

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Presentation Abstracts

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**Frandsen,
Joel**

Landscape-Level Changes: A Historical Perspective for Utah

Since European settlement, Utah's vegetative landscapes have changed. Like other arid states, these wildland systems were depleted and altered. Certain steps were taken through private, community, and finally public efforts, such as establishment of Forest Reserves (National Forests), to stop the slide. Conservation and management actions were taken to restore, rehabilitate and manage these landscapes. Utah has numerous examples where the productive capability of the land has been restored. Unfortunately, in this environmental era, we are again in a downward ecological spiral, and the productivity of these landscapes towards desired objectives is not being met. The action needed to stop this trend is not getting the attention to stabilize and correct the problem. The Healthy Forests Restoration Act provides some positive steps. The knowledge and technology are available and can be expanded upon. The challenge is, can we muster the will and support to reverse the downward spiral?

**Huffman,
David**

A Demonstration Project to Test Ecological Restoration of a Pinyon-Juniper Ecosystem

To test an approach for restoring historical stand densities and increasing plant species diversity of a pinyon-juniper ecosystem, we implemented a demonstration project at two sites (CR and GP) on the Grand Canyon-Parashant National Monument in northern Arizona. The demonstration treatment consisted of thinning small trees (<10 inches diameter at root collar (DRC)), lopping and scattering thinned trees, and seeding native understory species. Before treatment, a bark beetle outbreak at GP resulted in >50% pinyon mortality, which was positively related to tree size and age. Thinning and mortality reduced overstory density from 258 and 337 trees per acre (TPA) pretreatment to 113 and 102 TPA post-treatment at CR and GP, respectively. Post-treatment densities were similar to those occurring in the late 1800s as suggested by stand reconstructions. Thinning increased quadratic mean diameter (QMD) and relative importance of juniper at both sites. QMD of pinyon was increased at CR. At GP, pinyon snags >4 inches DRC increased by 7 TPA. Treatment had no immediate effects on herbaceous cover or species richness, both of which may take more time to develop. Herbaceous composition appeared to shift in dominance from annual forbs at pretreatment to perennial forbs and grasses at post-treatment, although cover was sparse (<7%) at both sites across the two study years. Shrub cover was 2.8-2.9% and 1.8-2.1% at CR and GP, respectively, across both study years. Further monitoring will help to clearly evaluate the effectiveness of this treatment for satisfying conservation goals.

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Hughes, Lee

Restoration of Ponderosa Pine Ecosystem and its Understory

Restoration of the Mt Logan ponderosa pine ecosystem has been on-going since 1995. This effort included tree thinning to a density based on what the tree density was in 1870. The thinning has occurred on most units to be treated. The desired plant community objectives from the Mt Trumbull Resource Conservation Area Plan had a forest objective as 50% trees to be in a diameter class of 20-31.9+ inch diameter at breast height (dbh)- old growth. The other 50% of the trees were to be spread amongst the diameter classes ranging from openings to 19.9 inch dbh trees. The plan addressed a desired plant community for the understory in the pinyon and juniper, sagebrush, mountain shrub plant communities, but not the ponderosa pine ecosystem. There has been a debate on whether to seed the thinned units to native plants in the form of cultivars or imported seed or not seed the treated units and let the seed bank and re-sprouts provide the understory plant community. Most treated sites have been seeded and there are experimental blocks not seeded. One restored unit (Lava) has had both done for comparative purposes.

The two Lava Units, on Mt Logan, were logged, thinned, burned and one was seeded (13 acres), in 1996, and the other was not seeded (33 acres) as part of the restoration process. Northern Arizona University's Ecological Restoration Institute personnel set up monitoring plots in the units and recorded the progress of succession after treatment. Using that plot data, the seeded and unseeded units will be compared. Also a 1989 fire, that burned on top of Mt Trumbull, had vegetation transects completed to assess what species are dominant after several years, without seeding in the fire scar. The seeding of native grass cultivars and imports does increase species diversity of grasses, but it seems to suppress the native grasses (squirrel tail, muttongrass, and blue grama) extant in the ecosystem. The other reason for seeding is to prevent annual bromes from becoming a major presence. The data on annual bromes in the Lava seeded unit and unseeded units show annual bromes equally evident in both, to the present. Also, after the long drought 1998-2004, the unseeded natives appear to have had a better survival rate.

But, the question whose answer is being sought: Is allowing restoration with only local species of grass, forbs and shrubs just as effective as with seeding imported cultivars or imported native seed?

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**Johnson,
Marllin**

Forest Restoration and Fuels Reduction in Ponderosa Pine and Dry Mixed Conifer in the Southwest

Most people agree that ponderosa pine and dry mixed conifer stands need to be thinned and burned to move the stands to within a *normal range of variability*. Unfortunately, people are in disagreement beyond that point. To some, restoration and fuels reduction means restoring stands to more open, pre-European (pre-1880) conditions. To others, fuels reduction should involve the removal of only the smallest trees (less than 6-9") within the treated stands.

The *Forest Vegetation Simulator (FVS)* stand model, along with the *Fire and Fuels Extension (FFE)* of FVS, were used to demonstrate the effects on fuel hazard and forest stand structures when various stocking levels and diameter caps are applied. The effectiveness of the various treatments was evaluated based upon resulting crowning and torching index values following various thinning treatments.

The results of the stand treatment simulations point out that pine and dry mixed conifer stands need to be fairly open (residual basal areas <80ft²) to adequately reduce fuel hazard to reduce the threat of stand-replacement fires in these forest types. Stand simulations also pointed out that when diameter caps are applied that are too small, treatments tend to remove most or all of the smaller trees, reducing within-stand diversity and moving the stands toward more even-aged stand structures. Amended forest plans (1996) in the Southwestern Region specifically call for multi-storied stand structures to increase within-stand diversity to promote better goshawk, Mexican spotted owl, and old growth habitats.

