Mixed conifer/aspen ecology and management, Santa Fe, Feb. 20

AGENDA, Page 1-2
SUMMARIZED TALKS, pages 2-21

8:40 – 9 am Introductions: Ken Smith (NMFWRI) and Susan Rich (OFWH)

9 – 9:30 Evaluation of silvicultural treatment effects on 1) fire behavior, 2) vegetation response, and 3) infiltration, runoff, and sediment yield in a south central New Mexico dry mixed conifer forest, Red Baker, Doug Cram, Glenn Mason (NMSU)

9:30 – 10 am A Landscape Perspective on Fire and "Restoration" in New Mexico Mixed Conifer Forests, Craig Allen (USGS) and Esteban Muldavin (Natural Heritage New Mexico, UNM)

10-10:15 Break

10:20 – 10:50   Landscape Heterogeneity: Key to Understanding and Restoring Southwestern Mixed Conifer Forest.   John L. Vankat (Professor Emeritus, Miami University, Vankat Consulting, LLC, Flagstaff, AZ)

10:50 – 11 Break

11 – 11: 20 Management Strategies in Mixed Conifer and Aspen in the Chama District, Joe Carrillo (NM State Forestry)

11:25 – 11:40 Harvesting in mixed conifer stands, Arnie Friedt and Ernie Lopez (NM State Forestry)

11:45 – 12:10 Large ungulate, small mammal, and livestock response to forest management in a south central dry mixed conifer forest, J. Boren, B. Hurd, G. Mason, T.T. Baker, H. Halbritter (NMSU)

Lunch

1:15 pm - 1:45 Using the Historical Range of Variation and Quantitative Successional Modeling for Adaptive Restoration of Mixed Conifer Forests in the Southwest, Edward Smith (Forest Ecologist, TNC AZ)

Break

2 – 2:20 Mixed Conifer Insect and Disease Trends in New Mexico, Deb Allen-Reid (Supervisory Entomologist/NM Zone Leader for Forest Health, USDA Forest Service, R3)

2:30 - 2:45 Practical Politicin' in the WUI, Rick DeIaco (Director of Forestry, Village of Ruidoso)

2:50- 3:05 Historical fire regime in mixed conifer forest in southwestern Colorado, Carissa Aoki (Colorado State University) and Lesli Allison (Banded Peak Ranch Manager)

Break

3:30 – 4 Ecology and Management Issues in Mixed Conifer Forest in southern Arizona, Don Falk, Ann Lynch (U. of Arizona), and Craig Wilcox (Coronado NF)

4:15 – 4:45 Variability in historical fire regimes of aspen/mixed conifer forests of the southwest. Ellis Margolis (U of Arizona)

5pm Concluding remarks

Mixed conifer/aspen ecology and management summaries (for further information, please contact the speakers)

Santa Fe, Feb. 20 (State Land Office Building)

Sponsored by NM FWRI, NM Forest and Watershed Health Office, and NMSU Extension.

Introduction

Why this focus?

- Mixed conifer and aspen comprise approximately 15% of New Mexico's forest cover
- One of the state's most diverse forest types
- Habitat for variety of wildlife species, some at the heart of forest management battles
- Headwaters of many of our critical watersheds
- Altered fire regime changing overstory and understory composition and fire hazard

Meeting Objectives

- Mixed conifer and aspen treatments called for as aspen declines, as other forest health issues arise, as the WUI expands, and as fire hazards increase
- Recommendations for restoration of ponderosa pine relatively clear but for mixed conifer, they are not
- Restoration will be site specific
- What are the restoration guidelines for managers implementing treatments in mixed confer/aspen stands?
- Today is a step in understanding the current status of our knowledge of the ecology and the management of these systems
- Conclusions from the talks today will be summarized
- In the future, SWERI is including mixed conifer in all three Institutes' work plans
- Ecology and management under a changing climate scenario

Ecological Foundations

Key Characteristics

- Mixed conifer forests contain many potentially abundant tree species:

Ponderosa pine	*Pinus ponderosa*
White fir	*Abies concolor*
Douglas-fir	*Pseudotsuga menziesii*
Quaking aspen	*Populus tremuloides*
Blue spruce	*Picea pungens*
Engelmann spruce	*Picea engelmannii*
Subalpine fir	*Abies lasiocarpa*
Southwestern white pine	*Pinus strobiformis*
Limber pine	*Pinus flexilis*
Corkbark fir	*Abies lasiocarpa* var. *arizonica*

- Stand structure and composition was very heterogeneous, especially in the past:

    - Open & dominated by ponderosa pine
    - Dense & dominated by spruces and fir
    - Dominated by quaking aspen
- ➢ Disturbance also was very heterogeneous, especially in the past with a mixed-severity fire regime.

Vegetation Communities and Stand structures

- Mixed conifer forests are naturally highly variable across the Southwest with respect to vegetation composition and stand structure, and ultimately fuel loads.
- Fire regimes are variable as well, i.e., different frequencies and intensities across types.
- Landscape complexity adds to the challenge of defining the range of natural variability and specifying restoration criteria.

By some groupings, 200+ Mixed Conifer plant associations in the western U.S.
85 in the Southwest among three major Series (alliances or dominance types)

- White Fir -- *Abies concolor* Alliance *(30 associations)*
- Douglas-fir -- *Pseudotsuga menziesii* Alliance (*35 associations*)
- Blue Spruce -- *Picea pungens* Alliance (*20 associations*)
- Note: Aspen not on the list

Or, they can be arranged and further collapsed into three series:
Diversity of SW Mixed Conifer Forests: III Series

- I *Picea pungens* (5 associations)
- II *Abies concolor* (5 associations)
- III *Pseudotsuga menziesii* (1 assoc)

>600 Citations for eleven Potential Natural Vegetation Types (PNVTs)

Finally, our 85 or 11 mixed conifer associations can be collapsed down to two Ecological Systems:

- **Southwest – Southern Rocky Mountain Dry-mesic Mixed Conifer**
- **Southwest – Southern Rocky Mountain Moist-mesic Mixed Conifer**

Four new "alliances" within the Ecological Systems:
1) SRM Moist-mesic Mixed Conifer – Shrub
2) SRM Moist-mesic Mixed Conifer – Herbaceous
3) SRM Dry-mesic Mixed Conifer – Shrub
4) SRM Dry-mesic Mixed Conifer – Herbaceous

- They have fundamentally different compositions and stand structures, and hence fuel loads and fire regimes.
- They address the level of our current knowledge on forest dynamics, particularly fire.
- Stand structures are also quite variable.

With so much variability, two questions remain difficult to answer:

- ➢ What is the historical range of variability (HRV)?
- ➢ What would be a valid "restoration" prescription?

These questions are addressed now.

Stands and the landscapes they composed were largely products of elevation, topography, and disturbance, especially fire and insects. This discussion will focus on the **Southwest Mixed Conifer Triangle**, the interaction of vegetation, topography, and fire
Scale of Topography is Key: We can find *Large* Patches of Vegetation, Relatively *Homogeneous* Topography, and *Large* Patches of Fire, and we can find… *Small* Patches of Vegetation, Relatively *Heterogeneous* Topography, and *Small* Patches of Fire
Do Other Forests Have Similar Triangles?

