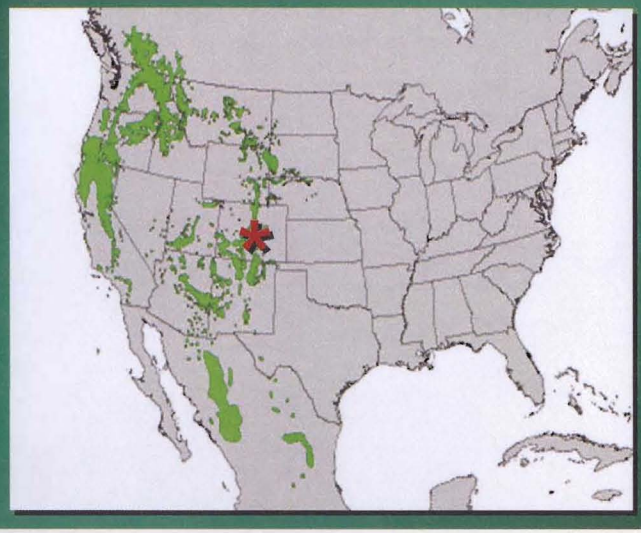
Exotic plants, restoration, and fire in ponderosa pine forests of the Colorado Front Range

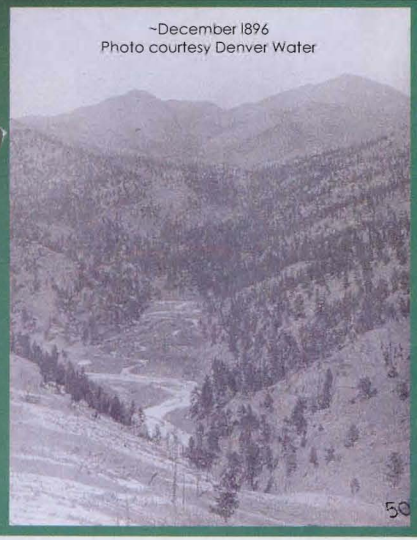
Paula J. Fornwalt
USDA Forest Service
Rocky Mountain Research Station
Fort Collins, CO

Third International Fire Ecology & Management Congress, 13-17 November 2006
San Diego, California

Forests of the South Platte Basin

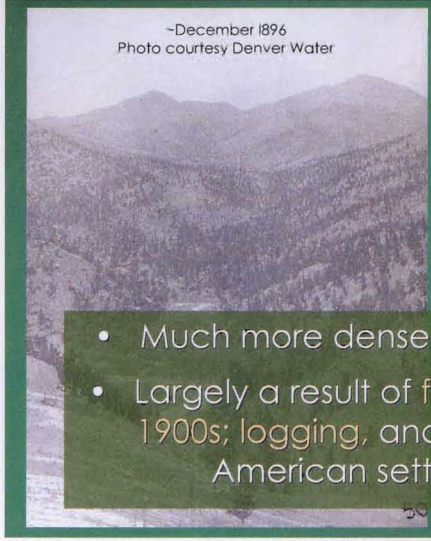


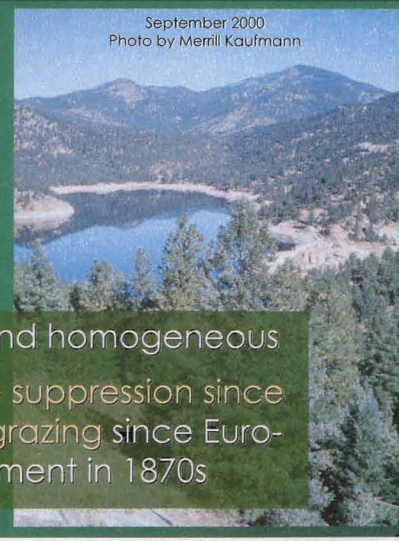
Historical forest structure



- Relatively open but heterogeneous mosaic of tree ages and densities
- Created and maintained by a mixed severity fire regime
- Fire interval: ~20 y for all fires; ~50 y for large fires