**Landis,
Andrew
Gascho**

Diablo Trust Piñon-Juniper Restoration Sites: Restoring Structure to Woodlands and Savannas

Piñon-juniper restoration sites are being implemented in northern Arizona on lands managed by the Diablo Trust that have experienced increased piñon and juniper densities. Such land managers want to restore basic ecosystem structure and function to their lands in a way that preserves their livelihoods and open space in the region. The first objective of this project was to create reference conditions by reconstructing age structure and spatial arrangement to 1860, prior to livestock grazing, across three soil types. Stand reconstruction using stem mapping and ring counts revealed pulses of juniper establishment between 1860 and 1880 on both basalt and sandstone-derived soils. Limestone-derived soil showed no increase during this time period, but rather steady increase in tree density since approximately 1700. Juniper trees in 1860 across all soil types were found in clumps of a minimum radius of 15 m. Presettlement diameter distributions and basal area were reconstructed and used to develop structure control (e.g., BDq) prescriptions to best approximate stand conditions of both piñon-juniper savannas and woodlands. After these appropriate density and distributions were determined, the next phase of this project is to test restoration methods, which include burning, seeding, and slash treatments (leave tree, pile, lop and scatter) to determine which treatment fosters greatest understory plant response.

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**Mackes,
K.H.**

Identifying Markets for Pinion Pine in the Four Corners Region

A search for opportunities to use pinion pine trees is currently being conducted at Colorado State University by the Colorado Wood Utilization and Marketing Program as part of an effort to improve financial feasibility of forest restoration and fuel hazard reduction work in pinion-juniper. The properties of wood from pinion pine trees are currently being investigated to identify potential value-added uses for it. Based on this study, a detailed discussion of potential products that might be manufactured from pinion wood will be presented. Consideration will be given to both existing and new product opportunities. The presentation concludes that for wood processors to consider using pinion wood, future restoration and fuel mitigation programs must be designed to provide a consistent supply of raw material to them. Further, uses for pinion pine are currently limited and there is likely no single product market that will utilize all the material being removed. Therefore, a stable diverse set of value-added uses for pinion wood appears to be the most desirable future.

**Malhotra,
Ravi**

Sustainable Development Through Biomass Utilization, A Practical Approach

Many forested areas and nearby communities in the West face increased risks of wildfire and insect infestation due to dense forest conditions. Matching the supply of small diameter trees removed to reduce forest density with appropriately scaled technologies that can produce power, heat or wood products, can help create new jobs in the West, while promoting forest stewardship.

Our approach to evaluate the potential for establishing enterprises that utilize locally available forest resources is tailored specifically to the needs of the local community.

We evaluate the:

1. Technical feasibility
2. Economic viability and
3. Social Acceptance

of establishing bio-energy and/or wood products manufacturing technologies in the local community.

To accomplish our objective, the following tasks are completed:

- A resource assessment of forest and other biomass sources in the region (including quantity, quality, and procurement costs);
- Identification and evaluation of bio-energy and wood product manufacturing technologies that match the resource availability;
- Recommendations of options for the establishment of biomass-based enterprises;
- Business plan development for the recommended options;
- Outreach efforts to disseminate information on the business plans developed.

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**McGlone,
Christopher**

Cheatgrass Encroachment on a Ponderosa Pine Ecological Restoration Project in Northern Arizona, USA

Land managers frequently thin small-diameter trees and apply prescribed fire to reduce fuel loads and restore ecosystem structure, function, and process in forested areas. There is increasing concern that disturbances associated with these management practices can facilitate nonnative plant invasions. *Bromus tectorum* is an annual grass from the Mediterranean region. It has invaded large areas of the Interior West and has become the dominant species in many of these areas. In 2003, a ponderosa pine ecological restoration site on Mt. Trumbull in the Uinkaret Mountains of northern Arizona experienced a large increase in *Bromus*. Thinning and burning projects had been conducted on this site since 1996. *Bromus* frequency increased on the thinned and burned plots by six-fold between 1996 and 2003. While *Bromus* also increased on thinned plots that were not burned and the untreated control plots, the frequency of *Bromus* was significantly lower than on the thinned and burned plots. There were two additional factors that may have influenced the *Bromus* invasion. In 2002, the region experienced the most extreme drought recorded in the past 100 years. Substantial rainfall returned to the area in September 2002, coincident with the timing of *Bromus* germination. Additionally, cattle were reintroduced to the study area in July 2002 after a five year hiatus in grazing. We present data that suggest the interaction of prescribed fire, small-diameter tree thinning, cattle grazing, and drought were the primary causes of the spread of *Bromus*.

**Monsen,
Steven B.**

A Native Plant Development Program for the Colorado Plateau

Revegetation programs instigated in the Intermountain West have relied on the use of introduced perennial grasses, with attention focused upon improving the agronomic and forage attributes of these species. Currently, a wide number of site adapted native species are required to restore the extensive disturbances throughout the West including the Colorado Plateau. Through cooperation with Federal and State agencies and Universities in Colorado and Utah studies have recently been initiated to identify the principal species associated within Pinyon/juniper and sagebrush communities of this region. Studies are designed to evaluate ecotypic variability and ecological adaptation of individual taxa. Concurrently, seed production studies are being established to determine culture requirements to produce, harvest, and process seed for large-scale restoration projects. In addition, seed germination and seedbed ecology studies are being developed to reassemble multiple species including interseeding into areas where retention of some species is desired. The progress and status of individual studies will be reported.

