Poster Abstracts

100 Years of Landscape Change in the North Fork of the Gunnison River Valley, Colorado

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Vegetative changes on western landscapes continue to be questioned, discussed, and debated. The author researched historic writings describing presettlement explorations, surveys, and studies to determine vegetative conditions at the time of American settlement. Research included rephotographing 46 landscape photographs taken from 1887 to 1916. Results indicated (1) most vegetative changes have occurred in and around the towns and settlements; (2) sagebrush grasslands have been extensively modified by intensive agriculture; and (3) widespread increases in woody vegetation. These include increases in pinyon/juniper woodlands; increases in the mountain shrub communities; and three distinct trends in the aspen forests: (a) most aspen are older, mature, and becoming decadent, (b) some aspen have increased into meadows and parks, (c) conifers have invaded some aspen stands that existed 100 years ago, and (d) subalpine conifer forests are bigger, older, and healthier.

Aspen Regeneration in the Book Cliffs

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In the Book Cliffs of eastern Utah, the Bureau of Land Management noticed that Douglas-fir appear to be increasing in abundance at the expense of quaking aspen in the Douglas-fir/aspen ecosystem. The purpose of this study is to assess the vigor of the aspen stands. In order to do this, the Douglas-fir/aspen ecosystem, a 30 mile x 2 mile (46 km x 3 km) study area, was divided into three sections. Eighty-six stands larger than 0.1 ha were delineated on topographic maps. For each stand selected, a transect was established that bisects its long axis. Sample points, representing plot centers, were then placed at 40 m intervals along the transect and GPS referenced, allowing for a 20 m buffer from the edge of the stand. Twenty-six stands were sampled with a grand total of 157 plots. Each sample stand was rated for vigor as follows: (1) vigorous, pure aspen; (2) declining, pure aspen; (3) declining aspen with Douglas-fir in the understory; (4) declining aspen with Douglas-fir in the overstory; and (5) predominantly Douglas-fir with declining aspen. No stands were found in the first category, 73 stands were found in the second category, 55 were found in the third category, 14 stands were found in the fourth category, and 15 stands were found in the fifth category. Most of the aspen stands need to be rejuvenated, but the animal pressure needs to be considered before anything is done—otherwise all of the aspen suckers will be eaten.

Genetic Variation Among Isolated Populations of Quaking Aspen: Implications for Species Conservation and Management

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In the Blue Mountains of eastern Oregon, aspen stands representing the western fringe of the species range are in rapid decline and at risk of extirpation. We investigated the genetic structure of these stands to develop recommendations for the management and conservation of aspen genetic resources. We also were interested in using genetic information to make inferences about the historical distribution of aspen in this area. Forty-five stands were analyzed for isozyme variation at 18 loci. Overall, we found relatively high levels of allozyme variation, with 72% of the loci polymorphic and an average of 2.4 alleles per locus. Individual stands were much less variable, with 24% of the loci polymorphic, and an average of 1.3 alleles per locus. About half (47%) of the stands appeared to be single clones, while only a few contained more than 10 clones, indicating that sexual reproduction has played a minor role in aspen regeneration. We also found genetic evidence that one or more geographically disjunct clones may well have been part of a large contiguous stand in historical times. The level of genetic differentiation among stands was very high, which has several implications for conservation and ecological restoration efforts. Most importantly, we have allocated our limited resources to locate and protect as many relict stands as possible, rather than trying to conserve all the clones within the larger stands. We discussed additional applications of these results to the conservation and management of aspen in the Blue Mountains, including the development of plant materials for artificial regeneration, and silvicultural methods to enhance stand regeneration.

