TITLE: Investigating causes for mortality in Vermont and adjacent states.

LOCATION: Vermont
DURATION: 3 years   **FUNDING SOURCE:** Base Evaluation Monitoring
PROJECT LEADER: Robert DeGeus, Vermont Dept. of Forests, Parks & Recreation; 802-241-3671; Robert.degeus@state.vt.us
COOPERATORS: Randy Morin, USFS; Bob DeGeus, Vt. FPR; Sandy Wilmot, Vt. FPR
FHP SPONSOR/CONTACT: Margaret Miller Weeks, Forest Health Protection, USFS, Durham, NH; 603-868-7712

PROJECT OBJECTIVES:
➢ Investigate potential causes of tree mortality detected in recent FIA data for Vermont and adjacent states.
➢ Identify site conditions that contributed to tree decline to support forest management strategies for future forest health.

JUSTIFICATION:
a. **Linkage** to FHM Detection Monitoring. The 2006 Vermont FIA data showed a 56% increase in mortality of growing stock volume since the last inventory. Preliminary investigations of FHM aerial survey and ground plot data also indicate a variety of stress events that have affected different tree species and locations at various times since the last FIA inventory. This project will use our entire suite of aerial detection, ground survey plots and FIA plots to investigate this forest health disruption.
b. **Significance.** Preliminary data analysis within Vermont shows the number of dead trees increased from 25 million to 100 million trees from 1997-2006 (296% increase) statewide. New York, New Hampshire and Maine FIA data show a similar trend since the last inventory. County level data shows that the decline was well distributed.
c. **Biological impact**. While a decrease in growing stock can be a significant economic and ecological problem, there is added importance in knowing whether or not this trend will continue. Information on the cause for this decline gained from this investigation will shed light on the future trend and may alter resource management options. In addition, current efforts toward increasing carbon sequestration and storage in forests will be hindered by increasing trends in mortality.
d. **Scientific Basis/Feasibility.** Vermont has been diligent in collecting an abundance of forest health data for several decades. Data are available and accessible for this project, and key data analysts are participating.
e. **Priority Issues**. This proposal addresses several of the priority issues: tree mortality, tree growth, drought, soil conditions, air pollutants, and climate change.

DESCRIPTION:
a. Background:
     In preparation of the 5-year FIA report for Vermont, data analysis of decline and mortality trends showed a startling increase from the last inventory data of 1996-1997. Screening for possible data errors or explanations verified the increase. Existing FHM data sets for each of the years were then used to identify stress events that had occurred since the last inventory. Initially it seemed that the 1998 ice storm may have been responsible for the mortality, but that doesn't seem to be the case since that initial wave of dead trees was counted in the last inventory. FHM data does show increases in decline associated with drought, insect defoliations, wind storms,

and other factors. Recovery may vary with site conditions such as soil fertility, soil depth, species composition, elevation, and others.

This evaluation project will be conducted in two parts: 1. an integration of FIA plot data and spatial data to determine most likely stress events responsible for the decline for each tree species affected; 2. field measurements to verify timing and probable cause, and determine whether site conditions are playing a role in forest decline or recovery.

This project seems like the perfect model of evaluation monitoring: integrating data collected on forest inventory plots with forest health plots, aerial survey, and additional site-related spatial data layers to develop a better understanding of stress-induced decline, and how forest managers may be able to deal with tree health under various site conditions.

b. Methods:

1. **Initial data analysis** to determine FIA/FHM ground plots involved. Identify spatial locations, species, size class involved in mortality trend.

2. Conduct **spatial analyses to determine most probable cause** for each species/plot. This will include overlaying FIA plots with statewide data layers such as: soil depth, soil dryness index, palmer drought index/precipitation measures, aerial survey data for ice storm, wind storm, defoliation, etc. These data sets have been developed and are available for use.

3. Query foresters for additional insight on probably causes and field measurements that would help discern cause as well as site factors.

