STUDY PLAN

Applied Silvicultural Assessment:

Quaking Aspen Affected by Sudden Aspen Decline in Southwestern Colorado

U.S. FOREST SERVICE
Rocky Mountain Research Station
Rocky Mountain Region, Forest Health Protection
Grand Mesa, Uncompahgre, Gunnison NF

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INTRODUCTION

In Colorado, aspen (*Populus tremuloides*) is the dominant forest cover on 2,635,000 acres (USFS Forest Inventory and Analysis data). Since 2004, USFS Forest Health Management aerial surveys and local field observations have reported a rapid increase in crown dieback and stem mortality in Colorado's aspen. State wide aerial surveys from 2006 indicate that approximately 138,000 acres (5.2%) of aspen forest were experiencing this type of rapid decline. In 2007, nearly 340,000 acres of aspen damage were recorded or 12.8% of the 2,645,000 acres of Colorado's aspen forest. Site specific data from the Mancos-Dolores Ranger District, San Juan National Forest showed a three to five-fold increase in aspen stem mortality from 2003 to 2006 (Worrall et al., 2007).

This rapid decline in aspen is attributed, in part, to the following group of biotic agents: Cytospora stem canker (usually caused by the fungus *Valsa sordida*), aspen bark beetles (*Trypophloeus populi* and *Procryphalus mucronatus*), poplar borer (*Saperda calcarata*), and bronze poplar borer (*Agrilus liragus*), all of which typically affect stressed trees (Worrall et al., 2007). Recently this type of rapid decline in aspen has been termed "Sudden Aspen Decline" (SAD) to distinguish it from other types of aspen declines attributed to fire exclusion and the associated succession of conifer species, and extreme browsing pressure from large ungulates like deer and elk (Romme et al., 1995; Kay, 1997; Bartos, 2001; Ripple and Larsen, 2000; Kulakowski et al., 2004; Kaye et al., 2005; Smith and Smith, 2005).

Aspen typically regenerates by profuse root suckering following a disturbance. It is not uncommon to have aspen clones produce tens of thousands of suckers per hectare following clearfell harvesting (Shepperd 1993). Uncut, intact aspen stands typically have about 2,500 suckers per hectare in southwestern Colorado (Crouch, 1983). In stands with heavy mortality attributed to SAD, Worrall et al. (2007) found sucker densities at or below the range typical of uncut stands, indicating that there has been little to no suckering response to the overstory mortality. This lack of a suckering response raises questions regarding the root condition of SAD-impacted stands and their ability to regenerate. Shepperd et al. (2001) found that the root systems of non-regenerating aspen do decline when the clones do not periodically self regenerate. If root system mortality is also occurring in stands affected by SAD, entire aspen clones could be lost in a short amount of time since initially it appears that self regeneration is not occurring. However, if aspen could be stimulated to sucker before all overstory stems are lost, clones might survive.

The potential loss of aspen clones in some aspen dominated landscapes could be quite profound to aspen ecosystems and local economies. Aspen has long been recognized for its rich diversity of understory plant species and diversity of bird and mammal habitats. Aspen is also extremely important to many local economies for its scenic value, production of forage for domestic livestock, production of wood products and water absorption capacity for downstream domestic and agricultural purposes. If affected aspen clones are to persist on the landscape then intensive management activities may be needed to induce a more severe disturbance and initiate a sprouting response from the remaining "healthy" portions of the clone.

This proposal describes an assessment to determine if the silvicultural system of clearfell harvesting can initiate a sprouting response in stands affected with varying amounts of SAD. Knowing at what level of overstory mortality an aspen stand can still be successfully regenerated could be used to develop management guidelines to minimize the loss of aspen clones and prioritize aspen stands for treatment.

OBJECTIVES

1. Determine aspen sprouting response and survival following treatment by clearfell harvesting of aspen stands with varying levels of crown dieback and mortality attributed to SAD.
2. Based on results, develop management guidelines to prioritize aspen stands for treatment.

METHODS

Study Area

The study area is located within the Terror Creek and Alder Creek watersheds of the Paonia Ranger District on the Gunnison National Forest in southwestern Colorado. This area was selected because the lower portions of the watershed are dominated by pure aspen stands (no conifer species present) that have varying levels of SAD. This area also has a 20 year history of successful aspen management indicating that in the past aspen stands and site conditions were fully capable of regenerating new aspen stands following clearfell harvesting prior to the occurrence of SAD.