Yes, but Mixed Conifer Forest is much more heterogeneous than other montane forests in the Southwest because of

1. More tree species (with varied ecological requirements)
2. Mixed-severity fire regime

Changing Landscapes
Consider the **Topographic Profile in a Heterogeneous Landscape**, with a Valley Bottom, South-Facing Aspect, Ridgetop, and North-Facing Aspect. The elevation difference may be as little as 100 ft.

Likely Vegetation Pattern before Fire Exclusion
Valley Bottom – dense Spruce, Spruce-Fir, and Aspen
South Aspect – open Ponderosa Pine, Douglas-Fir, and Aspen
Ridgetop – open Ponderosa Pine
North Aspect – moderately dense Ponderosa Pine, White Fir, Douglas-Fir, and Aspen

Likely Fire Pattern
Valley Bottom – dense Spruce, Spruce-Fir, and Aspen - surface fires plus occasional crown fires
South Aspect – open Ponderosa Pine, Douglas-Fir, and Aspen - surface fires
Ridgetop – open Ponderosa Pine - surface fires
North Aspect – moderately dense Ponderosa Pine, White Fir, Douglas-Fir, and Aspen - surface fires plus occasional crown fires

Methods for determining fire history - Multiple lines of tree-ring evidence

- Age structure
- Death dates
- Fire survivor growth changes/traumatic resin ducts
- *Fire scars* (rare in some forest types)

Eastern Jemez Mts. fire-scar network:
At each location, 10-25 trees sampled for fire-scars.
Chihuahuenos Bog fire scars

- Recent suppression period since ca. 1900 AD appears to be an anomaly over last ~8,000 years.
- Major increase in charcoal concentrations with climate transition in early Holocene.

Camp May North fire scars,

- mixed severity fire history, Mesic Mixed Conifer Forest
- For all of these, lots of fire until 1900

Canada Bonito North fire scars

- mixed severity fire history
- mesic Mixed Conifer Forest
- Can't really tell the difference in mesic and xeric mixed conifer from fire scars

Upper Frijoles Watershed fire scars

- upland mixed conifer had 8-yr fire return interval
- riparian mixed conifer had 10-yr fire return interval

Fire History Studies on the North Rim of the Grand Canyon

- Mixed-severity fire regime
- Surface fires had a mean fire interval of about 7-19 years, at 25% scarring
- Crown fires were limited to small patches ≤2 ha
- Fire regime correlated with topography and forest structure

What was the historic fire return interval in mesic mixed conifer?
For surface fire, it looks like 15-20 years

Crown fire

- History of crown fire determined from aspen patches
- 10-yr fire return interval in mixed conifer at 9600 ft, synchronized with ponderosa pine below it

- Changes in some mixed conifer sites increases fire severity, but not all; historically, South aspects weren't as dense, and prevented landscape-level crown fire

With Fire Exclusion, vegetation became more homogeneous and fuels increased across landscape
Valley Bottom – dense Spruce, Spruce-Fir, & Quaking Aspen → *no significant change in vegetation*
South Aspect – open Ponderosa Pine, Douglas-Fir, and Aspen → d*ense Ponderosa Pine, Douglas-Fir, White Fir, and Aspen*
Ridgetop – open Ponderosa Pine → *moderately dense Ponderosa Pine*
North Aspect – moderately dense Ponderosa Pine, White Fir, Douglas-Fir, and Aspen → *dense Ponderosa Pine, White Fir, Douglas-Fir, and Aspen*

Changes in quantity and connectivity of fuels are drivers of higher severity fire in some Mixed Conifer forests. Landscape fuel continuity leads to landscape-scale crown fire, which further increases landscape homogeneity. For example, with the 2006 Warm Fire, 40% of the area burned with high severity, and 19% with medium/high severity. And with the 2000 Outlet Fire on the North Rim, the patch size is far outside the HRV, and the area is a largely homogeneous landscape of quaking aspen. These historically anomalous high-severity fires are now creating "landscape scars"

Restoration
Both Process and Structure are part of forest ecosystem resilience. Factors involved in Process are number of years between surface fires, probability of a crown fire, and time to recovery. Factors that are part of Structure are tree density, vertical continuity, and horizontal continuity. We need to differentiate between Mesic mixed conifer, with high values for process and structure variables, and xeric mixed conifer, with lower values for process and structure.
Xeric stands, with a shorter fire return interval and more heterogeneous fuel distribution, are better suited to Restoration than are Mesic stands, which are naturally dense and have heavy fuel loads.
Treat/restore xeric Mixed Conifer stands first, thus interrupting landscape-scale fuel patterns, but use restraint with mesic MC forests. Dieback caused by insects and disease might be a blessing for mixed conifer forests, leading to increased resilience and reduced crown fire risk.
The overall **Restoration Goal** should be to reestablish patterns of vegetation and fire that are spatially congruent with site topography, i.e., to reestablish the Southwest Mixed Conifer Triangle at the scale of the specific landscape

Restoration Aids can be thought of as passive (stand self-thinning or insect-caused mortality) or active (manual thinning and prescribed fire).

Passive Restoration	Advantages	Disadvantages
Self-Thinning	Requires no human action No management costs Perceived by public as "natural"	Effects are poorly understood Integration into a multifaceted restoration plan may be problematic
Insect-Caused Mortality	Requires no human action No management costs Perceived by public as "natural" (or not)	Effects of recent insect outbreaks are poorly understood Integration into a multifaceted restoration plan may be problematic Mortality may be excessive and differentially affect older age classes and some species
Active Restoration	Advantages	Disadvantages
Manual Thinning	Tree mortality is controllable	Expensive Perceived by public as "unnatural"
prescribed fire	Less expensive than manual thinning, at least for large areas Perceived by public as similar to "natural"	Risk of landscape-scale crown fire All the other problems that prescribed burning entails

Active restoration treatments to increase forest ecosystem resilience may involve combinations of mechanical thinning and prescribed fire

Two medium-scale prescribed burns currently are planned in Southwest SW Mixed Conifer Forest:

- SW Roost Burn on the North Rim of GCNP, 2130 acres, planned for Fall 2007.
- An interagency project, the Puma Burn in Utah, nearly evenly divided between in Bryce Canyon NP and Dixie NF (an interagency project), about 4100 acres, date uncertain.

