TITLE: Investigation of factors contributing to shore pine (*Pinus contorta* var. *contorta*) mortality and damage in SE Alaska

LOCATIONS: SE Alaska; potential for future collaboration with R-6, R-5 and British Columbia

DATE: Fall 2011

DURATION: Year 1 of 2-yr project **FUNDING SOURCE:** Base

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PROJECT OBJECTIVES: This project will investigate shore pine mortality and damage in SE Alaska, a trend revealed through comparisons of Forest Inventory Analysis (FIA) re-measurement data from 2004 and 2008; (1) monitor biotic damage agents of shore pine and evaluate the extent of mortality and damage; (2) assess correlation between biotic damage agents and shore pine dieback and mortality to determine the primary causal agent/s; (3) examine the role of abiotic factors that may directly or indirectly contribute to shore pine mortality (e.g. annual or seasonal changes in water table depth); (4) evaluate geographic, plant community, or age-class trends associated with shore pine dieback and mortality through assessment of ground-based plots and continued analysis of FIA plot data.

JUSTIFICATION: The 5-yr FIA Report, Forests of Southeast and South-Central Alaska 2004-2008, documented a 4.6% (SE 2.1%) net loss of *Pinus contorta* biomass over the study period, despite negligible harvest (Barrett and Christensen 2011). Shore pine is a distinct subspecies of lodgepole pine that occurs on coastal and wetland sites from SE Alaska to N California, and has a significantly different growth habit and ecological niche than other lodgepole pine subspecies. *P. contorta* was the only tree species to experience a statistically significant loss, and shore pine was the subspecies present in 128/130 plots (Fig. 1). There are several unusual aspects to this mortality: 1) losses were significantly higher for trees >8" dbh (8.6 vs. 4.9% of trees dead), 2) the factors causing this mortality are unknown, and 3) there is no apparent geographic pattern to the mortality, making it difficult to detect through aerial survey. Although it is not possible to know whether this loss is part of a continuing trend, it is alarming that mortality rates are higher for larger trees and that there is virtually no baseline information on the insect and disease problems of shore pine (Pers. comm. Paul Hennon, Dave Shaw and other forest health specialists). Due to its low commercial value, shore pine is understudied in SE Alaska and throughout its range.

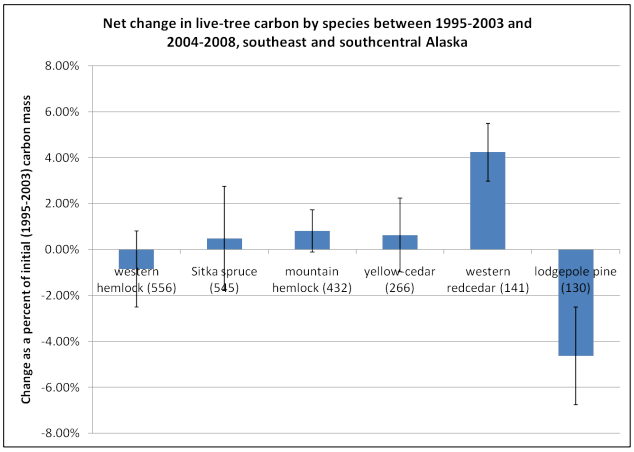

Figure 1 Forest lands; trees >5" dbh. Excludes NF Wilderness and Glacier Bay NP. Parentheses indicate number of plots with species present. Provided by T. Barrett (PNW Research Station).

There is limited tree diversity in SE Alaska. Many of the bog and muskeg sites on which shore pine commonly grows have already been impacted by the loss of Alaska yellow-cedar (*Callitropsis nootkatensis*) and are particularly vulnerable to

further loss of tree species. Shore pine serves a significant structural and ecological role in forested wetland ecosystems, providing shade, habitat and an important food source. Few tree species are able to survive under the harsh conditions of these habitats (high water table and high soil acidity).
This project addresses the following Evaluation Monitoring selection criteria:

1) Linkage to FIA plot data: The idea for this project stemmed directly from FIA data analysis conducted by Tara Barrett and Glenn Christensen (2011).
2) Significance in terms of the geographic scale: Although the mortality trend was observed in Alaska, information on the biotic damage agents of shore pine is also lacking throughout its distribution along the Pacific coast. This study will evaluate shore pine health in SE Alaska, with findings that are likely to be relevant throughout the range of shore pine.
3) Biological impact: Information gathered from this project will help to determine the causal agent/s involved in shore pine dieback and mortality, evaluate the extent and patterns of dieback and mortality, and determine if there is reason for heighted concern regarding the health and survival of shore pine in SE Alaska.
4) Scientific Basis/Feasibility: A systematic survey of shore pine can be successfully completed. The survey will be used to determine the role of biotic agents in shore pine stands, and can help to evaluate whether abiotic factors may also be important to shore pine mortality.
5) This project addresses several EM Priority Issues:
    a. Climate change has significantly altered species composition on muskeg and bog sites in SE Alaska through its role in yellow-cedar decline (>500,000 ac. in SE Alaska), making these sites sensitive to the continued loss of dominant tree species (Forest Health Conditions in AK 2010).
    b. Drought may be a factor impacting shore pine. Shore pine is able to tolerate sites with high water tables, in part, by rooting shallowly to avoid root hypoxia. This may make shore pine vulnerable to drought and seasonal fluctuations in water table depth that bring the water table out of reach of the rooting zone (Pers. comm. Dave D'Amore, PNW Juneau, Sept 2011).
    c. Tree mortality: This project will evaluate the extent/causes of mortality.
    d. Poor crown conditions: This project will assess biotic agents contributing to premature needle shed, top kill, and branch and whole-tree mortality.
    e. Soil conditions: Shore pine is able to survive on harsh boggy sites with low soil pH (3.5-3.8), and becomes less dominant on sites with relatively higher soil pH, where it must compete with other tree species. Loss of shore pine on sites with low soil pH may create a void that other tree species are maladapted to fill.