Study Design

Stands proposed for treatment will be stratified into three categories of crown dieback and mortality (0-20%, 20-60% and 60+ %). Preliminary identification of candidate stands will be completed using 2007 aerial photos of the Terror Creek area. Field verification will follow and adjusted as necessary to obtain final stand selections that meet the study criteria. Dieback categories will be established on a stand basis by determining the percentage of the overstory basal area that has died or is in decline (thin crowns, small chlorotic leaves). This can be determined from a prism tally of overstory trees (those larger than 5.0 inches in diameter at breast height (dbh). Stands with self-regenerating understories will not be selected for treatment. Understory stems are any aspen in the seedling (<1.0 in. dbh) or sapling (1.0 to 4.9 in. dbh) size class. The stocking level of understory stems determining whether a stand can be considered self-regenerating, regardless of overstory mortality,will be based on local stocking conditions within the Terror Creek study area. The rationale behind this approach is to determine whether non-self-regenerating aspen that are in decline can be stimulated to produce new suckers by a clearfell harvest.

This will be a paired study in that stands selected for treatment will be split, so that one portion will be randomly selected for harvest treatment and another will remain untreated. This will allow testing of harvest treatment effects across the three crown dieback categories. Pairing will also minimize site and genetic (clonal) variation in treatment response, as variation in those factors should remain constant within a selected stand. In so far as possible a paired treatment / non-treatment unit will be selected within a single clone, as identified by phenotypic characteristics. A minimum of three replications will be chosen for each crown dieback category, which will require a total of nine candidate stands. Selected stands should be on operable terrain within 1,300 ft of an existing road. Selected stands within each block should be a minimum of five acres, be located on similar elevation, aspect, and soil type. Each block should be within the same grazing allotment to avoid the potential of different timing and exposure to browsing animals within a block. After harvest treatments have been randomly assigned, a five acre monitoring area will be delineated in each un-harvested and harvested treatment that is representative of the stand and not impacted by logging operations (e.g. skid trails, landings, etc).

Pre-harvest Field Data

- Within each monitoring area five variable radius inventory plots will be established using a BAF 10 or 20 prism factor (yielding an average of 4-10 trees/point). Plot centers in harvested treatments will be marked with 4-foot steel T-posts, those in un-harvested treatments will be marked with PVC stakes. Plots will be established by randomly locating an initial point near the edge of a monitoring area (walk 100 ft into the stand, select a random distance and bearing from computer generated tables and navigate to the first point), with the remaining points placed on a systematic grid within the monitoring area on compass bearings at measured distances apart. GPS all points and record all bearings (with declination setting used) and distances between points to facilitate re-location of missing stakes in future data collections. GPS plot centers in UTM, NAD83.
- Record site characteristics of slope, aspect, elevation and dominant shrub, grasses, and forb species at each plot.
- Record light interception at each plot using a light interception meter (Decagon Accupar LP - 80 ceptometer).
- For each tree greater than 5 inches at DBH measure and record: tree species, tree status (live, dead, or declining), DBH, height, % recent crown loss (on sampled stems), presence/absence of listed aspen damaging agents and for dead trees record the estimated time since death (≤ 5 years or > 5 years [no bark]). Trees will be measured beginning at true north and proceeding clockwise around the plot.
- For each plot take an increment core from the first live tree on the overstory plot greater than 5 inches at DBH. Place cores in paper straws and label as to stand, plot, and tree. Carry straws in a capped plastic PVC tube to avoid damage. Mount increment cores in wood trays for later aging in the lab.
- Nest a 1/100th acre fixed radius plot inside of the larger plot to sample trees less than 5 inches at DBH. Tally trees by tree status, size class and damage code. Establish an additional ten 1/100th acre fixed radius plots between each pre-treatment overstory plot (with an additional plot located beyond the last pre-treatment plot). Permanently mark and label these plots with T-posts, or PVC stakes and record bearings and distances between plots as above, and GPS plot centers in UTM, NAD83.
- Take a cross-sectional wood disk from the base of one tree in the seedling size class (< 1 inch at DBH) and collect an increment core from the first tree in the sapling size class (1 to 4.9 inches at DBH) on the plot. Label the wood disk or core as above, and place in a labeled paper bag, stapled shut. Aging will occur later in the lab.

Logging Operation Specifications

- Ground based logging equipment will be used. Although the timber sale contract cannot specify the logging equipment used, it would be very unlikely that the trees would be hand felled. Timber purchasers in the local area typically use feller-bunchers to cut trees and grapple skidders to move trees to landings.
- Minimize the number and size of skid trails and landings to minimize the amount of soil compaction that could impede a sprouting response. This would limit the sum of detrimentally compacted, eroded, and displaced soil to no more than 15% of any activity area as specified in Forest Service Handbook 2509.25_14.1-Management Measure (13) (USDA Forest Service 2006a). This standard is achieved through the timber sale contract

under provision B6.422 Landings and Skid Trails. Location of all landings, tractor roads, and skid trials shall be agreed upon prior to their construction. The cleared or excavated size of landings shall not exceed that needed for efficient skidding and loading operations (USDA Forest Service 2006b).