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**Negron,
Jose**

Attributes Associated With Probability of Infestation by the Piñon Ips, *Ips confusus*, (Coleoptera: Scolytidae) in Piñon Pine, *Pinus edulis*

We examined attributes associated with the probability of infestation by piñon ips, *Ips confusus*, in piñon pine, *Pinus edulis*, in an outbreak in the Coconino National Forest, Arizona. We used data collected from 87 plots, 59 infested and 28 uninfested, and a logistic regression approach to estimate the probability of infestation based on plot- and tree-level attributes. Piñon pine stand density index was a good predictor of the likelihood of infestation by piñon ips at the plot level and a cross-validation analysis indicated that the model correctly classified 82% of the cases. Diameter at root collar and piñon dwarf mistletoe infestation level were good predictors of individual tree infestation and a cross-validation analysis indicated that the model correctly classified 72% of the cases. Results suggest that the occurrence of piñon ips infestations may be related to stress factors associated with increased stocking and piñon dwarf mistletoe infestations.

**Roccaforte,
John Paul**

Changes in canopy fuels and fire behavior after ponderosa pine restoration treatments: A landscape perspective.

We modeled crown fire behavior and assessed changes in canopy fuels before and after the implementation of restoration treatments in a ponderosa pine landscape at Mt. Trumbull, Arizona. We measured 117 permanent plots before (1996/1997) and after (2003) thinning and burning treatments. The plots are evenly distributed across the landscape and represent an area of approximately 1200 ha (2964 ac), about half of which is an untreated control. Basal area decreased significantly by 42% from 32.6 m² (142.0 ft²) to 18.9 m² (82.3 ft²) in the treated area between 1996 and 2003 while the control did not change significantly over the same time period. Canopy biomass decreased significantly by 50% from 18.3 Mg/ha (8.2 tons/ac) to 9.1 Mg/ha (4.1 tons/ac) and canopy bulk density decreased by 42% from 0.093 kg/m³ (0.006 lb/ft³) to 0.048 kg/m³ (0.003 lb/ft³) in the treated area while slight increases occurred in the control. Analysis of crown fire behavior using simulation models under extreme drought and wind conditions suggests that the proportion of the landscape susceptible to active crown fire and the mean patch size of these areas were both reduced in the treated area. In contrast, the models suggest little change in active crown fire susceptibility in the control over the same time period.

Shaw, John

Assessment of Drought Related Mortality in Pinyon-Juniper and Ponderosa Pine Forests Using Forest Inventory and Analysis Data

Widespread mortality in several forest types is associated with several years of drought in the Southwest. Implementation of USDA Forest Service Forest Inventory and Analysis (FIA) annual inventory in several states coincided with the onset of elevated mortality rates. Analysis of data collected 2000-2004 reveals the status and trends of mortality in pinyon-juniper and ponderosa pine forests across the Southwest. A complex of drought, insects, and disease is responsible for mortality rates approaching 100 percent in some areas, while other areas have experienced little or no mortality. Drought-related mortality is almost exclusively limited to the pinyon component in pinyon-juniper stands. The proportion of mortality of ponderosa pine varies among the cover types in which it occurs. Elevation and Palmer Drought Severity Index appear to be correlated with observed mortality.

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Snider, Gary

The Irrationality of Continued Fire Suppression: A Partial Analysis of the Costs and Benefits of Restoration-Based Fuel Reduction Treatments vs. No Treatment

In 1905, the Bureau of Forestry became the U.S. Forest Service and was given responsibility for protecting newly designated forest reserves. A critical part of its charge was the prevention and control of fires. In 1908 Congress set up a unique system, like an open checkbook, that assured payment for fire suppression as needed. Since that time the fire suppression checkbook has never run out of blank checks and federal land management agencies continue to spend orders of magnitude more money on suppression than on pre-fire fuel control. We argue that the perpetuation of this pattern represents an irrational investment in the further disruption of fire cycles and the continued depreciation of forest values. We present results of an economic analysis comparing restoration-based fuel treatments to no treatments for areas identified at high risk for crown fire to support our claim. The with and without treatment comparison focuses on ponderosa pine and dry mixed conifer forest ecosystems in Arizona and New Mexico (Forest Service Region 3). The analysis provides a conservative estimate of the potential economic losses due to no action.

Wightman, Catherine

Restoration of Southwestern Ponderosa Pine Forests: Implications and Opportunities for Wildlife

After a century of fire suppression, livestock grazing, and even-aged timber harvest practices, forest managers in the Southwest face an enormous challenge. Millions of acres of ponderosa pine forest are extremely susceptible to uncharacteristic, high intensity wildfires, the consequences of which were amply demonstrated by recent mega-fires in Arizona and New Mexico. Current condition ponderosa pine forests are also atypically homogeneous in structure and composition, which results in reduced habitat biodiversity for wildlife. In response, land managers have begun planning and implementing extensive forest treatment projects along urban interfaces and in wildland areas. Although many of these projects are designed primarily to reduce the risk of high intensity wildfire, these treatments have considerable potential to improve wildlife habitat, by creating diversity at the stand and landscape level and increasing productivity in shrub and understory layers. While there is widespread agreement that restoration of Southwestern forests is needed, the location, scale, and approach of treatment prescriptions remain controversial, especially when addressing wildlife needs. We present a conceptual overview of wildlife responses to treatment-induced changes in ponderosa pine forest structure and summarize results from ongoing studies on the Mt. Trumbull restoration area in northern Arizona.