Take-Home Points on Southwest Mixed Conifer Forest

1. Mixed conifer associations can be coarsely grouped into two broad ecological systems: Dry-mesic Mixed Conifer and Moist-mesic Mixed Conifer
2. Mixed conifer landscapes formerly consisted of mosaics with patches of highly contrasting vegetation and burn severities
3. These mosaics and patches were products of the interactions of topography, vegetation, and fire, i.e., the Mixed Conifer Triangle
4. Fire exclusion increased fuel loads and landscape homogeneity and led to landscape-scale crown fires
4. These crown fires burned across topographic sites, further increasing landscape homogeneity
5. Restoration should attempt to reestablish patterns of vegetation and fire that are spatially congruent with site topography
6. Restoration should begin with the Dry Mixed Conifer, due to historically shorter fire return interval and lower fuel loads

Literature Cited

Fulé, P.Z., J.E. Crouse, T.A. Heinlein, M.M. Moore, W.W. Covington and G. Verkamp. 2003a. Mixed-severity fire regime in a high-elevation forest of Grand Canyon, Arizona, USA. Landscape Ecology 18:465-486.
Fulé, P.Z., T.A. Heinlein, W.W. Covington, and M.M. Moore. 2003b. Assessing fire regimes on Grand Canyon landscapes with fire-scar and fire-record data. International Journal of Wildland Fire 12:129-145.
Vankat, J.L., D.C. Crocker-Bedford, D.R. Bertolette, P. Leatherbury, T. McKinnon, and C.L. Sipe. 2005. Indications of large changes in mixed conifer forests of Grand Canyon National Park. p. 121-129 in van Riper, C. III and D. J. Mattson (eds.). The Colorado Plateau II: Biophysical, socioeconomic, and cultural research. Proceedings of the 7th Biennial Conference of Research on the Colorado Plateau. University of Arizona Press, Tucson, Arizona.
White, M.A. and J.L. Vankat. 1993. Middle and high elevation coniferous forest communities of the North Rim region of Grand Canyon National Park, Arizona, USA. Vegetatio 109:161-174.
Wolf, J.J. and J.N. Mast. 1998. Fire history of mixed-conifer forests on the North Rim, Grand Canyon National Park, Arizona. Physical Geography 19:1-14.
Community Diversity Citations:
Moir and Ludwig1979, RM-RP-207: A classification of spruce-fir and mixed conifer habitat types of Arizona and New Mexico.
DeVelice, Ludwig, Moir, and Ronco. 1986. RM-GTR-131: A classification of forest habitat types on Northern New Mexico and Southern Colorado.
Muldavin, DeVelice, and Ronco. 1996. RM-GTR-287: A classification of forest habitat types Southern Arizona and portions of the Colorado Plateau.

Presenters

A Landscape Perspective on Fire and "Restoration" in New Mexico Mixed Conifer Forests

Esteban Muldavin - Natural Heritage New Mexico, University of New Mexico, Albuquerque
Craig D. Allen - US Geological Survey, Jemez Mountains Field Station, Los Alamos, New Mexico

Using the Historical Range of Variation and Quantitative Successional Modeling for Adaptive Restoration of Mixed Conifer Forests in the Southwest, **Edward Smith (Forest Ecologist, TNC AZ)**

Landscape Heterogeneity: Key to Understanding and Restoring Southwestern Mixed Conifer Forest. **John L. Vankat (Professor Emeritus, Miami University, Vankat Consulting, LLC, Flagstaff, AZ**)

More on the Historic Range of Variation (HRV) and Historic Fire Rotation (HFR)

Arizona and New Mexico contain montane Forests [spruce-fir, mixed conifer, and ponderosa pine totaling 12.1 million acres. About 1,780,100 acres of that is mixed conifer.

Disturbance Regimes for SW MC
"Mixed Severity Fire" (both surface/non-lethal, and stand-replacing) return interval minimum of 1-17 years (Pinaleños), maximum fire interval of 18-76 years (Jemez Mtns.), for an average fire rotation (for >25% scarred trees) of 5-33 years.
More than 40% of fires occurred between early May and early June, 30% occurred in June, 20% of fires occurred before early May, and approximately 9% occurred late June to mid-July, and about 1% occurred between July and September.
Insect Outbreaks occur about once every 33 years.

Fire Patch Size for SW MC
Prior to 1900, extensive >250 ac crown fires did occur in higher elevation mixed conifer and spruce-fir forests, but lower elevation mixed conifer forests burned primarily as surface fires, and stand-replacing events probably occurred at smaller scale (<250 ac).
If fire is excluded ,the landscape moves further outside of HRV. Stand-replacing fire is a result of European settlement.

Historic Southwest Climate Information: frequency and magnitude of fires and other disturbances
As part of the Southwest Forest Assessment Project, The Nature Conservancy (www.azconservation.org) determined the frequency and magnitude of wet or dry periods for each climate division in New Mexico and Arizona. Then they assigned multipliers to the fire frequencies based on published information on the relationship. For example, for ponderosa pine, the probability of fire during a Severe Drought was twice as likely as during a Normal year, and the probability of fire during extremely wet periods was half as likely as during a Normal year. 45% of the years were Normal, 19% Extremely Wet, 6% were Wet, 8% were Drought years, and 21% were Severe Drought. Then the proportion of those year types was added into the model for the 1000 year modeling period.
This work led to two models, a four-box **Historic SW Mixed Conifer Forest with Aspen State and Transition Model,** and a seven-box **Current SW Mixed Conifer Forest with Aspen State and Transition Model.** The diagrams representing the models are not reproduced here, but are available from TNC.

Specific communities – Aspen

Aspen age structure and history of surface fires

The high number of fire scars and lack of a single aspen recruitment pulse indicates a higher frequency *surface fire regime* (i.e., from meadows burning into the surrounding forest) that was not stand-replacing.
Chiricahua Mountains (Southeast AZ): 46% of aspen recruited within 5 yrs of a widespread fire
Aspen/Mixed Conifer sites with historical stand-replacing fire regimes

Stands with fire-killed conifer remnants, lots of even-aged aspen, and a lack of fire scars

Santa Fe Ski Basin: Distinct aspen recruitment pulse and a lack of fire scars indicates a stand-replacing fire regime

Aspen/Mixed Conifer sites with historical mixed-severity fire regimes

- Mixed-severity in *space*: Single fire events may have crown fire and surface fire along the elevation gradient
- Mixed-severity in *time:* Landscapes may experience stand-replacing fire and surface fire through time

How has the cessation of frequent surface fire affected aspen age and stand structure?

Most likely, we would not see the even-aged stands of well-formed trees that we associate with aspen; the aspen clones would look like a shrub field.

Specific landscape - Pinaleño Mountains of Arizona

Fire regimes of the Pinaleño Mountains

Subalpine forest	Stand-replacing, 300-400 yrs
Mixed-conifer forest	*mixed* fire regime (topography, dry → mesic MC)
	frequent surface fires, 15-30 yrs
	occasional stand-replacing events and/or patches
Pine, pine-oak woodland	frequent surface fire, 5-15 yrs
Desert grassland	frequent grass canopy fires

Landscape linkages – in the above 4 plant communities in the Sky Islands, the majority of fires begin below the mixed-conifer, and burn upwards into the mixed-conifer.

High elevation vegetation history

Stand-replacing fires in 1685, 1996 & 2004.

