

## RESULTS SUMMARY

**Project Name: Colorado Front Range – CFLR004**

**State: Colorado**

**Initial Landscape-scale Desired Conditions for the life of the project as defined by the Collaborative**

Desired Conditions Target for **Fire Regime Restoration**: 100 % change (relative to the desired condition) occurs across 7.9% of the landscape area by 2019 date.

- Decrease basal area
- Increase quadratic mean diameters
- Increase the ration of ponderosa pine to other conifers
- Decrease the litter and duff depths
- Decrease or similar coarse woody material
- Reduced crown fire potential at 90<sup>th</sup> percentile weather

Desired Conditions Target for **Fish and Wildlife Habitat Condition**: 100 % change (relative to the desired condition) occurs across 7.9% of the landscape area by 2019 date.

- Protection and enhancement of old-growth conditions
  - openings, snags, coarse woody debris, groups/clumps of trees, large and old trees (both live and dead; occurring as both individuals and groups)
- Providing improved and sustainable fish and wildlife habitats
  - a mosaic of vegetation composition, structural stage, and age classes at various scales (project- and landscape-level)
- Reducing the potential for high-severity stand-replacing fires that negatively impact habitats
  - reduced risk of large-scale land disturbances that can degrade or eliminate fish and wildlife habitats

Desired Conditions Target for **Watershed Condition**: 0 % change (relative to the desired condition) occurs across 7.9% of the landscape area by 2019 date.

Desired Condition Target percentage is not calculated for this indicator because we anticipate that any changes in watershed condition will not be either measurable or significant during the project timeframe, due to the minor amount of treated area within the CFLR Project Area when measured at the landscape scale.

- Improve the condition class of those watersheds rated as Class II (at-risk) or Class III (impaired), and maintain the condition of Class I (properly functioning) watersheds
- Improve the Fire Regime Condition Class (FRCC) attribute where the attribute is rated as either Class II or Class III, and to maintain it where it is rated as Class I

Desired Conditions Target for Landscape Scale **Invasive Species Severity**: 7.9% of the CFLR landscape area was restored by reducing invasive species severity (preventing, controlling, or eradicating targeted invasive species) to meet desired conditions by 2019 date.

- Maintaining or decreasing the occurrence and cover of invasive plant species

Below (Tables 1 & 2) is a summary of the Landscape and Project Scale Scoring using the required template provided by the Collaborative Forest Landscape Restoration Program Manager at the Washington Office, USDA Forest Service. This is followed by an overview of the project's status and more detailed descriptions of progress toward desired conditions for each of the four categories of Ecological Indicators.

### **LANDSCAPE SCALE SCORING**

Scoring at the landscape scale reflects the degree to which the Colorado Front Range Landscape is moving towards desired conditions at the broader spatial extent. Landscape-scale scoring was conducted by the multi-party monitoring group. For this calculation, the 6<sup>th</sup> level watersheds surrounding each implemented treatment were considered the landscape of interest, to provide a more meaningful estimate of progress toward desired conditions at a broad spatial scale. For landscape scale scoring, it was assumed that treatments receiving scores in the "Good" category represented progress towards fire regime restoration across an

area equivalent to 10 times the acres treated. “Fair” scores represented progress equivalent to 5 times the acres treated and “Poor” scores represented progress equivalent to 2 times the acres treated.

- Good = Expected progress is being made towards Desired Conditions across 25% of the CFLR landscape area.
- Fair = Expected progress is being made towards Desired Conditions across 20% of the CFLR landscape area
- Poor = Expected progress is being made towards Desired Conditions across 10% of the CFLR landscape area

Table 1: Current Landscape-Scale Evaluation based on treatments implemented and monitored in 2010-2013

<b>Ecological Indicators</b>	<b>Datasets and/or databases of records used</b>	<b>Good, Fair, Poor and (%) landscape across which progress is being made towards desired conditions</b>	<b>Are you achieving your CFLRP objectives? (Y/N)</b>	<b>If NO, briefly explain...</b>
Fire Regime Restoration	Common Stand Exam (CSE)	Good = 6% Fair = 18% Poor = 1%  25% of landscape moving towards desired conditions	YES	
Fish and Wildlife Habitat Condition	No Data		N/A	Data being collected as of 2014
Watershed Condition	National Forest datasets were consulted		N/A	No measurable change
Invasive Species	CSE at project scale		N/A	Limited data available so far, at project scale only

## PROJECT- SCALE SCORING

Each project was designed with objectives that contribute to achieving desired conditions at the larger landscape scale. Project-scale scoring reflects how well the results of an individual management activity met the objectives for that project. Individual projects may not meet every desired condition of the CFLRP project. Project-scale scoring was conducted following completed management activities and assessment of monitoring data by the multi -party monitoring group.

- Good = 75% or more of implemented treatments result in measurable progress towards individual **project-level** objectives.
- Fair = 26% - 74% of implemented treatments result in measurable progress towards individual **project-level** objectives.
- Poor = 25% or less of implemented treatments result in in measurable progress towards individual **project-level** objectives.

Table 2: Current Project-Scale Evaluation

<b>Ecological Indicators</b>	<b>Datasets and/or databases of records used</b>	<b>Project Level Good, Fair, Poor and (%) treatments resulting in measurable progress as defined above</b>	<b>Are you achieving your CFLRP objectives? (Y/N)</b>	<b>If NO, briefly explain...</b>
Fire Regime Restoration	CSE	Good = 12% Fair = 79% Poor = 9%	YES	
Fish and Wildlife Habitat Condition	No Data		N/A	Preliminary data still being analyzed
Watershed Condition	No Data		N/A	Data not available at this scale
Invasive Species	CSE	Good = 100%	YES	

## **INTRODUCTION**

In 2010, the Colorado Front Range Landscape Restoration Initiative proposal was born to create a long-lasting ecological, social and economic benefit across a 1.5 million-acre landscape covering much of the Arapaho and Roosevelt and Pike and San Isabel National Forests of Colorado. The proposal was based on a collaboratively designed ecological restoration strategy to manage Front Range ponderosa pine forests for a condition that reduces the threat of catastrophic fire, increases forest resilience to disturbances, and provides for a variety of desirable and sustainable resource conditions and community needs.

With the passage of the Omnibus Public Land Management Act of 2009, Congress required Collaborative Forest Landscape Restoration (CFLR) projects to submit a 5-year report assessing whether, and to what extent, the CFLR program is fulfilling its purposes. The Forest Service is required to report on progress towards meeting the desired conditions that were developed specifically for the Colorado Front Range Project. The desired conditions for this landscape are guided by a set of key objectives within four ecological categories explicitly identified within the Act; they are Fire Regime Restoration, Fish and Wildlife Habitat Condition, Watershed Condition, and Invasive Species Severity. This is the report on our progress toward the desired outcomes.

## **FIRE REGIME RESTORATION**

Forests in the lower montane of Colorado's Front Range are dominated by ponderosa pine, with Douglas-fir present in many locations. Since 1860, human activities such as timber harvest, grazing, mining, fire suppression and urban development have been significant catalysts for change in these forests, resulting in dramatically increased forest densities, notable homogeneity in terms of tree age and size class across the landscape, and an overall lack of understory vegetation and patchy openings. The recommended focus on restoration of lower montane ponderosa pine forests has been identified as the area where science most clearly supports the need for active ecological restoration.