Restoring Fire Process and Function at the Site and Landscape Scale

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The Powell Ranger District, Dixie National Forest (R4), completed a landscape scale vegetation analysis for the Sevier Plateau. The focus of this 310,000 acre assessment, including multiple land ownership, was to determine vegetation changes that had occurred over the past 100–150 years as a result of management practices and the exclusion of fire. The assessment looked at ecosystem processes of disturbance pattern, structure, and composition to determine if this landscape is functioning and that vegetation patterns are sustainable. The findings of the interdisciplinary team assessment showed that many vegetation types on the Sevier Plateau were being impacted by successional change, which was placing many of these types at risk due to insect, disease, and wildfire potential. It was noted that the aspen ecosystem had been modified to the point that as much as 60% of the landscape had changed from aspen dominance to late seral conifer dominance. The outcome of this assessment was a proposal to reintroduce disturbance patterns into the landscape through the use of prescribed fire and wildfire for resource benefit (PNF). The plan was intended to treat many of the vegetation types to create change over the entire landscape rather than just focusing on a small portion of the Plateau. The first project to be implemented was the Jones Corral Vegetation Project encompassing 26,000 acres of the assessment area. Approximately 6,000 acres were targeted for burning. In June 1997, approximately 1,000 acres of aspen-conifer, in patch sizes from ¼ acre to 150 acres in size, were prescribe burned in a stand replacement treatment to initiate new aspen regeneration. During a 1998 monitoring visit to the treatment area, it was determined that as many as 150,000 aspen suckers per acre had regenerated with growth of the dominant suckers reaching 3 feet in height. During a 1999 visit, growth of the dominant suckers was approaching 6 feet. Additional burning was completed in 1999 (currently totaling 15,000 acres across the Plateau). Additional planning efforts are ongoing to implement additional treatments over the next decade.

Production and Total Root Carbon Allocation for Single-Storied and Multi-Storied Aspen Stands in Southern Wyoming

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We compared aboveground net primary production (ANPP) and total root carbon allocation (TRCA) of vigorous, single-storied aspen stands to that of mature, multi-storied stands to address the issue of long-term aspen stand stability in the central Rocky Mountains. We also examined differences in leaf area efficiency (LAI) and growth efficiency (E_{ANPP}) between the two stand structures.

The single-storied sites were young and even-aged, with a mean age of 19 years. Tree heights, diameters, and ages were normally distributed. The multi-storied sites were uneven-aged, with tree ages ranging from 23–146 years; the stands exhibited negative exponential, or "inverse-j" shaped age, diameter, and height distributions. Total ANPP at the single-storied sites was approximately half of the total ANPP at the multi-storied sites (112 g C m^{-2} y^{-1} and 240 g C m^{-2} y^{-1}, respectively). Stemwood and foliage production at the single-storied sites were also only half of that at the multi-storied sites. The single-storied sites produced 44 g C m^{-2} y^{-1} of stemwood and 59 g C m^{-2} y^{-1} of foliage, while the multi-storied sites produced 113 g C m^{-2} y^{-1} of stemwood and 117 g C m^{-2} y^{-1} of foliage. LAI was 1.0 at the single-storied sites and 2.0 at the multi-storied sites. E_{ANPP} for the two stand structures did not differ ($p = 0.47$); E_{ANPP} was 111 g C per m^2 of leaf area (LA) at the single-storied aspen sites, and 120 g C per m^2 LA at the multi-storied sites. Soil respiration was significantly higher at the multi-storied sites than at the single-storied sites for all months that it was measured. Growing-season soil respiration was 400 g C m^{-2} at the single-storied sites and 561 g C m^{-2} at the multi-storied sites ($p = 0.03$). When the estimated below-snow values were added, annual soil respiration was 502 g C m^{-2} at the single-storied sites and 664 g C m^{-2} at the multi-storied sites ($p = 0.03$). TRCA was also higher at the multi-storied sites, although the difference was not significant. The single-storied sites allocated 394 g C m^{-2} to the roots, while multi-storied sites allocated 500 g C m^{-2} ($p = 0.14$).

Results from this study do not provide any evidence of lowered productivity at the older, multi-storied sites. These findings shed a positive light on the possibility of long-term persistence of Rocky Mountain aspen stands growing in a multi-storied stand structure.

