survey GIS related activities; prepares maps and performs some analysis on a project level.

Ogden Field Office:

Dawn Hansen - Entomologist

Prepares maps and performs some analysis on a project level.

Valerie DeBlander - Forestry Technician

Prepares maps and performs some analysis on a project level.

Hardware/Software:

Boise Field Office

Data General Aviion 410 workstation w/32mg ram	Used for digitizing
DG UNIX 5.4R-3.00	primary data storage
Arc/Info 6.2	special projects
PC 386/33 w/4mg ram	Used for editing and plotting
MS DOS 5.0, Windows 3.1	secondary data storage
PC-Arc/Info 3.41	special projects
PC-Arcview 1.0	documentation
Calcomp 9100 digitizer	All peripherals can be
HP 7595A DraftmasterI 8 pen plotter	operated by either computer
HP Laserjet III printer	
Epson EX1000 dot matrix printer	
Airborne Video Camera system	Being evaluated

Ogden Field Office Currently uses Regional Office equipment for GIS related activities.

GIS Activities within FPM:

Aerial Detection Survey(ADS):

FPM prepares about 350 maps with current ADS information for annual distribution. In addition we prepare about 100 additional maps tailored to specific user requests, and distribute digital data to 6 forests and a number of private and state organizations. We tabulate and summarize all ADS information for Regional and National reports. We also have over 30 years of hard copy ADS maps that are gradually being converted to digital format and made available for distribution and analysis.

Special Projects:

Projects that FPM has been, or is currently involved with include preparing trap location maps for a cooperative gypsy moth program with Russia, and preparing maps to summarize and display data for the gypsy moth program in Utah; providing ADS and GIS training to two individuals from the Peoples' Republic of China in a United Nations cooperative agreement; evaluating GPS and airborne video technology to see how they might fit in to our survey program and GIS; preparing maps for biological evaluations and reports; and to make pest overlay maps to show insect trends.

Metadata:

FPM participates as a member of the Idaho Geographic Information Advisory Committee-metadata subcommittee developing metadata standards for GIS users in Idaho and is currently updating existing ADS digital coverage's to meet these standards.

GIS Activities outside of FPM:

Virtually all forests in Region 4 have some type of GIS equipment and are using it for a variety of activities some of which are insect and disease related. The Caribou NF has hazard rated some of their timber stands using GIS with information provided by FPM. Forests which have some digital ADS information include the Boise NF, who is using the data and evaluating the need for revising their forest plan; the Payette NF, who will use the information to hazard rate some of their timber stands; the Wasatch-Cache NF, Manti-La Sal NF, and Dixie NF, who have digital data but are not known to be actively using it at the present time; and the Targhee NF who is just beginning to receive digital ADS information.

Insect & Disease standards:

Insect and disease standards follow this, used with stand inventory in Region 4. Insect and disease codes used by ADS have finer divisions and have been used by FPM since the early eighties with few modifications.

Boise Field Office

1750 Front St., Rm 202
Boise, Idaho 83702
(208) 364-4220
DG (R04F02A)

Ogden Field Office

4746 S. 1900 E.
Ogden, Utah 84403
(801) 476-9720
DG: (S22L02A)

PACIFIC SOUTHWEST REGION FOREST PEST MANAGEMENT GIS SUMMARY

Sheri L. Smith

Forest Pest Management, Lassen National Forest,
USDA Forest Service, Susanville, California 96130

Personnel and Responsibilities:

The Pacific Southwest Region (R-5) FPM has no personnel dedicated to GIS. Efforts are underway to obtain a half-time position to be shared with the remote sensing lab in Sacramento.

Hardware and Software:

Data Capture for aerial surveys is conducted at the Forest level
- Most data is digitized or scanned
- LTPlus is run on a PC

Data Manipulation and product generation
- DWRIS - run on DG.
- MOSS - run on DG.

Current GIS Projects:

Annual aerial detection survey
- 1992 - 1 National Forest
- 1993 - 4 National Forests
- 1994 - 10 National Forests

Current contract with Pacific Meridian Resources to produce GIS maps for the following insects and pathogens. Maps will be in MOSS, ARC/INFO and hard copy.

Detection maps	Black stain root disease
	Eucalyptus long-horned borer
	Pitch canker
	Gypsy moth
	Dutch elm disease
	Port Orford cedar root disease
	White pine blister rust

Historical defoliator outbreak areas

- Pandora moth
- Douglas-fir tussock moth
- Lodgepole needleminer
- Modoc budworm

Plot location maps

- Ozone monitoring stations
- Ozone damage trend plots

Spatial Data Layers available:

Annual aerial detection survey - 1991-1993.
All above mentioned maps when contract is completed.
Port orford cedar and *Phytophora lateralis* occurrences in R-5 and R-6.

Discussion:

R-5 I&D standards are in place for the aerial surveys. Other standards are being developed under the GIS contract.

PACIFIC NORTHWEST REGION FOREST INSECTS AND DISEASES GIS SUMMARY

Julie L. Johnson

Forest Insects and Diseases, Natural Resources,
USDA Forest Service, Portland, Oregon 97208

Personnel and Responsibilities:

1 GS-460-11; GIS Coordinator/Program Manager/Analysis/Products

1 GS-404-07 (10 months/year); Data capture/Analysis/Products

Hardware and Software:

Data Capture

Most data is scanned using a borrowed scanner and LDScan software.

LTPlus is run on a Gateway 2000 486/33.

Altek digitizer.

Data Manipulation and product generation

Arc/Info 6.1.2-run on an IBM X-terminal LAN'ed to an IBM workstation.

MOSS - run on the DG.

R-6MAP - run on the DG.

Plots generated in both Arc/Info and MOSS. Plots generated in Arc/Info are plotted on an electrostatic plotter; plots generated in MOSS and R-6MAP are plotted on an HP draftmaster.

Current GIS Data Automation and Analysis Projects:

Annual aerial detection survey - current year's as well as backlog.

Current goal is to automate data back to 1970 (hard copy map data is available all the way back to 1947 for R-6) - regional coverage.

Dwarf mistletoe plot locations - forest coverage

Root disease surveys - forest coverage.

Change detection using satellite imagery and testing the Most Similiar Neighbor method to determine causal agent(s) for damage identified with the change detection process. This is a proposed project for FY 95 - district coverage.

Douglas-fir Tussock Moth trap locations - regional coverage.

Western Spruce Budworm spray effectiveness analysis - using aerial survey data and spray project boundaries - regional analysis.

Spatial Data Layers available:

Annual aerial detection survey data for 1980-1993.
Spruce Budworm spray project analysis areas for 1980-1992.
Port orford cedar and *Phytophora lateralis* occurrences in R-5 and R-6.

Discussion:

Approximately 65 percent of R-6 FID GIS use is focused on the automation, manipulation and transfer of the annual aerial detection survey data. This is our most complete and extensive data set and it is used by many agencies throughout the Region.

The other 35 percent of our time is spent on the more project-oriented uses listed above.

R-6 I&D standards have been in place for 4 years, but they are still only Regional standards. We are hoping to incorporate and/or move to national standards when they are in place.

SOUTHERN REGION FOREST HEALTH ANALYSIS TEAM AND GIS DATABASE INFORMATION

Theresa Valentine *

Forest Health Analysis Team, Southern Region, USDA Forest Service, Atlanta, Georgia 30367

Personnel and Responsibilities:

Regional Office:	*R08A*	*404-347-2961*
Dan Brown		Pathology Group Leader
Theresa Valentine		Forest Health Analytical Biologist GS12
Chris Kahle		Cartographic Technician GS7 3/4 time
Michelle Morrison		Cartographic Technician GS5 1/2 time
Vacant position		Forest Health Analytical Biologist GS11
Ashville Field Office:	*S29A*	*704-257-4843*
Brian Spears (50 percent)		Forest Health Analytical Biologist GS12
Don Tweed		GIS Specialist
Steve Covington		Biological Technician
Alexandria Field Office:	*R08F06A*	*318-473-7286*
Doug Rubel		Forest Health Analytical Biologist GS9

Hardware and Software:

Regional office:

Data General MV15000 mini computer running ARC/INFO version 5.0. Calcomp electrostatic plotter, two PC's capable of running PC ARC/INFO, digitizer, and numerous graphics terminals.

Field offices:

Both field offices have PCs to run the GypsES program (gypsy moth expert system). This system uses GRASS. Both field offices have Sun workstations and ARC/INFO version 6.1.

Both field offices have been using the MIPS system with aerial videography projects.

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* Theresa Valentine has since become the GIS Adminstrator for the Oregon State Service Center for Geographic Information Systems, Salem, Oregon 97310.

Current GIS Projects:

Publications:

FHAT is working on three publications scheduled for release this fiscal year. Topics are data preparation, FHAT awareness, and Forest Health in the South.

Gypsy Moth:

Suppression projects are happening in Arkansas, Virginia, North Carolina, and Tennessee. GIS has been used for the preparation of contract specifications, EA preparation, public meetings, and project planning.

FHAT is analyzing data for the National Gypsy moth EIS. We are analyzing spray blocks over several years in Virginia.

Southern Pine Beetle:

The Southern Pine Beetle Demonstration project is wrapping up and FHAT will be providing analysis for the final report. Twelve products have been defined ranging from risk assessment to animation of spots over time.

Forest Health Monitoring.

Documentation of the atlas layers is underway for inclusion in the Forest Health publication (data covers the R8). Enclosed is a list of data available for the Southern Region.

Ashville field office is working on Slow the Spread Gypsy Moth, Gypsy Moth suppression, Southern Pine Beetle, Gypsy Moth eradication projects in Tennessee and North Carolina, and other minor projects.

The Alexandria field office is working with the INFORMS-Region8 expert system, SPBIX (Southern Pine Beetle expert system), and IPM Decision Key. They also work with MIPS and ADRISI for the integration of aerial videography and GIS.

Discussion:

Emphasis on project work has shifted from the Regional Office to the field units. RO role will be to coordinate activities in the field and maintain the Forest Health Atlas. RO is working on some projects until field offices are fully operational and to finish projects like the Southern Pine Beetle Demonstration Project report.

FHAT is scheduled to be a pilot unit for project 615. At that time, hardware and software will be updated.

We expect the role of FHAT in Forest Health Monitoring to increase over the next year. As we acquire project 615 equipment, we will move toward helping others have access to forest health data (states, other federal, counties, private cooperators).