DESCRIPTION:

1) Background: FIA data is designed to act as an early-indicator of forest health problems, and the unexplained mortality of shore pine in SE Alaska warrants further attention in the form of a systematic ground survey. Damage and mortality of shore pine has not been mapped through aerial survey, and it is possible that widespread, low density mortality is not apparent from the air, or that shore pine mortality was masked by other damage (e.g. yellow-cedar decline).

    There is limited knowledge of the biotic damage agents of shore pine. Specifically, information is needed on foliar and canker pathogens, and pathogenic fungi and insects that enter through western gall rust (*Endocronartium harknessii*) cankers and cause branch and bole girdling. Sarah Bisbing, a Colorado State graduate student conducting research on shore pine in SE Alaska, has observed deterioration in the health of shore pine at several study sites near Juneau over the last three years, possibly associated with foliage disease and/or mortality of gall rust-infected branches. Damage to shore pine foliage has also been reported on Prince of Wales Island, Sitka and other locations. Severe, repeated defoliation caused by *Lophodermium seditiosium*, *Dothistroma pini*, other foliar pathogens, or the lodgepole needle miner (*Coleotechnites milleri*) may contribute to mortality. Western gall rust cankers generally do not directly cause branch mortality, but secondary insects and pathogens are attracted to galls and may girdle branches or boles. In N California,

Nectria fuckeliana, Gibberella lateritium and *Diplodia pinea* were associated with dead/dying gall-infected branches of shore pine and other coastal pine species (Byler et al. 1972). Bark beetles and cone moths were also common, particularly *Pityophthorus*, *Ips radiata* and *Dioryctoria*.

2) Methods: Evaluation and monitoring of shore pine health will be conducted through installation of permanent monitoring transects at 5 locations throughout SE Alaska (Juneau/Douglas, Hoonah, POW, Wrangell and Petersburg), with 10 plots at each location. These locations are well-distributed throughout SE Alaska and have abundant shore pine habitat that can be accessed by road or hiking trail. To focus the sampling effort, emphasis will be placed on stands with visible shore pine foliage disease, dieback and mortality. Variable length transects will account for the variable density of shore pine stands, and live trees will be tagged to allow for long-term monitoring. Information that will be collected from live trees includes dbh, height, years of foliage retention, number of galls and year of gall formation. Branches will be systematically collected from every 10th sample tree at each site to allow for closer examination and quantification of foliar pathogens and insects. Size and damage information will be recorded for dead trees. It will also be important to collect information on abiotic factors that may be important to shore pine health, including minimum/maximum water table depth, soil and air temperature, soil pH and other basic site characteristics. Utilization of ecological and hydrological data collected by Sarah Bisbing in Juneau will allow us to explore relationships between shore pine health and abiotic factors.

   To complement the installation of ground survey plots, assistance with foliar and canker pathogen identification will be provided by experts from British Columbia, Dr. Alex Woods (BC Ministry of Forests) and Dr. Kathy Lewis (University of Northern British Columbia). A portion of the cost of their visit to SE Alaska will be incorporated into the project budget ("BC Expert Visit"). Another priority will be Tara Barrett's continued analysis of FIA shore pine re-measurement plot data as it becomes available (expected Jan 2012), and a contribution to cover her time has also been budgeted. This analysis will provide an important means of identifying geographic or other patterns relevant to biotic or abiotic damage agents or host conditions of shore pine.

3) Products: FHM meeting poster; first and final year reports; baseline information on agents impacting shore pine health; potential recommendations for shore pine management; report or publication blending findings from FIA analysis and ground surveys; a permanent plot network for long-term monitoring of shore pine health.

4) Schedule of Activities: In 2012, Alex Woods and Kathy Lewis will visit SE Alaska to provide expertise on foliar and canker pathogens, and Tara Barratt will continue analysis of FIA plot data. Reconnaissance work will be conducted at all five field locations. Plot installation will begin, with a focus on biotic damage agents. In 2013, plot installation will continue, and additional abiotic information may be collected if it is determined that the damage observed in 2012 is insufficiently explained by biotic agents. Plots installed in 2012 will be resurveyed in 2013 to document changes in survival, foliage retention, symptom expression, etc. In 2013, work can begin on a formal report or publication incorporating the results of the survey and FIA analysis.

5) COSTS: 2013 costs are expected to be similar to 2012, minus "BC Expert Visit" (2013: $23,000).

2012 BUDGET	**Item**	**Requested FHM EM Funding**	**Other-Source Funding**	**Source**
Administration	Salary		$12,000	Base FHP
	Overhead		$750	Base FHP
	Travel	$11,500	$3,000	Base FHP
Procurements	BC Expert Visit	$4,000		
	Tara Barrett Analysis	$5,000	$5,000	PNW (Salary)
	Supplies	$1,500		
	Seasonal Technician	$5,000	$6,000	Base FHP
Total		**$27,000**	**$26,750**	