TITLE: **Sugar Maple Dieback in the Upper Great Lakes Region**

LOCATION: Michigan, Wisconsin, Minnesota
DATE: September 30, 2009
DURATION: Year 2 of 3-year project **FUNDING SOURCE:** Base

PROJECT LEADER: Dr. Andrew J. Storer, School of Forest Resources and Environmental Science, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931

COOPERATORS: Dr. Martin F. Jurgensen (Co. PI), Michigan Technological University
Tara Bal, PhD Candidate, Michigan Technological University
Dr. Robert L. Heyd, Michigan Department of Natural Resources
Dr. Manfred Mielke, USFS St. Paul, MN.

FHP SPONSOR/CONTACT: Dr. Joseph O'Brien, USFS St. Paul, MN. Phone (651) 649-5266
Email: jobrien@fs.fed.us

PROJECT OBJECTIVES:
1. Evaluate the extent of sugar maple dieback in the Northern Great Lakes Region
2. Characterize the rate of change of dieback symptoms in sugar maple
3. Compare the current sugar maple dieback with previous CFI data going back to the 1930s.

JUSTIFICATION:

a. **Linkage.** This project will utilize long-term plot data through access to CFI plot data across a broad range of soil types throughout Upper Michigan going back to 1938, and FHM survey data to identify areas where dieback has been recorded more recently. This dieback has become more prevalent in recent years, and this led to our preliminary data collection that was conducted using industry support.

b. **Significance.** Sugar maple is one of the most important timber species in the North Central region. Reports of dieback have been made from multiple locations and on multiple ownerships. Dieback during the last five decades has been reported in Upper Michigan, northern Minnesota and northern Wisconsin. This dieback has been attributed to various factors such as drought, insect attack, or soil rooting volume, but nothing definitive has been shown The current concern is that the dieback that is currently occurring may be of greater severity and geographic scope than previously reported episodes, and that other compounding factors, including weather pattern shifts that may be attributed to climate change, may be contributing to the observed patterns of decline.

c. **Biological impact.** Recent management of sugar maple dominated forests has typically involved selective harvests, and strongly favors an increase in sugar maple basal area. This has led to virtual monoculture of sugar maple over large areas. Growth reduction and mortality in these forests has potentially great biologic and economic impacts. The current dieback in many trees exceeds 30% in some stands, which may be the point at which trees are not likely to recover.

d. **Scientific Basis/Feasibility.** A network of 60 permanent plots has already been established on private lands in Upper Michigan and these document the dieback occurring in those areas. Soil cores, foliage samples, and tree and stand level data have already been collected from these plots. Expanding the network of plots to other geographic and climatic areas will enable us to determine whether a single causal factor is responsible for sugar maple dieback, if a combination of factors are important, or if different combinations of factors are important in different areas.

e. **Priority Issues.** This project addresses a number of the priority issues listed in the RFP. In particular it addresses tree mortality – deviation from expected levels and poor crown conditions – deviations from normal. Since factors that are being considered as potential contributors to the dieback include soil conditions, drought, and changes in weather patterns that may be attributable to climate change**,** these

priority issues are also being addressed.

DESCRIPTION:

a. Background: Major maple mortality events have occurred in pockets in various locations and extents throughout the 20th century. Mortality was attributed to drought, pathogens, past cutting practices pollution and insect defoliation. Recently, unusual levels of dieback of sugar maple have been reported in the western Upper Peninsula of Michigan and other areas in the North Central region.

b. Methods: Our work expands our current network of 60 evaluation plots to add an additional 60 plots on national forest land in Upper Michigan, Northern Wisconsin and Minnesota. We will work with National Forest staff and Forest Health Monitoring to identify areas with and without significant levels of dieback, and use historical CFI data to identify where dieback has been documented in the past. Description of the plots establishment is found in the progress report section below.

c. Products: We anticipate completing peer-reviewed papers describing our findings, and developing guidelines for management of sugar maple in areas where dieback is present. In addition, we will contribute poster and oral presentations at meetings attended by stake-holders, including the annual Forest Health Working Group Meeting.

d. Schedule of Activities (Year 2 and 3):

Fall Winter 2010-11	Process soil and foliage samples.
Spring/Summer 2011	Visit sites identified as having had dieback in CFI plots dating back to 1938. Assess canopies of trees in plots
Fall/Winter 2011-12	Complete processing of soil and foliage samples. Initial data analysis to identify data gaps
Spring/Summer 2012	Revisit plots for canopy assessments and change in dieback and to collect data to fill data gaps (e.g. additional soil samples if needed)
Fall/Winter 2012-2013	Complete analysis of data and prepare manuscripts.

e. Progress/Accomplishments: The network of sixty additional plots has been established, predominantly on forest serice land (Table 1). Regional foresters were contacted to identify suitable sites for plot installation. These plots are in addition to the 60 already established on industry land. During the summer of 2010, the 60 new, 1/10th acre plots were established in sugar maple forests on federal, state, and private lands.