Information in the Southern Region Forest Health GIS Database

Gypsy Moth

Defoliation in VA, WV	1984 - 1993
Mortality in VA	1992
Spray blocks in VA, WV, AR, GA	1986 - 1993
Male moth trap catch	1988 - 1993 (for specific eradication projects)
Egg mass surveys	(for specific eradication projects)
Fall cankerworm defoliation	select years in VA

Southern Pine Beetle (SPB) Demonstration Area Project

SPB spots	1988 - 1993 (Oconee & Homochitto NFs)
SPB hazard rating	1988, 1989, and comparison by stand

Red-cockaded woodpecker colony sites and habitat areas in select NFs

Spruce-Fir

Mortality	Transportation	Ownership
Disturbance history	Drainages	
Study plot locations	Elevation	

Forest Health Atlas

Forests

Forest distribution in the Southeast by county; 22 forest types in cubic feet/acre

SAF forest types in the US

Pests & Diseases

County occurrence data for:

Dogwood anthracnose	1986 - 1993
SPB	1960 - 1993
Littleleaf disease	historical occurrence, 1951 survey
Fusiform rust	1977 and 1987 surveys
Butternut canker	occurrence
Hemlock woolly adelgid	

Oak decline plot data for the Southeast (points)

Root rot hazard, attached to corresponding soils

Littleleaf disease, attached to corresponding soils

Soils

State soil association maps; need to acquire STATSGO data from Soil Conservation Service.

Ozone

Seven hour average by month | April - October 1978 - 1990
Kriged data for the Southeast

Weather

Data from 1951 - 1984, being updated to 1990. Includes all of the Southeast except western OK and TX and northern KY and VA.

Acquire *National Forest* data from the National Forests.

NORTHEASTERN AREA FOREST HEALTH PROTECTION GIS SUMMARY

Susan J. DeLost

Forest Health Protection, Northeastern Area,
USDA Forest Service, Morgantown, West Virginia 26505

Personnel and Responsibilities:

The GIS responsibilities for Forest Health Protection (known as Forest Pest Management in other areas of the country) in the Northeastern Area (NA) are shared among the three field offices:

1. Morgantown, WV (MFO)	1 Cartographer (GS-1370-11) NA FHP GIS Coordinator
	1 Computer Assistant (GS-335-07) (25 percent GIS)
2. St. Paul, MN (SPFO)	1 Computer Assistant (GS-335-08)
3. Durham, NH (DFO)	1 Forester (GS-460-11)
	1 Biologist (GS-401-09)

We all have responsibilities for data capture, analysis, and product generation. The Northeastern Area is comprised of 20 states and the District of Columbia. Each field office has an area of responsibility that covers several states near the field office. The Durham office's area covers Maine, New Hampshire, Vermont, Connecticut, Rhode Island, Massachusetts, and New York. Morgantown's area covers New Jersey, Delaware, Maryland, Pennsylvania, West Virginia, and Ohio; and St. Paul's area covers Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, and Missouri. Within each area of responsibility, field office employees interact with the state cooperators; National Forest personnel and counterparts at other federal sites in providing support for pest identification and suppression programs and more recently with forest health programs.

Hardware and Software:

Data Capture

Gypsy moth and other pest data is digitized using ARC/INFO or pcARC/INFO; some data is obtained in digital format from our state cooperators; base information is obtained from USGS DLG files or other sources. Each site has a large format Calcomp digitizing board.

Data Manipulation and product generation

Each site runs ARC/INFO on:

a. Morgantown, WV: Hewlett-Packard series 9000 model 705 workstation with 64MB RAM and 3.0GB of storage; 4mm DAT cartridge; CD-ROM; 1/4" QIC tape drive. Output devices: Calcomp Colorview Thermal Wax 300 dpi plotter (11" by 17") and Calcomp Model 1023 8-pen plotter (24" by 36").

b. St. Paul, MN: Hewlett-Packard workstation as above, minus the QIC drive. Output devices: Calcomp Postscript Thermal Wax plotter (8-1/2" by 11") and Calcomp model 1023 8-pen plotter (24" by 36").

c. Durham, NH: SUN Sparc 2 workstation with 64MB system memory and 2.0GB of storage; CD-ROM; 1/4" QIC tape drive. Output devices: Calcomp model 1043 8-pen plotter and Hewlett-Packard DesignJet 650C plotter.

Current GIS Projects:

Produce maps for the Northeastern Area Forest Health Report (1991, 1992, 1993 - in work) in support of the Forest Health Monitoring Program

Incorporate incidence data by county into GIS for larger pine shoot beetle, hemlock looper, hemlock wooly adelgid, spruce budworm, gypsy moth, ash yellows, beech bark disease, butternut canker, forest tent caterpillar, and dogwood anthracnose

Goal is to collect and incorporate damage data in areas surveyed where damage is greater than 5,000 acres (will be recorded as polygonal data). Data to be recorded on 1:100,000 scale or larger maps:

- acquire base information for other federal sites,

- incorporate gypsy moth and hemlock looper defoliation data from aerial surveys into GIS,

- assist state cooperators in implementing GIS in pest management and forest health programs,

- provide GIS support for pest suppression activities on Native American lands,

- evaluating usefulness of MIPS (Map and Image Processing System) software to process aerial videography,

- acquire other relevant data such as: soils, weather, and forest cover type (AVHRR data),

- continue to support North American Maple Project (NAMP) - DFO,

- digitize Ecomap Section and Sub-section delineations as defined by a working group comprised of Forest Resource Management and Research units and outside cooperators.

Spatial Data Layers available:

Major Forest Cover Types of the conterminous U.S. - from Eyre, 1980. Society of American Foresters. Digitized version produced in 1989 by S.H. Azevedo, Forest Ozone Team, USEPA Environmental Research Lab, Corvallis, Oregon. Scale of source: 1:7,500,000.

Forest pest data on a county-level basis for 20 Northeastern Area states for 1991, 1992, and 1993 (in-work).

Native tree species range information within the NA for:

Eastern Hemlock
Spruce-Fir
American Chestnut
Sugar Maple
American Beech
Butternut
Flowering Dogwood

Tree species range map information was digitized from Silvics of North America, Volumes 1 and 2 (Burns 1990).

Data for National Forests at 1:100,000 scale in the SPFO area (includes: roads, water, boundaries, sections, gypsy moth trap data, forest type).

State and county boundaries at 1:2,000,000 scale from USGS DLG data (does not include Alaska or Hawaii).

Discussion:

The NA FHP GIS Team meets several times each year to discuss GIS projects of common concern (e.g., the NA Forest Health Report); data standards; and implementation issues.

In October 1993, the NA FHP GIS Team met with the Region 9 GIS Coordinating Committee for the first time. We met to identify common needs and areas of common interest. This was necessary because, unlike other areas of the country, there has not been a strong link between the National Forests and State and Private Forestry. The Northeastern Area and Region 9, which encompass roughly the same area, function independently of each other in most cases. In the area of GIS implementation, we felt a need to communicate and coordinate in a proactive manner.

Some data collection and reporting standards are being developed by the Forest Health Team. We plan to move to national standards when they are developed.

UPDATE ON CURRENT GIS APPLICATIONS IN THE METHODS APPLICATION GROUP

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The Methods Application Group (MAG) has been working on a variety of GIS-related projects, including the following:

Computer-Aided Classification of Forest Stand Cover Types from Airborne Video Imagery

MAG flew an airborne video mission for the Nez Perce National Forest in 1992 to acquire true-color imagery at a 1-mile swath width for use in exploring issues such as range allotment and analysis, noxious weeds, pest defoliation, and land ownership in riparian areas. Forest staff were interested in assessing the usefulness of video imagery in computer-aided classification of forest stand cover types.

An area was selected for which a stand map was available and stand data had been collected. The stand map was digitized into Arc/Info. For this test, stands were lumped into four general categories. Video frames to cover the area were selected and captured with MIPS software. The frames were then georeferenced to a scanned orthophoto quad, warped, and mosaicked using Erdas software to produce a single, rectified, digital image for the entire area.

Erdas was also used for the analysis and classification process. Color signatures for each of the stand classifications were extracted from the video imagery based on the stand map. Each color signature was analyzed to determine whether the spectral distributions between the known images were different enough to allow classification, and which band combinations would yield the best results.

Each pixel was examined independently, compared to class signatures, and assigned to a class. Four different algorithms for classification were tested and the results evaluated.

The result was that there was little or no relationship between the classifications assigned to pixels and the class (stand) boundaries regardless of the algorithm used. The project team concluded that true color video imagery flown at a 1-mile swath width lacked sufficient spectral information to discern differences among the four cover types studied. This held true both over the entire area (five adjacent flight lines), and within single flight lines.

The methods and results are documented in a MAG in-house report, "Computer-Aided Classification of Forest Stand Cover Types from Airborne Video Imagery," by Jeanine LaFontaine Paschke and Lowell G. Lewis, dated March 22, 1994.

Use of an Airborne Video Camera System for Detecting and Mapping Gypsy Moth Defoliation

Three methods for the detection of gypsy moth defoliation were compared to evaluate their relative costs and accuracy. The study area under consideration was on the George Washington National Forest in Virginia. The three methods of detection were (1) aerial sketch mapping, (2) true color super VHS airborne video imagery at a 1¼-mile swath width, and (3) color infrared aerial photography.

The video imagery was interpreted for defoliation in three ways: (2A) The video tape was viewed in the office to allow sketch mapping to a 7.5 minute topographic map from a tape monitor. (2B) The second method was the same as the first except the defoliation was sketchmapped to an orthophotoquad rather than to a map. (2C) Video frames to provide full coverage of the area were selected, captured, georeferenced to a scanned orthophotoquad, warped, and mosaicked with MIPS software to produce a single rectified digital image for the entire area. This image was used in the office for on-screen digitizing.

The color infrared photographs were photo-interpreted for defoliation, and the results transferred to a 7.5 minute topographic map with a Zoom Transfer Scope. These results were used as the control against which the other methods were compared for accuracy. Arc/Info was used to digitize, analyze, and compare the results of the three methods relative to the control.

The best spatial accuracy was obtained with on-screen digitization (2C), followed by office sketch mapping to orthophotoquad (2B), followed by office sketch mapping to topo map (2A). Aerial sketch mapping was least accurate. With respect only to person-hours expended and photo processing costs, the costs of aerial sketch mapping and the two forms of office sketch mapping from video tape were relatively closely clustered, followed by color infrared photo-interpretation, followed by on-screen digitization. When the prorated costs of camera systems, computer hardware, and software were also considered, the methods ranked in the same order, but there was a greater difference in cost between aerial sketch mapping and the two forms of office sketch mapping.

The methods and results are documented in an as-yet unpublished paper entitled "Use of an Airborne Video Camera System for Detecting and Mapping Gypsy Moth Defoliation," by Brian M. Spears, Lowell Lewis, John R. Omer, Richard J. Myhre, and Robert E. Acciavatti. This paper is currently in draft form.

