Restoring the West Conference 2008: Frontiers in Aspen Restoration

September 16-18
Utah State University
Logan, UT

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Conference Co-chair
USU Forestry Extension

Paul Rogers
Conference Co-chair
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Agenda

Tuesday, September 16 Presentations, USU Eccles Conference Center Auditorium	
7:30 to 8:30 am	Registration; coffee and juice provided
8:30 to 8:55 am	*Welcome.* **Darren McAvoy**, Utah State University Forestry Extension Associate, **Dr. Johan Du Toit,** Department Head, Utah State University Department of Wildland Resources, and **Dr. Dale Bartos,** Ecologist, USDA Forest Service Rocky Mountain Research Station.
8:55 to 9:25 am	*Historical Landscape Ecology of Seral Aspen in the Western U.S.* **Dr. Paul Rogers**, Director, Western Aspen Alliance.
9:25 to 10:10 am	*Future Climates in Western North America.* **Dr. Robert Gillies,** Director, Utah Climate Center.
10:10 to 10:30 am	**Break**
10:30 to 11:15 am	*Gypsy Moth Risk Assessment in the Face of a Changing Environment: A Case History Application in Utah and the Greater Yellowstone Ecosystem.* **Dr. Jesse Logan**, Retired, USDA Forest Service Rocky Mountain Research Station.
11:15 to 12:00 pm	*The Physiological Ecology of Aspen-Conifer Interactions.* **Dr. Sam St. Clair,** Assistant Professor, BYU Department of Plant and Wildlife Sciences.
Noon to 1:30 pm	**Lunch (provided) and Poster Session (Room 205/207)**
1:30 to 2:00 pm	*Promoting Regeneration of Aspen in the Boreal and Montane Forests of Alberta.* **Dr. Victor Lieffers,** Professor, University of Alberta Department of Renewable Resources.
2:00 to 2:30 pm	*Aspen Utilization in the Intermountain West.* **Scott Bell,** Rural Community Assistance Coordinator, USDA Forest Service State and Private Forestry.
2:30 to 3:00 pm	*Various Means of Limiting Ungulate Use of Aspen Regeneration in the Black Hills.* **Dr. Dale Bartos,** Ecologist, USDA Forest Service Rocky Mountain Research Station.
3:00 to 3:30 pm	**Break**
3:30 to 4:00 pm	*Efficacy and Consequences of Aspen Treatments: The USU/Deseret Land & Livestock Manipulation Project.* **Dr. Joshua Leffler,** Research Assistant Professor, Utah State University Department of Wildland Resources.
4:00 to 4:30 pm	*Monitoring and Assessment of Vegetation Root-Zone Status in the T.W. Daniel Experimental Forest.* **Dr. Scott Jones,** Associate Professor, Utah State University Department of Plants, Soils, and Climate.
4:30 to 5:00 pm	*What Does the Forest Inventory & Analysis Soil Indicator Tell Us About Aspen Soils?* **Dr. Michael Amacher,** Research Soil Scientist, USDA Forest Service Rocky Mountain Research Station.
5:30 to 8:00 pm	**Reception** at Cafe Sabor, appetizers and cash bar (see included map).

Agenda, continued

Wednesday, September 17 Presentations, USU Eccles Conference Center Auditorium	
8:00 to 8:30 am	**Coffee and juice provided**
8:30 to 8:45 am	*Announcements and Day Two Preview.* **Darren McAvoy**, Utah State University Forestry Extension Associate.
8:45 to 9:30 pm	*The Economic Value of Aspen: Beyond Board Feet.* **Dr. Cindy Swanson,** Human Dimensions Program Manager, USDA Forest Service Rocky Mountain Research Station.
9:30 to 10:00 am	*Aspen Classification.* Ron Ryel, Professor, Utah State University Department of Wildland Resources, and **Dale Bartos**, Ecologist, USDA Forest Service Rocky Mountain Research Station.
10:00 to 10:30	**Break**
10:30 to 11:15 am	*Sudden Aspen Decline in Western Colorado.* **Dr. James Worrall,** Pathologist, USDA Forest Service, Rocky Mountain Region.
11:15 to 12:00	*Chemical Ecology of Aspen: Herbivory and Ecosystem Consequences.* **Dr. Richard Lindroth,** Professor, University of Wisconsin Department of Entomology.
12:00 to 1:00 pm	**Lunch (provided)**
1:00 to 1:30 pm	*Non-permanent Fixed Radius Plots: A Monitoring Protocol for Aspen Managers.* **Steve Kilpatrick,** Habitat Biologist, Wyoming Game & Fish; and **Diane Abendroth**, Fire Ecologist, Grand Teton National Park.
1:30 to 2:00 pm	*Monitoring Aspen Using Remote Sensing.* **Dr. Randy Hamilton,** Entomologist and Remote Sensing Specialist, USDA Forest Service Remote Sensing Applications Center.
2:00-2:30 pm	*Status and Trends of Aspen in the Interior West: A View from Forest Inventory Analysis.* **Dr. John Shaw,** FIA Team Leader, USDA Forest Service Rocky Mountain Research Station.
2:30-3:00 pm	**Break**
3:00 to 3:30 pm	*Can Wolves Help Restore Aspen?* **Dr. Joshua Halofsky,** Landscape Ecologist, Washington Department of Natural Resources.
3:30 to 4:00 pm	*Avian Response to Frost-Damaged Aspen in the Wasatch Mountains of Northern Utah.* **Andreas Leidolf,** Research Fellow, Utah State University Department of Wildland Resources.
4:00 to 4:30 pm	*The Role of Stand-replacing Fires and Biophysical Setting on the Persistence of Aspen in Eastern Colorado.* **Dr. Dominik Kulakowski,** Assistant Professor, Clark University School of Geography.

