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Collaborative monitoring of the impacts of forest restoration treatments on ponderosa pine ecosystems in the Front Range, Colorado

Principal Investigators (PIs):
Jenny Briggs, Research Ecologist, USGS, jsbriggs@usgs.gov;
Paula Fornwalt, Research Ecologist, USFS-RMRS, pfornwalt@fs.fed.us;
Jonas Feinstein, State Forester, NRCS, jonas.feinstein@co.usda.gov

1. INTRODUCTION

A. Summary of project background and objectives

In 2010, Colorado Front Range National Forests were awarded a Collaborative Forest Landscape Restoration (CFLR) grant to facilitate the implementation of restoration treatments across 32,000 acres of ponderosa pine-dominated forests. Collaborative, multi-party monitoring of the impacts of restoration was a required component of the grant; however, the budget for this work was limited, and initial monitoring plans for the Arapaho-Roosevelt National Forest (AR) and the Pike-San Isabel National Forest (PSI) did not include a strong emphasis on key components of the ecosystem such as wildlife and understory plants. Members of the Front Range Roundtable, an interagency collaborative with representation from 50+ stakeholder groups, prepared a supplemental proposal to the Southern Rockies LCC in 2011 to significantly expand the CFLR monitoring effort and integrate several goals of these 2 important new national programs.

We initiated a study in July 2011 to expand the scope of forest restoration monitoring in the Front Range in 5 key ways: (1) to monitor the effectiveness of restoration treatments implemented by partner agencies as well as on National Forest lands; (2) to conduct monitoring in adjacent areas not planned for treatment (controls); (3) to evaluate changes in within-stand structural heterogeneity due to treatments; (4) to measure the use of treated areas by a diverse suite of wildlife species; and (5) to investigate the effects of treatments on understory plant communities.

Our progress to date, methods, and preliminary data summaries are presented below. We hope to integrate our additional data to help quantify restoration impacts on diverse components of the ecosystem, to help develop a long-term (10+ years) monitoring strategy for CFLR work, and to help inform the adaptive management process in Front Range forests threatened by increasingly severe and frequent disturbances.

B. Summary of project achievements

1. <u>Field Study</u>
We received funding from the SRLCC in June 2011 and initiated a field study in July 2011. We collected pre-treatment data on 8 treatment units and adjacent controls at 3 major study areas in the Front Range between July and September 2011 (pre-treatment period) and on 5 of the 8 treatment units and 2 additional units in June-August 2012 (post-treatment period). Data still

needs to be collected at 3 of the original units in Summer 2013, because treatments there were delayed. Details of all sites, schedules, and field methods, and preliminary data are described below in Sections A-G.

2. Reports and work with local collaborators

This project has been a fully collaborative effort during all phases of planning and implementation to date. In July 2011, representatives of 4 agencies (USFS, USFWS, NRCS, and RMRS) assisted USGS with developing the final field methods and training the field crew. In June 2012, we obtained further input in the field from staff of the Colorado Division of Wildlife (CDOW) and Boulder County Parks and Open Space (BCPOS; this agency also awarded supplemental funding in 2012 to facilitate work on their lands.) We have coordinated our fieldwork with numerous members of staff of the Canyon Lakes Ranger District (Arapaho-Roosevelt National Forest), Pikes Peak Ranger District (Pike-San Isabel National Forest), and BCPOS – all of whom have provided site maps, treatment plans, GIS files, advice, and logistical support.

As stated in our proposal to the SRLCC, we completed a project report in February 2012 to the Front Range Roundtable collaborative. We gave presentations describing our progress and inviting input from this collaborative at 2 of its quarterly meetings (November 3, 2011 and August 23, 2012.) The Roundtable includes all agencies participating in the study as well as many other stakeholder agencies and institutions across the Front Range. Regular attendees include the Supervisors of the 2 National Forests implementing the CFLRP treatments, the Colorado State Forester, representatives of US Fish and Wildlife Service and the Colorado Division of Wildlife, members of the Colorado Forest Restoration Institute, and staff of Boulder County Parks and Open Space, The Nature Conservancy, and The Wilderness Society, among many others.