Current forest structure





- Much more dense and homogeneous
- Largely a result of fire suppression since 1900s; logging, and grazing since Euro-American settlement in 1870s

Wildfire, restoration treatments, & the South Platte Basin

After a largely fire-free century in the SPB, there has been a recent rash of large and intense fires

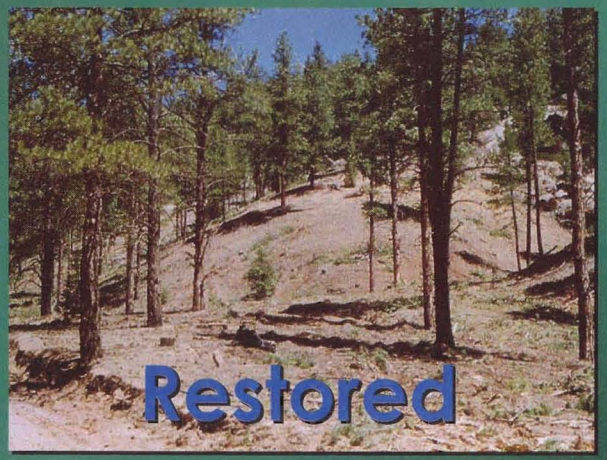
- 1996 — Buffalo Creek (12,000 ac)
- 2000 — Hi Meadow (11,000 ac)
- 2002 — Schoonover (4000 ac), Snaking (3000 ac), Hayman (138,000 ac)

Wildfire, restoration treatments, & the South Platte Basin

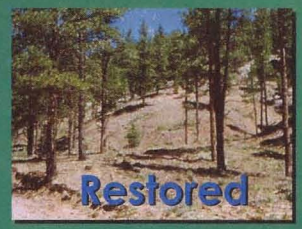
There has also been a recent rash of forest restoration treatments

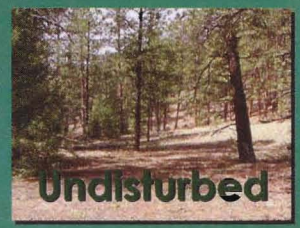
- Talk of restoration stimulated by Buffalo Creek Fire
- 2001 — go-ahead to restore17,400 ac of FS land
- 2002 — first tree cut on FS land, at Trumbull
- 2006 — ~80% of the 17,400 ac restored

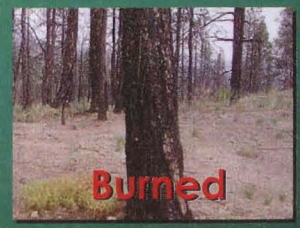
What are the effects of wildfire and restoration on exotic plant species?



What are the effects of wildfire and restoration on exotic plant species?







What are the effects of wildfire and restoration on exotic plant species?

Understory species composition data
collected in 2004, 2005, 2006
using the modified-Whittaker technique
(2-4 years post-fire, post-restoration)

Study Areas

Restored: Trumbull

Undisturbed reference:

-Sugar Creek

-Hatch Gulch

-Manchester Creek

Burned: Turkey Creek

For all study areas:

-15 plots per study area

-Plots stratified by topography

Restored site

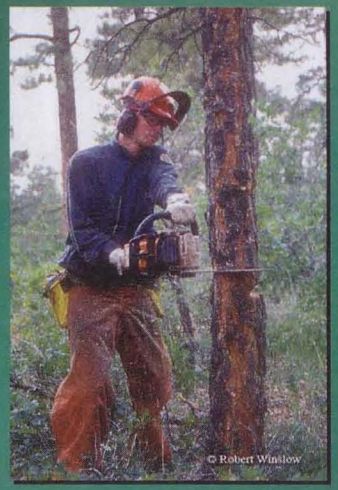
- Trumbull restoration area
- Treatment occurred in 2002
- Variety of treatments used