Agenda, continued

Thursday, September 18 Concurrent Workshops	
8:30 to 8:45 am	*Directions and announcements.* **Darren McAvoy,** Utah State University Forestry Extension Associate.
8:45 to 10:30 am	*Aspen Genetics and Phytochemistry.* Facilitator: **Dr. Richard Lindroth,** Professor, University of Wisconsin Department of Entomology.
	Merging Monitoring at Varying Scales. Facilitator: **Dr. Paul Rogers**, Director, Western Aspen Alliance.
	Experiences and Recommendations from the Field. Facilitator: **Robert Campbell**, Ecologist, Fishlake National Forest.
	Wildlife Interactions. Facilitator: **Steve Kilpatrick**, Habitat Biologist, Wyoming Game & Fish.
10:45 to 12:00	*Summaries and Wrap-up.* **Dr. Dale Bartos,** Ecologist, USDA Forest Service Rocky Mountain Research Station.
1:30 to 3:00 pm	**Western Aspen Alliance Open Meeting**

Speaker Abstracts

In order of presentation,
presenting author in italics

Historical Landscape Ecology of Seral Aspen in the Western U.S.: Examples from the Sierra Nevada and Bear River Ranges.

Paul C. Rogers, Utah State University, Logan, UT

Many factors are influencing contemporary aspen stands of the western United States. Whether herbivory, fire, insects, disease, livestock, environmental conditions, or genetic make-up are directly impacting aspen stand health, human actions and climate play disproportionate roles. Examples of historic impacts on aspen at landscape (Utah/Idaho) and regional (California/Nevada) scales present a context for subsequent talks. We will examine predominately seral aspen communities in light of 19th and 20th century land use and climate patterns. In the Sierra Nevada, aspen plays a smaller role, often confined to riparian communities in terms of geographic extent. However, this limited coverage should not imply a minor role in regional biodiversity. While smaller in size, the Bear River range is represented by extensive aspen forests in upland as well as riparian zones. Beyond this initial distinction, historical patterns are strikingly similar between the two areas, although it may be argued the scale of impacts is different. In both areas, during the mid- to late-19th century, huge sheep herds grazed in the montane zones, leaving a highly modified landscape. Additionally, a pattern of intense drought late in the 19th century followed by very high moisture in the first two decades of the 20th century was conducive to widespread aspen stand initiation. Large fires set annually by sheep herders cleared competing vegetation and stimulated aspen sprouting. Cessation of settlement burning, implementation of fire suppression, and a century of above average moisture allowed aspen to flourish at first, but later in this period favored succession to shade-tolerant conifers. Are these changes within the 'natural range of variability?' Past climate data presented here places this period in the context of aspen stand ages and a much longer (1000 yr.) climate record. Understanding of these patterns may assist managers in altering actions to fit future conditions.

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Future Climates in Western North America

Robert R. Gillies, Utah Climate Center, Logan, UT

In arid and semi-arid western North America, observations of climate change point to an increase in average temperature that is greater than the rest of the world average. In line with such a warming trend in climate, several studies of the precipitation regime for the region have documented less snowfall as evidenced by decreases in snowpack, as well as earlier snow melt, increased winter rain events and reduced summer flows. An ensemble of global climate model (GCM) projections for western North America reflect just such conditions in that they suggest intensifying drying conditions to be the norm for the Southwest region due primarily to Hadley Cell intensification. Regions that lie to the Northwest, the GCMs have as benefiting from increased precipitation but in transitional zones, i.e., between the wetter and drier zones, any gains in projected precipitation are offset by the likelihood of an increased frequency of above normal temperatures during the summer months; such results in an overall deficit in water resources.

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Gypsy Moth Risk Assessment in the Face of a Changing Environment: A Case History Application in Utah and the Greater Yellowstone Ecosystem

Jesse Logan, USDA Forest Service (ret.), Logan, UT, J. Régnière, Canadian Forest Service, Québec, Quebec, D.R. Gray, Canadian Forest Service, Fredericton, New Brunswick, and A.S. Munson, USDA Forest Service, Ogden, UT

Risk assessment for establishment of introduced pests is an important ecological and economic issue. Evaluation of climate is fundamental to determining the potential success of an introduced or invasive insect pest. However, evaluating climatic suitability poses substantial difficulties; climate can be measured and in a multitude of ways. Some physiological filter, in essence a lens that focuses climate through the requirements and constraints of a potential pest introduction, is required. Difficulties in assessing climate suitability are further exacerbated by the effects of climate change.