We also made regular contributions to monthly meetings of the Roundtable's Science and Monitoring Team (September 2011-July 2012), which focuses on more detailed technical discussions and work. One of its major goals in 2012 was development of a 10-year plan for CFLRP monitoring in the Front Range. In the meetings we presented updates on our methods and data from this study, and made suggestions for revision of long-term monitoring methods and objectives based on our findings. Some of these were accepted and/or further revised by the staff of the 2 NFs implementing the CFLRP treatments and the baseline Common Stand Exam (CSE) monitoring effort on NF lands, and were incorporated into future plans. Some topics and suggestions are still under discussion by the group. Based on our progress, another collaborative team implementing restoration on private lands near Woodland Park through a grant led by The Nature Conservancy invited us to help them design a monitoring program which was initiated in Summer 2012. Our study has helped catalyze extensive debate and considerable progress on the topics of wildlife monitoring, understory monitoring, and stand structure assessment in regional and national CFLRP efforts as well as in related work at a local level. In our final report in August 2013, we will include a detailed summary of this collaborative learning process and its outcomes.

3. Regional and national conference presentations

Jenny Briggs and Paula Fornwalt gave and/or contributed to 3 invited talks describing this study at regional/national conferences in FY12. These were (presenter indicated by asterisk):

1. Briggs, J.S.*, P. J. Fornwalt*, J. Feinstein, C. Hansen, T. Cheng, G. Aplet, and P. Lewis. 2012. "Collaborative monitoring of restoration treatment impacts in ponderosa pine ecosystems of Colorado. Invited talk in Special Session on "Monitoring Landscape Level Forest Restoration Success." Southwest Association for Fire Ecology conference, Santa Fe, NM. February 27-March 1, 2012.

2. Finch, D.*, P.J. Fornwalt, J.S. Briggs, and C. Davis. 2012. "Integrating Opportunities for Restoration Science and Adaptive Management: LCCs and CFLRP". Invited talk at National LCC (Landscape Conservation Cooperative) Workshop, Denver CO, March 28-29, 2012.

3. Briggs, J.S.*, P. J. Fornwalt, J. Feinstein, C. Hansen, T. Cheng, G. Aplet, and P. Lewis. 2012. "Collaborative monitoring of restoration impacts on ponderosa pine ecosystems in the Southern Rockies Landscape Conservation Cooperative". Invited talk in Special Session on "Emerging Science in the LCCs." International Association for Landscape Ecology, Newport, RI. April 8-12, 2012.

2. FIELD STUDY METHODS AND PRELIMINARY RESULTS

A. Study sites

Pre-treatment period.
Data were collected between July and October 2011, on a total of 79 plots divided among 8 "restoration treatment" units (pre-treatment) and 8 untreated "control" areas at the following sites:

A. Pike-San Isabel National Forest (PSI), Phantom Creek area. 2 units were sampled: Phantom 1 Unit 2 (approx. 150 acres) and Phantom 2 Unit 3 (approx. 350 acres). These sites were thinned in July 2011 and September 2011, respectively.
B. Boulder County Parks and Open Space (BCPOS), Hall Ranch. One unit, a 66 acre prescribed fire, was sampled. The fire occurred on October 5, 2011.
C. BCPOS, Heil Valley Ranch. 2 units of approx. 100 acres each were sampled. The units were scheduled to be thinned Winter-Spring 2012.
D. Arapaho-Roosevelt (AR) National Forest, Estes Valley area. 3 units were sampled: EV13 (approximately 75 acres; EV34 (approximately 150 acres) and EV28 (approximately 250 acres). All were scheduled to be thinned Fall 2011-Spring 2012.

Post-treatment period
In May-June 2012, the PIs made site visits to assess the status of the sites:
A. Both units on the PSI NF had been treated as scheduled.
B. The Boulder County BCPOS prescribed burn had occurred on the planned date.
C. The 2 additional BCPOS units had not been treated, due to constraints on funding and scheduling. Their treatments are now planned for Fall 2012-Winter 2013.

D. Two of the 3 units on the AR national forest had been treated as planned during Fall 2011, but work on the third unit ("EV13") was not conducted until early summer 2012. Therefore, we could not conduct post-treatment sampling during the 2012 field season.