Spatial Rulebases on the Jessieville Ranger District

INFORMS-R8 (the Integrated Forest Resource Management System developed for use in Region 8) is an integrated decision support system that has been developed as part of a cooperative effort involving R8 Forest Pest Management, the National Forests in Texas, Texas A&M University, and Washington Office Forest Pest Management. INFORMS-R8 has recently been installed at a new pilot site--the Jessieville Ranger District on the Ouachita National Forest in Arkansas.

The Jessieville RD recently held a knowledge engineering session to identify knowledge about local conditions and the implementation of the forest plan for incorporation into rulebases. Rulebases have been in use on the Neches RD on the Davy Crockett National Forest in Texas for a few years in conjunction with

INFORMS-R8, but the Jessieville RD has added a new twist--some of the rulebases require spatial analysis that can be accomplished only through GIS.

The following are some examples of how spatial analysis can be used within rulebases for different purposes. (1) The need for road closures can be identified through examination of road densities on a compartment basis. (2) Foraging areas for a management indicator species (scarlet tanager) can be identified as contiguous areas that meet certain spatial requirements and share certain attributes. (3) Potential scenic viewpoints can be identified as points on trails and roads on slopes that meet certain criteria for length and steepness. (4) The survey intensity needed to identify potential cultural sites over large project areas can be assigned on a local level by proximity to water, slope, aspect, and other land features.

The rulebases are uncompiled text files containing rules that represent knowledge about analyzing or evaluating situations. They are interpreted and processed by software called CLIPS (C Language Integrated Production System), a public domain expert system developed by NASA. CLIPS has been modified by the STARR (Systems Technology And Renewable Resource) Lab at Texas A&M University, and incorporated into INFORMS-R8. The modifications added functions that can be called from within the rulebases to access data stored in the Oracle relational database management system, and can run and access the results from Arc/Info AMLs.

For example, in searching for potential foraging areas for the scarlet tanager, the rulebase uses AMLs to locate areas that meet certain basal area and age requirements, occupy at least 250 contiguous acres, and are always at least ⅛-mile wide. The potential foraging areas are stored in a new coverage, which can later be displayed and used through INFORMS-R8. The Arc/Info DB Integrator is used to build an Oracle table that contains information that will be used by the rulebase to rate the forage potential of the areas meeting the spatial criteria.

For more information, contact Ron Perisho on the Jessieville RD or Steve Williams at MAG.

Technical Development Project for Forest Health and Ecosystem Management Planning

Region 1 FPM and MAG are involved in a new technical development project, entitled "Develop Methods for Assessing Forest Health for Ecosystem Management Planning." The purpose of the TDP is to develop methods to assess the role of insects and pathogens in forest succession, and describe how forests are likely to change as a result or in the absence of management activities. The results will be used to complete a Forest Health Assessment for the project area. The methods will be documented for use in further assessments in Region 1, and should be applicable in other Regions as well.

The first phase of the project will involve developing GIS and relational database representations of two sets of data available for the entire project area -- one from the 1930's and one from 1975. The two data sets will provide an opportunity for both spatial and temporal analysis of the effects of insects and pathogens in conjunction with vegetative characteristics on ecological succession.

The second phase of the project will build on the results of the first to answer the question, "What are the most likely pathways and timeframes for natural and human influenced changes in the landscape?"

The third phase of the project will be the production of a Forest Health Assessment through the use of the Forest Vegetation Simulator to predict landscape conditions for the next 100 years.

For more information contact Sue Hagle in the Northern Region Office in Missoula, Montana, or Steve Williams or Ross Pywell at MAG.

AIRBORNE VIDEO
WESTERN PERSPECTIVES

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Airborne videography is rapidly becoming popular in the western United States because of its ability to supply data in short time frames. Many natural areas of the western US are isolated enough that the feasibility of continually conducting or monitoring on plot surveys is difficult. Non traditional methods of data acquisition, such as airborne videography, offer timeliness, affordability, and accuracy that land managers can incorporate into GIS (Lachowski et al. 1992).

The new found popularity airborne videography is experiencing in the west in all disciplines can, to an extent, be contributed to the pioneering efforts in the field by the Methods Application Group (MAG) in Fort Collins. The consolidated procurement package features a simple but complete operational system for the Forest Service and other natural resource agencies wishing a tested and standardized system. Since the USDA Forest Service, Forest Pest Management (FPM) group was a co-sponsor in the development of airborne videography, many of the western regional FPM offices were the first to acquire operational systems. Airborne video image acquisition began to validate the expectations for which it was developed.

1. It is relatively inexpensive to acquire imagery.

2. Imagery can be acquired quickly.

   A. Because no film development is needed, quick turn-around time is possible.

   B. A mission can be planned and executed at a moment's notice to meet unpredictable temporal events.

3. Inexperienced personnel can be readily trained in airborne video image acquisition.

4. Production of high-quality imagery for incorporation with GIS and "heads up" sketch mapping (Myhre 1992).

However, along with the expected benefits we've discovered that environmental factors existing in the west can offer the videographer some interesting challenges. Geographically, the west is typified by low, sweeping desert panoramas and eroded mesas to the forested peaks of the Rocky Mountains and the sky islands of the southwest. Landscape phenomenon, combined with weather, can provide some of the most challenging filming situations. Some of the common problems that create difficult filming conditions for small aircraft include orographic lifting, created when layers of air flow in response to pressure gradients are lifted up over mountains.

Convection encountered when low-lying desert floors heat during the daytime making surface air unstable and force air upwards. And convection summertime currents coupled with the importation in the upper atmosphere of moist air leading to sudden and rapid development of intense squalls and thunderstorms. These conditions cause buffetting which can lead to blurred or jittery imagery. Chronic atmospheric disturbances, such as these, generally cause the discontinuation of filming. Beginning the filming early in the morning before convection flows begin, or moving to the evening when convection flows subside are sometimes viable alternatives if it is the right time of the year. Generally, during fall to spring months filming opportunity windows are short because the sun's zenith is short lived. Most of the morning and evening hours are not useful as long, deep shadows are cast by trees, canyons, and any other relief on the landscape.

Due to the degree of variability in geophysical features, it is not uncommon to have a subject site that has wide elevation fluctuations. Subject matter can be spread over peaks 10,000 feet in elevation and into canyons as low as 4,000 feet elevation. Calculating the height above sea level (MSL) with focal lengths of lenses in mind almost precludes the use of one of the telephoto selections in conjunction with flying at altitudes requiring oxygen. Otherwise, the continually changing landscape beneath the plane fluctuates so wildly it is almost impossible to keep swath width (ground coverage) constant. Results are blurred imagery, gaps in coverage on sidelaps, difficulty in registering digital imagery to adjoining frames, and safety concerns for pilot and crew. Of course, flying at these altitudes any time of the year, and particularly in fall to spring months, it can become quite cold. Light aircraft heaters for the rear-most passengers are not noted for their efficiency. In order to address the possibility of having to film at upper altitudes, the Cessna 206 and 206 turbo, Cessna 207, Cessna 210, Queen air, and Partenavia Observer tend to be favored as videography aircraft.

With all the potential problems to overcome, the videographer must take special care in planning a mission taking into consideration the objectives of the mission, time of year, type of aircraft, weather, pilot experience with mapping missions, and terrain. Planning should begin well ahead of the flight and should include maps identifying the subject area, flight lines plotted to reflect swath widths, flight altitudes, and directions. The mission and its objectives should be thoroughly reviewed with the pilot and maps made available for the crew. Flight following should be arranged in advance. Preflight equipment adjustments and checks should be performed. Special equipment for a particular mission should be secured (i.e., navigation camera and monitor for low-altitude flying of narrow swath widths, or oxygen tanks topped off in aircraft for a high-altitude flight). When all is ready and the pilot and crew thoroughly understand what is expected of them, still plan in extra time to allow for unexpected delays caused by weather.

Even with all the special precautions and planning, airborne videography continues to proliferate under the advantages it offers. Applications are becoming as varied as the imagination allows. Forest health monitoring and aerial detection survey validation continue to utilize airborne videography throughout the west. Assessment of damages to natural resources caused by disasters utilizing airborne videography is becoming more and more popular. Assessments of wildlife habitat along riparian areas and watershed stability projects are seeking benefits supplied by videography. New developments in technology will undoubtedly continue to enhance user friendliness and quality end product.

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REMOTE SENSING IN THE NORTHEASTERN AREA

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The Northeastern Area State and Private Forestry has been involved in the remote sensing field for many years. There are historical aerial sketchmaps, oblique aerial slides, and photos dating back to the 1950's. In recent years, the remote sensing programs of the three field offices in the Northeastern Area (St. Paul, MN, Durham, NH, and Morgantown, WV) have expanded to include large format aerial photography, vertical airborne S-VHS video, and MIPS image processing systems.

Large format aerial photography has been used successfully by the St. Paul field office since the early 1980's, and more recently by the Durham field office, for many pest-related applications. The 9" x 9" color infrared aerial photography has been successfully used as a tool in detecting oak wilt, oak decline, general oak mortality, ash yellows, saratoga spittlebug damage, hemlock mortality, flood damage, and tornado and storm damage. We have also used the 9" x 9" photography for urban tree surveys and wilderness forest health assessment. True color 9" x 9" photography has been used to detect oak wilt pockets, and recently to assess forest health monitoring plots.

The three Northeastern Area field offices also have true color super VHS airborne video systems which have been tested on various projects with varying degrees of success. The successful tests of the S-VHS video include the identification and mapping of gypsy moth defoliation, hemlock looper damage, documenting gypsy moth spray block success, assessing forest health conditions and assessing flood-caused mortality. Damage types that the video has been unsuccessful in capturing include jack pine budworm damage and oak wilt. These damage types can be detected using the airborne video system, but large-scale imagery necessitate narrow flight lines. Large-area blanket coverage becomes impractical. It has been our experience that the true color S-VHS airborne video system can be used for large-area blanket coverage only for detection of higher contrast pest damage such as gypsy moth defoliation and hemlock looper damage. Lower contrast damage like jack pine budworm can be captured, but only at such a large scale that blanket type coverage of large areas becomes impractical.

The most recent addition to the Northeastern Area's remote sensing capabilities is the MIPS image processing system. Each of the three field offices recently acquired the MIPS system which will allow us to digitally store and manipulate aerial video and photography as well as satellite data. This system should enhance our remote sensing capabilities in general and make our video system a much more practical and useful tool.