Gypsy moth (*Lymantria dispar L.*) is an exotic, tree-defoliating insect that is frequently introduced into the western United States. In spite of abundant host species, these introductions have yet to result in established populations. The success of eradication efforts and the unsuccessful establishment of introductions may be related to an inhospitable climate. Climatic suitability for gypsy moth in the western United States, however, is potentially improving, perhaps rapidly, due to a continuing general warming trend that began in the mid 1970s. In this presentation, we describe the application of a physiologically based climate suitability model for evaluating risk of gypsy moth establishment on a landscape level.

Development of this risk assessment system first required amassing databases that integrated a gypsy moth climatic assessment model with host species distributions and climate. This integrated system was then used to evaluate climate change scenarios for native host species (primarily aspen) in Utah, with the result that risk of establishment will dramatically increase during the remainder of the 21st century under reasonable climate change scenarios. We then applied the risk assessment system to several case histories of detected gypsy moth introductions in Utah and the Greater Yellowstone Ecosystem. These applications demonstrated the general utility of the system for predicting risk of establishment and for designing improved risk detection strategies.

Jesse Logan, USDA Forest Service, 860 N 1200 E Logan, Utah, 84321.

Physiological Ecology of Aspen-conifer Interactions

Sam St.Clair, Brigham Young University, Provo, UT

Forest inventory and analysis data suggests a 60% decline of aspen in the Interior West relative to historic highs. Succession to conifer is thought to be a major contributor to aspen habitat loss. Fire suppression has likely accelerated conifer displacement of aspen but there are important knowledge gaps in our understanding of how stable aspen communities transition to conifer dominated communities. Future forest composition and structure is largely driven by regeneration success of dominant tree species. The objective of this study was to characterize regeneration dynamics of aspen and subalpine fir as influenced by overstory composition in aspen-subalpine fir transition zones. We measured regeneration density and height classes of aspen ramets and subalpine fir seedlings at seven field sites across the state of Utah that were characterized as having a clearly demarcated overstory transition zone (pure conifer → aspen-conifer mix → pure aspen → gap).

Subalpine fir establishment was 2-3 fold higher under pure aspen and aspen-fir mixed stands compared to pure subalpine fir stands. Subalpine fir did not establish in canopy gaps adjacent to the transition zones. Taller height classes (> 1 meter) of subalpine fir were most common in aspen-conifer mixed stands. Aspen regenerated readily in pure aspen, aspen-conifer mixed stands and in adjacent gaps but regenerated poorly under subalpine fir dominated stands. The highest density of taller height classes (> 1 meter) for aspen regeneration was achieved in gaps and pure aspen stands. The data suggest that a dominant presence of overstory aspen facilitates the establishment of subalpine fir and aspen but that greater height is obtained under different conditions (aspen under pure aspen stands, subalpine fir in mixed stands). A follow-up greenhouse study demonstrated the height growth of aspen was twice as high under soil and light conditions found in pure aspen stands compared to the soil and light conditions underneath mixed or pure subalpine fir stands. It appears that shifts in soil chemistry and light environment with an increasing presence of overstory subalpine fir, increasingly favors subalpine fir regeneration.

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Promoting Regeneration of Aspen in the Boreal and Montane Forests of Alberta

Victor Lieffers and Simon Landhausser, Centre for Enhanced Forest Management, Edmonton, Alberta

Aspen is the most widely distributed tree in Alberta, ranging from the edge of the Great Plains to the boreal forest and up the Rocky Mountains. At the fringe of the Great Plains its growth is limited by drought. In the boreal and lower foothills zone, it is a very productive species and is often a strong competitor with conifers. Its spread into higher zones of the Rocky Mountains is limited by cold soils and short growing season. This presentation describes several findings of recent aspen research at the Centre for Enhanced Forest Management: 1) Root carbohydrates may be high late in the growing season but by early spring (prior to leaf flush) most of these carbohydrates are depleted. 2) Season of logging has little impact on the suckering of aspen if soil disturbance is minimized during logging. 3) Mechanical site preparation and moderate wounding of roots promotes numbers of root suckers. 4) Barriers to emergence of suckers from the soil (i.e., sods of grass, litter from grass or logging slash) delay emergence of and success of suckering. 5) Root damage associated with traffic stimulates number of suckers but most of these are too small to produce vigorous suckers, particularly if barriers limit their emergence. 6) Aspen is spreading into higher elevation sites of Alberta via reproduction from seed. Sites that have been given site preparation after logging lodgepole pine stands are recruiting up to 1000 seedlings/ha.

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Various Means of Limiting Ungulate Use of Aspen Regeneration in the Black Hills

Andrew M. Kota, Foothills Conservancy, Morganton, NC, and ***Dale L. Bartos***, USDA Forest Service, Logan, UT

Protecting regenerating quaking aspen (*Populus tremuloides Michx*.) stands from heavy ungulate use, especially elk (*Cervus elaphus L*.), is an important aspect of many aspen restoration projects in the western United States. High costs to build and maintain exclosure fences and the difficulty of bringing machinery to hard-to-reach areas often deter managers from constructing barriers. This paper details a study done in the Black Hills of South Dakota that compared the utility of livestock fences consisting of 3-4 strands of barbed-wire, complete wildlife exclosures 2.1-2.4 meters in height constructed from woven wire, barriers created from slash debris, and barriers created by a new technique referred to as tree "hinging." Slash treatments and livestock fences decreased ungulate utilization by 19%, hinge treatments decreased utilization by 39%, and wildlife fences, as expected, eliminated nearly all incidences of aspen sucker browsing.