Data were collected between June and August, 2012, at the 5 sites where treatments had been completed on schedule. Data were also collected on the neighboring control areas. A total of 51 plots were re-surveyed. In addition, we collected post-treatment data only on 2 additional units on BCPOS lands that had been treated via mechanical thinning in early summer 2011. Pre-treatment data had not been collected there by our crew, because treatments were done before our study began. For each of these 2 units, we surveyed 5 treatment plots and 5 control plots for a total of 20 additional plots.

Post-treatment data still needs to be collected at the 3 original sites where treatments were delayed (28 plots total). We plan to accomplish this in June 2013 if supplemental funds are granted (see Budget section below.)

B. Plot selection

Sampling density ranged from 1 plot per 10 to 50 acres, approximately. On each of the 8 treatment units, we established between 3 and 10 plots per unit pre-treatment in 2011. In the nearby control areas, we established between 3 and 8 plots per unit.

For almost 50% of the plots on treatment units, we found existing Common Stand Exam (CSE) plot locations, where CSE data had recently been recorded by USFS crews or contractors funded by CFLRP, and we collected our additional data there as described below. For the other treatment unit plots, and all control plots, we established new plots.

Plot locations were chosen using a combination of random and targeted selection strategies. On treatment units, in general, we initially visited either a randomly chosen subset of the existing CSE plots, or all CSE plots. The CSE plot locations had been determined by US Forest Service (USFS) silviculturalists using a randomized method in GIS. CSE data had been collected at most plots in June-July 2011 (some in the previous summer). When we visited an existing CSE plot, we assessed whether it contained at least 5 trees (using a Basal Area Factor (BAF) of 10), and had at least 1 sapling/mature ponderosa pine. If so, we used it as a "treatment plot" in this study. If neither of these criteria were met, or if the plot contained unusual conditions such as a high proportion of lodgepole pine, spruce, juniper, or beetle-killed ponderosa pine, we moved on to the next CSE plot. If none or very few of the existing CSE plots in a treatment unit contained ponderosa pine or conditions where ponderosa would be expected to grow, we established new plots within ponderosa pine stands in those treatment units.

To determine the location of control plots, we generated random coordinates (in GIS) for plot locations in areas within approx. 1 mile of treatment units that met 2 criteria: 1) the area appeared to have similar species composition to the treatment units, and 2) the area was not scheduled for treatment in the next few years. We visited each random point in the field and evaluated whether the conditions there (i.e. overstory/understory species composition) approximately matched the conditions in one of the treatment plots. If so, we used that location as a control plot. If not, we either continued to the next random point or selected a new site nearby which matched a treatment plot more closely. Overall, we attempted to select a set of control plots in which overstory and understory species composition and structure were similar to those in the treatment plots. We did not attempt to standardize variables such as tree density, slope and aspect between treatment and control plots, although these were sometimes similar.

C. Variables measured

We collected the following data at each plot, using a variable-radius plot (BAF10) for trees and a fixed-radius plot (1/10 acre; 37.2 ft radius) with the same plot center for most other measurements (Figure 1). Most of the variables we measured and the detailed protocols we used followed either the USFS CSE methods (manual and full documentation available at http://fsweb.nris.fs.fed.us/products/FSVeg/documentation.shtml), or were identified in the Monitoring Plan completed in June 2011 for the Roundtable by the Colorado Forest Restoration Institute (CFRI) (see p. 23-31 in plan available at http://www.frontrangeroundtable.org/uploads/Roundtable_CFLRP_Monitoring_Plan_062511.pdf).

1. Overstory trees.

a. We measured all trees that were at least 4.5 ft tall and had a diameter at breast height (dbh) of at least 1 inch within a variable-radius plot with a Basal Area Factor (BAF) of 10. For each tree, we recorded species, dbh, health status, height, canopy base height, crown ratio, canopy position, and any signs of physical damage, insect infestation, or wildlife damage.

b. We inspected all in-plot trees for indications of wildlife use (e.g. nests, cavities, squirrel feeding sign at base) and recorded these signs if present. We noted if nests appeared to be active or inactive. If in doubt about the type of wildlife use, we took photos for later identification by specialists.

c. We noted an estimated age class for each tree (young/transitional/old) based on morphological characteristics described by Huckaby et al (2003) and/or local foresters.

d. We took a core from one "old"-looking tree of each dominant species present in the plot, and one representative "site" and/or "growth sample" tree per dominant species present. We selected trees to core based on the characteristics of site/growth/old trees described in the CSE manual, Huckaby et al. 2003, and/or by local foresters. If no appropriate trees were present within the plot, we chose trees nearby that fit the criteria, up to a distance of about 100 ft from plot center. We recorded all data on cored trees as described above (dbh, height, etc) ; noted distance and bearing to plot center, and gave each a tag. We saved cores for later processing, dating, and analysis in a lab at RMRS.