Environmental Influences on Aspen Regeneration Failure

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Seven study sites were established on the San Juan, Grand Mesa, Uncompahgre, and Gunnison National Forests and State lands near the Routt National Forest to determine what environmental conditions predisposed aspen sprouts to infection by two canker-causing fungi (*Cytospora chrysosperma* and *Dothiora polyspora*). Each site was located where >95% aspen sprout mortality occurred in 1983, 1987, or 1990 and consisted of whole stands or portions of stands that ranged from two to 10 acres. At each site, a plot with >95% sprout mortality was paired with a plot within the stand or within 2 miles where at least 50% of the sprouts survived. Measurements of past meteorological conditions, current soil conditions, soil hydrologic factors, and current and previous stand conditions were taken during the summers of 1990 to 1993. Two scenarios explain the aspen regeneration failure at the seven study sites: (1) On "wet" sites, excess soil moisture (resulting from deep and late spring snowpacks on poorly drained soils) predisposed aspen trees to infection by canker pathogens. Root mortality from soil flooding and drought in mid summer may have caused drought stress. (2) On dry sites, drought conditions from low spring snowpacks and reduced summer precipitation on soils with poor water-holding capacity predisposed aspen trees to infection by canker pathogens. In addition, shallow rooting induced by a high water table appears to be related to potential drought on dry sites.

Predicting where mortality will occur is difficult because previous stand characteristics were not different between areas with or without sprout mortality. Soil differences were specific to a site and thus the soil conditions were not similar on all sites. Predicting when mortality will occur may be feasible with additional research that relates sprout health to the amount of water in spring snowpacks, summer precipitation, and Palmer Drought Index data. Failure of aspen regeneration will probably continue to occur. Based on 8 to 60 years of meteorological data, deep May snowpacks occur about 26% of the years at the study sites and shallow snowpacks occur 8% of the years.

Influences on Regional Timing of Aspen Regeneration in the Colorado Front Range

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Regional patterns in quaking aspen establishment can be influenced by a variety of factors, including climate, human land-use, and forest dynamics. We looked at the timing and frequency of aspen regeneration between 1860 and 1990 in Rocky Mountain National Park and the Roosevelt National Forest in the Front Range of Colorado. We related spatial and temporal patterns of aspen regeneration with regional climate and grazing history. A drought severity index was used to represent regional climate. Historical elk populations for the National Park and cattle populations for the National Forest were used to reconstruct grazing intensity. We found that climate explained approximately 30% of the variance ($p < 0.05$) of aspen establishment at high elevations in the elk summer range and in Rocky Mountain National Park. We found that aspen regeneration was consistently higher in the elk summer range than in the winter range and that regeneration was more frequent in Rocky Mountain National Park between 1900 and 1970 than in the Roosevelt National Forest. In the 1970s and 1980s aspen regeneration was more frequent in the National Forest. We conclude that in the absence of grazing pressure, climate has an influence on aspen regeneration. However, when grazing is present, it plays a dominant role in influencing aspen regeneration.

Effects of Prescribed Fire on Aspen Within a Mixed Ponderosa Pine/White Fir Forest at Grand Canyon National Park

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Grand Canyon National Park's fire effects monitoring program collects data throughout the Park before and after prescribed fire. As part of this program, the Park's forests have been divided into several types, each of which has relatively homogeneous vegetation and can be burned similarly throughout. One of the types found on the north rim of the canyon is composed of ponderosa pine mixed with white fir and, often, with aspen. The primary objectives of prescribed fire in this type are to reduce fuel loads, to reduce white fir pole density, and to maintain large ponderosa pine. We are interested in determining whether the fire prescription currently used to meet these objectives will also maintain aspen as a component within these stands. From 1993 to 1998, we collected data on overstory, pole, and seedling/sucker density for all species in 0.1 hectare rectangular plots. Because not all plots contained aspen, data are somewhat limited, but currently, we have data from 5 years postburn on two plots, 2 years postburn on four plots and 1 year postburn on six plots. These earliest results suggest that competition from white fir seedlings may limit aspen regeneration.