Slash barriers could replace livestock fences where cattle are the main user of aspen suckers. Hinge barriers are more useful than either slash barriers or livestock fences in areas where wild ungulates are the primary browsers. Protection by hinging was not as effective as the wildlife exclosures, but more area could be treated at less cost using this method. In the last couple of years, hinging has been used on public lands in the Black Hills area with success. Details about placement, size, shapes, and utilization will be given.

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Efficacy and Consequences of Aspen Treatments: The USU/Deseret Land & Livestock Manipulation Project

A.J. Leffler, H.V. Miegroet, T.A. Monaco, J.N. Long, and R.J. Ryel, Utah State University, Logan, UT

Utah State University, in cooperation with landowners in northern Utah, is conducting a forest manipulation study to examine the efficacy and consequences of various forestry treatments to regenerate aspen stands encroached by conifers. Treatments include control, selective harvest of merchantable timber, clear-felling, chaining, and burning, arranged in a split-plot design replicated four times on three north-facing hillslopes. Each block consists of eight 1-ha treatment units. Pre-treatment data were collected in summer 2007. Sampling was designed to 1) assess stand composition, 2) quantify understory biomass and species composition, and 3) determine soil bulk density and C and N status. Blocks differed considerably in canopy species composition, ranging from nearly uniform cover by aspen to virtually no aspen detected. Soils of aspen units had lower bulk density than soils from conifer and mixed units, while mixed units had lower soil C and N, and a higher C:N ratio. For understory biomass, there was a trend toward decreasing woody cover and increasing non-woody cover with increasing basal area of aspen. Over 70 species were observed in the understory and only eight of these were non-native. Blocks differed in species composition but species diversity was similar among blocks. Ordination analysis (DCA) suggests four distinct understory communities associated with each study block. Ordination axes are correlated with aspen basal area and basal area of sub-alpine fir, suggesting canopy species composition strongly influences the understory. Currently, mechanical treatments are taking place. Burning treatment is scheduled for fall 2009. Changes in these variables will be monitored for several years following all manipulations.

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Monitoring and Assessment of Vegetation Root-zone Status in the TW Daniel Experimental Forest

Scott Jones, Utah State University, Logan, UT

Ecohydrological processes are important drivers of vegetation establishment and growth. Subsurface properties have a significant impact on these processes, controlling soil moisture and nutrient storage and rates of fluid transport. Geophysical techniques have been well established for locating geological features and resource deposits but have not been widely tested as tools for determination of soil properties that control Ecohydrology. We hypothesized that subsurface maps of soil properties could be used to better inform placement of experimental plots or environmental instrumentation. We used GPS-based electromagnetic induction (EMI) and electrical resistance imaging (ERI) to uncover subsurface details relating to soil properties (i.e., texture and depth) that control processes (e.g., flow and evapotranspiration).

Existing instrumented plots within the T.W. Daniel Experimental Forest site in northern Utah were examined using near-surface soil electrical conductivity maps. Significant differences were found in soil texture across aspen, conifer, sage and grass treatments. In hindsight, tremendous benefit could be derived from EMI mapping of the study area to combine vegetation and soil electrical conductivity maps in the process of designating locations of vegetation plots for scientific study. The use of electrical resistance imaging, which probes deeper into the soil and resolves detailed vertical features, can be coupled with EMI maps to identify the soil textural profile and soil-bedrock interface. These provide detailed hydrologic information on the soil moisture reservoir capacity, which is an important vegetation constraint in semi-arid climates. Geophysical techniques using electromagnetic and electrical methods show great promise for ecohydrologic investigations where, for example, a small watershed of 40 ha can be mapped using EMI in a single day. Further research is needed to more definitively link measured geophysical response to hydrologic and vegetative feedbacks.

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Forest Inventory and Analysis (FIA) Characterization of Aspen and Conifer Soils in the Interior West

Michael C Amacher and Dale Bartos,USDA Forest Service, Logan, UT

Soils are the product of five soil forming factors: parent material, climate, landscape position, organisms, and time. Vegetation can and does have a major influence on the physical and chemical properties of forest soil. Mineral soils under conifers tend to have a leached layer, be more acidic, and are lower in organic matter and nutrient content. Aspen leaves are rich in nutrients, and aspen stands, when healthy, have a large understory of grasses and forbs. Thus, aspen soils tend to be relatively high in organic matter and nutrients and are usually only moderately acidic. As conifers invade aspen stands, there is a potential for soil property changes over time that would inhibit aspen re-establishment. Limited sampling of soils under mixed aspen-conifer stands on the Fishlake National Forest showed that many aspen-conifer forest soils could still support aspen regeneration if appropriate treatments were applied. A more extensive sampling of forest types throughout the Interior West as part of the FIA Soil Indicator of Forest Health showed that aspen soils tend to have lower bulk densities, attributable to aspen sinker and lateral rooting habit, understory vegetation, and burrowing fauna. Aspen soils also tend to be higher in soil organic matter and nutrients. Decline and loss of aspen from the Interior West landscape could have long-term consequences for forest soil productivity and hence, forest productivity.