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**Williamson,
Matthew**

Variation Among Pinyon-Juniper Woodlands: A Cautionary Note

The recent emphasis on ecological restoration of forests has forced both scientists and managers to address the idea of the "natural range of variability" of their systems of study. Indeed, much work has been done to identify this range in the ponderosa pine systems of the West and to use that information to develop restoration prescriptions for those forests. The pinyon-juniper woodland, in comparison, has been more intensively managed for a variety of uses yet much of the ecology of the system is relatively unknown. In many instances we lack reliable information on the role of disturbance within the system, the importance of soil erosion potential in determining the response to disturbance, and how species composition may alter these relationships. While the literature outlining the response of pinyon-juniper to treatment is extensive, very rarely are the site descriptions detailed enough to allow the reader to place the results of the study at hand in the context of the woodland that he/she may wish to manage. Thus two identical management strategies may differ drastically in their effects. The purpose of this paper is to highlight the variability among pinyon-juniper systems and to call for increased attention to the effects of this variability when planning treatments aimed at ecological restoration.

**Yarborough,
R. Fenner**

Home Range and Habitat Selection Patterns of Mule Deer in a Restoration-Treated Ponderosa Pine Forest

Forest restoration treatments are currently being conducted throughout the state of Arizona. Restoration treatments open the existing forest structure and may improve foraging habitat for mule deer (*Odocoileus hemionus*) but may reduce the suitability of day bed sites or decrease fawn recruitment due to removal of sufficient hiding cover. To evaluate mule deer habitat selection patterns across a restoration-treated ponderosa pine (*Pinus ponderosa*) landscape, we outfitted 15 female mule deer with GPS store-on-board collars in 2003. Our main objectives were to evaluate habitat selection within home ranges and core use areas, to evaluate whether female mule deer select different habitats during the fawning period, and to compare habitat selection patterns among day, night, and crepuscular hours. In 2004, we retrieved 2 collars from mortalities and plotted the location data in a Geographic Information System. Average home range size in summer was 2848.773 km² 100% MCP, 1736.526 km² 95% MCP, and 1430.019 km² 95% kernel estimates. We found mule deer in most habitat types except meadows and shrub lands during the day. We have recovered two collars and found that restoration-treated habitats were used 76% of the time during night hours, 26% during the day and 54% during crepuscular hours for one individual and found that the other deer used the treatment areas 76% during the day, 84% at night, and 73% at dusk. We plan to complete our data analysis after we retrieve all GPS collars in fall 2005.

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Anhold,
John

TITLE / ABSTRACT

Stand Level Impacts of *Ips* and *Dendroctonus* Bark Beetles in Pine Forest Types of Northern Arizona

Beetle related pine mortality has subsided significantly throughout Arizona's forested lands in 2004. This reduction in tree mortality still exceeds the average level of pine mortality prior to 2001. A complex of bark beetles continue to work in concert to kill ponderosa pine, several *Ips* and *Dendroctonus* species. The pinyon pine is being attacked primarily by pinyon ips and to a lesser extent twig beetles. Initial tree mortality seemed to be associated with poor site quality, shallow soils, cinder hills, south facing aspects and along transitional zones such as the Mogollon rim. High tree densities of the pine forests are suspected to be compounding the effect of the drought.

Forest health monitoring, evaluation monitoring, funds are being used to: 1) quantify the impact, extent and severity of bark beetles on ponderosa and pinyon pine at the stand level through an extensive plot network on a portion of Arizona's northern National Forests, 2) describe the forest conditions in areas that have experienced moderate to high levels of mortality induced by recent drought and bark beetles and 3) look for correlations between stand and site conditions and pine mortality.

A GIS approach is being used to populate sample points for each National Forest and forest type. The number of sample points is determined by the amount of area per forest type per Forest. Plots and transects have been established on five National Forests in Arizona in 2003 and 2004. Site and stand mensurational data are being collected along with bark beetle occurrence. All plots will be revisited in 2005.

The following is a summary of plots that have been established by National Forest and forest cover type.

	Ponderosa Pine Plots		Pinyon Pine Plots	
	Cluster/Plots	Single	Cluster/Plots	Single
Prescott NF	20/60	28	6/18	9
Kaibab NF	35/105	42	17/51	14
Coconino NF	69/207	67	43/129	43
Apache-Sitgreaves NF	47/141	47	24/72	26
Tonto NF	20/60	22	9/27	13
TOTAL	191/573	206	99/297	105

In addition, to this "on the ground" work, we have collaborated with FHTET, RSAC and Kodak to analyze different remote sensing applications for the extent and severity of pinyon pine mortality across the Southwest. Satellite and multispectral imagery were collected from the same areas where we have installed our ground plots.

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Anhold,
John

TITLE / ABSTRACT

Piñon Pine Mortality Event in the Southwest: An Update for 2005

Drought conditions in the Southwest have persisted for a number of years resulting in large areas of piñon pine mortality. In 2002 drought conditions became extreme, facilitating an outbreak of piñon ips beetles (*Ips confusus*, Coleo:Scolytidae) which, in 2003, killed many millions of piñon pines over a six-state region. In response to this unprecedented mortality, Forest Health Monitoring provided funds to Forest Health Protection units so that the extent and intensity of the event could be evaluated. This evaluation and monitoring project continued in 2004.

The results from this project reveal that the situation on the ground is a quickly changing phenomenon. While the huge amounts of mortality seen in 2003 were caused by the aforementioned piñon ips, mortality throughout much of the affected area decreased sharply in 2004. In addition, a number of other damaging agents played a more prominent role in the damage that did occur. Conditions varied widely throughout the project area, so brief summaries from each of the participating Forest Health Protection units are presented.