Very rarely do fires burn into the spruce-fir. Grissino-Mayer et al. dated a catastrophic fire in 1685. The extent of this fire is unknown, but included parts of the Mixed Conifer and Spruce-Fir, possibly the entire top of the mountain.

Fire scar chronology - Limited data in the mixed conifer shows fire exclusion begins 1870s-1880s, and live trees predate the 1685 fire. No spruce have been found that originated before 1685. Recruitment data and annual increment data indicate that canopy closure occurred 150 to 200 yrs after the 1685 fire. The original forest was dominated by Engelmann spruce, and corkbark fir began to recruit after canopy closure. The mature spruce-fir forest developed 240 years after the fire, with little recruitment after that, and that was corkbark fir.

Suspected historic condition:

- moist mixed-conifer: low to very high density, patchy
- dry mixed-conifer: very low density, near-savannah of mixed-species
- spruce-fir: much like contemporary conditions

Management situation and challenges

- Stand densities in great excess of natural condition, due to fire exclusion
  - Excessive ladder fuels
  - Shade-tolerant species have increased in dominance
- About one-half of the landscape has an SDI greater than 55% of the maximum SDI.
- Extreme fuel conditions
- About one-half of the landscape has a crown index of only 10-20-mph
- Poor forest health, esp. risk of Douglas-fir beetle outbreak and severe dwarf mistletoe infections

Specific landscape - **Banded Peak Ranch, Chromo, CO**

Forest composition:

SW white pine – 1%
Blue spruce – 1%
Ponderosa – 3%
Cottonwood – trace
Subalpine fir – 4%
Aspen – 31%
Douglas-fir – 17%
Engelmann spruce – 9%
White fir – 34%

Tentatively broken into even-aged (S-facing slopes) and uneven-aged (other) stands
Fire dates in common with previous studies - 1851, 1861, 1879
Some evidence suggests that fire history and forest development differs on the two sides of the Continental Divide, which runs through the ranch. This observation may point to regional vs. local drivers, which are being investigated.

HRV/HFR and Management

Historic Range of Variability }
} → **Management Decisions**
20th c. Structural Changes }

- **"From the land manager's perspective, the most difficult case is probably restoration of appropriate patch sizes and age class distribution in forests representing intermediate fire-free interval regimes**. It is difficult for many stakeholders to see beyond the immediate consequences of stand-replacing disturbances in fairly large patches. Nevertheless, **"missing fires" in these fire-dependent forest types are beginning to have substantial structural and compositional effects.** Unlike spruce–fir forests with long fire-free interval regimes, responsible stewardship of these intermediate fire-free interval systems demands serious consideration of the aggressive pursuit of reference conditions." **-Long 2003 (*Tree Physiology*)**

Management Implications

- Landscape Context is Primary
- Variation is Rampant
- Use Range of Values
- Summarize What You Know
- Monitor Effects of Actions
- Document & Communicate Observations
- Change Management as Appropriate

Management Implications for Aspen

- Stand-replacing crown fire is within the historical range of variability in some Aspen/MC types
- Relatively frequent surface fire was the historical fire regime in some Aspen/MC types and, similar to ponderosa pine, fire exclusion in these types may increase fuel loads and alter fuel structure resulting in increased crown fire risk
- Aspen regeneration was historically associated with fire occurrence (including surface fire); thus, fire exclusion at sites with historically frequent fire has likely changed aspen age and stand structure

Citations

(Grissino-Mayer *et al*. 1995)

Long 2003 (*Tree Physiology)*

Swetnam and Baisan 1996, Touchan et al 1996, Fule et al 2003, Heinlein et al 2005, Swetnam and Lynch 1989, Lynch and Swetnam 1992.

Margolis,E.Q., Swetnam,T.W., and Allen,C.D. 2007. A stand-replacing fire history in upper montane forests of the Southern Rocky Mountains. Canadian Journal of Forest Research 37(11): 2227-2241.

Presentations

Historical Fire Regime of a Mixed Conifer Forest in Southwestern Colorado
Lesli Allison, Banded Peak Ranch   Carissa Aoki, Colorado State University
Banded Peak Ranch, Chromo, CO

Ecology and Management Issues in Mixed-Conifer Forests in the Pinaleño Mountains of Arizona
Ann M. Lynch   U.S. Forest Service, Rocky Mountain Research Station
Craig P. Wilcox U.S. Forest Service, Coronado National Forest
Donald A. Falk   University of Arizona, School of Natural Resources and Laboratory of Tree-Ring Research

Variability in historical fire regimes of aspen/mixed conifer forests of the Southwestern U.S.
Ellis Margolis, University of Arizona, Laboratory of Tree-Ring Research

Using the Historical Range of Variation and Quantitative Successional Modeling for Adaptive Restoration of Mixed Conifer Forests in the Southwest, Edward Smith (Forest Ecologist, TNC AZ)

Current Management

HARVESTING IN MIXED CONIFER STANDS

MANAGEMENT GOALS

- Improve & maintain the overall health & vigor of the forest and watershed.
- Reduce the long term catastrophic wildfire hazard.
- Retain or improve the aesthetic value of the forest.
- Serve as an example to other residents and/or create demonstration areas.
- Protect and improve wildlife habitat.
- Remove hazard trees.
- Create fuelwood areas for the public.
- Address existing forest insect and disease conditions, and *protect* residual stands from insects.
- Lower stand density.
- Remove deformed, inferior trees.

Projects

- Angel Fire WUI – 8,700 ft, East facing slope, 33 acres, 2002
    - treatment – Shaded fuel break, 200 BA reduced to 60 BA
- Cimarron Canyon Habitat Improvement – 8,000 ft, North facing, 2 acres, 1982
    - treatment – Commercial Thin from below, 200 to 90 BA
- Coyote Fuels Reduction – 8,800 ft, South facing slope, 110 acres, 2005
    - treatment – Commercial thin from below, 160 BA reduced to 80 BA
- La Jara / Taos Pines WUI – 9,100 ft, South facing slope, 180 acres, 2007
    - treatment – Shaded fuel break, 150 BA reduced to 60 BA
- Little Blue Timber Sale – 9,600 ft, East facing slope, 160 acres, 1994
    - treatment – Range, 100 BA reduced to 100 BA, windthrow-reduced to 60 BA

RECOMMENDATIONS

SHADED FUEL BREAK

- A shaded fuelbreak is created by reducing surface fuels, increasing height to the base of the live crown, and opening the canopy by removing trees.

COMMERCIAL/PRECOMMERCIAL THINNING

- The harvest consists of “thin from below” with a combination of several different harvest types; single tree selection, group selection, and overstory removal.
- Hazardous trees; deformed, inferior, and dead trees; and ladder fuels are removed.
- Retain two snags per acre.