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The Economic Value of Aspen: Beyond Board Feet

Cindy S. Swanson, USDA Forest Service, Missoula, MT

Few can forget the wonder of listening to the wind rush through golden aspen forests in the fall. It is a sound that brings peace, lower blood pressure, and memories to those who stop and listen. This paper will explore the social and economic values of aspen, including timber production values, wildlife habitat and diversity, recreation experiences, and tourism revenue from viewing fall colors.

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Sudden Aspen Decline in Southwestern Colorado

James J. Worrall, Roy A. Mask, Thomas Eager and Leanne Egeland, USDA Forest Service, Gunnison, CO, and Wayne D. Shepperd, USDA Forest Service, Fort Collins, CO (retired)

Sudden aspen decline (SAD) has increased rapidly in recent years, approaching 350,000 acres in Colorado in 2007, or 13% of aspen cover type. We documented landscape and stand factors associated with SAD. There was a strong inverse relationship between elevation and damage. Damage tended to occur on south and southwest aspects and was most severe in open stands with large trees. Regeneration was poor in damaged stands. Five biotic agents were most frequently associated with SAD: Cytospora canker, poplar borer, bronze poplar borer, and two bark beetles. We proposed a causal hypothesis in a decline context: predisposing factors are low elevations, south/west aspects, low density, and stand maturity; inciting factors are warm drought conditions; contributing factors are the secondary, biotic agents mentioned above. We then conducted an intensive field survey with 76 plots on four National Forests. Preliminary analyses indicate that 1) regeneration has not responded significantly to crown loss, 2) root mortality varied from 0 to over 90% of root volume and was correlated with crown loss, and damaged plots had significantly higher volume of dead roots than healthy plots, 3) regeneration decreased significantly as root mortality increased in damaged plots, but not in healthy plots, 4) crown loss did not vary significantly with depth of soil mollic layer, and 5) crown loss did not vary significantly with average or oldest age of sampled codominant/dominant trees. The rapidity of mortality, landscape scale, mortality agents involved, and probably other causal factors distinguish SAD from the long-term loss of aspen cover caused by successional processes operating in an altered fire regime (and often exacerbated by ungulate browsing). There are significant management implications and there may be loss of aspen cover type where aspen stands are declining and regeneration is inadequate. Marginal regeneration may be further compromised by such factors as amount and duration of ungulate browsing.

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Chemical Ecology of Aspen: Herbivory and Ecosystem Consequences

Richard L. Lindroth, University of Wisconsin, Madison, WI

Much of the remarkable ecological and evolutionary success of aspen (*Populus tremuloides*) can be attributed to its secondary chemistry. This chemistry is dominated by phenolic compounds, principally phenolic glycosides (salicylates) and condensed tannins. Aspen exhibits extraordinary intraspecific variation in chemical expression, due to a complex of genetic, environmental, and ontogenetic (development) factors. This variation, in turn, mediates interactions with herbivores, shapes community organization, and influences ecosystem function.

The signature secondary compounds in aspen are the salicylate phenolic glycosides (salicin, salicortin, tremuloidin and tremulacin). Levels of these compounds are strongly genetically determined, but only slightly responsive to resource (e.g., nutrient, light) availability. Phenolic glycosides provide defense against a variety of insects, as well as against browsing mammals (e.g., elk and porcupine). Genetic variation among aspen clones in production of phenolic glycosides is related to a trade-off between growth and defense; well-defended genotypes grow slowly, whereas poorly-defended genotypes grow rapidly. Levels of phenolic glycosides are also influenced by plant development; they are exceptionally high in young trees and much lower in mature trees. This pattern suggests that mammalian herbivores were the driving selective force for the expression of high levels of defense in young aspen.

Levels of tannins in aspen are determined by a combination of genetic, resource, and developmental factors. Tannin concentrations are highly "plastic" (flexible) in response to resource availability. Tannin levels show developmental shifts to opposite those of phenolic glycosides; they are low in young trees and increase with age. To date, however, little evidence supports the role of tannins as defense against either insect or mammalian herbivores.

The efficacy of aspen chemical defense against herbivores is density-dependent. At critical densities of herbivores, aspen is consumed independent of its defense characteristics (poor food is better than none). This is the situation that occurs during major outbreaks of insect defoliators in the Great Lakes Region, and may explain the apparent lack of resistance of aspen to ungulate herbivores in the Intermountain West.

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Non-permanent Fixed Radius Plots: A Monitoring Protocol for Aspen Managers

Steve Kilpatrick, Wyoming Game and Fish Department, Jackson, WY

To evaluate the effectiveness of aspen treatments, concrete and measurable objectives are needed along with an acceptable monitoring protocol. In western Wyoming, an interagency group of wildlife habitat biologists, fire ecologists, and fire managers has developed a non-permanent fixed radius plot monitoring protocol for addressing aspen restoration objectives. This protocol is used by managers to monitor objectives desired for the ultimate return of a disturbed clone to an aspen forest. Objective examples include aspen overstory and live sucker density, height, browse status, and conifer density at the stand level. Using this protocol, it is possible to acquire statistically useful sample sizes at the stand level in a cost-effective and efficient manner. Examples of aspen data from several prescribed burn projects are used to illustrate aspen objectives, monitoring protocols, and analyses.

