TITLE: Utilizing Cooperative Alaska Forest Inventory permanent plots for boreal forest disease detection and quantification

LOCATIONS: South-central and interior Alaska

DATE: September 30th, 2013

DURATION: 3 Years **FUNDING SOURCE:** Base

PROJECT LEADER: Loretta Winton, Pathologist, USDA Forest Service, State & Private Forestry, Forest Health Protection, R-10, Anchorage, AK, lmwinton@fs.fed.us, 907-743-9460

COOPERATORS: Tom Malone, Forester, Department of Forest Sciences, University of Alaska Fairbanks, Fairbanks, Alaska; Tom Heutte, R10 Aerial Survey Coordinator, USDA Forest Service, State & Private Forestry, Forest Health Protection, R-10, Juneau, AK; Robin Mulvey, Pathologist, USDA Forest Service, State & Private Forestry, Forest Health Protection, R-10, Juneau, AK.

FHP SPONSOR/CONTACT: Trish Wurtz, R-10 Invasive Plant, Pesticide & Forest Health Monitoring Program Coordinator, USDA Forest Service, S&PF, FHP, twrtuz@fs.fed.us, 907-451-2799

PROJECT OBJECTIVES: This project will investigate tree disease and mortality in south-central and interior Alaska by utilizing the Cooperative Alaska Forest Inventory (CAFI), an existing network of boreal forest permanent plots to (1) monitor disease agents of forest trees and evaluate the extent of mortality and damage; (2) assess correlation between disease agents and tree damage and mortality to determine the primary causal agent/s; (3) evaluate geographic, plant community, or age-class trends associated with disease damage and mortality through assessment of ground-based plots, (4) evaluate correlations of individual diseases with tree growth and volume loss.

JUSTIFICATION: The boreal forest comprises 91% of the 126 million acres of forest land in Alaska (Smith *et al* 2009). However basic information regarding the distribution and impacts of forest diseases in this region is lacking. For example, Alaska is the only region for which no root disease distribution data are available for a national root disease paper currently in preparation (Blakey Lockman, pers. comm.). In addition, there is no quantitative data available with which to model boreal forest diseases for the National Insect and Disease Risk Map. Instead, qualitative unsubstantiated statements such as "common" or "the most damaging" for a number of pathogens are available in the Alaska Forest Health Conditions Annual Reports and the Insects and Diseases of Alaskan Forests publication.

This project addresses the following Evaluation Monitoring selection criteria:

1) Linkage to FHM program: The idea for this project stemmed from the lack of FIA data in boreal forests. Collection of this data will greatly expand our contributions FHM programs such as the Pest Event Recorder (PER), Risk Map, and the ground-truthing of Aerial Detection Surveys (ADS).
2) Significance/Impact: High oil prices are currently raising interest in wood energy from biomass, although due to high defect rates, south-central Alaska forests have historically had little economic value. Interior forests have supplied lumber, logs, and firewood for use in the region

since the gold rush. However, the extensive hardwood forests of interior Alaska offer potential for a variety of manufactured products and energy sources.

3) Scientific basis: Information gathered from this permanent plot network will help to determine the causal agent/s involved in disease damage and mortality, evaluate the extent and patterns of disease and mortality, and provide data for risk models. It will also allow us to track change over time.
4) Cost/Economic efficiency: A systematic survey of tree diseases to determine the role of pathogens in boreal forest stand productivity can be successfully completed. Utilization of an existing permanent plot system ensures that efficiency will be maximized by utilizing tree inventory, vegetation and damage data collected by University of Alaska Fairbanks CAFI crews. Will directly contribute to PER, Risk Map, and ADS ground-truthing. Selection criteria allows for broader population inferences to be made regarding the health status of boreal forest tree species.
5) This project addresses several EM Priority Issues:
    a. Climate change: Periodic inventory remeasurements can be used to test and monitor large-scale environmental and climate change as well as disease response.
    b. Unusual weather events: Wet weather patterns may immediately influence foliage disease severity. Drought may be a factor contributing to a variety of canker and root diseases in the boreal forest.
    c. Validating/filling data gaps in insect & disease risk models: There is currently no objective, quantitative data to model disease risk in Alaska.
    d. Tree mortality: This project will evaluate the extent and causes of boreal forest tree mortality.

DESCRIPTION:

1) Background: There is limited knowledge of tree disease severity and distribution in Alaska's boreal forest. Damage and mortality of boreal tree species is difficult to observe and map in Aerial Detection Surveys due to the paucity of aerial signatures. Therefore systematic ground surveys coupled with existing, periodic inventory data are warranted to address these deficiencies. FIA data is designed to act as an early-indicator of forest health problems, however FIA plots in Alaska are currently limited to the coastal rain forests. CAFI, initiated in 1984, was established to monitor growth, yield, and health of boreal forests in Alaska (Malone *et al* 2009). Repeated periodic inventories on CAFI permanent sample plots provide valuable long-term information for modeling of forest dynamics. In the last few years the database has been used to develop the first climate-sensitive matrix model for the Alaska boreal forest (Liang *et al* 2011), a controlled trend surface geospatial model representing large-scale trends in recruitment, diameter growth, and mortality (Liang & Zhou 2010), a prototype geospatial model for the Alaska boreal forest to study current and future stockings across the region (Liang 2012), a stand growth matrix model to assist management of Alaska's boreal forest (Liang 2010), volume models for white spruce in Alaska (Malone *et al* 2013), and to investigate the effects of tree species and size diversity on recruitment within the boreal forest (Young *et al* 2011). While the location, severity, and cause of the four most prominent visual damages on trees are recorded in the CAFI surveys, diagnosis of tree diseases is beyond the skills of seasonal crews.
2) Methods: Evaluation and monitoring of boreal forest tree diseases will be conducted through the permanent plot network of the CAFI program. CAFI consists of field-gathered information from nearly 600 permanent sample plots distributed across interior and south-central Alaska. New plots are being added to the inventory annually and the distribution of sites represents a wide variety of growing conditions. Site description (location, slope, aspect, landform, and soils