EQUIPMENT USED

- Feller/Buncher
- Stroke boom delimber
- Single Grip Processor
- Shear
- Hydro Axe
- Forwarder
- Timbco with processor
- Conventional logging
    - Chainsaw
    - Trunk with winch
    - Rubber tired skidder

CONCLUSION

- Lower fire intensity.
- Less probability of torching.
- Lower probability of independent crown fire.
- *Little or no adverse impact on residual stand (i.e. windthrow).*
- The residual stand retained its multistory characteristics.
- The tree species mix remained unchanged.
- The average diameter of the stand moved from 8-10 in. DBH to 12-16 in. DBH.
- Increase production of grass and forbs.
- Less risk from catastrophic wildfire by removing “ladder fuels”.
- Wildlife habitat improvement.
- Improved aesthetic appearance.
- Increased individual tree vigor and general forest health.
- Increased site productivity
- Decreased competition among trees.
- Lower stand density.
- Favorably stocked forest.
- Occasional episodes of windthrow happen after spring thaw-out, when soils are saturated and winds are high.

PROJECT: Green Mountain Blowdown

- Location: Eagle Nest, New Mexico
- Elevation: 10,000 feet
- Acres affected: 640+ acres, *circular pattern*
- Slope: North facing
- Timing of practice: Prior to 2001

MANAGEMENT GOALS

- None offered
- Event occurred in inaccessible roadless area, precluding removal/utilization or implementation of any management practices).

EQUIPMENT USED

- Mother Nature (wind event).

CONCLUSION

- Substantial amount of downed woody material on the ground, heavy fuel loading on 640 acres of blowdown.
- No entry or harvest activity prior to event.

- Extreme weather precipitated event.
- No appreciable insect activity.
- Some regeneration noted in area.
- Area could be firefighters' nightmare.

IN SUMMARY

- The mixed conifer type in general lends itself to harvest and thinning practices.
- Mixed conifer is not adversely affected by human activity.
- Mixed conifer continues to regenerate, as evidenced by the abundance of seedlings and saplings in older project areas.
- No adverse soil conditions noted after treatment, i.e. erosion.
- BMP's should be implemented, as always, as it is possible to have windthrow even in areas of human inactivity.

Special Case - Wildlife Management

Management practices that promote greater understory production (i.e., that reduce the overstory) typically result in higher deer, elk, and cattle use.

Prescribed burning

- A preferred management tool in conifer systems, releasing nutrients for understory grasses, forbs, and shrubs
- With opened overstory, the combination of mineral soil, high nutrient availability, and sunlight provides ideal condition for establishment of shade-intolerant species
- Fire suppression has allowed areas to reach climax stages, resulting in lower productivity and ultimately reducing carrying capacity for wild ungulates

Silvicultural treatments

- Numerous studies show increase in habitat use by large herbivores following timber harvesting
    - Attributed to increase in understory forage quantity and quality
- Use of clearcuts variable; effects differ by size, age, amount of slash, and season.

Aspen stands and mountain meadows are important components of mixed conifer stands, and provide significant values for all wildlife species

Aspen

- Mature stands have an abundant herbaceous and shrub component in understory that is typically significantly greater than other forest types
- Regeneration often fails as it is highly preferred by ungulates
- Challenge for management is treating enough acreage to allow adequate regeneration

Meadows

- Meadows used heavily due to abundant, nutritious, highly palatable, and digestible forage
- Meadows suffer from woody plant encroachment

A synopsis of recent research on the Sacramento Ranger District of the Lincoln National Forest

- The Mixed conifer has become dominated by Douglas-fir and white fir, with little pure aspen.
- Dense saplings dominate the understory, and grasses are uncommon.
- Mountain meadows are present, and the District manages 38 grazing allotments.
- Recent management included reducing elk and cattle numbers to minimize elk-cattle conflicts, elk depredation, and combined herbivory impacts on vegetation

Findings

- Pellet group densities of elk were significantly higher than cattle and deer on mountain meadows during fall/winter season
- Pellet group densities of elk and deer greater in logged than unlogged areas
- Kentucky bluegrass most abundant grass in elk and cattle diets in summer range (meadows)
- Buckbrush most important browse species for elk, deer, and cattle in winter range
- Little dietary overlap between cattle and elk in winter range (43% similar)

- Substantial dietary overlap between cattle and elk in summer range (84% similar)
- Thinned treatment had higher richness and abundance of large and small mammals in comparison with the 60-100 year non-thinned
- Chipmunk and vole abundance lower in the 60-100 year non-thinned stand than in all thinned treatments
- Most carnivores documented in lop/pile (91%) and lop/scatter (9%)
- 68% elk, 80% mule deer documented in thinned treatments
- Ranges of elk included aspen and large wildfire burn vegetation cover and structure types far in excess of their availability on the LNF landscape.
    - Elk also located in aspen and burns far in excess of their availability
- Accretion of body fat in elk most closely and negatively associated with abundance of piñon-juniper, ponderosa pine, and other conifer vegetation/cover structure types

Management Implications

- ❖ *Logging and/or other treatments to improve forage production in upland sites could relieve grazing pressure* on sensitive bottom-lands. *I*f we are concerned with decreasing the use of sensitive meadow areas by elk, a solution may be as simple as starting to timber harvest in the uplands again to increase grass production. This also has management implications as related to the management of the spotted owl.
- ❖ *Specific species of interest should be considered when making management decisions, but thinning appeared to benefit mammal community*.

Research at NMSU in LNF

- Byron Wright (2000) – Ungulate Distribution and Forage Utilization in the Sacramento Mountains
- Brian Hurd (2002) – Effects of Big Game and Livestock on Plant Cover, Composition, and Herbaceous Biomass in Logged Areas of the Sacramento Mountains
- Christina Wampler (2007) – Effects of Forest Thinning Treatments on Mammals in a Southwestern Mixed Coniferous Forest
- Heather Halbritter (2007) – Demographics, Habitat Use, and Foraging of Sympatric Elk and Cattle on Lincoln National Forest

Conclusions

- ➢ Low availability and high utilization of woody browse plants
    - Management needs to increase forage quantity
    - Use of meadows was uniformly below sustainable levels
- ➢ Most of the annual variation in residual stubble heights of grasses not attributable to large herbivore grazing
    - Managers need to consider other environmental factors
- ➢ Diet quality and performance matrices of elk and cattle all indicate habitat is capable of supporting substantially more animals
    - Not regulated by density-dependent factors
    - Management needs to focus on creating more forage to assist in distributing elk and cattle across landscape
- ➢ Results indicate that distribution and performance of cattle and elk can be affected by management actions aimed at opening conifer vegetation cover/structure types, increasing aspen abundance and distribution, and prescribed burning during late winter and spring

Special case – Fire use

Banded Peak Ranch, Chromo, CO

Map: Banded Peak Ranch Dominant Stand Inventory

52,000 acres, ranch is managed primarily for ecological health

Ranch managers decided that thinning first is the only viable option; additionally, they like cool fire.
Costs are now down to $100-200/ acre
Prefer late-fall aerial ignition
Lessons Learned

- Mixed conifer → mixed burns → mixed results
- Mixed results → pockets of unburned fuels → lots of mop up and late-season re-ignition hazard
- In spring, when pine duff is in prescription, white fir duff is like wet cardboard.
- When white fir duff is in prescription, pine straw is explosive.
- Once fall frosts have begun, pine needles burn well but aspen leaves do not burn at all
- Fire does not carry well due to lack of grass and other fine fuels
- Pre-thinning reduces some hazard and provides more fuel to carry fire through the stand
- Because fire does not burn across stands consistently, maintaining even strips is challenging
- Falling aspen trees in burned areas present a major hazard to mop-up crews
- Because of the tendency toward mosaic results, achieving clearly defined objectives is difficult
- No two mixed conifer stands are alike

Special case - Aspen

Primarily Doug-fir dominated stands, trying to remove white fir
Strategies:

- Try to mimic fire, based on owner goals, i.e., hunting
- Brush fences to funnel elk
- Patch cuts:
  - Remove 2-4 loads/ acre of aspen and white fir
  - Most of remaining stems are felled and piled, windrow-style, into a elk-proof fence
  - Aspen regeneration is allowed to take place inside fence, protected from elk
  - In 7-10 yrs, fence breaks down, but aspen has regenerated.