2. Saplings and seedlings.

We counted all seedlings and saplings (less than 4.5 ft tall) present in a 1/200 acre sub-plot (Fig. 1; 8.3-ft radius around plot center; consistent with CSE protocol.) We identified the species of each and classified them into 5 size classes: less than 1 ft tall, 1-2 ft, 2-3 ft, 3-4 ft, 4-4.5 ft. If any small trees were present (height > 4.5 ft but dbh <5 inches) that had not fallen into the BAF 10 overstory plot, we recorded them here also.

3. *Surface fuels.*

We tallied surface fuels on one 50-ft Brown's transect per plot, established along the north bearing from plot center. We followed standard protocols (Brown 1974 and CSE manual) to define and count all downed woody fuels in the 4 standard size classes that were present:

a. 1-hour fuels (up to 0.25 inches diameter) along an 8-ft section of the transect
b. 10-hr fuels (0.25-1 inches diameter) along an 8-ft section of the transect
c. 100-hr fuels (1-3 inches diameter) along a 12-ft section of the transect
d. 1000-hr fuels (more than 3 inches diameter) along the entire 50-ft length of the transect. For each of the 1000-hr fuel pieces, we also recorded the decay class, diameter at the transect tape, diameters at the small and large ends, and length (as specified in Brown 1974 and the CSE manual).

In addition, we measured the depth of the duff and litter layers and fuel bed (to the nearest 0.1 inch) at 2 points on the transect.

4. *Understory plants.*

a. We measured percentage cover of species present in the understory using a point-intercept method. We established 4 transects in the cardinal directions from plot center. Each transect was 30.75 ft long. At 100 evenly spaced points along each of these transects (i.e. every 3 inches between 6’ and 30.75’), we recorded any plant present that was up to 4.5’ tall. We identified herbaceous, forb, and shrub species present to the species level if possible in the field. If species identification was not possible in the field, we collected a specimen from outside the plot which was pressed for later identification in the lab. We noted substrate type at each point also, i.e. rock, litter, soil, or wood. We noted the size of woody surface fuels (1-hr, 10-hr etc as described above) if present. We noted if portions of trees intersected our sampling points, up to a height of 4.5’ off the ground. If more than one substrate and/or species was present at a sampling point, we recorded them all (e.g. litter, kinnickinnick (*Arctostaphylous uva-ursi),* Douglas-fir (*Pseudotsuga menziesii*) sapling.) The number of occurrences of each plant species and substrate type was tallied to calculate percent cover for each species and substrate.

b. We conducted a complete inventory of all understory species present in a 1/10 acre plot (37.2 ft radius). This entailed systematically searching for any plants that did not intercept the 4 transects surveyed for percent cover, and identifying those additional species either in the field, or from a sample that was removed, pressed, and keyed out in the lab.

Note: On the PSI, CSE crews had conducted a more general understory survey by visually estimating the percent cover of different life form categories (e.g. grass, shrub, etc) and noting the occurrence and percent cover of some individual species of interest. On the AR, no understory data were recorded.

5. *Wildlife use on forest floor*

a. Within the 1/10 acre plot (37.2 ft radius), we searched for and recorded feeding sign of Abert's squirrels and pine squirrels on the forest floor. We counted all chewed cones, middens, branch clippings, etc, that were present, attributing them to either species of squirrel based on descriptions of each species’ typical feeding evidence provided by local wildlife biologists. We categorized the cones and clippings as freshly harvested (within the current season) or older (from the previous season) based on their color. We categorized the middens as active vs.

inactive based on the presence of freshly harvested cones or plant material, recent signs of digging, etc.

b. We recorded any scat and tracks present in the 1/10 acre plot. If in doubt as to the species responsible, we took photos or samples for later identification by wildlife specialists. We categorized scat as fresh (from the current spring/summer season) or old (from before the past winter) based on texture, moisture, and other evidence described by local wildlife biologists.

c. If we observed or heard any animals that we could identify to species on or near the plot (within sight from plot center) during the data collection period, we recorded this information. (These data will not be analyzed formally, because we recognize that animals were impacted by our presence.)
d. We noted any other signs of animal use, such as game trails, burrows, feathers, bones, etc, and identified the species responsible in the field or from photos whenever possible.