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Anhold,
John

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Influence of Elevation on Bark Beetle Community Structure in Ponderosa Pine Stands of Northern Arizona

Andrew Miller¹, Kelly Barton¹, Joel McMillin², Tom DeGomez¹, Karen Clancy³, John Anhold²

¹Uniz of AZ, FH Extension; ²USFS FHP Flagstaff, AZ; ³RMRS, Flagstaff, AZ

Bark beetles killed more than 20 million ponderosa pine trees in Arizona during 2002 - 2004. Historically, bark beetle populations remained endemic and ponderosa pine mortality was limited to localized areas in Arizona. Consequently, there is a lack of information on bark beetle community structure in ponderosa pine stands of Arizona. Furthermore, it is unknown how elevation influences the community structure of these bark beetles. Understanding the bark beetle complex at different elevations will enable development of more effective forest management guidelines.

Ten ponderosa pine stands were selected in each of three elevational zones in north-central Arizona: 1) Low ~5500 ft, 2) Mid~7000 ft, 3) High~8500 ft. Three Lindgren funnel traps were placed at each of the 30 sites. Each trap was baited with a different combination of commercially available lures developed for *Ips pini*, *I. lecontei* and *Dendroctonus* spp. Traps catches were collected weekly (April – November) during 2004. Beetles and associated insects (predators and wood borers) were identified and tallied in the lab.

A total of 31,010 pine bark beetles belonging to 15 species were trapped and identified in 2004. More than 3,000 associated invertebrate predators and woodborers were collected. Preliminary observations indicate that *Ips* species in aggregate were most abundant at low elevation sites; however, individual species showed different distribution patterns. *Ips pini* was evenly distributed across elevations while *I. lecontei* and *I. calligraphus* numbers decreased with increasing elevation. *Dendroctonus* species in sum were most abundant at mid elevations; however, again there was considerable variation in distributions on the individual species level. *Dendroctonus frontalis* was much more abundant at low to mid elevations compared with the high elevation sites, while *D. brevicornis* was the most abundant at mid elevations. Numbers of other *Dendroctonus*, such as *D. valens*, *D. adjunctus*, and *D. approximatus*, increased with increasing elevation. The two most abundant invertebrate predators collected, *Enoclerus* and *Temnochila*, also showed disparate distribution patterns across the elevation gradient. *Enoclerus* species increased with increasing elevation, while *Temnochila* were most abundant at low to mid elevation. The study will be repeated at the same sites in 2005, and will be used to determine seasonal flight periods for each species by elevation.

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Anhold,
John

TITLE / ABSTRACT

Do Bark Beetle Sprays Prevent *Phloeosinus* Species from Attacking Cypress and Juniper?

Chris Hayes¹, Tom DeGomez¹, Karen Clancy², Joel McMillin³, John Anhold³
¹Univ. of Arizona, FH Extension, ²USFS RMRS-Flagstaff, ³USFS FHP-Flagstaff

Phloeosinus-caused mortality of Arizona cypress, *Cupressus arizonica*, one-seed juniper, *Juniperus monosperma* and alligator juniper, *J. deppeana* has been observed at high levels in Arizona during the past 3 years. Currently, there are limited preventative measures to protect high-value cypress and juniper trees against *Phloeosinus* attack. Insecticides that are being used to prevent bark beetle attack of individual high value pine trees may provide one method of protection.

This study was designed to determine the efficacy of Sevin SL (carbaryl), Permethrin Plus C (permethrin), and Biflex (bifenthrin) in protecting Arizona cypress and one-seed juniper from attack and colonization by cypress and cedar bark beetles (*Phloeosinus* spp.). Freshly cut bolts were used in the treatment as a surrogate to live trees. Treatments where 1.0% and 2.0% Sevin SL (carbaryl), 0.2% Permethrin Plus C (permethrin), and 0.03% and 0.06% Biflex (bifenthrin).

Preliminary results using Arizona cypress indicate both the bifenthrin treatments and the permethrin treatment passed the binomial test (Null: successful defense = 90%), carbaryl did not. The bark beetle species attacking Arizona cypress was identified as *Phloeosinus cristatus*. Results from the one-seed juniper treatments were not conclusive since only 50% of the control bolts experienced beetle attacks; causing this experiment to fail to meet the criteria set for a rigorous test of the treatments. Attacking beetles were identified as *Phloeosinus scopulorum neomexicanus*

The preliminary conclusions indicate Sevin SL (carbaryl) was not effective at a 2% formulation in preventing *Phloeosinus cristatus* attacks on Arizona cypress bolts, but was effective for protecting one-seed juniper at a 1% formulation. Both the 0.03% and 0.06% Biflex (bifenthrin) formulations and the 0.2% Permethrin Plus C (permethrin) treatment were effective at preventing successful *Phloeosinus* attacks on Arizona cypress and one-seed juniper. These single tree protection tests will be repeated in 2005 to draw more conclusive results, and will be extended to testing on alligator juniper.

Cataneo,
Michelle

Small-Scale Variation in Soil Moisture Content Under Canopies of One-Seed Juniper Trees

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Cibils,
Andrés

TITLE / ABSTRACT

Piñon Juniper Management Research at New Mexico State University's Corona Range and Livestock Research Center in Central New Mexico

Andrés Cibils¹, Sam Fernald¹, Jon Boren², Lou Bender^{2,3}, Kirk McDaniel¹, Mark Petersen¹, Shad Cox¹, Michael Rubio¹, Christy Black¹, Rachel Endecott¹, Michelle Cattaneo¹ and Santiago Utsumi¹

*Department of Animal and Range Sciences*¹, *Department Fish and Wildlife Sciences*², *NM Coop. Fish and Wildlife Research Unit*³, *New Mexico State University, Las Cruces, NM 88003*

Close to half the area of Corona Range and Livestock Research Center (CRLRC, ~28,000 ac) has been classified as actual or potential piñon-juniper (PJ) woodland. Much of the research that is conducted at CRLRC revolves around soil, plant, livestock, and wildlife responses to PJ woodland management. The objective of this paper is to provide an overview of on-going research projects at CRLRC dealing with sustainable management of PJ woodlands in central New Mexico.