Paying attention to mosaics
State Forestry looking at getting back into prescribed fire.
Want a harvest that provides enough ground scarification to get sprouting
Identify issues – pheromone studies to exclude elk

Special case - WUI

A separate chapter on WUI management could be justified, but cannot be included here.
Litigation by ambush; Politics – normal, public awareness, interaction with land agency neighbors
Fire management regulations apply to all land in the Village of Ruidoso. The standards follow FireWise and Cohen, and should be applied to other WUI areas in New Mexico.
Pleading for information to help [hard to read] *undo* things on the ground
Waiting for a fire to re-energize the public
Ecological Restoration is not the #1 Priority in the WUI, so don't fight that battle there

Special case – single species management

Mount Graham red squirrel (MGRS)

In the Pinaleños Mountains of Arizona, management of MGRS habitat is the dominant management issue, affecting all decisions and policies. MGRS is a larder hoarder of seeds and fungi. Population density is highest in spruce-fir, and most stable in mixed-conifer. Threats to this species are habitat loss from catastrophic wildfire and Douglas-fir beetle, and hunting by migrating birds of prey.
Reducing the wildfire and Douglas-fir beetle threats can only be accomplished with thinning and prescribed fire.
Because Mt. Graham is not a timber mountain, managers suffer from a paucity of stand data.

Management response - Revise and implement the Mount Graham red squirrel recovery plan. That plan would reduce fuels and Douglas-fir beetle hazard, and maintain forest structure for MG red squirrel. It is due to be released in Summer 2008.

Presentations

Historical Fire Regime of a Mixed Conifer Forest in Southwestern Colorado
Lesli Allison, Banded Peak Ranch   Carissa Aoki, Colorado State University
Banded Peak Ranch, Chromo, CO

Large ungulate, small mammal, and livestock response to forest management in a south central dry mixed conifer forest, J. Boren, B. Hurd, G. Mason, T.T. Baker, H. Halbritter (NMSU)

Management Strategies in Mixed Conifer & Aspen
JOE CARRILLO & LINDSEY QUAM, NM STATE FORESTRY DIVISION, CHAMA DISTRICT
IN CONSULT WITH GARY HARRIS, FORESTRY SERVICES OF CHAMA

Practical Politicin' in the WUI, Rick DeIaco (Director of Forestry, Village of Ruidoso)

Harvesting in mixed conifer stands, Arnie Friedt and Ernie Lopez
NEW MEXICO STATE FORESTRY DIVISION, CIMARRON DISTRICT

Ecology and Management Issues in Mixed-Conifer Forests in the Pinaleño Mountains of Arizona
Ann M. Lynch   U.S. Forest Service, Rocky Mountain Research Station
Craig P. Wilcox U.S. Forest Service, Coronado National Forest
Donald A. Falk University of Arizona, School of Natural Resources and Laboratory of Tree-Ring Research

Pests

Contemporary disturbances in forests in the southern portion of Region 3:
Persistent: dwarf mistletoe on Douglas-fir & Englemann spruce; root disease in White fir

Coronado (Pinaleños):
roundheaded pine beetle
Nepytia janetae
spruce beetle
western balsam bark beetle
spruce aphid
fir engraver
Enypia, possibly *griseata*

Lincoln (Sacramentos):
roundheaded pine beetle
piñon ips
New Mexico fir looper
Nepytia janetae
fir engraver
spruce aphid

The cumulative effects of these outbreaks have heavily impacted the high elevation forests, especially the spruce-fir. Almost everywhere in the Southwest where there is Douglas-fir, there are incipient Douglas-fir beetle outbreaks.

Recent Trends in NM Bark Beetle Activity from Aerial Detection Surveys - Grouped by Forest Type
Bark beetle activity observed in NM from aerial detection surveys exhibits a lag in the higher elevation forests of mixed conifer (2005 activity peak) and spruce-fir (2007).
Annual Incidence of Insects and Diseases in Mixed-Conifer: Bark Beetle & Defoliator Activity Summarized from 1997 – 2007 Aerial Surveys
Acres of bark beetles << defoliators << root rot and dwarf mistletoe
The root rots and dwarf mistletoe incidence is a constant in the landscape, a static incidence condition.

Specific damage-causing agents:

Douglas-fir dwarf mistletoe. *Arceuthobium douglasii*
For Douglas-fir dwarf mistletoe, seeds overwinter after dispersion and germinate in spring. There is no white fir mistletoe in NM; there is some in AZ. There is spruce mistletoe on the Gila and a little in the Sacramentos—similar in behavior to other mistletoes; Doug-fir mistletoe seed overwinters prior to germination; and Doug-fir mistletoe seed is disseminated later in the season (peak in Sept) than is ponderosa pine mistletoe (peak is in late July).

- An estimated half of mixed conifer stands in the Southwest have some level of Douglas-fir dwarf mistletoe infection.
- Chronic situation in affected stands. It can kill, but usually just decreases growth.
- Management considerations:
  - Douglas-fir dwarf mistletoe is greatly stimulated by selective cuts.
  - Higher probability for success in managing moderately or lightly infected stands.
  - Favor healthy pine where Douglas-fir dwarf mistletoe is extensive.
  - Presence of both Douglas-fir and ponderosa pine dwarf mistletoes in same stand can pose a challenge.

Western spruce budworm. *Choristoneura occidentalis.*
Windthrow in the Pecos Wilderness in the spring of 2007 was mostly in spruce-fir and amounted to about 2,420 acres. Spruce beetle could be a problem where roots remain in soil.