MORGANTOWN FIELD OFFICE AIRBORNE VIDEO PROGRAM

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Our office assists six states, the District of Columbia, three National Forests, and over 150 other federal sites (National Parks, Wildlife Refuges, National Monuments, military bases,...etc.) with their insect and disease problems. We provide aerial surveys, aerial photography and videography, and expertise with on-the-ground surveys and verification.

The aircraft I use most often for videography is a Piper Aztec. This plane provides an excellent combination of twin engine safety and speed, and affordable cost for operation. I primarily use an installed Loran Northstar unit for navigation, usually flying straight lines point-to-point.

I've used two methods for determining latitude and longitude for flight lines. The first and most often used method is simply working straight off a 7.5 minute topographic quadrangle. The second is using georeferenced maps in Arc View, and having the computer determine the coordinates.

Following are some examples of video missions I have flown, tornado swath tree regeneration, stream corridors for the Wild and Scenic River Program, tree mortality, crop tree release plot documentation, river ice cover (impact on bald eagle activity), and forest pest surveys--gypsy moth, elm spanworm, cherry scallop shell moth, hemlock wolly adelgid, and forest tent caterpillar.

SOUTHERN REGION AIRBORNE VIDEO SUMMARY

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For the past 3 years the Forest Health Field Office in Pineville, Louisiana has been using airborne video technology for southern pine beetle monitoring and spot detection in Texas, Arkansas, Louisiana and Alabama. We have been able to produce quality video imagery on hardcopy with the use of specialized software. Because of these results, our clients have expanded our use of video to include storm damage assessment, quality control checks of silvicultural practices for longleaf sites, aquatic weed encroachment on recreational lakes and monitoring of other pest damage in the Mississippi Delta and Atchafalaya Swamp in southern Louisiana, just to name a few.

Our state cooperators have expressed an interest in video and we are working together with them to develop a video mapping tool for use by the field forester.

Recently, we established a Geographical Information System (GIS) lab at the field office and are moving closer to integrating the two technologies together. With GIS and Global Positioning System (GPS) technologies, we are coming closer to building a strong, integrated program at the field office level.

We are in the process of testing a new software package together with special hardware that will enable us to produce a more accurate video product that has more precise geo-referencing capabilities, automatic video referencing to flight line position, automatic mosaicing using time encoded information and tip/tilt and roll correction capabilities. With this knowledge in hand, we will be able to significantly shorten the time needed to produce products for our clients. We are excited about the future of airborne video at this field office and Region and plan to improve our products and service in the future.

AERIAL DETECTION OF BLACK BEAR DAMAGE IN NORTHWEST ORGEON

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Introduction

In the Pacific Northwest, black bears damage conifers in the spring by peeling and eating the bark. When the entire circumference of the bole is peeled, the tree will die. Partial peeling can reduce the growth rate and vigor, introduce decay organisms, and also cause mortality if enough of the circumference is damaged. During 1988 and 1989, industrial landowners, federal land management agencies, and the Oregon Department of Forestry supported aerial surveys coupled with extensive ground sampling to define the extent and severity of bear damage on 2.4 million acres of forest land. The areas chosen for the project were the northern Coast Range and a low-elevation portion of the west-central Cascade Range. The following is a brief summary of the methods and findings of these surveys.

Methods

The aerial survey was flown at approximately 1,000 feet above the forest canopy in a twin engine Partenavia aircraft with a pilot and two observers. Average air speed was 90 miles per hour and survey lines were oriented north/south at 3-mile intervals. Potential locations of bear damage were based on the presence of foliage color indicating dead or dying trees. When observers detected dying trees, a figure or polygon was drawn on a map showing the location and number of damaged trees. Observers did not attempt to distinguish bear-damage trees from trees damaged by other agents. The 1988 aerial survey was flown in late September and October, while the 1989 survey was flown in June.

Ground surveys were conducted in both years to verify that polygons drawn by aerial surveyors contained bear damage and to measure the extent and severity of the damage. Sample polygons were randomly selected and data collected on the species, age, and size of trees as well as the percent of the circumference debarked. The 1989 ground survey sampled tree damage in polygons from an equal number of thinned and unthinned Douglas-fir stands.

Results

Timing of aerial surveys - Late May through June is the preferred time of year to detect bear damage with aerial surveys in western Oregon. During the fall surveys, aerial observers were hampered by a low sun angle and accompanying shadows. In addition, the fall foliage colors of hardwoods confounded the detection of bear damage in conifers.

Timing of bear damage and change in crown coloration - A majority of bear-damaged trees (those with red/brown foliage) detected by the aerial survey in June 1989 had been *completely* girdled in the spring of 1988. A small proportion of trees completely girdled in the spring of 1989 or 1987 also had red/brown foliage in June 1989. A June aerial survey for bear damage detects crown color changes from damage occurring over several years, but predominantly in the spring of the previous year.

Percent of polygons with bear damage - Of the 100 pologons ground-checked in 1988, 74 percent contained bear damage. In 1989, 147 polygons were ground-checked and 76 percent were found to contain bear damage.

Number of acres with bear damage - The average size of the 111 polygons ground checked for bear damage in 1989 was 30.57 acres (standard deviation = 43.3), and ranged from 1 to 280 acres. Assuming 76 percent of all polygons mapped contained bear damage, it was estimated that 1,593 polygons in the 2.4 million acre survey had bear damage. The total area represented by these polygons was 48,698 acres.

Bear damage in thinned vs. unthinned stands - Over the entire survey area, 79 percent of the polygons with bear damage were in thinned stands, and 72 percent of the polygons drawn in unthinned stands contained trees with bear damage. In the Coast Range, the proportion of polygons with bear damage was the same in thinned and unthinned areas. In the Cascades, however, 93 percent of the thinned polygons had bear damage, while only 44 percent of the unthinned polygons had bear damage.

Tree species preference by bears - Seven conifer and four hardwood species were represented in polygons containing bear damage. Douglas-fir was the most frequently damaged species. True firs, Sitka spruce, western hemlock and incense cedar showed some damage. Of four hardwood species examined, only red alder was occasionally damaged by bears.

Severity of damage on individual trees (percentage of bole circumference peeled) - Of 1,463 ground-checked conifers that were damaged by bears, one-third (33.2 percent) were completely peeled and two-thirds (66.8 percent) were partially peeled. For every tree killed by bears, two others were damaged.

Age class of bear-damaged trees - While bear damage occurred in nearly all age classes of trees, there was a clear concentration of damage in the 16- to 25-year age class. Bear damage was not found in trees less than 12 years old.

Diameter of bear-damaged trees - On the average, the diameter of bear-damaged trees was 2.7 inches larger than undamaged trees. The difference was significant at the .01 level. Bears apparently damage the fastest growing trees on the site.

A detailed discussion of the survey methods and results can be found in Forest Health Report No. 90-1, available from Forest Health Management, Oregon Department of Forestry, 2600 State Street, Salem, OR 97310.

OFF PLOT MONITORING

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The Environmental Protection Agency, in cooperation with other Federal and State Agencies, has developed a program to monitor the Nation's forest health. The primary information base will be gathered on fixed plots identified on a systematic grid covering the United States. A second level of monitoring will be data gathered off these plots. The "off plot" data can be compiled from any other information source, but they need to have a measure of accuracy. The aerial insect detection surveys that are flown each year have been proposed as one such source of data.

Each Region or group of States will develop their level of reporting accuracy, and confidence limits. It is anticipated that periodically each area will be expected to verify that these standards are being met. An example of how this could be accomplished would be to ground check a percentage of the polygons and compare the results to the aerial survey reporting data. While such quality assurance measurements would be expensive in both dollars and personnel, it is anticipated that funding for this activity would be provided by EPA, and would not be required until the funds are made available.

AERIAL SURVEYS: QUALITY, CREDIBILITY, VALUE - IS IT POSSIBLE?

Tim-McConnell

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Variability Between Sketchmappers

Duplicated Survey Flights

During the 1992 and 1993 field seasons in the Northern Region, three survey flights were duplicated over the same area. These duplications occurred because, (1) the area (125,000) on the western portion of the Priest River Ranger District, (the old Kaniksu National Forest) Idaho Panhandle National Forest is in Washington State and is surveyed by both the Northern Region and the Pacific Northwest Region, and (2) a portion (175,000 acres) of the Phillipsburg Ranger District, Deerlodge National Forest was surveyed 2 days in a row by different observers due to coverage miscommunication. All three of these duplications provided an opportunity to compare different observers' sketch maps of the same area, since they were done at nearly the same time and similar tree conditions should have existed. The terms sketchmapper and observer are used interchangeably in this paper.

Survey Map Processing

Each of these three pairs were digitized and the data summarized to make a comparison between the maps. The three pairs will be referred to as the 1992 Kaniksu, the 1993 Kaniksu and the 1993 Deerlodge. The spruce budworm polygons and the hail polygon were visited on the ground during routine follow-up ground checks. None of the polygons were ground checked to accurately determine which polygons were correct. This comparison is not to prove which observer made the right call, but to show two different data sets for the same survey area.

Map and Data Comparisons

After looking at the maps and the data tables, there appears to be a high degree of variation between the observers.