6. Ground-dwelling insects
On most of the plots in the study, we established pitfall traps to capture ground-dwelling insects. Each trap consisted of two16-ounce plastic cups stacked together and buried in the ground so that the lip was level with the forest floor. One trap per plot was set out and left in place for 2-5 weeks. Time of establishment and removal was noted. The insects (and any other organisms) collected in the cups were placed in ziplock bags and frozen to preserve them for later identification by an entomologist at RMRS.

7. Broadcast call surveys for goshawks/raptors
Adjacent to each plot, we performed a brief broadcast call survey for goshawks. These surveys were done before any other activity occurred on the plot. One person stood about 50 ft north of plot center and played a recording of a Northern goshawk alarm call on an iPOD attached to a bullhorn megaphone. The call was played for approximately 30 seconds with the bullhorn pointing in each of the 4 cardinal directions. The observer listened and watched in silence for 30 seconds between each set of calls. Total time needed was 4 minutes. The presence and/or response of any raptors was noted. This method is used by the PSI NF.

8. Within-stand forest structure (“clumpiness”).
To measure heterogeneity of stand structure beyond the scale of the plot, we established a sampling transect running 100 m (328ft) north of each plot center. Along this transect, we recorded the distances covered by closed-canopy forest vs. openings. In this context, we defined closed-canopy forest as saplings or overstory trees with a dbh of at least 1 inch. If canopies of trees/saplings were less than 5 feet apart, we counted them as part of the same closed-canopy “segment”. We defined openings as areas with no saplings/trees present >1 inch dbh. Shrubs could be present in either openings or closed-canopy segments but were not counted/measured. If regeneration (saplings/seedlings with dbh < 1 inch) was present in an opening, we recorded if regeneration covered less than 50% or greater than 50% of the opening’s length along the tape. Within the closed-canopy areas, we noted whether the structure was single-story vs. multi-story (canopies of > 1 sapling and/or tree intersecting the tape at the same point). If any snags, middens, or trees with an old-growth appearance were present on these transects, we noted their location (i.e. distance from the start of the 100-m tape) and their dbh/species if applicable.

9. Plot descriptive data and marking protocols.

At each plot, we followed CSE protocols to record GPS coordinates at plot center (by taking an averaged location from a hand-held GPS unit; stated accuracy usually 5-15 ft), slope (%), slope position, aspect (degrees), elevation (from GPS unit), fuel model (one of the 13 fuel model types described by Anderson 1983), any signs of past disturbance, and the start and end time of the data collection.

We marked plots with a labeled aluminum stake pounded into the ground at plot center. We attached a soft aluminum tag and some colored flagging to the tree closest to the N bearing from plot center, and noted on the tag that tree's bearing and distance from plot center. We also tagged any trees that we had cored and noted their distance and bearing to plot center. We placed additional, labeled aluminum stakes in the ground 37.2 ft N and E from plot center (marking 2 of the 4 radii of the 1/10 acre wildlife use/understory survey plots). Finally, we placed labeled aluminum stakes at 50m and 100m N of plot center to mark the mid-point and end point of the forest structure ("clumpiness") measurement transect. These markers will improve a crew's ability to find the same plot and transect locations to collect data following treatments.

D. Data collection in 2012

In June-August 2012, we collected the same set of data, with a few additional measurements described below, on all plots on 5 units that had been treated according to the planned schedule (see Section A) and the matching control plots. Data collection was not done on two BCPOS units where treatment has been delayed by 1 year, and was not done on one of the AR units where treatment was not completed until early Summer 2012.

We plan to complete data collection on the remaining 3 of the 8 units when at least 1 full growing season has elapsed there post treatment. This should be possible in June 2013. We now request supplemental funds from the SRLCC to complete this work (see Budget, Section 3 below) and the subsequent data analyses because the original budget had to be expended by September 30, 2012.