Management of mature PJ woodlands: Mechanical removal and aerial application of herbicides (Tebuthiron) in the 80's and 90's created a mosaic of treated and intact woodlands across much of the PJ area of CRLRC. Current research focuses on the implications of PJ removal on hydrology, mule deer habitat, and cattle grazing distribution.

Hydrology: A 2-year study is being conducted to monitor soil water movement under treated and living juniper trees. This study will characterize interactions between vegetation, soil, and understory defoliation regime.

Mule deer habitat: PJ modification has had a positive effect on mule deer numbers. Aerial surveys were conducted in 2005 to begin examining the relationships between predators and game animals on the ranch. A study focusing on the effects cattle grazing on seasonal density and distribution of deer is in the planning stage.

Cattle distribution: A 2-year study concluded this spring investigating habitat use (cleared or intact PJ) of open and nursing adult cows. Cattle locations were tracked using GPS collars during the calving season. PJ stands appear to play a critical role in providing shelter for both open and nursing cows. We anticipate expanding this study to address minimum critical density of mature trees necessary to provide adequate grazing habitat for cattle.

Management of PJ reinvasion: Heavy encroachment of juniper saplings is occurring in most cleared areas across CRLRC. Although fire and herbicides have been used successfully at CRLRC to control juniper reinvasion, extensive use of these tools is not always feasible. We are investigating the use of prescribed grazing by goats and sheep as an additional tool to develop integrated strategies for improved control of PJ reinvasion.

Prescribed grazing: A study with goats and sheep began earlier this spring to determine levels of one seed juniper (*Juniperus monosperma*) intake in relation to monoterpene concentrations and supplement type (by pass and rumen degradable protein). Grazing studies will be conducted beginning next spring to determine season, density, and type (mixed vs. single species) of prescribed grazing necessary to control juniper reinvasion.

Controlled defoliation: Heavy clipping in winter is being applied to plots under dead and live juniper trees to determine the potential impacts of high intensity infrequent defoliation on non-target herbaceous vegetation. We anticipate beginning a controlled defoliation experiment this summer, to determine the influence of simulated browsing on re-growth and secondary compound levels of transplanted one-seed juniper saplings.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Dhaemers,
J.M.

TITLE / ABSTRACT

Understory Recovery After Spring Prescribed Fire in a Pinyon-Juniper Watershed

J.M. Dhaemers^{1*}, J.C. Chambers², and R.J. Tausch²

¹ University of Nevada, Reno; ² USDA Forest Service, Rocky Mountain Research Station, Reno, NV.

Pinyon (*Pinus monophylla*) and juniper (*Juniperus osteosperma*) have increased in area and stand cover since European settlement of the Great Basin. Expansion of the competitive trees is increasing landscape-level fuel loads and causing the reduction of associated sagebrush communities. This component of a Joint Fire Sciences Program, Demonstration Area Project, aims to understand the recovery thresholds of these ecosystems as defined by an abundance of residual species sufficient to maintain ecosystem sustainability following fire or fire surrogate treatments. We examined the effects of elevation and tree cover on herbaceous and shrub species response for two years (2003, 2004) following a spring prescribed fire (2002) in central Nevada. Effects of elevation were examined on paired burn and control plots at three elevations (2103, 2225, 2347 m), and influence of stand cover (low-20%, intermediate-38%, high-78%) was examined at the 2225 m elevation. Native and non-native seeding plots were included within burned areas to test the effectiveness of rehabilitation seeding. High elevation sites had higher initial herbaceous species response (biomass and cover) to prescribed fire due to deeper soils and higher available moisture. High tree cover plots had lower volumes of shrubs and biomass and cover of herbaceous species prior to burning, and exhibited lower understory response than low and intermediate plots. Seeding was most effective on high tree density plots. This information represents a first step towards developing criteria for assessing both recovery potentials and the need for rehabilitation seeding following either tree removal or wildfire in these valuable Great Basin ecosystems.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Dickson,
Brett G.

TITLE / ABSTRACT

Spatial Tools for Predicting the Effects of Fuels and Restoration Treatments on Forested Landscapes

Brett G. Dickson,^{1,2} Yaguang Xu,² Haydee M. Hampton,² John W. Prather,² Jean A. Palumbo,² and Thomas D. Sisk²

¹*USDA Forest Service, Rocky Mountain Research Station, 2500 South Pine Knoll Drive, Flagstaff, Arizona, 86001, USA and Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, Colorado, 80523, USA*

²*Lab of Landscape Ecology and Conservation Biology, Center for Environmental Science and Education, Northern Arizona University, Flagstaff, Arizona 86011, USA*

Forest fuels reduction and restoration treatments can be important in managing the threat of fire to communities and resources. To minimize this threat, it is presently recognized that efforts to reduce or manipulate forest fuels must occur at large scales and that fuels treatment and restoration objectives should be compatible. However, the effects of these treatments on various ecosystem attributes, including forest structure, fire behavior, and wildlife, are not well understood and should be assessed before resource managers recommend and implement large treatments. Moreover, management policies that address the environmental effects of treatments at the stand level may not consider the unique and cumulative effects of such treatments at the landscape level. For this research the objectives of the Forest Ecosystem Restoration Analysis (ForestERA) project were to 1) broadly characterize a range of treatment alternatives for ponderosa pine (*Pinus ponderosa*) that could be used to model the effects of these treatments on various forest structure attributes; and 2) develop spatial tools framed within a spatial decision support system for predicting and comparing the impacts of alternative forest management strategies on forest structure, fire hazard, and wildlife. By presenting a range of treatment alternatives within a flexible user interface, ForestERA tools will allow predictive models of forest fuels and restoration treatments to be overlaid with taxonomic distributions, inhabited areas, and other spatial data relevant to forest and fuels management.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Hassler, F.C.