- Operations to be conducted when soils are dry, frozen, or covered by snow to minimize soil compaction.
- Slash disposal by lop and scatter. No more than 30% to 40% of an area will be covered with large cull logs as specified in timber sale contract provisions. (USDA Forest Service 2006c)
- Recent (≤ 5 years) standing dead aspen will be required to be removed.
- Control of Operations. Group treatment replicates into one payment unit. Require entire payment units to be cut out prior to opening the next payment unit. Require payment units to be cut in the same operating season.
- In order to control other factors that may influence aspen sucker survival, like domestic livestock and/or big-game wildlife grazing and browsing pressure, construct big-game fences around the five-acre monitoring areas.
- Payment units in the timber sale should be designated so that all blocks get harvested in a timely manner within the same year.

Post-harvest Field Data

- The pre- and post treatment sample design will be the same on both harvested and un-harvested treatments. All plots will be re-sampled following the first full growing season after harvest and yearly thereafter for a total of 5 years. All plots in harvested treatments will be re-measured following criteria for fixed-radius understory plots. Both overstory and understory plots will be re-measured annually in un-harvested treatments. This will allow monitoring of overstory mortality and any subsequent sprouting on untreated plots as well as quantification of the sprouting response to treatment.
- On understory (regeneration) plots, tally trees by tree status, size class and damage code (including diseases, insect, climatic, and animal damage). Note other site factors on the plot like the presence of skid trails, landings, or heavy slash that may influence a sprouting response.
- Re-inventory the untreated overstory plots in the untreated portion of the stand. Tally "in" trees, % recent crown loss, presence/absence of listed aspen damaging agents and for dead trees record the estimated time since death (≤ 5 years or > 5 years [no bark]). Also re-inventory light interception.
- Repeat post-harvesting sampling the 2nd through 5th years after harvest to measure survival and additional ingrowth of aspen suckers. Schedule sampling to occur at approximately the same time of year as the first year of sampling.

ANALYSIS

The Split Plot design of this study consists of paired treated and untreated sampling units selected at three initial levels of overstory mortality that are replicated at three locations in the Terror Creek landscape and sampled each year for five years.

ANOVA MODEL

Source of Variability	DF
Overstory Mortality Level	3-1 = 2
Reps within Mortality Level	3*(2-1) = 3
Treatment	2-1 = 1
Treatment * Mortality Level	1*2 = 2
Treatment * Reps within Mortality Level	1*3 = 3
Time	5
Time * Overstory Mortality Level	5*2 = 10
Time * Treatment	5*12 = 5
Time * Treatment * Overstory Mortality	5*1*2 = 10
Residual	5*3*2 = 30

These data will be analyzed using PROC GLMMIX in SAS, which allows modeling logistic and binomial response data with both fixed and random effects. It can also help deal with overdispersion issues, which may occur in this case.

APPLICATION and DISSEMINATION OF RESEARCH RESULTS

Meeting the objectives of the study will result in an understanding of how rapidly declining aspen stands respond to clearfell harvesting. The results obtained from the Grand Mesa, Uncompahgre and Gunnison (GMUG) National Forests will be applicable to other National Forests, as well as state and private lands, in the Rocky Mountain region and throughout the western U.S, where aspen stands are declining due to the phenomenon of SAD. The results could be most valuable in designing intensive silvicultural practices to retain aspen clones and prioritize stands for treatment. A final report of results will be prepared and submitted for publication in a suitable outlet. In addition, aspen management guidelines will be prepared and provided to the GMUG National Forest as well as other National Forests and land management agencies where the results are applicable.

SAFETY AND HEALTH

Data collection procedures will involve working in a forested field environment with exposure to such elements as extreme temperatures of heat or cold, wind, rain, lightning and/or snow. At the study site, travel will be by foot through rugged terrain and will require personnel to carry and use equipment such as hatchets, small saws, increment cores, chaining pins and T-posts. Potential hazards and abatement actions, associated with this type of work, are well documented in

Job Hazard Analyses (JHAs) developed by the local forest under similar work projects such as "timber field work", "silvicultural reconnaissance", and "regeneration surveys". The local forest will also be responsible for the preparation and administration of the timber sale. Again, JHAs have been developed that cover these project work activities.

Specified safety equipment, like hard hats, will be supplied to and used by field crews. All personnel will be trained in the proper operation of equipment.