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Monitoring Aspen Using Remote Sensing

Randy Hamilton, Eric Nielsen, USDA Forest Service, Salt Lake City, UT, and Dale Bartos, USDA Forest Service, Logan, UT

Large acreages of aspen (*Populus tremuloides*) are and continuing to disappear from western forests due to successional decline and sudden aspen decline (SAD). Land managers, anxious to restore aspen ecosystems, are often hampered in their efforts by limited budgets and by a lack of defensible information on the location and condition of aspen. Modern remote sensing technologies can provide cost effective monitoring methods to obtain the needed information about aspen populations at multiple scales. For example, a computer automated technique which compares historic Landsat satellite imagery with current imagery shows resource managers areas of the greatest aspen decline. This procedure was implemented for a study area located on Cedar Mountain, southeast of Cedar City, Utah. The map produced by this technique will help land managers identify and prioritize areas for potential treatments. Strata formed by the map allow resource managers to efficiently sample the area with field or photo-interpreted plots to derive defensible information about the change that has occurred. Similar techniques can also be applied to track the response of aspen to treatments. In addition to monitoring change in aspen abundance, remote sensing also provides an efficient way to map and quantify existing aspen, providing defensible information to support restoration activities and establishing a baseline for future monitoring.

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Status and Trends of Aspen in the Interior West: A View from Forest Inventory and Analysis (FIA)

John D Shaw, USDA Forest Service, Ogden, UT

The Forest Inventory and Analysis (FIA) program, which is national program maintained by the USDA Forest Service, is designed to monitor the status and trends of all forested lands in the U.S., regardless of ownership. The Interior West FIA unit (IW-FIA) has responsibility for the FIA program in eight western states (Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming) and therefore covers most of the aspen acreage in the West. During the 1980s and 1990s, IW-FIA conducted a series of periodic inventories within the eight states. These inventories covered most of the states using a systematic grid, over a period of a few years. Starting in 2000, FIA implemented an annual inventory system, in which a fraction of the entire sample grid is visited each year. While the periodic inventories provided a baseline, the annual system added new opportunities for analysis, including the ability to monitor year-to-year trends over large geographic scales. Although the annual inventory system is not yet fully implemented, the data obtained to date have enabled unique insights into forest change over a short period of time. Impacts from drought, insects, and disease have been described for pinyon-juniper and other forest types. Analysis of change in the aspen forest type, as well as other types that include an aspen component, is ongoing. In this presentation we will describe the IW-FIA program and data, and provide an overview of results from analyses that have been done on aspen forests.

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Can wolves help restore aspen?

Joshua S. Halofsky, Washington State Department of Natural Resources, Olympia, WA, William J. Ripple, Robert L. Beschta, Jeff P. Hollenbeck, and Cristina Eisenberg, Oregon State University, Corvallis, OR

Trophic cascades theory states indirect influences of apex predators, such as gray wolves (*Canis lupus*), can be transmitted beyond their immediate prey base to lower trophic levels. Implied in this theory is that such predators may be needed to maintain biodiversity. The extirpation of the gray wolves from Yellowstone National Park by 1930 and their reintroduction in 1995-96 has facilitated the study of a terrestrial trophic cascade involving carnivore absence and subsequent presence at broad geographic and long temporal scales, appropriate for studying the responses of organisms such as elk (*Cervus elaphus*) and aspen (*Populus tremuloides*). This "natural experiment" has been the impetus for trophic cascade research in the northern Rockies, and for our Trophic Cascades Program (www.cof.orst.edu/cascades). This presentation will review our work documenting changes in aspen stand dynamics before wolf extirpation, during wolf absence, and following wolf reintroduction. We explore interactions between herbivory and fire in burned and unburned areas in predator absence and presence, and examine how wolves may not only influence aspen stand dynamics by directly reducing elk densities, but also through changes in elk behavior following wolf reintroduction.

While factors such as fire, climate, and natural stand succession can influence aspen, the correlative results from our work support the hypothesis of a trophic cascade between wolves, elk, and aspen. Whether the aspen responses we have observed thusfar following wolf reintroduction are the first indicators of a changing ecosystem due to renewed wolf presence, or an exception to a broader decline in aspen numbers, is still an unknown. However, given the general support for trophic cascade theory, and the changes reported in the Greater Yellowstone Ecosystem, we believe that predators such as wolves can play a role in the stand dynamics of woody deciduous species such as aspen.

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Avian Response to Frost-Damaged Aspen in the Wasatch Mountains of Northern Utah

Andreas Leidolf and Ronald J. Ryel, Utah State University, Logan, UT

We examined the avian community response to frost-damaged aspen in the Wasatch Mountains of northern Utah as part of an avian monitoring program at Deseret Land & Livestock Company (DLL). In early May of 2007, DLL experienced a period of prolonged warmer-than-normal temperatures, followed by a frost event that killed most of the new aspen foliage. We used this event to assess the effects of a transitory disturbance on the aspen bird community by comparing avian monitoring data collected during 2005 and 2006 (pre-disturbance) to data from 2007 (post-disturbance). We compared relevant avian community summary statistics among years and three levels of frost damage severity (low, intermediate, severe). Interestingly, bird total abundance, species richness, and species diversity did not differ significantly among years. However, there were significant year-by-frost damage severity interactions, with plots with low levels of frost damage having significantly higher total abundance, richness and diversity. Our results suggest that 1) the post-disturbance avian community was essentially identical to the pre-disturbance community in terms of the number of individuals, as well as the composition and structure of the avian community, at the landscape level; 2) there was a pronounced shift in the spatial distribution of birds at the plot and stand level, with most individuals favoring stands with low levels of frost damage over those with intermediate and high levels of frost damage. We discuss implications of these findings for regional avian population dynamics and aspen management in the Intermountain West.