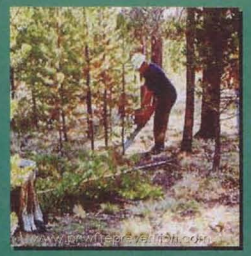
Restoration treatments at Trumbull

mulching

Restoration treatments at Trumbull

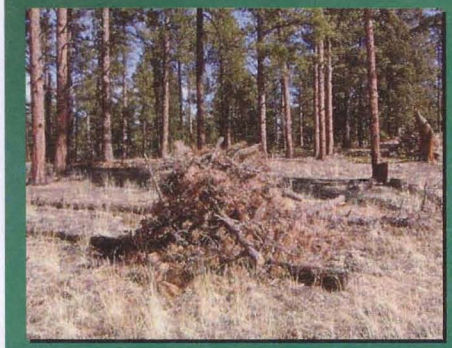
thinning





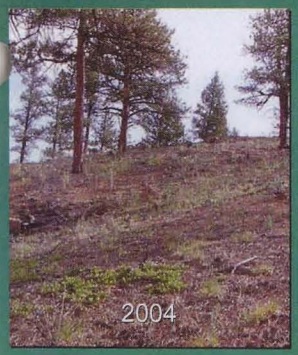
Restoration treatments at Trumbull

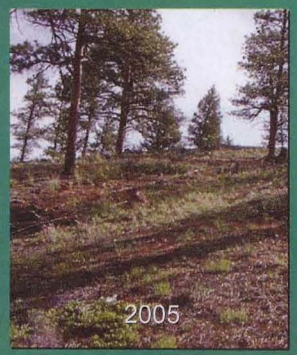
pile burning

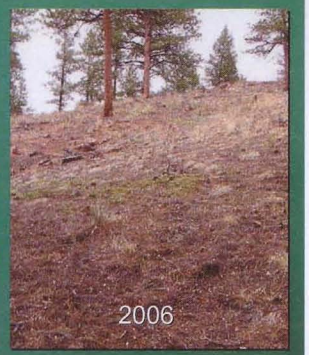


Restoration treatments at Trumbull

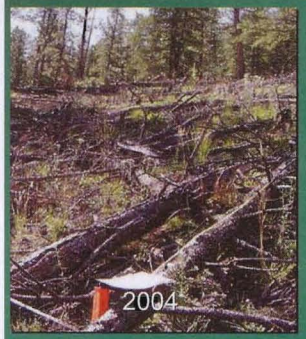
Little overstory tree removal in a low-density stand

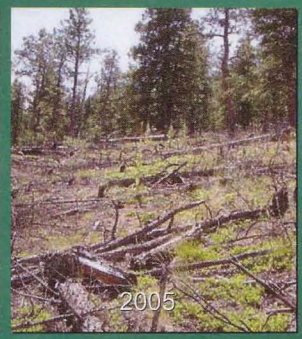


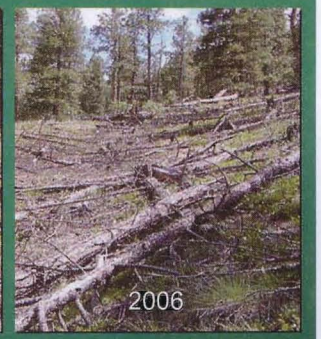




Restoration treatments at Trumbull







Significant overstory tree removal with considerable woody material remaining in a high density stand

Burned site

- Located within the 2002 Hayman Fire
- Site burned with mixed severity
- Study site originally established before the fire
- Monitoring changes within the site since 2003

Undisturbed sites

- Located within areas that were not disturbed for at least the last 5 years
- Not 'pristine' or 'unmanaged' forests
- 'Everyday Joe' condition that serve as a point of reference