<u>Post-treatment additional data collection</u>:

Based on the first year's data collection effort, we modified our sampling protocols as follows:

a. We added 2 additional sub-sampling plots in which we measured tree regeneration (seedlings and saplings.) This was done to better capture the clumped and irregular spacing of seedlings and saplings in the understory. When we had only one $1/200^{th}$-acre regeneration measurement plot, the variation among plots was very high. The data from the supplemental plots will not be included in pre- vs. post-treatment comparisons, but will be included in all post-treatment analyses comparing data on treatment vs. control plots over multiple years following treatment .

b. We also added 1 additional 50-ft Brown's surface fuel transect per monitoring plot to better capture the variation in surface fuels on the forest floor. Surface fuels (downed logs, twigs, woody debris) also occur in patches or pockets rather than being evenly distributed on the ground.

c. After recording wildlife scat on the 1/10-acre plots, we removed all scat (e.g. deer pellet groups) so that if surveys are done in future years, we will be confident that scat deposited before and shortly after treatment has already been counted and discarded. Any scat present in 2015, for example, can be attributed to animals using the plot area since July-August 2012.

d. Following treatments, we observed that on most treatment plots, some of the trees had been cut, and downed logs and slash had accumulated. We added protocols to measure:

i. the diameter and height of all stumps of "in" plot trees cut during the treatment

ii. the dimensions of slash piles (height x length x width) or areas of scorched ground from burned slash piles (length x width). We noted the location of these piles or scars on plots (e.g. pile occupies 25% surface area of NW quadrant of plot.)

iii. the dimensions of any logs (1000-hr fuels) added to the plots as a result of the treatment. We measured their diameters at the small and large ends, their total length, and their decay class (sound vs. rotten.) We focused only on logs >5 ft in length, which had >50% of their total length within the plot boundary. If more than 30 such "new" logs were present, we randomly selected 2 out of the 4 quadrants of the plot in which to measure the logs, to maximize efficiency of sampling.

E. Data collection in future years

If funding and support are available, we intend to repeat these surveys in future also, e.g. at 2, 5, and 10 years post-treatment.

F. Data analyses

To address the study's main questions about the short-term impacts of restoration treatments on ponderosa pine ecosystems, we will use our data to evaluate whether the variables listed below differed between treatment and control areas and between the pre- and post-treatment time periods (2011 vs. 2012/3) using 2-way repeated measures analysis of variance (ANOVA). Variation among the 3 different agencies' sites (PSI and AR National Forests, and BCPOS) will be evaluated in the analyses. Regression analyses will also be performed to evaluate potential relationships between continuous variables (e.g. overstory basal area and understory percent cover.)

For the ANOVAs, response variables of interest include:

a. Overstory: Basal area, tree density (stems per acre), species composition, canopy cover, canopy base height, canopy bulk density, proportions of trees of different age classes, age of cored trees
b. Regeneration: Density of seedlings/saplings per acre, species composition.
c. Fuels: Total fuel loading, fuel loading of 1, 10, 100, 1000 hr fuels, modeled fire behavior potential.
d. Understory: Total species richness and cover; species richness and cover by functional groups (e.g., native/exotic, grass/forb/shrub, annual/biennial/perennial); cover for species of interest (e.g., noxious species, dominant native understory species)
e. Wildlife: Number of species/guilds recorded using areas; amount of use by individual species/guilds (e.g., squirrels, ungulates, ground-dwelling insects); types of use of area (e.g., foraging, nesting, cover).
f. Within-stand forest structure: Number of openings/clumps; size of openings/clumps; number of single-storied v. multi-storied clumps.

We will include figures, tables, and a full description of all results in our Final Report to the SRLCC in August 2013. We intend to submit a manuscript based on this study to a peer-reviewed journal such as Restoration Ecology or Forest Ecology and Management in Fall 2013. Currently, our pre-treatment data from 2011 have been summarized but our post-treatment data from summer 2012 are still being compiled, as the field season did not end until August 17, 2012. Some corrections to both data sets will be necessary, but we present preliminary findings from the pre-treatment season here.