4. Field visits to collect supplemental data to assist with verification of possible cause: tree cores for dendrochronology and to discern timing of decline; site and soil characteristics; evidence of disturbance; canopy and understory health.

5. Climate change analysis will involve spatial analysis of spruce/fir forests subject to site conditions that increase risk of decline (soil depth, aspect, elevation, etc).

6. Analysis of air pollution data. Vermont has ozone exposure data from 1989 to present for comparison with FHM ozone bioindicator plant trends. Mortality areas will be compared with Vermont Forest Sensitivity Map to compare to exceedence of critical load for sulfur and nitrogen (buffering capacity). FHM lichen results will also be used.

c. Products:

1. Report of findings to adjacent states and USFS.
2. Poster presentation for the FHM Working Group.
3. Chapter(s) in the 5-yr FIA report that could serve as template for future FIA state, regional, and/or National reports.
4. Website posting for general audience.
5. Presentations to key user groups in Vermont including recommendations for revising forest management guidelines according to results.

d. Schedule of Activities:

Year 1: Preliminary analysis: Analyze available datasets for background information (FIA, FHM, NAMP, HHS, VMC, SCAN (soil climate stations)). Conduct preliminary spatial analysis of FIA plots and selected spatial data layers to assess relationships. Publish FIA report chapter with data summaries and basic results. Selection of sampling locations: Stratify FIA plots based on mortality and standing dead, species abundance, and probable cause. Use this to select areas for additional field measurements, preferably on public land.

Year 2: Field sampling and analysis of samples

Year 3: Data analysis and preparation of products, Distribute products

e. Responsibilities:

Bob DeGeus will serve as project leader, provide input and interpretation of data analysis, serve as liaison with foresters for input on decline observations and field measurements, assist in planning of field work, and coordinate reporting. **Randy Morin** will be the principal

data analyst for plot and spatial analysis, and assist in preparation of products. **Sandy Wilmot** will provide input and interpretation of forest health data, coordinate field data collection and analysis, and assist in product preparation.

f. Budget:

We are requesting a **total of $ 48,100** from the FHM Evaluation Monitoring Program. The total project cost will be $96,200. Part of the funds ($33,100) will be contracted to the State of Vermont, and the remaining portion ($15,000) will be contracted to the USFS Northeast Research Station. Match will be provided as indicated below.

	Item	Vermont Requested FHM EM Funding	Vermont Matching Funds	Vermont Total Project Cost	USFS Requested FHM EM Funding	USFS Matching Funds	USFS Total Project Cost	Total Requested Funds
YEAR 1								
Administration	Salary	5,000	1,516	6,516		5,000	5,000	5,000
	Overhead	200	4,250	4,450	4,000		4,000	4,200
	Travel	400	200	600	200		200	600
Procurements	Contracting							
	Equipment	200		200				200
	Supplies	200		200				200
	Y1 TOTAL	**6,000**	**5,966**	**11,966**	**4,200**	**5,000**	**9,200**	**10,200**
YEAR 2								
Administration	Salary	5,000	1,516	6,516		5,000	5,000	5,000
	Overhead	100	4,350	4,450	4,000		4,000	4,100
	Travel	300	200	500	400		400	700
Procurements	Contracting	10,000	10,000	20,000				10,000
	Equipment	500		500				500
	Supplies	200		200				200
	Y2 TOTAL	**16,100**	**16,066**	**32,166**	**4,400**	**5,000**	**9,400**	**20,500**
YEAR 3								
Administration	Salary	5,000	1,517	6,517		5,000	5,000	5,000
	Overhead	200	4,351	4,551	4,000		4,000	4,200
	Travel	300	200	500	400		400	700
Procurements	Contracting	5,000	5,000	10,000				5,000
	Equipment							
	Supplies	500		500	2,000		2,000	2,500
	Y3 TOTAL	**11,000**	**11,068**	**22,068**	**6,400**	**5,000**	**11,400**	**17,400**