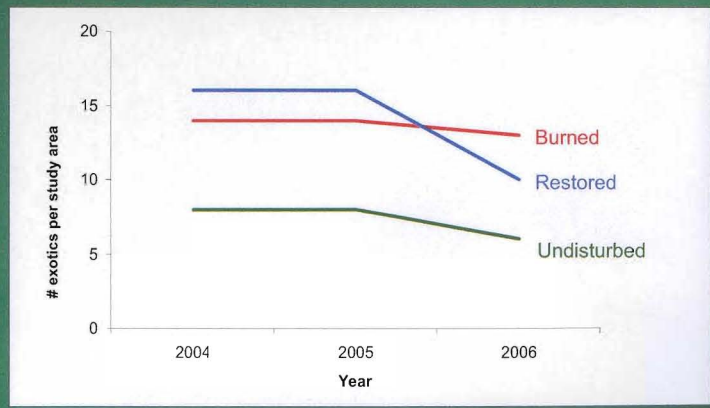
Findings: 29 exotics

29 of the 238 vascular plant species found were exotic

Agropyron cristatum (crested wheatgrass)
Amaranthus retroflexus (redroot amaranth)
Arabis glabra (tower rockcress)
Arabis hirsuta (hairy rockcress)
Bromus inermis (smooth brome)
Bromus tectorum (cheatgrass)
Carduus nutans (nodding plumeless thistle)
Centaurea diffusa (white knapweed)
Cirsium arvense (Canadian thistle)
Conyza canadensis (Canadian horseweed)
Hordeum vulgare (common barley)
Lactuca serriola (prickly lettuce)
Linaria dalmatica (dalmatian toadflax)
Linaria vulgaris (butter and eggs)
Melilotus officinalis (yellow sweetclover)
Nepeta cataria (catnip)
Phleum pratense (timothy)
Poa compressa (Canada bluegrass)
Potentilla norvegica (Norwegian cinquefoil)
Poa pratensis (Kentucky bluegrass)
Salsola tragus (prickly Russian thistle)
Sisymbrium altissimum (tall tumblemustard)
Sonchus asper (spiny sowthistle)
Taraxacum officinale (common dandelion)
Tanacetum vulgare (common tansy)
Tragopogon dubius (yellow salsify)
Trifolium repens (white clover)
Triticosecale rimpaui [*T. aestivum* × *S. cereale*] (triticale)
Verbascum thapsus (common mullein)

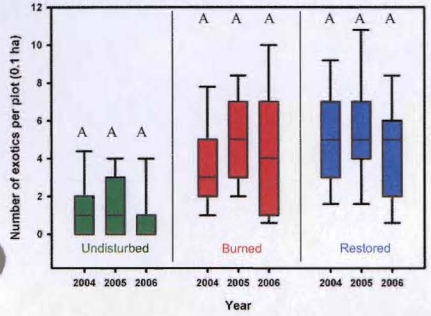
Findings

Exotic species in study sites



Findings

Exotic species richness per plot

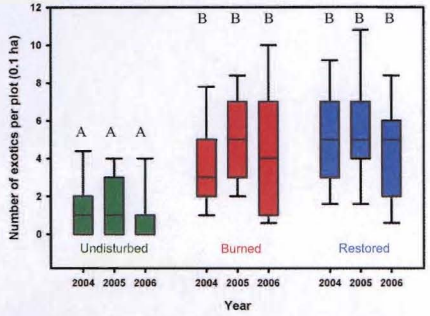


2 types of comparisons:

- Within a site for all years

Findings

Exotic species richness per plot

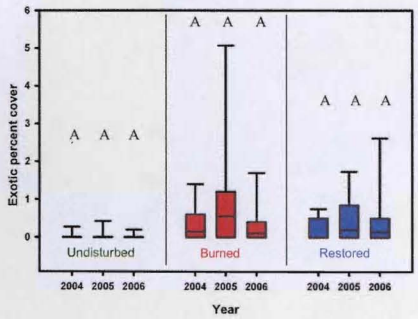


2 types of comparisons:

- Within a site for all years
- Within a year for all sites

Findings

Exotic percent cover per plot

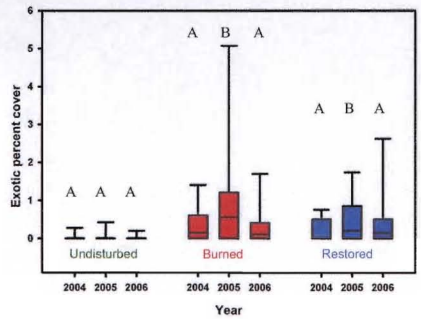


2 types of comparisons:

- Within a site for all years

Findings

Exotic percent cover per plot



2 types of comparisons:

- Within a site for all years
- Within a year for all sites

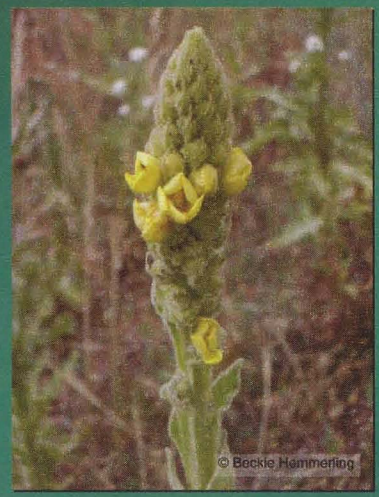
Findings

The six most common individual exotics:

- ******Cirsium arvense*** (Canadian thistle)
- *Conyza canadensis* (Canadian horesweed)
- *Lactuca serriola* (prickly lettuce)
- ******Linaria vulgaris*** (butter and eggs)
- *Taraxacum officinale* (common dandelion)
- ******Verbascum thapsus*** (common mullein)

*** noxious in Colorado

Findings



None of the most common individual exotics appeared to be affected by the disturbances for any year, except *Verbascum thapsus*.

2004: stimulated by the fire, but not by the restoration treatment

2005: stimulated by the fire and the restoration treatment

2006: stimulated by the fire and the restoration treatment

Findings

Predicting exotic richness

- Year
- Native % cover
- Number natives
- % litter cover
- % soil cover
- % wood cover
- Degrees from south
- Slope
- Elevation
- Tree density
- Basal area
- % mortality (tree density)
- % mortality (BA)

Findings

Predicting exotic richness

- **Year**
- Native % cover
- Number natives
- % litter cover
- % soil cover
- % wood cover
- Degrees from south
- Slope
- Elevation
- Tree density
- Basal area
- % mortality (tree density)
- % mortality (BA)

Findings

Predicting exotic richness

Year
Native % cover
Number natives
% litter cover
% soil cover
% wood cover
Degrees from south
Slope
Elevation
Tree density
Basal area
% mortality (tree density)
% mortality (BA)

Findings

Predicting exotic richness

Year
Native % cover
Number natives
% litter cover
% soil cover
% wood cover
Degrees from south
Slope
Elevation
Tree density
Basal area
% mortality (tree density)
% mortality (BA)

Findings

Predicting exotic richness

Year
Native % cover
Number natives
% litter cover
% soil cover
% wood cover
Degrees from south
Slope
Elevation
Tree density
Basal area
% mortality (tree density)
% mortality (BA)

Findings

Predicting exotic richness

Year
Native % cover
Number natives
% litter cover
% soil cover
% wood cover
Degrees from south
Slope
Elevation
Tree density
Basal area
% mortality (tree density)
% mortality (BA)

Findings

Predicting exotic richness

- Year
- Native % cover
- Number natives
- % litter cover
- % soil cover
- % wood cover
- Degrees from south
- Slope
- Elevation
- Tree density
- Basal area
- **% mortality (tree density)**
- **% mortality (BA)**