Aspen Regeneration Following Two Episodes of Wildland Fire on Shadow Mountain, Wyoming

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The regenerative response of aspen was monitored following two spatially overlapping wildland fire events on Shadow Mountain, Wyoming. The two fires occurred 6 years apart. The fires left a landscape mosaic of unburned, once-burned, and twice-burned aspen stands ranging in size from approximately 1.0 to 12.0 hectares. Aspen suckering in burned areas was significantly greater than that observed in unburned areas. Less regeneration occurred on plots that burned for a second time than on those which burned only once; however, by the second year postfire, sucker numbers on the reburned plots were not significantly lower than on the plots that burned only once. Self-thinning of suckers observed on the plots that burned only in the first fire suggests that sucker numbers on once-burned and twice-burned plots will converge over a 6- to 10-year period. Sucker numbers on burned plots appear sufficient for stand replacement, while those on unburned plots are very low, consistent with seral aspen stands that, in the absence of disturbance, may be subject to significant conifer encroachment or replacement.

Old Aspen Trees in Colorado

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In 1999, seven mixed-species stands composed of aspen, Engelmann spruce, and subalpine fir were sampled to determine establishment patterns, height growth rates, and shifts in dominance. Five out of the seven stands sampled contained aspen trees at least 220 years of age, including five trees over 250 years old and one tree that was at least 276 years old. The site of this oldest known aspen tree occurs on a northern aspect at 2,830 meters elevation on the Paonia Ranger District, Gunnison National Forest. Before this study, the oldest aspen tree recorded was 249 years of age (Abolt, R.A.P. 1997. Fire histories of upper elevation forests in the Gila Wilderness, New Mexico via fire scar and stand age structure analyses. M.S. thesis, The University of Arizona, Tucson. 120pp.).

Classification of Vegetation and Fuels in Aspen Communities in the Area of Los Alamos, New Mexico

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As part of an ongoing vegetative community classification/fuel hazard estimation project in and around Los Alamos National Laboratory, several aspen communities were sampled. Some differences in understory community structure were found, and the various communities did not always fit into current classification systems. Evaluation of fuel loads within these communities were lower than adjacent spruce/fir communities. The lower canopy density, with the resultant increase in understory vegetation, along with a reduction in ladder fuels when compared to spruce/fir forests, confirm that these communities could act as firebreaks if wildfires were to ignite in this area.

Modeling Understory Light in Young Trembling Aspen Stands

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The purpose of this study was to calibrate and validate the MIXLIGHT forest light model for use in immature aspen stands in boreal mixed wood forest of Alberta. This will allow the prediction of understory light regimes for stands of a range of height and density. Individual aspen tree characteristics needed to calibrate the light model include: leaf area, crown radius, crown length, height, diameter, and crown class. These were measured along with stand level attributes such as basal area, leaf area index, and stem density in 96 plots within relatively pure aspen stands ranging in age from 2 to 30 years old. Actual understory light as a percentage of above canopy light was also measured instantaneously in 17 separate plots during either overcast or clear sky conditions in order to validate the light model. Individual tree crown characteristics, such as leaf area, leaf area density, crown radius, and crown length, were best predicted by exponential functions of diameter at 30 cm; R^2 ranging from 0.59–0.69 for intermediate trees and from 0.78–0.87 for canopy trees. Including a measure of intraspecific competition, such as density or basal area, or using crown characteristics as a proportion of total tree height did not improve the prediction. Horizontal crown overlap was estimated for stands of various heights and was found to decline with increasing height. The validation of MIXLIGHT and subsequent prediction of light in young aspen stands of differing height and density is ongoing.

Status of Aspen and Manipulation of Stands in the Sierra Nevada of California

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Few studies have been conducted on the status of aspen in the Sierra Nevada in contrast to the Rocky Mountains and Intermountain West. There is a paucity of landscape-scale condition information and accurate vegetation classification of the aspen community type in the Sierra bioregion. We conducted aspen stand condition inventories on three National Forests across the Sierra Nevada to get an indication of the status of aspen. Our results indicate that the majority of aspen stands in the three forests are subject to the same factors implicated in the decline of aspen in the Rocky Mountains and Intermountain West. We also examined pretreatment and posttreatment conditions in stands manipulated for

aspen restoration. Stands manipulated with conifer removal or prescribed fire treatments appeared to largely achieve restoration objectives with some exceptions. We speculate that moisture regime and uncontrolled livestock browsing were the factors that most influenced the failure to meet regeneration objectives. We recommend a Sierran-wide aspen condition inventory, development of an accurate vegetation classification map, and controlled research studies on treatment options in the Sierra if the ecological restoration of this community type in the Sierra Nevada is to be successful.