Thousands of acres of dense, homogeneous forest now characterize lower montane landscapes that once sustained a complex mosaic of forest density, tree sizes and tree ages. As a result, these landscapes are highly susceptible to disturbances by insects, disease and wildfire at uncharacteristically large scales and severities. This vulnerability has been further increased by periodic drought, changing climate and the movement of a decade-long bark beetle epidemic from Colorado's High Country to the Front Range. While relatively frequent surface fires and mixed-severity fires used to be the norm for this life zone, dense ladder fuels are now capable

of carrying fire into the forest canopy, resulting in severe crown fires. High severity, stand replacing wildfires threaten the sustainability of lower montane ponderosa pine forests which regenerate very slowly and sometimes not at all if the seed source is compromised. Since the mid-1990s, numerous such fires have occurred across the Front Range, with major consequences for ecological and human communities.

The values at risk from severe wildfire in this landscape are tremendous. The Colorado Front Range landscape includes over 2 million people, 881 communities and more than 700,000 homes. There are also 4.2 million acres of forested watershed that are essential to drinking water supply, 65% are considered to be at high risk for post-fire erosion. In addition to water supply, several other components of critical Front Range community infrastructure are at risk from large-scale wildfire, including evacuation routes, power transmission lines, gas pipelines and communication towers.

The purpose of ecological restoration treatments in the lower montane zone of Colorado's Front Range is to:

- increase the forest's capacity to adapt to climate changes,
- create a more diverse age structure while also promoting ponderosa pine old growth
- substantially decrease the overall density of ponderosa pine and Douglas-fir in most stands

Treatments will focus on increasing patchiness of forests at all spatial scales, such that areas with varying amounts of canopy cover and clumps of trees are heterogeneously interspersed with herbaceous meadows and openings across the landscape. These treatments will result in:

- more resilient forests with increased resistance to insects and disease
- less severe wildland fires,
- reduced threats to urban communities and water quality
- improved habitat for fish and wildlife species

The primary measure of success in Fire Regime Restoration, through the use of ecological restoration and the maintenance and reestablishment of natural fire regimes, is the reduced risk of severe and uncharacteristic wildfire over large areas.

### **Scale**

There are approximately 1,085,000 acres of National Forest System lands (NFS) within the 1.5 million acre CFLR project area identified in our original 2010 proposal. The Front Range Roundtable (FRRT) identified approximately 800,000 of these acres that would benefit from restoration-focused management. Of those acres, roughly 629,000 acres are considered

priority acres for treatment as they are highly or very highly departed from the historic range of variability for vegetation conditions. Of these priority acres, 400,000 are located on federally managed land. Unfortunately, many of the 400,000 acres are unavailable for restoration treatment due to Forest Plan and other constraints including difficult/steep terrain, legal access and political issues. Restoration treatments, proposed for the ten-year period of the CFLR project, encompass 31,600 acres on National Forest lands. When completed as planned, this will represent 7.9% of the 400,000 federally-managed acres designated as high priority for restoration in the Front Range. To date, the Forest Service has completed treatment on more than 14,600 acres. Monitoring data was collected on treatments that were conducted between 2010 and 2013 on a total of 7,321 acres. The results in this monitoring report are based on those 7,321 acres where data was collected.

Progress was measured toward achieving desired conditions at both the landscape- and project-level scales. Landscape-scale measures reflect the proportion of the broader area where changes to structural and spatial heterogeneity of plant communities, as well as predicted fire behavior, directly affect the ecological indicators described in this report. With treatments, we expected to see some measure of success towards restoration within the life and boundaries of the project and beyond. For the landscape-scale scoring we conducted for this report, we defined the landscape affected by our treatments using the 6<sup>th</sup>-level watershed boundaries that surrounded each implemented project rather than the entire 400,000 acres of high-restoration-priority federally managed forest in the Front Range. Our collaborative group felt that a landscape-level focus on the watersheds in which treatments occurred would allow a more meaningful evaluation of progress towards desired conditions in the areas directly and indirectly affected by treatments. Thus, we used a landscape of 156,839 acres as the basis for assessment. Under this scenario, treatments show changes related to spatial heterogeneity, predicted fire behavior, wildlife habitat condition and plant communities.

At the project scale, treatments are designed to achieve site specific objectives and promote the desired conditions for the landscape scale. These fine scaled projects focus on forest stands that are composed of single isolated trees, groups of trees, openings, or some mixture that cumulatively form the forest stand. Treatments at the project scale usually range from the 10's to 100's of acres. Monitoring usually occurs at the project scale with measurements made from a plot-based sampling approach. In some cases, sets of plots on untreated land adjacent to treatments are used as controls, for comparative purposes. Project scaled monitoring is used to evaluate consequences so that undesirable conditions can be avoided and adaptive actions can occur.

**Desired Condition**

The following metrics (Table 3) provide the basis for evaluating attainment of overall ecosystem goals within the Front Range CFLRP. Desired conditions identified for the Front Range montane ecosystem are based on concepts of ecosystem structural and functional sustainability, resilience, and adaptive capability, and were developed through a collaborative multi-stakeholder process. The metrics do not include specific values for assessing success for each of the variables to be monitored, but rather use trends as the basis for evaluation. This is in contrast to lower montane forests in the Southwest or Black Hills, where there has been a great deal of scientific research on historic ecological values. However, the trends were based on comprehensive literature reviews of existing publications and unpublished research; and oral interviews with a group of scientists who are experts in Front Range montane forest and fire ecology. Not all metrics developed by the collaborative group were utilized for this report, primarily due to the lag time in developing protocols for measuring some metrics. For example, the protocol for measuring spatial heterogeneity within a treatment area was only recently developed, and uses the National Agriculture Imagery Program (NAIP) imagery to compare pre- and post-treatment stand structure diversity. NAIP imagery is updated every three years and was not available for more recently completed projects. Preliminary results are presented in this report on page 9.

Table 3: Desired Condition Parameters.

<b>Restoration Parameter</b>	<b>Desired Trend</b>	<b>Data Used</b>	<b>Discussion</b>
Tree Density	<ul style="list-style-type: none"> <li>Decreased Basal Area</li> </ul>	Pre- and Post-Treatment Common Stand Exam	Historic data shows that values in most areas were between 40 and 80 square feet of basal area while current conditions are much higher. Decreasing basal area also serves to reduce crown bulk density.
Tree Sizes	<ul style="list-style-type: none"> <li>Increased Quadratic Mean Diameters</li> </ul>	Pre- and Post-Treatment Common Stand Exam	Historic data shows that the density of smaller understory trees has increased dramatically due to lack of fire over the last century.



Tree Species	<ul style="list-style-type: none"> <li>Increased Ratio of Ponderosa Pine to Other Conifers</li> </ul>	Pre- and Post-Treatment Common Stand Exam	Historic data in the lower montane shows a higher percentage of ponderosa pine relative to other conifer species, in particular, Douglas-fir. Increasing the percentage of ponderosa pine also serves to increase canopy base height and reduce ladder fuels.
Surface Fuels	<ul style="list-style-type: none"> <li>Decreased Litter and Duff Depths</li> <li>Decreased or Similar Coarse Woody Material</li> </ul>	Pre- and Post-Treatment Common Stand Exam / Brown's Transect	Historic fire data shows that mixed frequency of fire kept surface fuels at varied levels. Lack of fire over the last century has dramatically increased litter, duff and surface fuels.
Fire Behavior	<ul style="list-style-type: none"> <li>Reduced Crown Fire Potential at 90<sup>th</sup> Percentile Weather</li> </ul>	Pre- and Post-Treatment Common Stand Exam / Brown's Transect	Historic stand data indicates areas across the landscape with low canopy bulk density and surface fuel plus high crown base height, contributing to a mixed-severity fire regime rather than extensive crown fires.