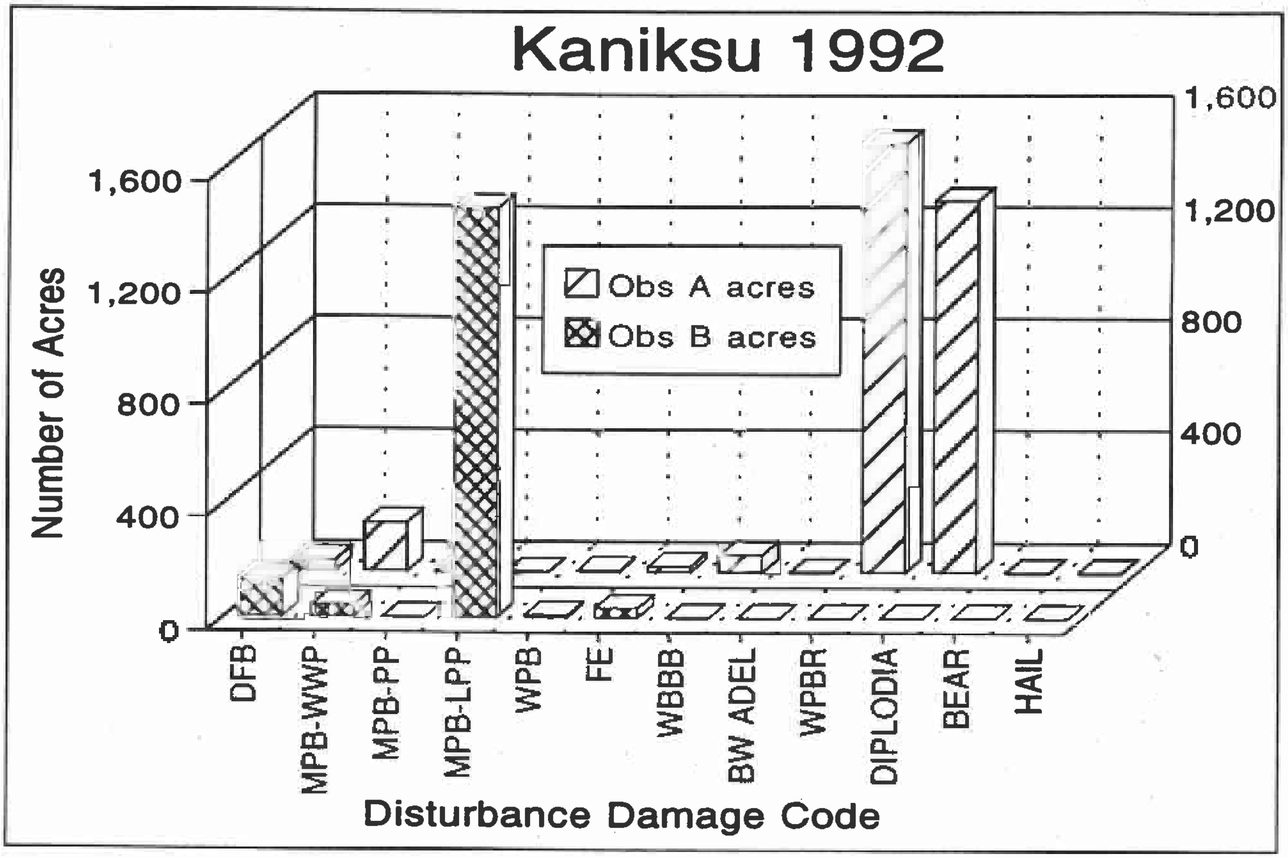
For the 1992 and 1993 Kaniksu, white pine blister rust and diplodia were either, not considered by Observer B or not observered by Observer B. It is possible that much damage was observed by both observers but given different attributes. To detect dead, mature western white pine and to determine if blister rust or mountain pine beetle was the primary tree killer from the air is at the least challenging.

For the 1993 Deerlodge, the primary difference was the occurrence of western spruce budworm defoliation on Observer B's map and no occurrence of western balsam bark beetle damage to subalpine fir. Subsequent ground checks of the budworm polygons showed that no 1993 defoliation occurred.

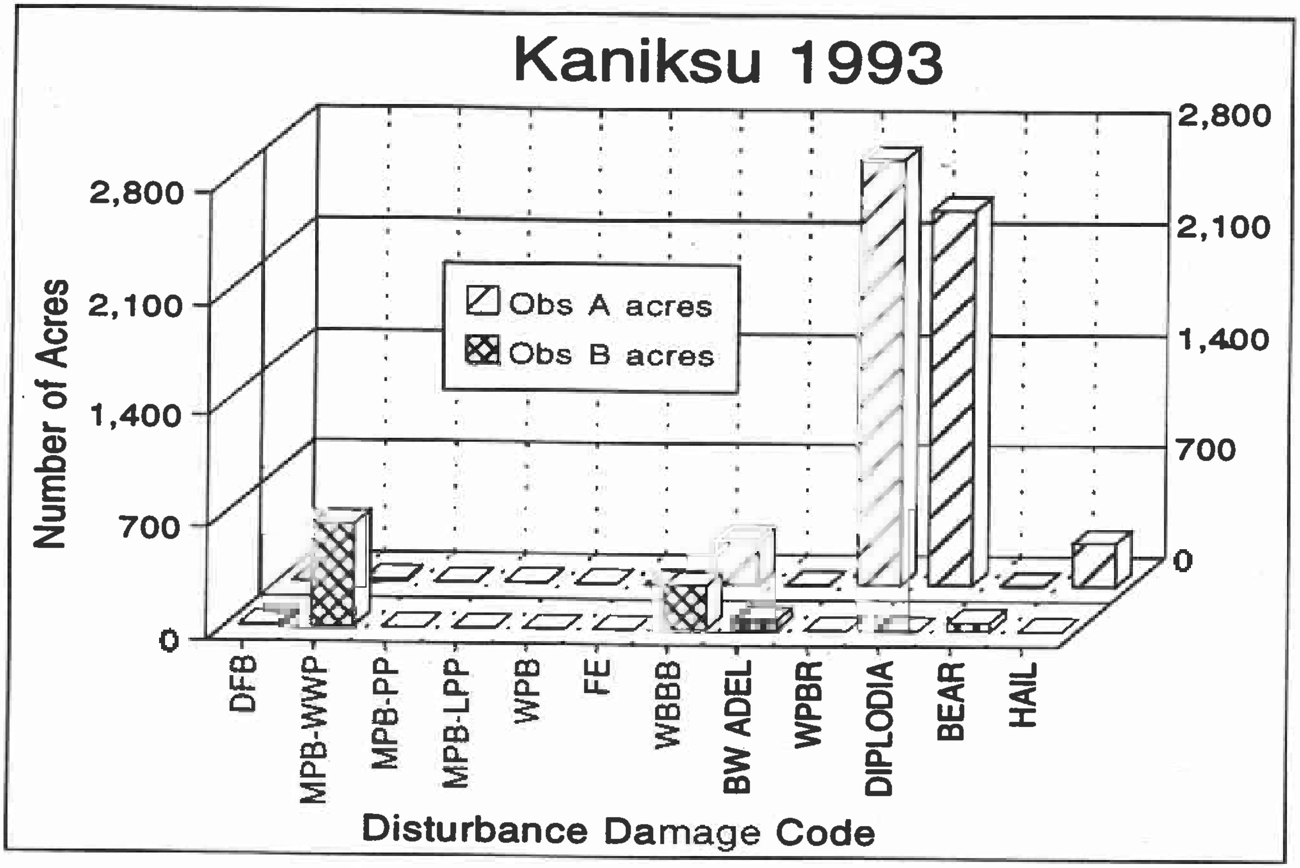
Survey Map Data Summary Tables

1992 Kaniksu

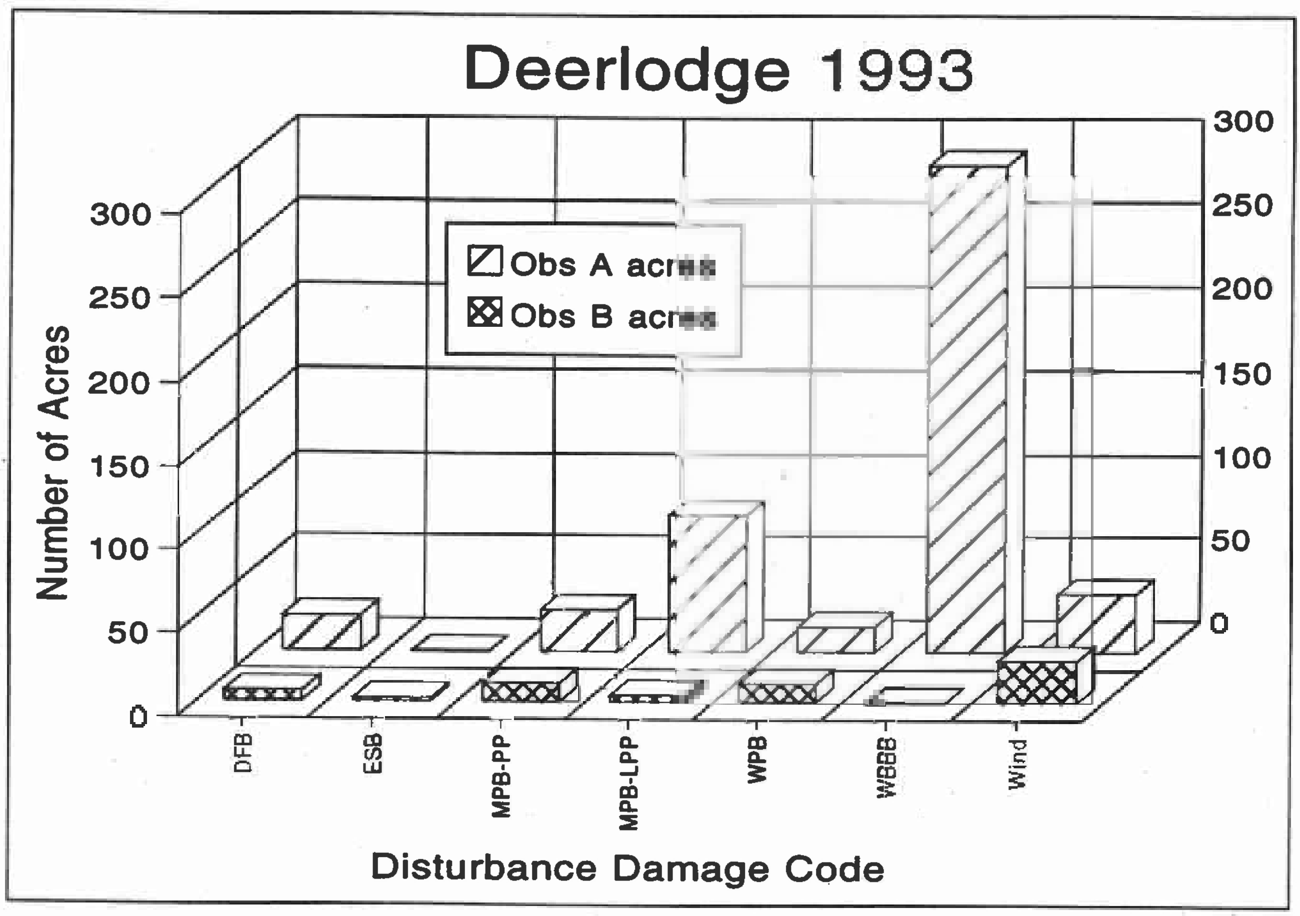
Code	Abbr.	Name	Observer A acres	Observer A trees	Observer B acres	Observer B trees
01	DFB	Douglas-fir beetle	38	42	132	70
04	MPB-WWP	Mtn pine beetle western white pine	171	102	40	55
06	MPB-LPP	Mtn pine beetle lodgepole pine	0	0	1457	1045
08	WPB	Western pine beetle	4	3	8	5
09	FE	Fir engraver	20	33	33	20
11	WBBB	Western balsam bark beetle (SAF)	60	85	0	0
50	WPBR	White pine blister rust	1532	0	0	0
68	DIP	Diplodia	1327	0	0	0