- Larval stage feeds on buds and current year-foliage.
- Persistent activity throughout mixed conifer type in northern NM.
- Causes only limited mortality. Comes in waves; prefers Douglas-fir and white fir]
- Past mgmt. approach:
  - Even-aged management
  - Aerial spraying
- Current mgmt. approach:
  - Favor pine when possible

Douglas-fir tussock moth. *Orgyia pseudotsugae*
Takes 2 years, but kills the tree
Recent Management Action

- June 2007, TM-Biocontrol, the Douglas-fir tussock moth virus, aerially applied to 1,130 acres in Santa Clara Canyon
- Slow-acting virus did not prevent heavy defoliation
- Achieved reduction in subsequent life stage abundance
- Ultimate measure of success will be in summer 2008 defoliation levels

A native looper that recently has caused defoliation, *Nepytia janetae*

- Short-term tactic:
  - November 2007 aerial spraying of 4,419 acres with Btk around Cloudcroft
- Long-term strategy:
  - monitor impacts
  - enhance stand vigor

Area affected by western spruce budworm is always much more than that of tussock moth and loopers (NM fir looper & *Nepytia janetae*).

Aspen defoliation and damage

- Historically most aspen defoliation attributed to western tent caterpillar*; can locally increase*
- In 2007, about 43,000 acres of aspen damage was mapped during aerial surveys; 7,000 (16%) of that identified as having some mortality.
- Increased mortality in aspen stands observed in last 2-3 years
- Possible factors include local late frosts, drought, stand senescence

Bark Beetles:
Douglas-fir Beetle (*Dendroctonus pseudotsugae*), Fir Engraver (*Scolytus ventralis*)

- Successful attacks result in tree mortality.
- Douglas-fir beetle has one generation per year.
- Fir engraver beetle can complete one generation in warm locations and start a second.
- Outbreaks associated with drought, root disease, dwarf mistletoe.

Management options

- Thinning to promote vigor
- MCH, a disaggregation pheromone to protect high value sites

Projected 2008 activity:

- With current moisture levels, expect activity of mixed-conifer bark beetles to decline.
- Sustained defoliation by western spruce budworm.
- Other defoliator activity possible.

White Pine Blister Rust: example of introduction/expansion of exotic insects and diseases.

- Invasive exotic disease.
- Further expansion of blister rust in mixed-conifer type.
- Potential for reduced diversity with loss of white pines in some locations.
- *Favor white pine during management activities to promote genetic diversity*.

The USDA Forest Service, Southwestern Region Forest Health website has information on insects and diseases, publications, conditions reports, maps and GIS data:

- http://www.fs.fed.us/r3/resources/health

Specific example – southern Arizona

Highest elevation areas have had the greatest number of damage causal agent
Spruce-fir > Mixed conifer > Ponderosa pine; some areas impacted more than others.

Fir engraver on white fir, 2006 – present
This insect feeds on any Engelmann spruce that has entered dormancy at least once, regardless of tree size or stand character.

Nepytia janetae 1996 – 1999
In the Sacramento Mountains, attacked all conifer species in the mixed-conifer.
In the Pinaleños, caused complete defoliation on Engelmann spruce and corkbark fir
Defoliation was not affected by species or tree size, and did not vary with standard measures of stand and site character such as species composition, elevation, slope, and aspect.
Severely defoliated Corkbark Fir and Englemann Spruce were often attacked by bark beetles, which was fatal.

Spruce aphid, *Elatobium abietinum* - an exotic
A single, severe event can produce mortality of 24 – 40%.
This insect feeds on any Engelmann spruce that has entered dormancy at least once, regardless of tree size or stand character.
White Mountain stands that have experienced multiple spruce aphid outbreaks are very degraded.

Plot infestation by different insects
In one study, virtually all of the plots were infested by spruce aphid; spruce beetle infested virtually all of the plots in the spruce-fir, and infestation in mixed conifer plots increased with time; and western balsam bark beetle infested 40-60% of the plots.

Presentations

Mixed Conifer Insect and Disease Trends in New Mexico
Debra Allen-Reid - Forest Health – NM Zone Office, Southwestern Region, USDA Forest Service

Ecology and Management Issues in Mixed-Conifer Forests in the Pinaleño Mountains of Arizona
Ann M. Lynch U.S. Forest Service, Rocky Mountain Research Station
Craig P. Wilcox U.S. Forest Service, Coronado National Forest
Donald A. Falk University of Arizona, School of Natural Resources and Laboratory of Tree-Ring Research

Research

Crown fire potential and vegetative response under different frequencies and intensities of silvicultural treatment

Objective 1: To determine how 4 silvicultural treatments affect midstory and herbaceous vegetation.
Objective 2: To determine the effectiveness of treatments to reduce the potential for crown fire.

- Site Description - Lincoln National Forest, Cloudcroft New Mexico
- Elevation ranged from 2560 to 2773 meters (8400 to 9100 feet)
- Mean Annual Precipitation 704.3 mm (27.7 in) *(World Climate 2006)*
- Mixed Conifer forest dominated by Douglas fir with a ponderosa pine component.

Study Design

- Completely randomized design with three study sites (Bailey Canyon, Cox Canyon, and Sleepy Campground) and three of four treatments (Untreated Control, Non-Commercial Pile, Non-Commercial Scatter, and Commercial Harvest) at each site.
- Non-commercial treatments were a thin-from-below prescription with a 22.86 cm (9 in) diameter cap and 4.9 m (16 ft) spacing.
- Commercial treatment had a target BA of 18-23 m^2 ha^{-1} (78-100 ft^2 $acre^{-1}$) and 61 cm (24 in) diameter cap.

Results

- Treatment significantly reduced tree density in the overstory.
- Significant increase in understory biomass in the Scatter and Commercial treatments
- No differences in species richness between treatments within sites
- Canopy cover was decreased by all treatments except at Cox Canyon.
- Herbaceous cover was low in all treatments
- Significant decrease in litter cover and increase in soil cover in response to commercial treatment. However litter cover increased (61.5 vs. 78.5 % in the 3rd year) and soil cover decreased (12.9 vs. 4.9 % in the 3rd year) rapidly post treatment.
- Downed Woody Fuels
  - 1-hr fuels - Significant first-year differences between treatments and controls at Cox and Sleepy.
  - 10-hr fuels - Some evidence for first-year differences between treatments and controls.
  - 100-hr fuels - No difference among treatments within sites.
  - Sound 100-hr fuels - Scatter treatment significantly greater than pile and controls
    - Commercial significantly greater than control.
- Canopy base height - Treatments significantly higher than controls, except at Cox
- Crown Fire Potential
  - Torching Index increased with Pile and Commercial treatments.
  - Crowning Index increased only with the Commercial treatment, with the exception of the Pile at Bailey.

Conclusions

- Commercial treatment increased herbaceous biomass 3 yrs post treatment.
- Commercial treatment significantly increased soil cover; however, soil cover rapidly decreased post-treatment
- The scatter treatment was the only non-commercial treatment to significantly increase herbaceous biomass 4 yrs post treatment.

- The scatter and commercial treatments significantly increased sound 1000-hr fuel loads, increasing the potential for stand damage.
- The same potential for increased stand damage exists in pile treatment on a localized scale if piles are not burned.
- Pile treatments had less potential for crown fire initiation (>TI) but are still prone to crowning from oncoming fires (=CI). Exception was Bailey pile.
- Scatter treatments had little to no effect on potential crown fire initiation (≤TI) or active crown fire spread(=CI).
- Commercial treatment drastically reduced the potential for crown fire initiation and spread (>TI and >CI).