**Evaluation Metrics**

Evaluation metrics that are applicable to Fire Regime Restoration desired condition per the 2011 Ecological, Social, and Economic monitoring plan (Clements and Brown) include: tree density (basal area and trees per acre), tree sizes, tree ages, within-stand spatial heterogeneity and structural stage diversity, tree species, surface fuels (litter and duff depths and coarse woody debris), and fire behavior (canopy base height and canopy bulk density). Tree age was not included in this evaluation since existing data has not yet been evaluated and sampling protocols are still being developed. Within-stand spatial heterogeneity and structural stage diversity were not included since the protocols were recently developed and only preliminary results are available at this time.

Table 4: Restoration parameter score by project, 2010 – 2013, (All CFLR funded projects).

DESIRED CONDITION RESTORATION PARAMETERS	Projects on the PIKE & SAN ISABEL NATIONAL FORESTS								Projects on the ARAPAHO & ROOSEVELT NATIONAL FORESTS				
	PHANTOM CREEK 1	PHANTOM CREEK 2	PHANTOM CREEK 3	PHANTOM CREEK 4	RYAN QUINLAN	LONG JOHN	CATAMOUNT 1	MESSENGER GULCH 2	TAYLOR MOUNTAIN	THOMPSON RIVER	WALKER BLACK	WALKER RED	ESTES VALLEY
PROJECT ACRES	597	870	656	507	356	304	351	425	405	679	134	682	769
DENSITY - Basal Area (ft <sup>2</sup> /ac)	Y	Y	Y	Y	Y*	Y	Y	Y*	Y	Y	Y	Y	Y
SPECIES COMP – Increased % of PIPO (ponderosa pine)	Y	Y	Y	N	UNK	N	N	UNK	N	N	N	N	N
AVERAGE TREE SIZE (QMD)	N	Y	N	N	UNK	Y	N	UNK	Y	N	Y	Y	Y
SURFACE FUELS (tons/ac)	N*	N*	N*	N	N*	N	N	N*	N*	N*	N*	N*	N*
FIRE BEHAVIOR - CBH (crown base height, feet)	Y*	Y*	Y*	Y	Y*	Y	Y	Y*	Y*	N*	Y*	Y*	Y*
FIRE BEHAVIOR - CBD (canopy bulk density, kg/m <sup>3</sup> )	Y*	Y*	Y*	Y	Y*	Y	Y	Y*	Y*	N*	Y*	Y*	Y*
<b>FINAL SCORING,</b>	67%	83%	67%	50%	50%	67%	50%	50%	67%	17%	67%	67%	67%

DESIRED CONDITION RESTORATION PARAMETERS	Projects on the PIKE & SAN ISABEL NATIONAL FORESTS								Projects on the ARAPAHO & ROOSEVELT NATIONAL FORESTS				
	PHANTOM CREEK 1	PHANTOM CREEK 2	PHANTOM CREEK 3	PHANTOM CREEK 4	RYAN QUINLAN	LONG JOHN	CATAMOUNT 1	MESSENGER GULCH 2	TAYLOR MOUNTAIN	THOMPSON RIVER	WALKER BLACK	WALKER RED	ESTES VALLEY
PROJECT	F	G	F	F	F	F	F	F	F	P	F	F	F

\* Only partial data available. Score determination based on pre or post treatment data and field visit by monitoring team.

Table 5: Score designations by project and evaluation parameters

Restoration Parameter Score	Description
Y	Post treatment condition <b>WITHIN</b> desired parameters.
N	Post treatment conditions <b>NOT WITHIN</b> desired parameters or not statistically significant.
UNK	No pre- and/or post- treatment monitoring data available, <b>OUTCOME UNKNOWN</b> . Not used in scoring calculation.

## Fire Regime Restoration Score Summary

### Landscape Scale

Table 6: Score for monitored treatments, landscape scale, 2010 – 2013.

Score	Project Acres	% of CFLRP Landscape Area (156,839 ac)*
<b>Good</b>	870	6%
<b>Fair</b>	5,772	18%
<b>Poor</b>	679	1%
Total	7,321	25%

\* Landscape area based on HUC-6 watershed areas where treatments occurred

### Project Scale

Table 7: Score for monitored treatments, project scale, 2010 – 2013.

Score	Project Acres	% Of Total Project Area
<b>Good</b>	870	12%
<b>Fair</b>	5,772	79%
<b>Poor</b>	679	9%
Total	7,321	100%

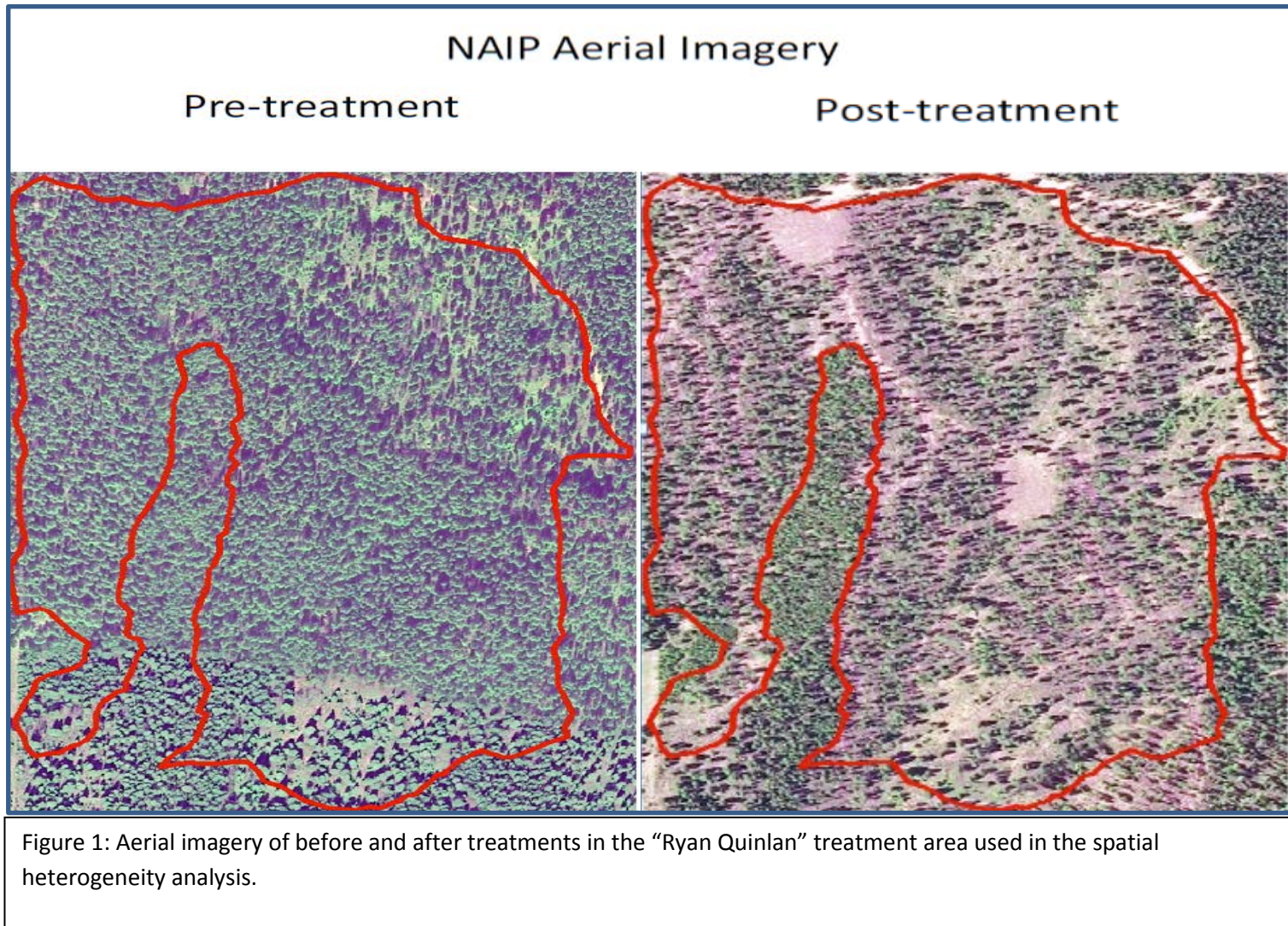
Based on our monitoring data (collected on treatments covering 7321 of the 14,600 acres treated from 2010-2014), we found that progress toward desired conditions for Fire Regime Restoration has occurred across 25% of the landscape our treatments are affecting (Table 6) and within 100% of the project treatment areas (Table 5). The majority of treatments received scores of “Fair” progress toward desired conditions at both the landscape- and project scales. As shown in Table 4, progress toward desired conditions has been especially consistent across the treatments for the metrics of decreased tree density/basal area and decreased modeled fire behavior. Progress has been more variable for the metrics of increased average tree size and increased ratio of ponderosa pine to other conifers; the desired trends have occurred to significant levels on some projects but not on others (Table 4). The metric for which we need to improve both our post-treatment outcomes and our sampling methods is reduction in surface fuels. By 2019, we also hope to fully incorporate our assessment of changes in spatial heterogeneity of forest structure in the scoring for this category. The assessment of this variable has been developed more recently, as described below.