1993 Kaniksu			Observer A		Observer B	
Code	Abbr.	Name	acres	trees	acres	trees
01	DFB	Douglas-fir beetle	0	0	10	10
04	MPB-WWP	Mtn pine beetle Western white pine	13	27	635	445
05	MPB-PP	Mtn pine beetle Ponderosa pine	3	5	0	0
06	MPB-LPP	Mtn pine beetle Lodgepole pine	5	23	0	0
08	WPB	Western pine beetle	1	2	0	0
11	WBBB	Western balsam Bark beetle (SAF)	273	262	270	80
17	BWA	Balsam woolley adelgid	0	0	58	30
50	WPBR	White pine blister rust	2671	0	0	0
68	DIP	Diplodia	2355	0	0	0
-	HAIL	Hail damage	267	0	0	0
-	BEAR	Bear damge	0	0	51	30



1993 Deerlodge Code	Abbr.	Name	Observer A acres	Observer A trees	Observer B acres	Observer B trees
01	DFB	Douglas-fir beetle	21	36	6	8
02	ESB	Spruce beetle Engelmann	0	0	2	1
05	MPB-PP	Mtn pine beetle Ponderosa pine	25	24	11	12
06	MPB-LPP	Mtn pine beetle Lodgepole pine	82	136	4	3
08	WPB	Western pine beetle	15	8	11	7
11	WBBB	Western balsam bark beetle (SAF)	291	290	0	0
18	SBWL	Spruce budworm light defol.	0	0	5921	0
19	SBWM	Spruce budworm moderate defol.	0	0	10475	0
72	WIND	Wind throw	35	0	25	0



Sketchmapper Responsibility

Anyone with some aerial survey experience will tell you that every-day flying aerial survey is a humbling experience. It is no easy task to keep track of your exact location, communicate with the pilot so you are at the right altitude and in the best position for observation, detect and identify pest damage, count or estimate the number of trees, sketch the observation onto the survey map and code it, and continue to do this for 4 to 7 hours a day. But this is no excuse for not capturing the essence of the host/pest interaction in a particular drainage. A sketchmapper should do everything possible to ensure the best calls are being made, because no matter the aircraft, the flying height, the weather, the survey map base, the opportune biowindow, the survey is always going to be less than perfect.

Luxury for a survey flight is when the observer has personally been working in the outbreak area just prior to the flight. Occasionally this happens, but when each observer must cover millions of acres, this is the exception. Therefore, the observer must rely on (1) getting information from others that are on the ground, (2) flying the same area year after year to gain a sense of understanding of the elements of disturbance, (3) experience, both on the ground and aerial sketch mapping. Using past survey maps done by someone else may lead the new observer down the path of another observer's bias.

If an observer only flew one National Forest or area, the challenges of making the right call would be much easier than what many observers must do when surveying several eco-regions at less than the ideal bio-window. Still, the observer is responsible for their polygons and attributes.

Credibility comes from (1) not missing extensive damage, (2) getting the polygon in the right spot, (3) calling the tree (host) species correct, (4) knowing and calling the pest damage correctly, and (5) accurately estimating the number of trees.

Where's the value in a sketchmap that could possibly be way off the scale of acceptable accuracy? That may depend on the severity of the pest outbreak and to the intent the survey map is being used.

Aerial Survey Limitations

Understanding the limitations

The general annual aerial survey cannot be everything for everyone. Understanding how an aerial survey is conducted is important to the user of the map and data. The aerial survey has found greater value in today's world of landscape level rather than at the old stand level. The quality of the survey can also be determined by the product user. What is good enough for a Washington Office report, may not be good enough for planning a timber sale. But the timber sale planners who use aerial survey maps, know enough to use the map to get them to an area on the ground to make the determination if the area has salvage potential before planning their project. To plan a spruce budworm aerial spray suppression project by using the previous year's defoliation polygons for an Environmental Analysis boundary is absurd, but it has been done. The right way to use the defoliation polygons is to get the project planners to the area and do a more intensive delineation of the potential unit.

Scale and Resolution

How many times has a sketchmapper been flying in a fixed-wing aircraft, using a half inch to the mile recreation map and said, "If only I had a helicopter, a 1:24,000 USGS topography map and lots of time to do a really good job." There are times on special projects and surveys that this type of flying is done. But with the limitations of time, dollars and qualified, available sketchmappers, most programs rely on the traditional fixed-wing systematic survey. All surveys, all photo interpretation, all aerial videography methods are a compromise to visiting every tree out on the ground. Understanding the limitations and the degree of resolution of any remote sensing method is important to the product user as well as the polygon delineator. The reality check comes when you consider you have x amount of acres to cover in x amount of time with x amount of dollars and x amount of personnel.

Acknowledgements

Thanks to Alice Green for her additional digitizing efforts for these maps, and to Larry Stipe for the data analysis and summaries from the digitized maps.

DEFOLIATING INSECTS THAT FEED ON WESTERN HEMLOCK FROM AN AERIAL SURVEY PERSPECTIVE

Bob Backman

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Roy Mask

Forest Health Management, Alaska Region,
USDA Forest Service, 2770 Sherwood, Suite 2A, Juneau, Alaska 99801

This presentation will include insect activity by western hemlock looper, hemlock sawfly, blackheaded budworm, and a combination of western blackheaded budworm and hemlock sawfly.

Western Hemlock Looper

Hemlock looper is a very difficult insect to detect unless high larval populations remove greater than 50 percent of the foliage. The larvae tend to start feeding on understory branches and work upward, often after taking a few bites from an individual needle. Most needles of western hemlock fall without fading and an aerial observer will see very little color change except for the brown from bare limbs wherever there is near total defoliation. In mixed stands, Douglas-fir and true firs will also be fed on and usually show reddish orange color. When western hemlock is less than 50 percent defoliated, the droop of the foliage and the top curled leader will be less pronounced and when observed from the ground, it often looks like Douglas-fir.

Hemlock Sawfly

Hemlock sawfly is also a difficult insect to detect. The main identifying signature is that it feeds on old foliage. Larvae tend to reduce growth rather than kill trees. Eggs are laid individually on needle margins of current year's growth, usually one per needle, and most of the population overwinters as eggs. The literature states that eggs hatch, and larvae feed from late spring to early summer. In 1982, the Washington Department of Natural Resources conducted a cooperative insecticide test using Carbaryl and Orthene. Evaluation of that test in the fall revealed that hemlock sawfly populations did not hatch until about August 7, 1982. This is a much later hatching date than reported in the literature. Fall egg counts indicated populations would decline in 1983, which we later verified. When western hemlock is defoliated by hemlock sawfly, much of the normal foliage droop disappears, and little color change is apparent other than thin crowns in trees and some yellowing. Western hemlock defoliated by hemlock sawfly can also look like Dougas-fir from ground observations because the normal branch and top droop characteristic of western hemlock tends to disappear as defoliation progresses.

Western Blackheaded Budworm

Blackheaded budworm defoliation is very easy to detect because the larvae are wasteful feeders and foliage injured by the feeding larvae turns a reddish brown color. This insect will freely feed on western hemlock, Sitka spruce and true firs. Trees of all ages can be killed, top killed or severely weakened. Moths deposit eggs singly on the underside of needles in late summer. Eggs hatch the following spring with bud development. The young larvae mine and feed in opening buds. When half grown, larvae leave the expanding buds to construct shelters. They feed on new foliage first, then they progress to the old foliage. Pupation occurs in late July to early August. Moths fly in late August, depositing eggs singly on the undersides of needles, mostly on the upper branches. Lammas growth often occurs after defoliation and can obscure some of the damage.

Western Blackheaded Budworm and Hemlock Sawfly

The concurrent defoliation of many of southeast Alaska's western hemlock stands by blackheaded budworm and hemlock sawfly, offers a special challenge to aerial sketchmappers. The signature of blackheaded budworm defoliation is a "scorched" appearance quite similar to that of western spruce budworm. The signature of hemlock sawfly is one more of foliage sparsity (older foliage) and less a matter of detecting discoloration.

On western hemlock (and Sitka spruce) in southeast Alaska, the blackheaded budworm signature is evident beginning in early July. In general, it is apparent across vast areas and will be most pronounced on higher productivity sites. The red hue begins to fade in late August as heavy rains dislodge much of the dead foliage that has been webbed together by foraging larvae.

Hemlock sawfly defoliation is less likely to exhibit a profound red hue since older needles are consumed or are clipped and fall readily from host branches. The typical signature is the bare appearance of the inner crown of defoliated host (hemlock, rather than both hemlock and spruce as with budworm) trees. This bare appearance can be confused with heavy blackheaded defoliation, especially after heavy rains in late August (or later).

Ideally, hemlock with simultaneous defoliation by blackheaded budworm and hemlock sawfly appear red on the outermost branch tips with very sparse foliage up the branches. Because of varying degrees of defoliation severity between the two insects, this "ideal" scenario is not the norm. In order to address this problem, sketchmappers have taken two courses of action:

1) data from approximately 60 defoliator plots (with beach access) are collected annually to help identify defoliating insect trends, and also to supplement aerial survey observations. Plots are accessed by floatplane and the data is collected concurrently with the aerial survey, and

2) based on results from past and current defoliator plot data, and other on-site evaluations, sketchmap observations are refined to represent the best available information.

Based on experience, areas that receive heavy defoliation concurrently by blackheaded budworm and hemlock sawfly normally experience top-kill of western hemlock after a single year's defoliation. In two instances in 1993 in southeast Alaska, hemlock mortality was also evident following a single season's defoliation.