TITLE / ABSTRACT

Expansion Patterns of *Juniperus Monosperma* into a Semi-Arid Grassland at Wupatki National Monument in Northern Arizona, USA

Hassler, F.C. and J.D. Bailey. Northern Arizona University, Flagstaff, AZ 86001-5018 USA.

Land managers at Wupatki National Monument in northern Arizona, USA have become increasingly concerned about expansion of one-seed juniper (*Juniperus monosperma*) into grasslands and grassy interspaces within savanna ecosystems. We are quantifying these trends by means of dendrochronological analysis across multiple geologic formations within and south of the Monument. Juniper size attributes (height, drip line, diameter at root collar) of all trees in experimental plots were measured. A root collar cross section of one tree from each of four size classes were removed from each plot for dendrochronological analysis. Tree size was then correlated to tree age, thus allowing the estimation of the age of all measured trees with minimal tree destruction. Preliminary data suggest that junipers became established in juniper "savanna" stands within the monument within the last 150 years on most geologic formations. However, denser, juniper woodland stands on the adjacent Coconino National Forest appear to have been established for 800 years or more. Growth and survival rates, are highly variable depending on site specific conditions that affect moisture availability. In grassland wildfire areas trees of all ages were found to be equally susceptible to fire induced mortality, with an average of 58% mortality. This suggests that though juniper woodlands on the National Forest were effectively 'fireproof' due to low levels of grass and herbaceous fuels, within Wupatki National Monument historically regular, low intensity fires were necessary to maintain the semi-arid grassland.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Horncastle,
Valerie

TITLE / ABSTRACT

Tree Roosting Bat Responses to Forest Restoration: Techniques and Preliminary Results

Valerie J. Horncastle, Mylea L. Bayless, Michael F. Ingraldi
Arizona Game and Fish Department

Ponderosa pine forests are being treated on Camp Navajo using restoration prescriptions to restore ecosystem function of the ponderosa pine forest community. We are studying the effects of ecosystem restoration on forest dwelling bats within ponderosa pine communities. We constructed 288 artificial tree roosts and attached them to trees in March 2004. Bat boxes were randomly located in 3 different treatments: thin, thin and burned, and deferred. Pre-treatment data was collected in 2004 and will be compared to post-treatment data collected in the future. Treatments are planned to occur in 2005-2006. In our poster we discuss the methodology used to monitor bats and preliminary evidence that bats will return to artificial boxes after disturbance using these methods. Bat boxes were checked for occupancy 15 times throughout summer 2004. Bats were removed from bat boxes and marked once in mid July and once in mid August. Bats were individually marked using a tattoo punched through the plaglopatagium, between the fourth and fifth digits. Bats were also color banded for visual confirmation of species and treatment areas where bats were captured. Overall we captured and marked 29 bats consisting of six species: *Myotis occultus*, *Eptesicus fuscus*, *Myotis evotis*, *Myotis volans*, *Myotis thysanodes* and *Myotis auriculus*. Bats removed from boxes for marking did use boxes again with a 35% return rate. By recapturing individuals, we were able to determine that our tattoo marking lasted at least a month. The use of bat boxes peaked in mid August with a 9% occupancy rate. Bats occurred more often in south and west facing boxes and in areas that will receive the thin and burn treatment.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Loveall,
Mark W.

TITLE / ABSTRACT

Prediction Equations for Aboveground Biomass and Carbon Distribution in *Pinus edulis*

Mark W. Loveall and John T. Harrington
New Mexico State University – Mora Research Center

Pinon-juniper woodlands encompass over 19 million hectares in the Western United States with almost half of the forested lands in New Mexico being this forest type. The pinon-juniper woodlands are valued for wildlife habitat, forest products, recreation, cultural significance and more. This study was designed to improve the understanding of the pinon-juniper woodlands by a detailed examination of the above-ground structures found within these systems. The objectives of this study were to describe the distribution of above-ground biomass within individual pinon trees and predict biomass distribution based upon common field measurements. Sample trees were located on a private ranch in Mora County, New Mexico in pinon-juniper woodland bordered by short grass prairie at lower elevations, and ponderosa pine forest at higher elevations. Five sample trees were selected in each of three 1-meter height categories and an additional three trees were selected whose heights were greater than 3 meters, resulting in a total of 18 trees in the study. Selected trees were measured in the field then dissected in a laboratory, where fresh and dry weights were recorded based on five tissue classifications. Predictive equations were developed to provide estimates of each tissue category and total tree biomass using crown width, total height and diameter at 30 cm field measurements.