## **Spatial Heterogeneity and Structural Stage Diversity**

Many portions of the landscape formerly burned under low to mixed-severity fire and likely had lower canopy cover and more varied spatial structure than we see today. One of the goals of the FR-CFLR treatments was to increase spatial heterogeneity of forest conditions. If treatments achieved these goals, we expected to see reduced overall canopy cover, and generally increased number of patches and complexity of patch shape/arrangement. We analyzed aerial images (National Aerial Imagery Program, 2.4 m resolution) to assess the effects of management on forest cover at the stand scale, and used 30 m resolution canopy cover data to assess changes at the landscape scale (or HUC12 watersheds).

We found treatments generally caused forest conditions to move in desired directions. Canopy cover was reduced by treatments from 44% to 26% at the stand scale, on average. Despite the drop in cover, the number of patches increased, due to their smaller size. Size of the largest canopy patches also decreased, from covering 22% to 7% of the treatment units. Patches were more heterogeneously dispersed following treatment than before treatment, with a greater average distance, and greater range of distances, between patches of forest cover. All of these changes indicate that forest cover is less continuous, more spatially variable, and less likely to burn as part of a contiguous stand replacing fire.

Some changes, however, indicate decreases in complexity of cover patterns. The range of patch areas decreased, and the amount of forest edge per area of canopy cover decreased. At the landscape scale, we did not expect large changes in forest cover due to the small portion of each watershed treated. But, although changes caused by treatments were small, they were noticeable. The proportion of the landscape with dense canopy cover (>70% cover) decreased slightly, while the portion of the landscape with sparse canopy cover (0-10%) increased slightly. Sparsely forested areas were also nearer following treatment (average of 23 m apart), on average, than before treatment (average of 156 m apart). The treatments in some cases decreased the complexity of forest cover patch shapes at the landscape scale, similarly to what we found in the stand-scale analysis. Overall, our treatments are achieving the objective of reducing continuity of canopy cover. The treatments are increasing number of patches and, in some cases, the complexity of patch arrangement. The following aerial imagery highlights the effect of treatments showing changes in canopy closure. Pre and post treatment imagery and analysis provides a visual result of the changed condition.