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Catastrophic and Non-catastrophic Modes of Aspen Regeneration in Western Colorado

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The decline of quaking aspen across the western United States has received considerable research attention. This decline has been attributed to fire exclusion as well as other causes. To assess long-term changes in the extent of aspen in western Colorado, we compared historical (1898) maps of vegetation and fires to current maps of forest cover. Based on these comparisons, a larger portion of the current landscape is dominated by quaking aspen, relative to the late 19th century. During the 20th century, aspen was persistent over most of its extent, even in the absence of fire. Fires of the late 19th century also increased aspen cover in stands that were previously dominated by spruce and fir.

To investigate regeneration dynamics of both persistent and seral aspen stands, we reconstructed patterns of stand development in 26 aspen stands. Stand-level age structures were determined from 1919 increment cores and size structures from counts and diameters of all stems in 40 m × 40 m plots. Stand structures were interpreted to determine modes of tree regeneration and patterns of stand development. In the eight seral stands aspen regeneration was generally catastrophic (depended on coarse-scale, severe disturbance by fire). However, most aspen stands showed signs of aspen self-replacement despite presence of conifers. In the 16 persistent aspen stands showing no conifer invasion, aspen were able to regenerate through a variety of regeneration modes that did not appear to require severe disturbance. Over 70% of the persistent aspen stands sampled did not require coarse-scale disturbance to regenerate. Two (11%) of the persistent stands regenerated continuously through time, and 11 (61%) had aspen cohorts that appeared to develop episodically without being triggered by severe fire or other severe disturbance. In the persistent stands sampled in our study, episodic regeneration not dependent on severe fire is the main mode of stand re-initiation.

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Poster Abstracts

Presenting author in italics

Restoration of Aspen, a Fire-adapted Species: Lessons for the Future

Dale L. Bartos, USDA Forest Service, Logan, UT, ***Robert B. Campbell, Jr.***, USDA Forest Service, Richfield, UT, and Linda Chappell, Central Utah Interagency Fire, Richfield, UT

Quaking aspen (*Populus tremuloides Michx*.) is widely dispersed across North America. The importance of aspen in the Interior West is well described and documented in the literature. Besides adding diversity to the landscape, aspen forests provide water, forage, wood products, wildlife habitat, and scenery for the public. An aspen clone is a group, or grove, of numerous stems that are genetically identical. Regeneration in aspen is primarily vegetative and the root sprouts are often called suckers. Initially, the clone began from a single seed that germinated some time in the past and continued to produce suckers for millennia. Usually new suckers grew after periodic disturbance that allowed the clones to survive, regenerate and expand in the area. Since European settlement, the natural disturbance regime (usually fire) has been interrupted. This absence of disturbance allows many aspen dominated landscapes to be replaced by conifers or other vegetation types.

Numerous techniques are available to aid managers to restore and sustain aspen landscapes. Various management actions (including some natural episodes) have been used in the recent past to restore aspen on the landscape. Some of these attempts have been successful while others failed. This poster documents some of these lessons, including: 1) prescribed fire (western Wyoming), 2) coppice harvest (central Utah), 3) large ungulate exclusion (central Utah), 4) tree hinging (South Dakota), 5) conifer removal (northern California), and 6) wildland fire (northern California, central Colorado and central Utah).

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Aspen Response to Prescribed Fire in Southwest Montana

Clayton Marlow and ***Dan Durham***, Montana State University, Bozeman, MT

Aspen response to prescribed fire was evaluated as part of the Whitetail Watershed Restoration Project. Controlled burns were conducted in 2005 and 2006 to address aspen decline, conifer encroachment, and altered hydrologic function. A survey of unburned portions of the drainage indicated that 39 out of 40 untreated stands were not regenerating. Three-part exclosures were constructed in 5 of the treated aspen stands to compare sucker height and density among plots protected from browse, plots used by big game only, and plots used by big game and cattle. Three years post-treatment, mean sucker density was higher in the burned stands than adjacent unburned stands. Preliminary analysis indicated big game browsing has affected sucker height but not sucker density in the burned stands. While it appears fire stimulated sufficient suckering to replace these stands, more time is needed to determine whether unprotected stems can escape browsing pressure.

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Elk Impacts on Post Mountain Pine Beetle Forest Regeneration on Blue Valley Ranch

John Kossler, Blue Valley Ranch, Kremmling, CO, and Bob Woodmansee, Colorado State University, Fort Collins, CO.