Miller,
McKinley-
Ben

The Essence of Fire Regime Condition Class

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Ochoa,
Carlos

TITLE / ABSTRACT

Rainfall, Soil Moisture, and Runoff Dynamics in New Mexico Piñón-Juniper Woodland Watersheds

Carlos Ochoa and Alexander Fernald

We studied rainfall and runoff dynamics of six 1-1.35 ha experimental watersheds near Santa Fe, NM. The purpose of the project was to evaluate piñón-juniper woodland hydrological conditions before planned tree clearing. In 2003, we started automated data collection for rainfall, soil moisture, and runoff. Volumetric water content reflectometers (VWCR) were used to measure soil moisture hourly at each watershed, measurements were taken at wooded hillslope, grass hillslope, and valley bottom locations. Time domain reflectometry (TDR) experimental probes were installed in two watersheds to measure real-time soil wetting at hillslope, gully headcut and channel locations. Spatial dynamics of rainfall and runoff interactions were evaluated for 4 rain storms. Runoff was present at all watersheds in 3 of the 4 rain storms. Rainfall of 4.5 mm was calculated as the minimum precipitation before any significant runoff occurred. During high intensity rain storms, greater soil moisture was observed at the valley bottom of the watersheds when compared to soil moisture from the grass hillslope and wooded hillslope. At the watershed scale, the ratio between runoff and rainfall was relatively low. Lower runoff delivery ratios were associated with greater soil moisture increases. Antecedent soil moisture was important for runoff response. Wetting depth measured with TDR probes was consistent with increases in soil moisture measured with VWCR. In general, the wetting depth was greater at the channel, followed by the gully headcut and then by the hillslope.

These results suggest clearing trees may reduce rapid surface runoff from heavily wooded hillslopes for smaller precipitation events, while tree clearing may have little impact on runoff generation from larger precipitation events. More pre-clearing calibration data and post-clearing analyses will increase our understanding of the PJ clearing impacts on hillslope and watershed runoff responses.

Steed,
Brytten

Piñon Pine Mortality in Utah and Nevada: 2000-2004

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Stoddard,
Michael T.

TITLE / ABSTRACT

Does Slash Help Retain Soil And Increase Grass Cover in a Pinyon-Juniper Woodland?

Stoddard, Michael T., David Huffman, Thom Alcoze.
Northern Arizona University, Flagstaff, AZ

We established an experiment within the interspaces of pinyon (*Pinus edulis*) – juniper (*Juniperous osteosperma*) tree canopies to examine the effects of slash treatments on soil stability, soil chemistry and herbaceous emergence. The study site is in the Grand Canyon-Parashant National Monument, at Mt.Trumbull, Arizona. Our goal was to create favorable microsites or “islands” of elevated soil fertility for graminoid seed establishment. In 2003, we selected thirty \approx .1 acre interspaces across cinder and sedimentary soil types. The four treatments consisted of a control (no treatment), seed, slash, and slash/seed, each measured on 1-m² plots. By 2004, mean one year sediment loss equaled 2.1 cm in the control vs. 1.3 cm in the slash treatment. Slash treatments also significantly increased litter cover and decreased soil exposure. Soil moisture increased slightly within slash treatments compared to non slash treatments. Available NO₃ decreased significantly within slash treatments, possibly indicating increased microbial activity. Graminoid cover increased over 200% within slash and seed treatments compared to seed-only treatments. Our data shows that slash treatments do create favorable microsites for herbaceous emergence, therefore contributing to the recovery of these degraded ecosystems.

Sturtevant,
Robert
Trudeau,
Joseph

Colorado Wood – Utilization and Marketing Program

Fungal Inoculum and Wood Mulch Application in Restoring Roads in Arizona Ponderosa Pine Forests

I initiated an experiment to test the effects of using ground waste-wood (mulch) and fungal inoculum to foster plant establishment, and to evaluate the use of saprophytic fungi to accelerate decomposition of organic material on temporary roads used in forest restoration. I selected three roads at Northern Arizona’s Centennial Forest near Flagstaff, Arizona. I divided each road into five experimental blocks containing identical treatments. Treatments are 1)control, 2)mycorrhizal inoculum, 3)mulch, saprophytic fungi (*Hypholoma capnoides*), and mycorrhizal inoculum, and 4)mulch only. All plots were seeded with a mix of native grass and forb seeds. Data were collected in September 2004, two months after treatment. In this brief period mycorrhizal inoculation had an insignificant effect on establishment of seedlings, and mulched plots had significantly less plant establishment. However, mulch was successfully colonized by the saprophyte, and competition existed between the saprophyte and existing soil fungi. The short time between application of the treatments and data collection may explain the insignificant increase in establishment, and future benefits are anticipated as the mycorrhizae become established. One-year measurements will be collected in September 2005 and will shed more light onto the effectiveness of mulch and fungal inoculum for restoring forest roads.

Ecological Restoration of Southwest Ponderosa Pine and Pinyon-Juniper Ecosystems

Poster Abstracts

POSTER PRESENTER

Williams,
Mary

TITLE / ABSTRACT

Carbon Distribution Within a *Pinus edulis/ Juniperus monosperma* – *Bouteloua gracilis* Interface Site in North Central New Mexico

John T. Harrington & Mary Williams
New Mexico State University – Mora Research Center

Recent concerns over anthropogenic induced changes in atmospheric conditions have heightened interest in ecosystem capabilities for carbon sequestration. Much of the recent efforts in this area have focused oceanic systems or forested systems in tropical or boreal climates. The carbon sequestration potential of other terrestrial systems has been less studied. Semi-arid coniferous woodlands occupy a significant land mass world wide. More specifically, the general pinon/juniper (*Pinus* spp./*Juniperus* spp.) type occupies over 19 million hectares in the western United States. This presentation will review several investigations evaluating the above- and below-ground carbon distribution in a *Pinus edulis/ Juniperus monosperma* – *Bouteloua gracilis* interface site in north central New Mexico. The presentation will include the impacts of plant community composition on soil, soil surface and above-ground carbon pools.