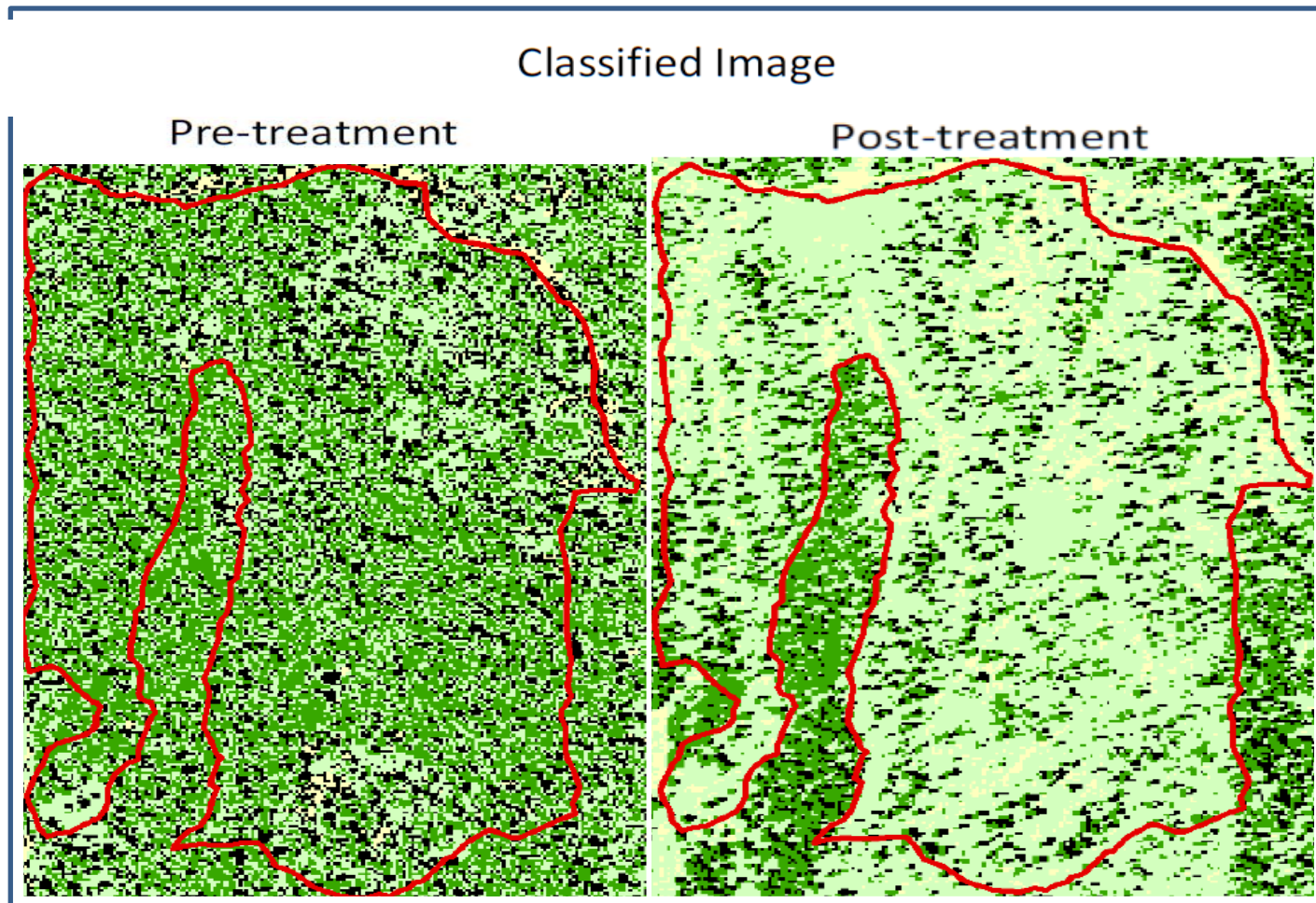


Figure 2: Classified image showing the results of treatment for canopy closure and spatial heterogeneity used for analysis.

## **Adaptive Management**

The Colorado Front Range (CFLRP) has developed an adaptive management (AM) model to incorporate data to be developed by its Multiparty Monitoring Program into future goals and treatment actions for restoration of Front Range forest ecosystems. The AM model is designed to evaluate: 1) whether treatments were implemented as designed; as well as 2) the effectiveness of treatments. Using both collected data and annual collaborative monitoring trips, projects are evaluated against CFLRP metrics. Based on those evaluations, future treatments may be redesigned to meet the desired condition.

One significant change that occurred as a direct result of monitoring evaluation is the modification of the silvicultural prescription to increase spatial heterogeneity. The first iteration of CFLR projects used a standard tree spacing regime to achieve hazardous fuels objectives, which did not meet the goals for restoration of more diverse stand structure with increased resilience to disturbance. Subsequent project prescriptions have included design features to enhance structural diversity to produce more clumpy, patchy stand conditions that more fully reflect the historic mixed-severity fire regime.

## **FISH AND WILDLIFE HABITAT CONDITION**

### **Desired Condition**

The desired conditions for Fish and Wildlife Habitat Condition are closely linked to the anticipated effects described in the original CFLR project proposal. Progress towards desired conditions is difficult to measure at this time due to the project implementation schedule and post treatment monitoring data that is only beginning to be collected. However, some progress can be reported as it relates to Ecological Outcome Measure 1- Fire Regime Restoration - as the restoration objectives for vegetation directly affect habitat conditions. Key components of restoration activities that directly contribute to the desired conditions that can be measured before and after treatments occur include: tree density, species composition, distribution of trees of different sizes and ages, and the spatial heterogeneity of areas with varying amounts of canopy closure, individual trees, and openings.

Addressing fish and wildlife habitat more specifically, the original proposal called for the protection and enhancement of old-growth conditions; providing improved and sustainable fish and wildlife habitats; and reducing the potential for high-severity, stand-replacing fires that negatively impact habitats.

To move towards these broad conditions, more detailed specifications for CFLR project prescriptions have been designed to result in:



- Provision and/or retention of features across the landscape that are important to a variety of species identified in the Wildlife Monitoring Plan, such as openings, snags, coarse woody debris, groups/clumps of trees, large and old trees (both live and dead; occurring as both individuals and groups)
- a mosaic of vegetation composition, structural stage, and age classes at various scales (project- and landscape-level)
- Reduced risk of large-scale land disturbances that can degrade or eliminate fish and wildlife habitats.

We anticipate that, by 2019, our wildlife monitoring work and our other monitoring activities focused on vegetation will have progressed and been integrated to a point at which we can more fully evaluate the effects of CFLR treatments on wildlife habitat condition.

### **Fish and Wildlife Habitat Condition Summary**

Scoring for National Reporting on Fish and Wildlife Habitat Condition as currently outlined is difficult at this first year of implementation (2014). Provided below is the progress and process of the Wildlife Monitoring Team between 2011 and 2014.

In 2010-2011, members of the Science and Monitoring team (SM Team, later known as Landscape Restoration Team) of the Front Range Roundtable conducted a preliminary assessment of possible monitoring options for wildlife species that might be affected by the treatments done in the CFLR Project Area. Representatives from the US Fish and Wildlife Service (FWS), the Colorado Division of Wildlife (CDOW, now Colorado Parks and Wildlife), US Geological Survey (USGS) and the US Forest Service (FS) discussed the list of species known to occur in Front Range lower-montane ponderosa pine forests. Based on their professional opinions, experience, and searches of the relevant scientific literature, the group made informal predictions of the potential effects of the restoration treatments on each species (or “guild” of species with similar habitat requirements) and discussed the possible costs, benefits, feasibility, and rationale for monitoring each species. In June 2011, the group summarized this information and their informal recommendations for a wildlife monitoring program in a table included in the 2011 CFLR Draft Monitoring Plan. However, because of limited funding and additional questions and information needs, these recommendations were not fully adopted and the document remained in Draft form.

Instead, in the summers of 2011-13, funding from the Southern Rockies Landscape Conservation Cooperative (SRLCC) was granted to a sub-team of the SM Team to implement a more general wildlife use survey protocol on a subset of the Common Stand Exam plots being established pre- and post-treatment on CFLR units to monitor changes in over-story and fuels.

These wildlife sign surveys covered the forest floor and all trees within tenth-acre plots, and included: nests, burrows, scat, and feeding sign from five “guilds” or groups of species (birds, tree squirrels, small mammals, large mammals, and ungulates). Pitfall traps were also used to monitor occurrence of ground-dwelling insects. In 2011, pre-treatment data were collected on a total of 50 plots on five treatment units (including control plots in adjacent areas not planned to be treated); then post-treatment data were collected one year after treatment, in 2012 or 2013. Preliminary analyses indicate that 90-100% of all plots had wildlife sign (from at least one guild) pre-treatment, but a year after the treatments, this value dropped to 75% for treated plots and remained at 90+% for untreated plots. Sign left by individual guilds did not show significant changes in abundance post-treatment, but the timeframe may still be too short for trends to become apparent. Future surveys in years five, seven, and 10, as well as correlation of wildlife use data with data from other monitoring efforts, are needed to discern detectable trends over time and evaluate progress toward desired conditions for wildlife habitat at this project-level scale. Analysis is in progress for the data from the SRLCC study, and a final report and manuscript are being developed.

In November of 2012, a second effort at developing a broader-scale wildlife monitoring plan was launched and the Wildlife Working Team (WWT) was formed as a sub-team of the Landscape Restoration Team (LR Team – formerly the SM Team). The WWT is made up of biologists and ecologists from the US Forest Service, Colorado Parks and Wildlife (formerly CDOW), and US Geological Survey (USGS). The WWT met monthly from November 2012 through July 2014 and is currently on a quarterly meeting schedule. Several members of the WWT are also members of the LR team so communication between teams is frequent and updates are provided to ensure transparency and solicit feedback.