Aerial Survey Optimum Viewing Windows for Defoliator Outbreaks in Washington and Oregon

Defoliator	*Survey Period*
Western hemlock looper	Aug. 15 - Sept. 30
Hemlock sawfly	Sept. 1 - Sept. 30
Western blackheaded budworm	July 1 - Sept. 1
Western blackheaded budworm and hemlock sawfly (Alaska)	July 15 - August 15

Major Insect Outbreaks in Washington on Western Hemlock

Year	*Insect*	*Acres*	*Treatment*
1929-32	Hemlock looper	50,000	Calcium Arsenate
1952	Hemlock looper	2,000	No Treatment
1963	Hemlock looper	70,000	Carbaryl, DDT, Bt and Phosphamidon
1967-69	Hemlock looper	3,160	Zectran and Pyrethins
1982	Hemlock sawfly	15,000	Test Carbayl and Orthene
1992-93	Hemlock looper	50,000	No Treatment

Aerial Pest Detection and Monitoring Workshop Summary

AERIAL PEST DETECTION AND MONITORING WORKSHOP

APRIL 26-29, 1994 LAS VEGAS, NEVADA

by

Tim McConnell[1], Andy Knapp[2], and Dave Bridgwater[3]

AGENDA

Tuesday, April 26, 1994

0800	Welcome to the Workshop and Introductions	Tim McConnell Andy Knapp
0820	Welcome to the Intermountain Region	Laura Ferguson
0830	Aerial Detection Surveys, Washington Office Perspective	Mel Weiss
0900	Aerial sketch mapping: A Historical Perspective	Andy Knapp
1000	Airborne Video, from the Beginning	Steve Dudley
1030	Aerial Detection Surveys and Geographic Information Systems (GIS)	Theresa Valentine
1100	Aerial Detection Survey Map Users, A Land Managers' Perspective	Rich Jeffs & Joe Frost Boise National Forest
1200	**LUNCH**	
1300	Aviation Safety and Aerial Surveys, An Overview	Les Miller
1330	Aerial Survey Program Presentations	**See Table A**
1500	Aerial Survey Program Presentations (cont)	
1600	Ecosystem Management, An Overview	Mark Jensen
1700	Daily Wrap-up	

[1]USDA Forest Service, Forest Pest Management, Missoula, MT

[2]USDA Forest Service, Forest Pest Management, Boise, ID

[3]USDA Forest Service, Forest Insects and Diseases, Portland, OR

Wednesday, April 27, 1994

Concurrent Sessions, the GIS Group and the Aerial Survey Group

GIS Working Group — **Meets in breakout room**

0800	Region or Area GIS Presentations: aerial survey data capture, processing methods and generated products. Remote Sensing and GIS in the Forest Pest Management World. Forest Pest Management GIS Data Standards.	Julie Johnson and Theresa Valentine

The GIS Group rejoins the Aerial Survey Group after break

Aerial Survey Working Group — **Meets in primary meeting room**

0800	Aerial Survey Program Questionnaire Results Summary	Andy Knapp
0830	Aviation Safety, Airspace Management	Bill Bulger
1030	Flight Following and Aerial Surveys, Operational Realities, A Panel Discussion	Andy Knapp Mike Plattes Bob Jennings Randy Johnson
1200	**LUNCH**	
1300	Aerial sketch mapping, Operational Techniques	
1300	Survey Flight Methods and Logistics	Tim McConnell
1330	Pest/Host Interactions and FPM/A&FM Interactions	Dave Bridgwater
1400	Pest Signature Challenges	Andy Knapp
	The GIS Group Returns	
1500	Airborne Video, Operational Demonstrations	
1500	Introduction and Western AirVid	Steve Dudley
1530	Midwest	Marc Roberts
1600	Northeast	John Omer
1630	South	Richard Spriggs
1700	Daily Wrap-up	

Thursday, April 28, 1994

0800	GIS Working Group Presentation of Previous Day's Discussion	Julie Johnson
0830	Data Visualization	Steve Munson
0900	Aerial Detection Surveys for Black Bear Damage	Dave Overhulser
0915	Off-site Forest Health Monitoring	Dave Bridgwater
1000	Open Discussion:	Andy Knapp and Entire Group
	How do we organize to form an effective detection and monitoring program?	
	Future needs in aerial pest detection and monitoring survey programs?	
1030	Entire group wrap-up	Tim McConnell
	Adjournment for people not participating in aerial survey training	Andy Knapp Julie Johnson Dave Bridgwater
1100	Aerial Surveys: Quality, Credibility, Value - Is it Possible?	Tim McConnell
1200	**LUNCH**	
1345	Western Hemlock Defoliators from an Aerial Survey Perspective	Bob Backman
1500	Survey Flight Orientation	Tim McConnell
	Briefing and Team Selection	Tim McConnell
	Expected Pest Damage	Andy Knapp
	AirVid Mission of Survey Area	Steve Dudley
1630	Daily Wrap-up	

Friday, April 26, 1994

Morning Aerial Survey Flight Practicum

0745	Meet to car pool to North Las Vegas Terminal	
0830	Preflight briefing at terminal conference room	
0900	First Survey Flight Takes Off	See Table B
1130	Final Survey Flight Takes Off	
1330	Regroup back at Alexis Park Meeting Room	
1330	Survey Flight Critique	Tim McConnell
1400	Survey Flight sketchmap Comparison Discussion	Tim McConnell
1500	Survey Map Types	Tim McConnell and Entire Group
1530	Informal Open Discussion: Flying hazards, aircraft capabilities, war stories, pest signature questions.	Tim McConnell and Entire Group
1600	Daily Wrap-up and Critique	

Table A

Presentations of Aerial Survey Programs (Tuesday, 1330 hours)

Pacific Northwest	Dave Bridgwater	Southern	Pat Barry
Southwestern	Michelle Frank	Rocky Mountain	Judith Pasek
Intermountain	Andy Knapp	Canada	Allan Van Sickle
Pacific Southwest	Sheri Smith	Kenya	J.J. Ngasi
Northeastern Area	Marc Roberts	Idaho	David Beckman
Alaska	Roy Mask and Bob Wolfe	Missouri	Susan Burks
		Northern	Tim McConnell

Table B
Flight Schedule Friday morning

0930	Flight #1	1030	Flight #4	1130	Flight #7
0945	Flight #2	1045	Flight #5		
1000	Flight #3	1100	Flight #6		

flight no.	right front sketchmapper	right rear sketchmapper	backseat senior observer	aircraft tail number
1.	B. Gardner	K. Ripley	D. Overhulser	36Z
2.	S. Wiley	S. Burks	J. Omer	82U
3.	L. Merrill	B. Schaupp	D. Beckman	69U
4.	J. Ngasi	S. Johnson	M. Roberts	36Z
5.	J. Pasek	S. Mbithi	K. Sprengel	82U
6.	S. Stelling	J. Hart	B. Wolfe	69U
7.	E. Johnson	A. Dymerski	D. Schultz	36Z

II. BACKGROUND, IMPRESSIONS, AND RECOMMENDATIONS

The workshop was designed to provide training for personnel responsible for insect and disease aerial detection surveys, both sketch mapping and videography across the country. There has been a shortage of experienced observers, a lack of a national training programs, and few opportunities for aerial survey folks to meet to discuss items of mutual interest. This, combined with a renewed interest in aerial survey programs, were the motivation factors behind the 1994 Aerial Pest Detection and Monitoring Workshop. The goal of the workshop was "to provide a forum for information sharing and technology transfer to people involved in all aspects of aerial insect and disease detection and monitoring surveys." The strong attendance from many agencies was an indication of the need.

The attendee list was a broad cross section of people interested in conducting sketchmap surveys, airborne video missions and the processing (GIS) and use of the data collected. Attendance included U.S. Forest Service Forest Pest Management (FPM) representives from every Region, many state agency people, U.S. Forest Service Aviation and Fire Management (AFM), and aerial survey program managers from the Canadian Forest Service and Kenya.

During the workshop, the group raised several aviation safety and quality control concerns. This was primarily due to many people being asked to do surveys with little training or expertise. A list of these concerns has been forwarded to the FPM Washington Office.

Many of those in attendance who have not had such formal training as AFM's "Interagency Aviation Management and Safety" course, considered the aviation safety agenda items to be very valuable. Both Les Miller's (survey mission team concept) and Bill Bulger's (airspace management) aviation safety talks were considered workshop highlights, especially to the new observers.

A consensus was reached among the FPM attendees for the need to provide "minimum training standards" for personnel responsible for flying aerial surveys. Most units with ongoing aerial survey programs, and a long history of annual surveys, provided training primarily from "senior observer" to "junior observer." This on-the-job training is the primary method to train new observers. With some Forest Service Regions restarting their aerial survey programs, this senior/junior training method doesn't work because of the absence of a senior observer. Other units barely have enough senior observers. Therefore, a national formal training session may be necessary to meet the needs of FPM, and some states, across the country. Today, most AFM training is not specific enough for FPM.

If aerial survey programs are to be used as an effective method of pest detection and monitoring, then adequate training is a must to accomplish these remote sensing efforts in a safe manner.

There is a need to bring FPM and AFM closer together to improve survey operations and to inform AFM of other Forest Service aviation programs and needs outside of fire management.

The FPM Washington Office must play a key role to assure that AFM and FPM develop a good training plan for aerial surveys. The details of this training can be worked out with an appointed FPM and AFM team. This training should include information on contract management, aircraft performance, radio use, meteorology, survey flying method techniques, sketch mapping, etc. Additional local pest signature (recognizing pest damage) training may be needed at the Regional level.

A national aviation management training course for the 1994 field season is not possible due to the short time period prior to the aerial survey season. However, some senior observers are being detailed to Regions in need of help where possible for 1994. A 1-day aviation management and safety training course is planned in the Southwest Region prior to the survey season for 1994.

The Workshop proceedings will be compiled and published this fall or early winter. It will be distributed to all Staff Directors and workshop attendees.

Aerial Survey Program Concerns to Management

During the Aerial Pest Detection and Monitoring Workshop held in Las Vegas, Nevada, April 26 - 29, 1994, a number of items came up that we feel need immediate attention. Most of these items are serious safety deficiency-related aspects of flying aerial detection surveys, the others are survey accuracy and quality concerns. All these items of concern are due to a lack of experience and training. Aerial surveys mentioned in this document refer to both sketch mapping and airborne video missions.

Flight Safety

1. Lack of knowledge of appropriate aircraft for the survey mission.

2. Lack of knowledge of safe flight practices in mountainous terrain.

3. Lack of knowledge of aircraft contract specifications and crew responsibilities.

4. Lack of knowledge of airspace coordination.

5. Lack of understanding of Forest aviation programs to be able to obtain correct air to ground radio frequencies required for proper flight following.

6. Lack of proper radio equipment necessary for proper flight following.

7. Lack of coordination with Regional and Forest aviation groups. (FPM groups are usually not associated with A&FM groups and generally do not carry on a dialog with each other.)

Personal Safety

1. Lack of awareness of proper hearing protection.

2. Lack of knowledge of adequate mission and aircraft briefing procedures.

3. Lack of knowledge of appropriate dress and equipment that should be on board during survey missions.

Survey Accuracy and Quality

1. Lack of aerial observation experience to conduct aerial detection surveys.

2. Lack of knowledge of appropriate mission planning.

3. Lack of knowledge of appropriate survey techniques for mountainous terrain and expected insect activity.

4. Lack an understanding of the purpose for conducting the aerial survey.

Summary

This workshop was designed to allow for an interchange of ideas and procedures between Regions and States about aerial detection surveys. Also included was some introductory information for those just getting into aerial surveys. The workshop was not designed as a training session that would take untrained people and make them into "trained observers", although in more than one case that is what was expected. What we learned was that Forest Pest Management has assigned people to do a task that results, in our opinion, in a dangerous situation to new survey personnel and risks the integrity and quality of traditional aerial surveys. Even Regions with a long history of annual aerial surveys are continually trying to build depth into their cadre of qualified observers. We would hope that in 1994 FPM personnel are not put in any compromising position in order to accomplish the task of aerial surveys.