Population Biology of Aspen (*Populus tremula*)

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Approximately 30,000 mature aspens (d.b.h. >15 cm) as well as dead standing trunks and logs have been spatially mapped in an area of over 100 km^2, including both virgin areas with large amounts of aspen and ordinary managed forests, in east-central Finland (northern Europe). Trees with d.b.h. <15 cm, as well as small saplings, will be mapped on sample plots within the area in 2000–2001. Experiments will also be set up to study the establishment of root suckers in canopy gaps, browsing by moose, and minimum gap size for successful vegetative recruitment. The temporal and spatial dynamics of dead aspen in different decay classes will also be included in the analysis.

I will work at two hierarchical levels. At the individual tree and stand levels, key questions are reproductive biology and seed dispersal and regeneration in old-growth forests without large-scale disturbances. At the landscape level, the focus is on the clonal structure, dynamics, and spatial aggregation of mature aspen populations in managed and virgin forests.

A Remotely Sensed Aspen Deterioration Classification for the Study and Management of Quaking Aspen in the Intermountain West

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It has been shown that quaking aspen is quickly disappearing in the Intermountain West, thus altering the structure, function, and composition of the landscape into the foreseeable future. Before management action can be taken to restore the presence of this keystone species, cross-scale knowledge of the distribution and health of aspen clones must be obtained. Drawing upon a recently developed, field-tested aspen stand deterioration classification, a remotely sensed aspen deterioration classification is proposed. Five deterioration classes have been defined in a Douglas-fir/aspen ecosystem in the Book Cliffs of eastern Utah, and these will be correlated to LANDSAT-TM imagery to generate a supervised classification. This remotely sensed classification will be tested using other vegetation patches in the study area and may with equal ease be applied and tested in similar landscapes across the Intermountain West. After integration into a GIS, the classification will provide valuable information on the spatial distribution and health of aspen stands, environmental variables regulating aspen presence, and other information for the development of future silvicultural prescriptions.

Landscape Scale Restoration of Aspen and Mountain Brush Communities in Northern Utah

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Historically, periodic disturbances such as wildfire and windthrow played an important role in the vigor of aspen and mountain brush communities, contributing to a diversity of stand ages and structure. Cultural land management practices such as fire suppression and domestic livestock grazing introduced by Europeans since the late 1800s have translated into increasingly homogeneous landscapes, reduced biodiversity, and landscapes dominated by catastrophic disturbance. The change in forest structure and composition has caused a decline in ecological health in aspen and mountain brush communities. A long-term, landscape-scale aspen and mountain brush treatment project initiated on the Wasatch-Cache National Forest in northern Utah serves to target those aspen and mountain brush communities across a two district area that are approaching late successional stages due to a lack of natural disturbances. Disturbance was reintroduced in the form of prescribed fire to encourage the restoration of composition, structure, and function by allowing for periodic disturbance. Additional objectives of the treatment applications were to reduce hazardous natural fuels, increase biodiversity, increase the number of wildlife species (specifically big game, nongame, and upland game), maintain the long-term habitat stability at the landscape level, and increase the resistance of the landscape to insects and disease. Permanent monitoring plots were installed in all three areas. Monitoring will allow for adaptive management by reviewing effectiveness and applying appropriate variations to future applications. Monitoring variables include target species' regeneration success measured by species and number of stems, increase in species diversity, change in stand structure and composition, and change in fuel loading. Data collected will also provide for the development of custom fuel models for aspen-dominated stands. Future analysis will seek to validate these models.