G. Preliminary summary of selected data

Pre-treatment period

a. Overstory

Basal area of trees across all sites ranged from around 50 square feet/ac to nearly 180 square feet/ac., with a mean value of approximately 110 square feet/ac for both treatment and control plots and no striking differences between the treatment and control areas at each site prior to treatment. Variation in basal area among sites was correlated with elevation, which ranged from approximately 6000 feet at our Hall Ranch site near the grassland ecotone (low basal area) to around 8500 feet near the mixed-conifer zone on the Pike National Forest (these sites had high basal area).

b. Understory

Percent cover of plants was between 10% and 30% across all treatment and control plot except on one site (Heil Ranch Unit 7) where cover values were unusually low on control plots (<5%). No major differences in understory variables were recorded between treatment and control plots across all sites except for this one. Two main plant species, common juniper and kinnickinick, were the most widely distributed and represented around 25% cover on average. Cover of litter on the forest floor was uniformly high – approximately 80% across all plots. Cover of exotic plants was generally very low (<1%) except at one low-elevation site (Heil Ranch Unit 5) where higher proportions of cheatgrass were present on most plots (1-5% of total plant cover). Overall, 15 exotic species were encountered. Five are listed as noxious weeds in Colorado: cheatgrass (Bromus tectorum), musk thistle (Carduus nutans), Canada thistle (Cirsium arvense), Dalmation toadflax (Linaria dalmatica) and mullein (Verbascum thapsus.)

c. Wildlife use

Numerous species were identified as having used plots, through sign and/or presence. These fell into 6 major guilds:

i. Tree squirrels: Abert's squirrel, pine squirrel.
ii. Small mammals: Deer mouse, chipmunks, ground squirrels, rabbit
iii. Large mammals: Coyote, fox, black bear, mountain lion
iv. Ungulates: Deer, elk, moose
v. Birds: Northern flicker, Steller's jay, American robin, Merriam's turkey, Western tanager, owls, hummingbirds, sapsuckers, woodpeckers
vi. Insects: ground-dwelling beetles, ants, spiders.

In 2011, overall use of plots by wildlife was similar between treatment areas and controls. 100% of all treatment plots and 100% of all control plots had evidence of use by one or more of the major 6 guilds. Treatment plots contained sign of between 1 and 5 guilds (mean = 2.8, SD = 0.9), while control plots contained sign of between 2 and 5 guilds (mean = 3.0, SD = 0.9).

Looking at each guild separately, the percentage of treatment vs. control plots with signs from each guild appeared similar for ungulates (sign present on 88% of treatment plots and 87% control plots), small mammals (36% and 38%, respectively), and ants (19% vs. 10%) More variation was recorded for birds (sign present on 43% treatment plots and 57% control plots), tree squirrels (71% treatment plots vs. 89% control plots), and large mammals (24% vs. 16%). We will conduct numerous additional analyses to explore this data set in more detail, for example addressing correlations between amount and type of wildlife use and characteristics of the overstory and understory, as well as analyzing possible changes in use of treatment vs. control plots over time after treatment.

d. Stand structure

We found considerable variation among sites in measurements of stand structure prior to treatment, as well as differences between treatments and controls within sites. The mean proportion of transects covered by openings (vs. covered by closed-canopy forest) ranged from only 15% for the treatment stands at one site on the AR National Forest, to 70% for control stands at one of the Heil Ranch sites in Boulder County. At most sites, openings covered an average of 30-50% of the length of transects. The mean numbers of openings present was also variable, ranging from an average of around 4 openings per stand transect at 3 of 8 sites, to an average of 8 at 2 sites. The mean sizes of openings were fairly similar at 7 of 8 sites – between 4m and 7m in length. However, one site (Hall Ranch) had openings that were 10m long on average on the treatment unit, and 20 m long on average on the control. Given this large amount of variation present before treatment, our post-treatment measurements of stand structure will be essential to evaluate whether there is a consistent effect of treatment on these metrics across sites.