We feel the need to quickly alert you to our concerns. We are looking for the right method to present these problems to the Washington Office. We would be glad to work with you to further develop guidelines for program safety and quality for FPM aerial surveys that may lead to minimum training standards. We intend to write a summary of the aerial survey workshop that would include our concerns, suggestions, recommendations, and critique. A workshop proceedings will also be published later this year.

III. COMMENTS FROM THE STUDENTS

I thought the workshop was great and am happy that we were able to come to closure on the need for some future training standards. The group was quite diverse in background and experience, which always makes for good interaction.

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Although I did not come away from Las Vegas any richer financially, I certainly gained a great deal in knowledge and contacts concerning surveys, GIS and videography. It was a great workshop whichshould be emulated (and if we do we would hope for further cross border sharing). Thanks for the invitation to participate.

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It was a very worth while session.

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This workshop was extremely important to people with very little experience doing aerial surveys, like myself. The collaborative efforts born of the workshop are to be congratulated!!! Thank you for sponsoring a workshop of such importance (sounds dramatic but my life and the lives of others are the bottom line in this work.) Look forward to participating in this workshop again-hopefully with something more concrete to contribute. Again, thank you for sponsoring a workshop so vital to our work.

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Here are my notes for the Aerial Detection and Monitoring Workshop. As you can tell, I thought a lot of the workshop and took alot of notes.

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The workshop last week was on of the best courses I have ever attended. I hope that my level of naivety didn't drag the discussion down too much for the more experienced people. I can't thank you enough for what you put into it, it made a huge difference to me.

I'd like to commend you for a very well organized and informative week. It was nice to see other doing things with videography. Steve Dudley and I have been communicating and sharing information about specific camera systems and I'll probably be purchasing some forward camera and monitoring equipment due to the information he gave me. The international visitors were very interesting and all of the other presenters did a very good job. I hope to see this workshop held again in the future.

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Enjoyed the meeting, we need to do it al least every other year. The only negative thing was on Wedsnesday afternoon. The talks on airborne video go repetitious. There was a lot of positive ideas and discussions. It does look like we need to develop a training video or a sketch mappers handbook, for those new to the game. It would also help, if time permitted and survey for different regions did not overlap, for an experienced person to be along for a few days. A short detail might work.

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As an attendee at the workshop, it was obvious to me that the organizers had great expertise and were committed to producing reiable pest damage data in a safe manner. I was convinced that producing credible data required a skilled aerial sketchmapper trained in pest signature recognition. We in FPM frequently lack the dollars and personnel to ground truth aerial sketchmap data, and we must be able to rely on those data. An unskilled observer will produce unreliable data - not an appropriated use of taxpayer dollars.

The workshop organizers brought in speakers from outside FPM to discuss aviation safety and airspace management. This is a complex issue and is our responsibility as aerial surveyors. Finally, this may be the best workshop or short course I've ever taken. The organizers did a superb job.

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We're working on developing an Forest Health Management Aviation Safety Plan for R-2.

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The workshop has contributed valuable insights toward job performance and safe working environments among aerial detection surveyors nationwide.

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Found out our new Cessna 206 is outfitted with programmable radio and is cheaper than our contract planes, so our safety problems may largely be solved. I think the workshop has really helped us get a start on revitalizing our aerial survey program--thanks!!!!

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I really do appreciate your letting us include the GIS meeting - I think everyone who participated in that was glad we got the chance to meet and talk. I think the workshop was a great forum for lots of good discussion - plus I was really happy to meet so many other FPM folks who I'd heard of over the past few years. It sounds like there was a lot of interest in continuing to have this kind of meeting.

Here's a brief outline on my thoughts/realizations about major issues facing aerial survey programs throughout the country.

1. Identify/*Purpose*

a. There are major differences in the purpose of aerial survey programs around the country.

For example:

WA & OR state: Major clients are timber interests. Need fine resolution, annual survey, funding source is timber related or control related.
CA, R-6 Forest Svc: Shifting from salvage/control utility to "Ecosystem" monitoring. Requires coarser resolution, less frequent flights, funding source????

If we don't understand our purpose, we won't be able to assert the importance and utility of the survey to appropriate sources of funding or targets for application.

b. Let's look for some new uses/products/adaptations for the aerial survey (as "pest management" dries up).

How 'bout mapping fires, disturbances, habitats?
Maybe we ought to become training specialists to teach folks how to do the aerial survey work they want to do. Or like Oregon contract to survey more special projects. We could also be more involved in environmental education - training the public about disturbances, forest health impacts, etc.

2. *Safety*. WOW
Highly variable safety standards and practicies throughout the country. Much could be resolved with improved training and equipment contracts. Some people discovered that they are probably putting themselves in danger everytime they go up. Eeeekk! Serious business. Hopefully they have some concrete plans for improvement now.

3. *Training* needs exist for new aerial surveyors. People get put in planes without adequate training to accurately identify and maps trees, acres, etc. They also don't know enough to make sure safety procedures (radios, flying methods, etc) are followed sufficiently.

4. *Standards*/Quality Control
We all want to be part of high-quality credible survey programs. Improving the quality and credibility may be achieved by:

* improving surveyor *training* to be sure all sketchmappers have a certain, definable skill level.

* try to elucidate a *level of confidence (quantifiable)* for the maps we make. This may be difficult due to inherent variability in topography, forest types, weather and light conditions, damage apparency.

* improve *documentation* which accompanies maps about the specific conditions, observers, circumstances of data collection.

* improve *general documentation* about the inherent limitations of an aerial survey, so the people who are getting copies of our maps can have better understanding of how the data's collected and what to expect from it in terms of quality.

5. Desire to continue group meeting and training sessions like this one. We can learn a *lot* from each other. Some areas don't have "seniors". We all are experiencing changes in responsibilities and technologies. We need to learn from each other.

Thanks for a very helpful, enjoyable session. I learned a lot.

IV. ATTENDEES

1. Backman, Bob	Washington DNR, Olympia, WA
2. Barry, Patrick	USDA FS, Forest Health, Ashville, NC
3. Beckman, David	Idaho Dpt of Lands, Coeur d' Alene, ID
4. Bridgwater, Dave	USDA FS, FPM, Portland, OR
5. Bulger, Bill	USDA FS, AFM, Portland, OR
6. Burks, Susan	Missouri Dept. of Conservation, Jefferson City, MO
7. Cain, Bob	Forestry Division, Santa Fe, NM
8. Dudley, Steve	USDA FS, FPM, Flagstaff, AZ
9. Dymerski, Alan	USDA FS, FPM, Ogden, UT
10. Ferguson, Laura	USDA FS, SPF, Ogden, UT
11. Fisher, Scott	USDA FS, Toiyabe NF, Carson City, NV
12. Frank, Michelle	USDA FS, FPM, Flagstaff, AZ
13. Frost, Joe	USDA FS, Boise NF, Boise, ID
14. Gardner, Brian	USDA FS, FPM, Boise, ID
15. Halsey, Dick	USDA FS, FPM, Boise, ID
16. Harman, Matt	USDA FS, AFM, Ogden, UT
17. Hart, James	USDA FS, Deschutes NF, Bend, OR
18. Jeffs, Rich	USDA FS, Boise NF, Boise, ID
19. Jennings, Bob	USDA FS, Toiyabe NF, Carson City, NV
20. Jensen, Mark	USDA FS, RAWE, Missoula, MT
21. Johnson, Erik	USDA FS, FHM, Gunnison, CO
22. Johnson, Juli	USDA FS, FPM, Portland, OR
23. Johnson, Randy	BLM, Las Vegas, NV
24. Johnson, Susan	USDA FS, FHM, Denver, CO
25. Knapp Andy	USDA FS, FPM, Boise, ID
26. Knighten, John	USDA FS, FH, Ashville, NC
27. Lister, Ken	USDA FS, FHM, Denver, CO

Attendees, continued

28.	Mask, Roy	USDA FS, FPM, Juneau, AK
29.	Mbithi, Sarah	Kenya Forest Dpt, Kenyan FHM Centre, Nairobi
30.	McConnell, Tim	USDA FS, FPM, Missoula, MT
31.	Merrill, Laura	USDA FS, FPM, San Bernardino, CA
32.	Miller, Les	USDA FS, EAM, Juneau, AK
33.	Munson, Steve	USDA FS, FPM, Ogden, UT
34.	Nelson, Dave	USDA FS, AFM, Albuquerque, NM
35.	Ngasi, J.J.	Kenya Forest Dpt, Kenyan FHM Centre, Nairobi
36.	Norris, Rick	FPM, R-3, Albuquerque, NM
37.	Omer, John	USDA FS, FHP, Morgantown, WV
38.	Otwell, Gary	USDA FS, FPM, Ogden, UT
39.	Overhulser, Dave	Oregon, Dpt of Forestry, Salem, OR
40.	Pasek, Judith	USDA FS, FHM, Rapid City, SD
41.	Plattes, Mike	USDA FS, AFM, Missoula, MT
42.	Ripley, Karen	Washington DNR, Olympia, WA
43.	Roberts, Marc	USDA FS, FHP, St. Paul, MN
44.	Rogers, Terry	USDA FS, FPM, Albuquerque, NM
45.	Roschke, David	USDA FS, MAG, Ft. Collins, CO
46.	Schaupp, Bill	USDA FS, FHM, Rapid City, SD
47.	Schultz, Dave	USDA FS, FPM, Redding, CA
48.	Sloan, Terry	Arizona State Land Dpt of Forestry, Prescott, AZ
49.	Smith, Sheri	USDA FS, FPM, Sonora, CA
50.	Sprengel, Keith	USDA FS, FPM, Portland, OR
51.	Spriggs, Richard	USDA FS, FH, Alexandria, LA
52.	Stellings, Shelly	Bureau of Indian Affairs (FPM), Portland, OR
53.	Valentine, Theresa	USDA FS, FH, Atlanta, GA
54.	Van Sickle, Allan	Canadian Forest Service, Victoria, BC
55.	Weiss, Mel	USDA FS, FPM. Washington, D.C.
56.	Wiley, Suzanne	USDA FS, FPM, Portland, OR
57.	Wolfe, Bob	USDA FS, FPM, Anchorage, AK