The team started their work by assessing the approximately 300 species that could occur within the lower montane CFLRP landscape-level footprint and would meet the needs of the Forest Service and CFLR monitoring programs. Through discussions about likelihood of occurrence and influence of CFLR projects on each species, the list was filtered to 145 species of potential interest. The team then assigned “scores” to each species within the categories of “Ecologically Informative” “Politically Prudent” and “Socially and/or Economically Important” and applied specific criteria to further refine the list to 64 species which had high scores in one or more of these categories. From those 64 species, the team considered stressors, life histories, sampling approaches, standard monitoring protocols, and other factors to evaluate which species (or groups of similar species) could be monitored to generate the most useful information about the effects of the CFLRP on wildlife habitat. The final result was a list of 12 candidate species/groups including bats, songbirds/woodpeckers, selected raptors and owls, tree squirrels, and carabid beetles.

The team then determined and defined Tier 1 and Tier 2 species monitoring. Tier 1 species include songbirds/woodpeckers, tree squirrels, and the Northern Goshawk. For these species, monitoring will be accomplished using CFLR funds and will likely occur on a rotational basis (not every species every year) based on priority and funding. For the Tier 2 species/groups – bats, flammulated owls, and carabid beetles - monitoring will be conducted based on the availability of interested partners and supplemental funding opportunities.

In 2014, the WWT initiated monitoring of select Tier 1 species (songbirds and tree squirrels) by procuring a 5 year agreement between the Forest Service and Rocky Mountain Bird Observatory (RMBO) and developing a spatially balanced sampling approach to estimate density and occupancy rates across the CFLR landscape (defined to include both CFLR treatment projects and untreated areas). In May 2014, the first field season was implemented and songbirds and pine squirrels were monitored by RMBO using protocols from the Integrated Monitoring of Bird Conservation Regions (IMBCR) program. A total of 120 sample units (1800+ avian points) were surveyed across the CFLRP landscape in treated and untreated areas; data analysis will occur in the winter/spring of 2015.

From August-October 2014, the WWT also monitored Abert's squirrels using remote camera stations at approximately 40 locations across the CFLRP landscape; data analysis will occur in the winter/spring of 2015.

Finally, the WWT developed a draft protocol for conducting Abert's squirrel feeding sign surveys and field tested it for future use by RMBO; the goal is to incorporate feeding sign surveys into the IMBCR point surveys.

The next steps for the WWT are to:

- Complete the Final Report/Wildlife Monitoring Plan. The Report will contain the process, methodologies, and recommendations for implementation of the recently initiated Monitoring Plan, as well as the rationale for species selection.
- Continue working with the LR Team to ensure that the Wildlife Monitoring Plan is implemented in a way that is complementary to other CFLR efforts.
- Identify funding and implementation opportunities for monitoring Tier 2 species. Develop presentations to inform potential internal and external partners and encourage their involvement.
- Manage and analyze the data collected such that it contributes to the assessment of progress toward desired conditions and implementation of the adaptive management cycle for the Front Range CFLR.

## **WATERSHED CONDITION**

### **Desired Condition**

The desired condition for watershed condition is to improve the condition class of those watersheds rated as Class II (at-risk) or Class III (impaired), and to maintain the condition of Class I (properly functioning) watersheds. Within the context of monitoring CFLR indicators, the desired condition is to improve the Fire Regime Condition Class (FRCC) attribute where the attribute is rated as either Class II or Class III, and to maintain it where it is rated as Class I. A more in-depth description of condition class indicators can be found in the Forest Service Watershed Condition Classification Technical Guide ([http://fsweb.wo.fs.fed.us/wfw/watershed/classification/FS\\_watershed\\_classification\\_TechGuide\\_July\\_2011.pdf](http://fsweb.wo.fs.fed.us/wfw/watershed/classification/FS_watershed_classification_TechGuide_July_2011.pdf)).

### **Watershed Condition Summary**

Watershed Condition Classification is a nationally consistent approach to assess the condition of Forest watersheds (Figure 3). The classification is applied at the 6<sup>th</sup>-code watershed level. Sixth-code watersheds are typically 5,000-40,000 acres in size.

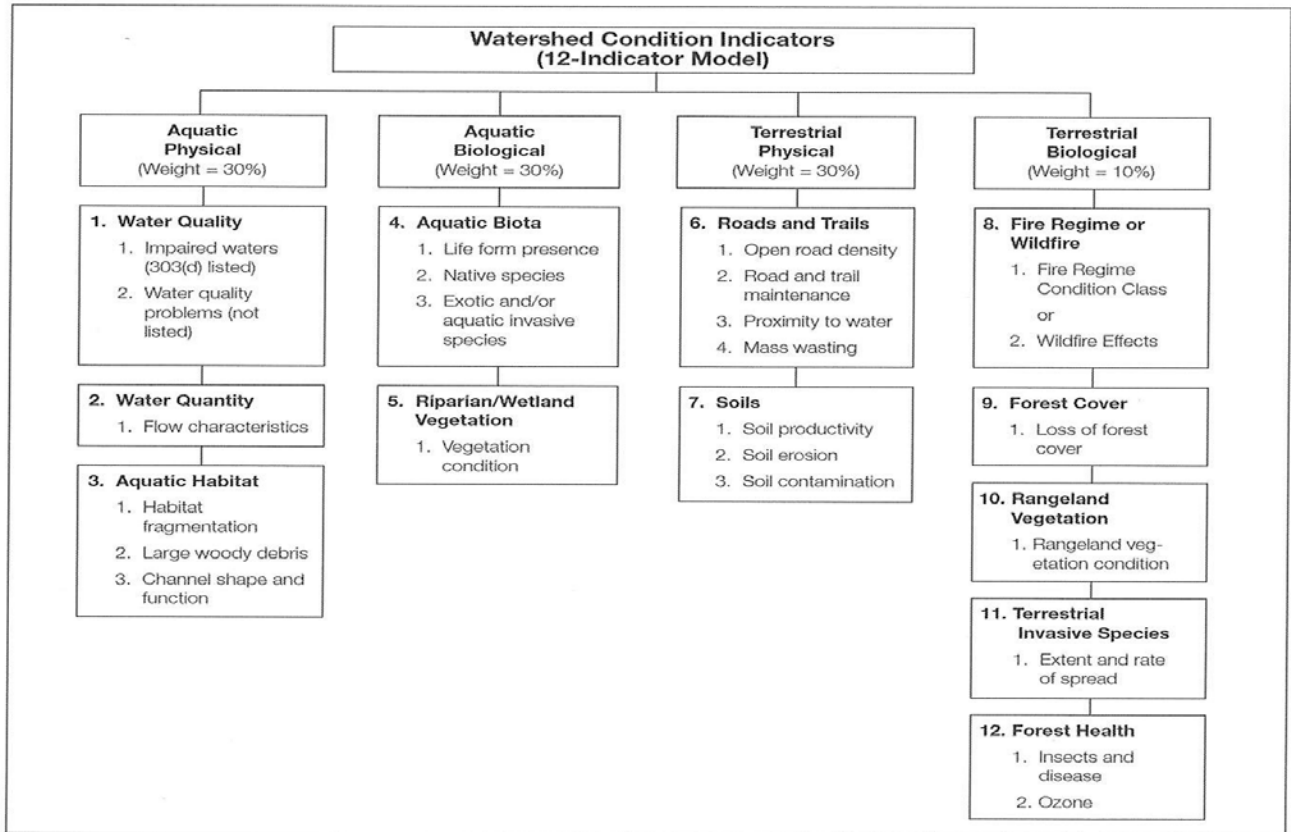


Figure 3: Watershed Condition Indicator Model

For each watershed, 24 attributes are examined. The attributes are organized into 12 indicators and four process categories as shown in Figure 3, above. Each attribute receives a rating of 1 (functioning properly), 2 (functioning at risk), or 3 (impaired). Attribute ratings are then averaged to provide an Indicator rating, Indicator ratings are averaged to produce a Process Category rating, and finally, Process Category ratings are given a weighted average to determine Watershed Condition Class. There are four Process Categories; Aquatic Physical, Aquatic Biological, Terrestrial Physical, and Terrestrial Biological. The first three categories are given a weight of 30%, and the fourth category, Terrestrial Biological, is given a weight of 10%. The rationale for giving a different weighting to Terrestrial Biological indicators is that while attributes in the first three categories represent direct effects to watershed or stream condition, attributes in the fourth category represent indirect effects or risks to watershed condition. For example, while a change in the FRCC indicator represents a change in risk that a high severity fire may occur, the condition of the watershed would not be affected until such a fire actually did occur.