H. References

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I. Acknowledgements

We acknowledge the many members of the Roundtable's Science and Monitoring team for their support and input; in particular our partners on the SRLCC proposal: Craig Hansen (USFWS); Paige Lewis (TNC); Jessica Clement and Peter Brown (CFRI); Hal Gibbs, Sara Mayben and Janelle Valladares (USFS); Greg Aplet (TWS); Mike Battaglia (RMRS) and Scott Woods (CSFS). For logistical support at each field site, we thank Jeff Underhill, Ed Biery, and Chris Oliver (PSI); Dave Hattis, Kevin Zimlinghaus, and Adam Messing (AR); and Chad Julian, Nick Stremel, Susan Spaulding, and John Staight (BCPOS). For field training and field help we thank Craig Hansen (USFWS); Ed Biery, Janelle Valladares and Felix Quesada (PSI); Nick Stremel and Chad Julian (BCPOS); as well as our field crew members: Peter Pavlowich, Stephanie Asherin, Abigail Smith, Danny Volz, Matt Thomas, Rebecca Harris, and Kristen Doyle. We have received considerable assistance and equipment for work on special topics from Laurie Huckaby (tree core analysis; RMRS) and Dan West (entomology; CSU).

3. BUDGET STATUS AND SUPPLEMENTAL FUNDS REQUEST

FY11-12: Funds received were expended as described in our original proposal to accomplish the stated objectives. However, unexpected delays and/or demands on our time necessitate the following supplemental funding request for FY13:

1. Field crew time, June 2013, $6000

The unexpected delay in the Arapaho-Roosevelt National Forest's and the Boulder County Parks and Open Space's plans to treat 3 of our 8 study sites in the original time frame means that we cannot complete field data collection until June 2013. We will not be able to fully evaluate the effects of treatment on the ecosystems with adequate replication unless we obtain the full set of data. Surveying these final 3 sites will be essential to the completion of our analyses and will allow us the possibility of providing useful information to management partners, the SRLCC, and fellow scientists in the form of full reports and/or a journal publication. We therefore request supplemental funds below to fund the time of a field crew in June 2013 to complete data collection.

2. Salary support for PI Jenny Briggs, USGS, 3 PP FY13, $13,000

In the original proposal, we requested and received 1PP salary for Jenny Briggs in FY11 and FY12 to lead the study, hire and manage field crews, coordinate with all partners, manage and analyze data, communicate and present results, prepare publications, etc. 2PP per year were committed from USGS as matching time. However, due to the considerable complexity of the study, the number of partners who play an active role, and the project's connection to an active interagency collaborative that is developing a 10-year plan of work, Jenny Briggs has invested at least 5 additional PP per year of matching time (10 PP total) to perform these roles, even with considerable investment of time from co-PI Paula Fornwalt. At least 4PP of time will be necessary in FY13 to hire and oversee a short-term field crew (as above), complete data analyses, and prepare reports and publications. Because USGS has already invested significantly more matching funds than expected in FY11-12, we request 3PP of Jenny Briggs's salary from the SRLCC in FY13 to enable successful completion of the project.

3. Salary support for project partner Craig Hansen, USFWS, 2PP FY13, $6000

Our original proposal included a plan to complement the field study by gathering and analyzing existing spatially explicit data from partner agencies on wildlife species of management concern in ponderosa pine ecosystems in the Front Range. Records of presence and abundance exist for many species at many sites managed in different ways (e.g. Northern Goshawk, Abert's squirrel, large carnivores, ungulates) but have not been integrated and incorporated into a single, shared GIS database. This effort would provide a valuable baseline to inform not only our short-term study of forest restoration impacts but also any continued investigations of wildlife responses to forest change across the landscape over time. To date, we have not had sufficient time, funds, or expertise on our project team to initiate this effort; however, a key partner in the study, Craig Hansen (Wildlife Biologist, USFWS, Lakewood CO, and GIS Instructor at the National Conservation Training Center) has indicated willingness to contribute to this work if funds for 1 month of his time are available. We request 2PP of funding for him in FY13.

Summary of supplemental funding request FY13	
	$
1 GS-3 field technician, 120 hrs	1560
1 GS-3 field technician, 120 hrs	1560
1 GS-6 botanist, 120 hrs	2160
	5280
Vehicle lease and gas, 3 weeks	720
subtotal, fieldwork	6000
3 PP salary, GS-12 Research Ecologist Jenny Briggs	13,000
2PP salary, GS-9 Wildlife Biologist Craig Hansen	6000
Total requested	**25000**