Management Implications

- Non-commercial treatments
    - May be useful for shaping future stand composition.
    - Increased spacing, larger diameter cap, and disturbance to forest floor may give even more dramatic results.
    - Surface fuel treatments should be used to reduce potential for extreme fire behavior.
    - Treatments should vary depending on initial stand characteristics, landscape position, and management goals.
- Commercial treatments offer the most potential to
    - Increase forage production
    - Provide alternative feeding sites for large ungulates
    - Mitigate wildlife / livestock conflicts where they exist.
    - Alter fire behavior

Evaluation of silvicultural treatment effects on infiltration, runoff, sediment yield, and soil moisture.
Importance in relation to post treatment water quality and quantity, to help managers better select thinning prescriptions.
Hypothesis:
1) Disturbance on the pile and scatter treatments would result in reduced infiltration, increased runoff, and increased sediment yield.
2) Soil moisture content during simulated rainfall would differ among treatments, with greater soil moisture on the control treatment than on pile and scatter treatments.
Study design:

- Same site as above
- Three treatments: Untreated control, Precommercial thin with slash piled, and Precommercial thin with slash scattered
- Thinning Prescription: Noncommercial; low intensity thin; cut up to 9 inches dbh; 16 ft spacing; chainsaw felling

Summary and Discussion
● *Infiltration rates, runoff rates, and soil moisture did not differ among treatments.*
● *No statistical difference in sediment yield between treatments*:
– Control: 1.1 kg/ha (0.98 lb/acre);
– Pile: 2.3 kg/ha (2.05 lb/acre);
– Scatter: 1.8 kg/ha (1.61 lb/acre)
● These sediment yield rates are extremely low; 25% of the average annual precipitation was applied and measured less than 2 kg/ha (1.8 lb/acre) of sediment. Other studies found increases in sediment yield from 673 to 7,846 kg/ha (from 600 to 7000 lb/acre) following forest management.
● Limited sediment yield was probably due to the slight amount of ground disturbance during thinning and the great amount of litter that provided cover to the forest soil.
● Time to peak runoff was greater on pile and scatter treatments. Longer time to peak runoff suggest infiltration was greater on treatment sites vs. control.
Conclusion: Mixed conifer forests in NM can be thinned without risk of significant increases in hill slope runoff and sediment yield.

Mechanical thinning impacts on runoff, infiltration, and sediment yield following fuel reduction treatments.

Site description: - Smokey Bear Ranger District, Lincoln National Forest; 50 ac timber sale.

- Mixed conifer (Douglas-fir, white fir, ponderosa pine)
- Elevation: 8530 ft; Precipitation: 29 in/yr; Soil Texture: sandy loam & loam
- Area: 50 ac timber sale

Objectives

Following use of a mechanized harvester / forwarder or "harwarder"

1) Quantify soil disturbance on steep and moderate slopes
2) Estimate runoff and erosion on steep and moderate slopes

Hypothesis: Heavy and moderate disturbance sites would result in reduced infiltration, increased runoff, and increased sediment yield as compared to control sites on steep and moderate slopes.

Study design

- A factorial design with two slopes (Intermediate (10 – 25 %) and steep (26 – 43%)) and three disturbance levels (Untreated control, Light-moderate disturbance, and heavy disturbance).
- The silvicultural prescription was a thin-from-below cut based on slope. Intermediate slope Rx: 80 to 100 ft^2/ac basal area; 25 ft spacing. Steep slope Rx: 100 to 120 ft^2/ac basal area; 20 ft spacing. The intent of treatments is to provide a reduction in hazardous ladder fuels, promote forest health, economic value.
- No diameter cap. Slash treatment: scattering and cutting residual limbs to within 24 in of surface.
- 8 rainfall simulators / treatment

Results

If surface disturbance is minimized, regardless of slope, sedimentation following harwarder disturbance did not exceed background levels. Only heavy disturbance on the steep slope showed significant sediment production. However, the obvious caveat remains: on steep slopes mechanical equipment can cause heavy disturbance and must be operated with care.

Management Implications

1) not necessary to abandon steep slopes
    - take precautions
    - consider hand crews
    - do a test run
    - work downhill if possible
2) soil reclamation such as scattering slash, straw mulching, erosion control blankets
3) avoid suspect soils past threshold slopes
4) consider some degree of surface disturbance may be desirable
5) consider machine configuration; e.g., tracks instead of tires
5) increase operator efficiency; e.g., better boom operation
5) technology offers new opportunities; e.g., forwarding
6) keep tools in the tool bag; e.g., mechanical opportunities

Mixed Conifer Research at NMSU

Cram, D.S., and T.T. Baker. 2008. Understory response following wildland fire in treated vs. untreated forest stands. Forest Ecology and Management (Manuscript in preparation).

Mason, G., T.T. Baker, D.S. Cram, J.C. Boren, A.G. Fernald, and D.M. VanLeeuwen. 2008. Mechanical treatment effects on vegetation in a south central New Mexico dry mixed conifer forest. (Manuscript in preparation).

Cram, D.S., T.T. Baker, A.G. Fernald, A. Madrid, B. Rummer. 2007. Mechanical thinning impacts on runoff, infiltration, and sediment yield following fuel reduction treatments in a southwestern dry mixed conifer forest. Journal of Soil and Water Conservation 62:359–366.

Mason, G., T.T. Baker, D.S. Cram, J.C. Boren, A.G. Fernald, and D.M. VanLeeuwen. 2007. Mechanical fuel treatment effects on fuel loads and indices of crown fire potential in a south central New Mexico dry mixed conifer forest. Forest Ecology and Management 251:195–204.
Madrid, A., A.G. Fernald, T.T. Baker, and D.M. VanLeeuwen. 2006. Evaluation of silvicultural treatment effects on infiltration, runoff, sediment yield, and soil moisture in a mixed conifer New Mexico forest. Journal of Soil and Water Conservation 61:159–168.
Cram, D., T.T. Baker, and J. Boren. 2006. Wildland fire effects in silviculturally treated vs. untreated stands of New Mexico and Arizona. Research Paper RMRS-RP-55. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 28 p.

Presentations

Evaluation of silvicultural treatment effects on 1) fire behavior, 2) vegetation response, and 3) infiltration, runoff, and sediment yield in a south central New Mexico dry mixed conifer forest

Terrell T. "Red" Baker Professor & Riparian Management Specialist
Doug Cram Extension and Research Associate
Glenn Mason Extension and Research Associate
Extension Animal Sciences & Natural Resources Department

Ecology and Management Issues in Mixed-Conifer Forests in the Pinaleño Mountains of Arizona

Ann M. Lynch U.S. Forest Service, Rocky Mountain Research Station
Craig P. Wilcox U.S. Forest Service, Coronado National Forest
Donald A. Falk University of Arizona, School of Natural Resources and Laboratory of Tree-Ring Research