Because the Terrestrial Biological category is given a 10% weighting, because there are five indicators in the category and one attribute in the Fire Regime or Wildfire indicator, the Fire Regime attribute reflects 2% of the Watershed Condition Classification rating. As discussed above, each attribute is rated from 1 to 3, so if the indicator reflects 2% of the final rating, the range of the Fire Regime attribute's contribution to the rating would be 0.04 (from 0.02 for a fire regime rating of 1 – properly functioning to 0.06 for a fire regime rating of 3 – impaired). A change in the attribute rating due to the accomplishment of CFLR projects would only affect the Watershed Condition Class of those watersheds whose ratings put them on the very edge of the class boundaries. Therefore, no change in watershed condition is expected as a result of CFLR treatments.

## **INVASIVE SPECIES**

### **Desired Conditions**

Initial Front Range CFLRP desired conditions and trends developed in 2010-2011 by the Science and Monitoring Team (SM Team) focused on evaluating restoration treatment impacts on overstory trees, tree regeneration, and fuels, but did not include a strong emphasis on evaluating understory plant (i.e., grass, forb, and shrub) impacts, including invasive plants. The Team's desired condition/trend with regard to invasive plants was solely defined as maintaining or decreasing the occurrence and cover of invasive plant species.

### **Invasive Species Summary**

Scoring for invasive species is difficult at this point in time. The SM Team has yet to implement a full-fledged monitoring effort to evaluate treatment progress toward the desired condition/trend. The discussion below provides a summary of the progress since the initial desired condition/trend was outlined in 2010-2011.

During the summers of 2011-2013, funding from the Southern Rockies Landscape Conservation Cooperative was granted to an understory sub-team of the SM Team to develop and implement a pilot understory plant monitoring protocol. Understory monitoring occurred on 24 Common Stand Exam plots within four Front Range CFLRP projects; the Common Stand Exam plots were being measured pre- and post-treatment for the monitoring of overstory trees, tree regeneration, and fuels. Understory data were collected in the 24 plots prior to treatment (2011) and one year post-treatment (2012 – 2013), using a point-intercept method. Four transects were established in the cardinal directions from plot center, each 30.75 feet long. At 100 evenly spaced points along each transect, all understory plants were recorded to the species level. If more than one species was present at a sampling point, all were recorded. The

number of occurrences of each plant species was tallied along each transect to calculate percent cover by species. In addition, a complete inventory of all understory species present in a 0.1 acre plot (37.2 feet radius) was also conducted. This entailed systematically searching for any plants that did not occur along the 4 transects.

In contrast to the desired condition/trend outlined by the SM Team, which focused on maintaining or decreasing invasive plants in treated projects, the sub-team stressed minimizing increases in invasives. This is because the sub-team felt that treated areas could experience some small level of invasive species increase and still be in a desirable condition, especially in areas where invasives were absent or rare prior to treatment. Specific desired conditions/trends developed by the sub-team include:

- Invasive plant (i.e., exotic plants not native to North America) cover unchanged following treatment, or if greater following treatment, then post-treatment cover < 5%.
- Noxious weed (i.e., defined as a noxious plant by the state of Colorado) cover unchanged following treatment, or if greater following treatment, then post-treatment cover <3%.
- Post-treatment invasive plant cover is <10% of total post-treatment plant (graminoid, forb, shrub) cover.
- Post-treatment invasive plant richness is <10% of total post-treatment plant (graminoid, forb, shrub) cover.

Project-level scoring utilizing this sub-team's pilot data and desired conditions/trends is provided in Table 8. The scores provide some insight into how treatments have affected invasives in the Front Range, but they are not sufficient to complete a full assessment because they are limited in spatial (i.e., only four projects are evaluated) and temporal (i.e., post-treatment data were only collected in one year) scope. Nonetheless, scores indicate that treatments are currently meeting desired conditions/trends with regard to invasives. Indeed, neither invasive nor noxious weed cover exceeded 1% for any project, either before or after treatment. Similarly, the proportion of total understory plant cover/richness comprised of invasives never exceeded 5%.

Table 8: Invasive species parameter scores by project. Y indicates the desired condition/trend is being met; N indicates it is not. Data were collected in 2010, prior to treatment, and again in 2012 – 2013, one year post-treatment.

DESIRED CONDITION/TREND PARAMETERS	PIKE & SAN ISABEL NATIONAL FORESTS		ARAPAHO & ROOSEVELT NATIONAL FORESTS	
	PHANTOM CREEK 1	PHANTOM CREEK 2	ESTES VALLEY	WALKER BLACK
INVASIVE PLANT COVER (%)	Y	Y	Y	Y
NOXIOUS WEED COVER (%)	Y	Y	Y	Y
INVASIVE PLANT COVER (% of total understory plant cover)	Y	Y	Y	Y
INVASIVE PLANT RICHNESS (% of total understory plant richness)	Y	Y	Y	Y
<b>FINAL SCORING, PROJECT</b>	100%	100%	100%	100%
	G	G	G	G

Building on the 2011-2013 effort, a second sub-team was formed in early 2014 to develop and implement a final SM Team understory plant monitoring protocol. This second sub-team’s efforts are still ongoing. The sub-team’s intent is to develop the plan early in 2015, and begin implementation during the 2015 field season. It is expected that the sampling protocols will be similar to those used by the first sub-team, but sampling will be implemented in a broader selection of projects and plots.

## GOALS, ACHIEVEMENTS, AND NEXT STEPS

Since funding was awarded to the Front Range CFLR in 2010, notable progress has been made in many areas. Associated with the planning and implementation of restoration treatments, a group of stakeholders, partners, and USFS representatives within the Front Range Roundtable collaborative formed a CFLR-focused team (initially the Science and Monitoring team; later the Landscape Restoration team) in which several active sub-groups addressed separate but complementary goals. Eight of these goals are listed below, followed by descriptions and citations of all the reports, published papers, professional presentations, and other products generated for each goal.