Tree mortalities of lodgepole pine (*Pinus contorta*) in Colorado will soon exceed 80 percent due to the exponential spread of Mountain Pine Beetles (*Dendroctonus ponderosae*) (CFSF, 2007). Efforts to mitigate the impacts of Mountain Pine Beetle on Blue Valley Ranch have included thinning, patch clear-cutting, and clear-cutting, with over 1,100 of the ranch's 6,500 acres treated in the past five years. Forest regeneration and fuels reduction drive the ranch's forestry program, as well as watershed improvement, wildlife habitat, and overall forest ecosystem health. Regeneration of lodgepole pine seedlings has average 1,500 stems per acre with a range of 100 to 8,000 stems per acre, and aspen regeneration has ranged from under 100 stems per acre to nearly 10,000 stems per acre. Elk (*Cervus elaphus nelsoni*) are attracted to new aspen regeneration, preventing successful growth of aspen shoots except where fencing has offered protection from ungulate browsing. Mitigation of elk impacts has included management hunts, fencing of aspen regeneration, and strategic placement of treatments to distribute elk browsing, but these efforts are limited in scale by the boundaries of the ranch. Elk impacts on forest regeneration remain a significant issue for Blue Valley Ranch and present a challenge for managing healthy elk populations and distribution as well as aspen regeneration over scales that extend beyond ranch boundaries.

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A Remote Sensing Landscape Analysis of Sudden Aspen Decline (SAD) in Southern Utah's Cedar Mountain

Chad Oukrop, Ron Ryel, and Doug Ramsey, Utah State University, Logan, UT, and Dave Evans, USDA Forest Service, Logan, UT

Quaking aspen (*Populus tremuloides Michx*.) is the most widespread deciduous tree species in North America (Baker, 1925). In the Intermountain West, aspen communities are highly valued multiple use ecosystems, noted for forage production, understory diversity, wildlife habitat, timber, and aesthetics (Bartos, 2001). However, aspen communities in the Intermountain Region of the western United States are in evident decline, with certain areas experiencing sudden aspen decline (SAD) over the past decade, a phenomenon defined by rapid overstory mortality with little or no regeneration. Recently, landowners on Cedar Mountain in southern Utah have expressed concern over the occurrence of SAD across portions of the mountain and surrounding area. Land managers lack critical information on the extent and magnitude of SAD and could utilize detailed spatial information to plan, implement, and monitor aspen restoration projects. The main objective of this study is to produce a map of the present aspen health status and to estimate past and future aspen coverage across the Cedar Mountain landscape. Bio/physical parameters (i.e. slope, aspect, elevation), climatic trends, and conifer encroachment are being evaluated in relation to aspen health status. Sampling consisted of a 900 m systematic grid laid over an aspen cover layer extracted from the SWReGAP Landcover classification project. Ninety points were randomly selected from the grid and verified for aspen cover using 2006 NAIP imagery. During the 2008 summer, field crews collected stand-level data for ground-truthing purposes on composition, canopy cover, basal area, tree status, bio/physical parameters, stand age, regeneration, and tree damage. These data will be used to train Landsat TM imagery into four distinct aspen health classes: 1) healthy, 2) dying, 3) dead, and 4) seral. Once the classification map is established for 2008, it can be used to generate change detection products for the past 25 years using Landsat TM imagery. Climatic data will be evaluated over the same time period to determine the role of drought in aspen die-off. These time series products will be used to determine the rate of change in aspen health status, assisting managers in projecting future aspen landscapes on Cedar Mountain.

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The Western Aspen Alliance: Promoting Sustainable Aspen Ecosystems in Western North America

Paul C. Rogers, Ronald J. Ryel, Utah State University Department of Wildland Resources, Logan, UT, and Dale L. Bartos, USDA Forest Service Rocky Mountain Research Station, Logan, UT

A consortium of researchers and managers has formed the Western Aspen Alliance (WAA) to coordinate and facilitate advances in aspen ecology in western North America. Our prime goal is to disseminate state-of-the-science aspen information to interested managers, scientists, the public, and other users. Recent events, some potentially related to climate change, have spurred interest in aspen ecology. For example, reports of sudden aspen mortality, large-scale seedling establishment following wildfires, and documentation of trophic interactions between wolves, elk, and aspen, have all significantly modified our understanding of aspen ecosystems. We realize, regionally, that an aging aspen cohort will need to successfully regenerate to maintain sustainable populations. Wildlife pressure on aspen regeneration is an issue of concern for managers throughout the western United States. The WAA will incorporate these lessons into an ongoing resource bank for managers throughout the region. From a science perspective, we wish to engender a cross-disciplinary network of researchers willing to take on pertinent aspen topics. For example, there is a current need to assess the extent of Sudden Aspen Decline (SAD), seral/stable aspen stands, and historic aspen coverage. Basic research on aspen physiology, disturbance ecology, water yield, genetics, herbivory, and biodiversity/trophic interactions issues are also desired. The social/aesthetic value of aspen is an up-and-coming research area needing further exploration, too. We will form working groups for these issues and pursue additional aspen topics that arise. A central role of the WAA will be to sponsor field visits, workshops, conferences, and collaboration between researchers. In the coming year we plan to compile a bibliographic database of aspen research and management topics for use by WAA members. Though sponsored by Utah State University's College of Natural Resources and the USDA Forest Service, Rocky Mountain Research Station, we are currently working with numerous state and federal agencies, NGO's, and universities. We welcome your input and participation.

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