ENVIRONMENTAL CONSIDERATIONS

This study plan does involve the harvesting of timber from National Forest System lands administered by the GMUG National Forests. Environmental analysis of the timber harvest is required under the National Environmental Protection Act (NEPA). The GMUG National Forest is proposing to use the authorities under the Healthy Forest Restoration Act (HFRA), to rapidly assess the proposed silvicultural approach to address SAD. Title IV – Insect Infestations and Related Diseases, Section 404, provides for applied silvicultural assessments, on Federal land that is at risk of infestation by or is infested with, forest-damaging insects. Assessments carried out under Section 404 on not more than 1,000 acres may be categorically excluded from documentation in an environmental impact statement or environmental assessment under NEPA. The Grand Mesa Uncompahgre Gunnison National Forest plans to conduct public scoping and sign the decision memo for this applied silvicultural assessment prior to the 2008 field season.

PERSONNEL ASSIGNMENT

Dr. Dale L. Bartos will be the principle investigator responsible for the study. In cooperation with Colorado State University, Dr. Wayne D. Shepperd (Research Scientist) and Dr. F.W. (Skip) Smith (Professor of Silviculture) will serve as project leaders responsible for over all data collection and analysis. The following personnel from USFS Rocky Mountain Region's Forest Health Management (Gunnison Service Center, (GSC)) will serve as technical consultants in the fields of pathology and entomology, initial stand selection, and public involvement: Jim Worrall (pathologist), Roy Mask (entomologist) and Tom Eager (entomologist). Carol McKenzie (silviculturist/timber management assistant) from the GMUG National Forest, Paonia Ranger District, will be responsible for overall project coordination, initial stand selection, public involvement, environmental analysis under NEPA, silvicultural prescriptions and timber sale preparation.

BUDGET

This budget was developed under the assumption that collaborators would share the workload of establishing and maintaining the study, with RMRS and CSU being responsible for data collection associated with the study with help from the Gunnison Service Center. The GMUG NF's would be responsible for initial sale prep and treatment costs and provide administrative oversight for the study. Actual budget distribution and responsibility among collaborators could shift, depending upon funding sources for the study.

TOTAL PROJECT BUDGET from 2008 through 2013				
	Rocky Mountain Research Station (RMRS)	**Colorado State University (CSU)**	**Region 2's Gunnison Service Center (GSC)**	**Grand Mesa, Uncompahgre and Gunnison National Forests (GMUG)**
TOTAL	**69,000**	**176,410**	**88,200**	**80,600**

Fiscal Year 2008 BUDGET				
Description	**RMRS**	**CSU**	**GSC**	**GMUG**
Personnel Salary				
Research Scientist				
Research Scientist		4000		
Research Scientist		4000		
Research Technicians	2500	4800		
Supervisory Entomologist			2,700	
Pathologist			5,200	
Entomologist			2,900	
Biological Science Technician			3,400	
Silviculturist				12,000
Sale Prep Foresters				7,900
Supervisory Forestry Technician				1,400
Forestry Technicians				17,400
Equipment and Supplies				
T-posts		540		
Marking paint				2,300
Flagging		200		200
NEPA (legal notices, printing, postage)				200
Scientific equipment and supplies	2000			
Travel and Pre-diem	5000	3000		700
Vehicles and Mileage	2000	600	500	1,500
2008 BUDGET TOTAL	**11,500**	**17,140**	**14,700**	**43,600**

Fiscal Year 2009 BUDGET				
Description	**RMRS**	**CSU**	**GSC**	**GMUG**
Personnel Salary				
Research Scientist				
Research Scientist		4000		
Research Scientist		4000		
Research Technicians	2500	3200		
Supervisory Entomologist			2,700	
Pathologist			5,200	
Entomologist			2,900	
Biological Science Technician			3,400	
Silviculturist				3,000
Timber Sale Administrator				19,000
Equipment and Supplies				
Fence Installation		54,000		
T-posts		270		
Scientific Equip & Supplies	2000			
Travel and Pre-diem	5000	2000		
Vehicles and Mileage	2000	600	500	1,000
2009 BUDGET TOTAL	**11,500**	**68,070**	**14,700**	**23,000**

Fiscal Years 2010, 2011, 2012, 2013 BUDGET				
Description	**RMRS**	**CSU**	**GSC**	**GMUG**
Personnel				
Research Scientist				
Research Scientist		4000		
Research Scientist		4000		
Research Technicians	2500	3200		
Supervisory Entomologist			2,700	
Pathologist			5,200	
Entomologist			2,900	
Biological Science Technician			3,400	
Silviculturist				3,000
Equipment and Supplies				
Fence maintenance/removal		9,000		
Scientific Equip & Supplies	2000			
Travel and Pre-diem	5000	2000		
Vehicles and Mileage	2000	600	500	500
Per Year BUDGET TOTAL	**11,500**	**22,800**	**14,700**	**3,500**
Combined BUDGET TOTAL	**46,000**	**91,200**	**58,800**	**14,000**

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