information), tree (diameter, height, health, and quality and quantity of regeneration), and understory vegetation data are collected to quantify site characteristics. To date damages attributed to human activities, environment, animals, fire, weather, and insects appear to be reliable. Therefore personnel trained in forest pathology will accompany crews for three field seasons to both gather reliable disease information and provide specialized training to the permanent crew boss.

To complement the installation of ground-based observations, samples of unknown or difficult pathogens will be taken to the lab for microscopic, cultural, and/or molecular identification. A summary of pathological observations will be provided to the R10 coordinators for the PER and the ADS in September of each year. In May of each year a geo-referenced list of the CAFI plots that will be visited during the upcoming field season will be provided to the R10 ADS coordinator and the locations will be added as a layer to the Digital Aerial Sketch Map systems. During ADS this will allow surveyors to overfly these specific locations, when possible, allowing these plots to be used as ground truthing data. These activities will be continued by the CAFI program as standard practices after the timeframe of this project is completed.

3) Products: FHM meeting poster; first and final year reports; baseline information on disease agents impacting boreal forest health; potential recommendations for stand management; report or publication blending findings from CAFI analysis and ground surveys; a permanent plot network for long-term monitoring of boreal forest health which includes disease. As an affiliate with the Bonanza Creek Long-Term Ecological Research, the CAFI database, including our contributions, are available at www.lter.uaf.edu. In addition, the data will be available in the Alaska Scholarworks project which functions as an institutional repository for publications and databases. An annual summary of pathological observations will be entered in to the PER database, and data for ADS ground-truthing will be queried and provided to the R10 ADS coordinator.
4) Schedule of Activities: In 2014 FHP pathologists and/or a pathology trained seasonal technician will begin accompanying CAFI crews. Approximately 90 plots will be remeasured and disease data obtained while at the same time field training the CAFI crews and crew boss. A similar number of plots will be visited in 2015 and 2016 for a total of 270 plots over the 3 years requested funding. In 2016 work can begin on formal reports or publications incorporating the results of disease data in growth models and on the distribution and severity of boreal forest diseases in Alaska.

5) COSTS:

2014 Budget	**Item**	**Requested FHM EM Funding**	**Other-Source Funding**	**Other-Source**
	Salary		$14,000	Base FHP
	Overhead		$900	Base FHP
	Travel	$12,500	$2,500	Base FHP
	Supplies	$1,500		
	Seasonal Technican	$8,000	$5,000	Base FHP
2014 Total		**$22,000**	**$22,400**	
2015 Budget				
	Salary		$14,000	Base FHP
	Overhead		$900	Base FHP
	Travel	$12,500	$2,500	Base FHP

	Supplies	$1,500		
	Seasonal Technican	$8,000	$5,000	Base FHP
2015 Total		**$22,000**	**$22,400**	
2016 Budget				
	Salary		$14,000	Base FHP
	Overhead		$900	Base FHP
	Travel	$12,500	$2,500	Base FHP
	Supplies	$1,500		
	Seasonal Technican	$8,000	$5,000	Base FHP
2016 Total		**$22,000**	**$22,400**	
Grand Total		**$66,000**	**67,200**	

Literature Cited (all except Smith *et al* are based upon CAFI data)

Liang, J. (2010). Dynamics and management of Alaska boreal forest: An all-aged multi-species matrix growth model. *Forest Ecology and Management, 260*(4), 491-501.

Liang, J. (2012). Mapping large-scale forest dynamics: A geospatial approach. *Landscape Ecology, 27*(8), 1091-1108.

Liang, J., & Zhou, M. (2010). A geospatial model of forest dynamics with controlled trend surface. *Ecological Modelling, 221*(19), 2339-2352.

Liang, J., Zhou, M., Verbyla, D. L., Zhang, L., Springsteen, A. L., & Malone, T. (2011). Mapping forest dynamics under climate change: A matrix model. *Forest Ecology and Management, 262*(12), 2250-2262.

Malone, T., Liang, J., & Packee Sr., E. C. (2013). Total and merchantable volume of white spruce in Alaska. *Western Journal of Applied Forestry, 28*(2), 71-77.

Malone, T., Liang, J., & Packee, E. C. (2009). Cooperative Alaska Forest Inventory. *USDA Forest Service - General Technical Report PNW-GTR*, (785), 1-42.

Smith, W.B., Miles, P.D., Perry, C.H., & Pugh, S.A. (2009). Forest Resources of the United States, 2007. Gen. Tech. Rep. WO-78. Washington, DC: U.S. Department of Agriculture, Forest Service, Washington Office. 336p.

Young, B., Liang, J., & Stuart Chapin, F. (2011). Effects of species and tree size diversity on recruitment in the Alaskan boreal forest: A geospatial approach. *Forest Ecology and Management, 262*(8), 1608-1617.