Findings

Predicting exotic richness at <u>undisturbed</u> sites

Variable	Correlation	
1. Native % cover	+	} $R^2 = 0.47$
2. Number natives	+	
3. % litter cover	-	
4. % soil cover	-	
5. Elevation	-	
6. Year	-	
7. Degrees from south	-	
8. Basal area	+	

Total $R^2 = 0.58$

Findings

Predicting number of exotics at <u>burned</u> sites

Variable	Correlation	
1. % mortality (tree density)	+	} $R^2 = 0.48$
2. Number natives	+	
3. Degrees from south	+	

Total $R^2 = 0.67$

Findings

Predicting number of exotics at <u>restored</u> sites

Variable	Correlation	
1. % wood cover	+	} $R^2 = 0.54$
2. % soil cover	-	
3. Post-disturbance tree density	-	

Total $R^2 = 0.68$

Take-home message

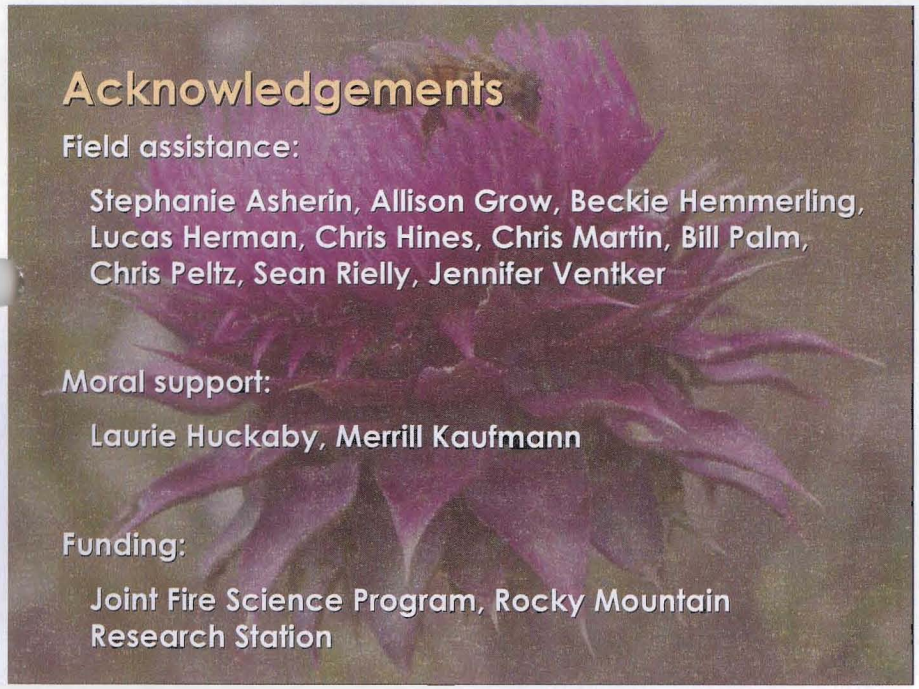
Preliminary results indicate:

- The number and cover of exotics was low for all sites
- However, both the Hayman Fire and the restoration treatments at Trumbull increased the number of exotics relative to the surrounding undisturbed forest, but generally not the cover of exotics
- There was no difference between the two disturbance types for any analysis

Take-home message

Preliminary results indicate:

- The number of exotics does not appear to be tapering off four years after the disturbances
- Of the six most common exotics, only mullein was stimulated by either of the disturbances
- Regression modeling indicates that disturbance intensity is probably important in determining invasibility of burned and restored sites



Acknowledgements

Field assistance:

Stephanie Asherin, Allison Grow, Beckie Hemmerling, Lucas Herman, Chris Hines, Chris Martin, Bill Palm, Chris Peltz, Sean Rielly, Jennifer Ventker

Moral support:

Laurie Huckaby, Merrill Kaufmann

Funding:

Joint Fire Science Program, Rocky Mountain Research Station