Table 1. Ownership and state location breakdown of plots established summer 2010.

Ownership	Location	Ownership	Number of plots
Federal Ownership	Wisconsin	Chequamegnon-Nicolet National Forests	16
	Minnesota	Superior National Forest	6
	Michigan	Hiawatha National Forest	6
	Michigan	Ottawa National Forest	24
State Ownership	Michigan	DNRE and Michigan Tech	7
Private Ownership	Michigan	CFA Land – Industry owned	1
		Total Plots Established 2010	60

Data Collection/ Plot establishment methods

Each plot was established following the protocols we used on private land in our other current project with the coordinates recorded and trees tagged at the base for future monitoring. Each tree in a 1/10 acre plot was measured and underwent a full canopy assessment. Understory and regeneration subplots were included within the plot. Biotic factors impacting the vigor of trees were assessed, including sugar maple borer, cankers, sap streak disease, and wounds. Further plot characteristics recorded included skid trail and forest soil penetrometer readings, canopy density measurements and earthworm activity. From a subset of 30 of the 60 plots, foliage samples were collected in August from trees with high, intermediate and low dieback for nutrient analysis that will be conducted this fall and winter. On these same 30 plots, soil samples were collected by horizon from beneath healthy and dieback trees, and are being analyzed for carbon content, total nitrogen, available cations, and pH and

texture this winter. Tree cores were taken from the same trees as foliage and soils were collected from, and are processed on a growth-ring analyzer to calculate the effect of dieback on tree radial growth.

Initial Results

The average summer dieback of sugar maple, including dead trees at all 60 of these plots is 12.5 %. The large amounts of rain during the recent summer months has eliminated most of the precipitation deficits across Upper Michigan this year (National Weather Service Monthly Hydrologic Information Center, Drought Information Statement, Marquette, MI, Sept 9 2010). The above average precipitation in some areas may have stimulated growth in stands that had higher levels of dieback in previous years.
Other information from the plot establishment data is currently being processed and analyzed. Average values for dieback and other factors are listed in Table 4

Table 4. Average plot values for sugar maple dieback and biotic factors on sugar maple trees for each ownership area. Decay was recorded if noted or fungi other than the cankers were present. Also included are the averages of plot values for earthworm impacts (see scale) and percent of light density through the canopy.

Ownership	Total # of plots	Summer Dieback	% with cankers	% with wounds	% with decay	# with sugar maple borer	earthworm density (1-5 scale)	% light density
Superior N.F.	6	18.09	0.00	21.85	3.60	2.7	5.0	16.9
Chequamegnon N.F.	8	11.12	6.48	17.39	5.45	7.1	4.9	16.7
Nicolet N.F.	8	13.95	5.36	12.73	5.03	9.9	3.8	13.7
Hiawatha N.F.	6	11.49	9.48	24.03	7.40	7.3	5.0	17.7
Ottawa N.F.	24	12.58	5.29	22.01	7.17	4.4	4.5	22.4
MI State-DNRE	5	9.29	0.77	12.90	3.64	6.8	4.6	37.7
MI State-MTU	2	6.37	0.00	19.29	0.00	5.5	4.4	21.1
CFA land	1	12.32	5.26	5.26	5.26	3	5	33.8
Overall Average		12.53	4.79	19.21	5.76	5.83	4.58	20.88

Future activities

During the fall and winter of 2010, samples will be processed and analyzed and all data compiled. Historic CFI plot data in Upper Michigan will be accessed to determine historic plot locations and vigor ratings for comparison of the historic forests to current conditions at those sites. Revisiting the sugar maple dieback evaluation plots in the next summer seasons will allow us to determine the rate change of sugar maple dieback over the short term and whether it is progressing in the area.

COSTS:

Item	Year 1 FHM	Year 1 MTU	Year 2 FHM	Year 2 MTU	Year 3 FHM	Year 3 MTU
Personnel and fringes	40,563	9,269	40,545	8,986	40,545	8,986
Supplies	2000		2000		2000	
Travel	5982		5982		5982	
Services	6000		6000		6000	
Overhead (10%)	5,455	29,643	5,455	23,999	5,455	23,999
Total	60,000	38,912	60,000	37,837	60,000	37,837

Personnel: 1 PhD student, faculty summer support and undergraduate field assistants. Supplies include those for the fieldwork and sampling. Services include soil and foliage analysis. Travel covers travel to field sites and travel to the annual FMH Work Group Meeting. More than 50% of the work described in this proposal takes place on federal land, and hence the costshare proposed is less than 1:1.