The goals addressed from 2010 – 2014 can be described as:

- a) Identification of desired conditions for forest structure at varying scales
- b) Assessment of historic stand conditions in the Front Range
- c) Techniques and results for measuring and monitoring landscape-scale spatial heterogeneity with aerial imagery



- d) Development of monitoring plans for key variables and metrics of interest
- e) Social and economic monitoring
- f) Adaptive management process development
- g) Assessment of silvicultural and general progress of the Front Range CFLRP.
- h) Adaptive NEPA: Upper Monument Creek Restoration Initiative

Work began on two additional goals in 2012, and fuller efforts and funding have been invested in those goals as follows:

- i) Wildlife monitoring (planning phase 2012-2014; first year of implementation 2014)
- j) Understory plant community monitoring (planning phase 2013-2014; first year of implementation scheduled for 2015)

Next steps for the Front Range CFLR in the coming 5 years include:

1. Continue to monitor effects of treatments on forest structure at various scales (stand, project, landscape) using the techniques and information generated to date
2. Develop and implement refined protocols for monitoring surface fuels, age- and size diversity of residual trees, and spatial heterogeneity of forest structure at diverse scales
3. Fully implement monitoring of wildlife and understory plants
4. Systematically analyze and manage monitoring data from all efforts
5. Evaluate all data in the context of all applicable National Reporting Ecological Outcome Measures
6. Implement the adaptive management process more fully and effectively each year by using the monitoring data, field trips, collaborative discussions, etc. to modify treatment prescriptions as and when needed, following the adaptive management cycle that our collaborative has developed
7. Identify and complete an "Adaptive NEPA" process on the Arapaho-Roosevelt NF similar to the Upper Monument Creek Restoration Initiative on the Pike-San Isabel NF
8. Complete work on a US Forest Service General Technical Report on the principles of ecological restoration for Front Range montane forests that was stimulated by the Front Range CFLR and is being authored by several members of our collaborative.

## **Colorado Front Range CFLR Science and Monitoring Products, 2011-2014**

This list summarizes the major reports, presentations, and publications related to the Front Range CFLRP, by members of the Front Range Roundtable's Landscape Restoration team (formerly Science and Monitoring team.) Products are grouped according to the 6 major goals pursued from 2010-2014, as listed above.

### **a. Identification of stand- and landscape-scale desired conditions for forest structure:**

Dickinson, Y.L. and the Spatial Heterogeneity Subgroup of the Front Range Roundtable. 2014. Desirable Forest Structures for a Restored Front Range. Colorado Forest Restoration Institute, Colorado State University, Technical Brief CFRI-TB-1402, Fort Collins, CO. 23 p.

Dickinson, Y. 2014 Landscape restoration of a forest with a historically mixed-severity fire regime: What was the historical landscape pattern of openings and canopy? *Forest Ecology and Management* 331:264-271

### **b. Identification of historic stand conditions**

Brown, P.M., C. Julian, M. Battaglia, P. Fornwalt, L. Huckaby, A.S. Cheng. 2012. Historical fire regimes and forest structure in lower montane ponderosa pine forests of Boulder County, central Colorado Front Range. Association for Fire Ecology 5th International Fire Ecology and Management Congress: Uniting Research, Education, and Management. Portland OR; December 5, 2012.

Fornwalt, P.J., P. M. Brown, L.S. Huckaby, M.A. Battaglia, A.S. Cheng. 2012. The Front Range Forest Reconstruction Network: Reconstructing Forest Structure and Fire History in Montane Front Range Forests to Inform Restoration Activities. Association for Fire Ecology 5th International Fire Ecology and Management Congress: Uniting Research, Education, and Management. Portland OR; December 5, 2012. (Poster)

Dickinson, Y.L., Brown, P.M., Fornwalt, P., Huckaby, L.S., Battaglia, M.A. and Cheng, A.S. (2013) Front Range Reconstruction Network: Reconstructing Forest Structure and Fire History in Front Range Montane Forests to Inform Forest Restoration Activities. Piecing Together the Fragments: sustaining forest ecosystems in the 21st Century. North American Forest Ecology Workshop, June 16-20, Bloomington, IN (Poster).

**Battaglia, M.A.**, Brown, P.M., Huckaby, L., Fornwalt, P., Cheng, A.S., Negron, J. Asherin, A. 2013. Restoring characteristics of historical forest structure of Colorado montane forests. Society of American Foresters, North Charleston, SC, October 2013.

Brown, P.M., P.J. Fornwalt, L.S. Huckaby, M.A. Battaglia, A.S. Cheng. Reconstructing Forest Structure, Fire History, and Stand Spatial Patterns in Colorado Front Range Montane Forests to

Inform Forest Restoration: The Front Range Forest Reconstruction Network. 2<sup>nd</sup> American Dendrochronological Congress (AmeriDendro). Tucson AZ; May 13, 2013. (Poster)

Battaglia, M., and P.M. Brown. 2014. Restoration and Resiliency in Lower Montane Forests: A Historical Perspective. Colorado-Wyoming Society of American Foresters 2014 Annual Meeting. Denver CO; April 25, 2014.

Brown, P.M., M. A. Battaglia, L.S. Huckaby, P.J. Fornwalt, C. Julian, A.S. Cheng. In review. Historical (1860) forest structure in ponderosa pine forests of the northern Front Range, Colorado. Canadian Journal of Forest Research.

**c. Techniques for measuring forest spatial heterogeneity at the landscape scale:**

Dickinson, Y.L., and E. Giles. 2014. Monitoring landscape-scale forest heterogeneity: a protocol. Colorado Forest Restoration Institute, Colorado State University, Technical Brief CFRI-TB-1404. Fort Collins, CO. 24 p.

Pelz, K.A., and Y.L. Dickinson. 2014. Monitoring forest cover spatial patterns with aerial imagery: a tutorial. Colorado Forest Restoration Institute, Colorado State University, Technical Brief CFRI-TB-1401. Fort Collins, CO. 47 p.

**d. Development of a monitoring plan and protocols for assessing restoration treatment effectiveness:**

General monitoring plan, version 1:

Clement, J. and P. Brown. 2011. Front Range Roundtable Collaborative Forest Landscape Restoration Project 2011 Ecological, Social and Economic Monitoring Plan. Colorado Forest Restoration Institute, Colorado State University, Fort Collins, CO. 51p.

Forest Service Watershed Condition Classification Technical Guide

([http://fsweb.wo.fs.fed.us/wfw/watershed/classification/FS\\_watershed\\_classification\\_TechGuide\\_July\\_2011.pdf](http://fsweb.wo.fs.fed.us/wfw/watershed/classification/FS_watershed_classification_TechGuide_July_2011.pdf)).

Analysis of pre- and post-treatment overstory conditions, 2011-2012:

Young, N., Reeder, C., Addington, R., Dickinson, Y., Evangelista, P. and Cheng, T. (2013) Colorado Front Range Collaborative Forest Landscape Restoration Project: 2011-2012 Pre- and post-treatment stand structure analyses for the Pike and San Isabel and Arapaho and Roosevelt National Forests. Colorado Forest Restoration Institute, Ft Collins, CO.

Monitoring of understory plant communities, wildlife habitat use, and forest structure, 2011-2013:

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.

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.

Briggs, J.S., P. J. Fornwalt, and J. Feinstein. 2012, 2013. Status of collaborative forest restoration monitoring in Front Range ponderosa pine ecosystems: Reports to the Southern Rockies Landscape Conservation Cooperative.

**e. Social and economic monitoring:**

Mattor, K., K. Ng, J. Schaefers, T. Cheng, and C. Tremblatt. 2012. Colorado Front Range Collaborative Landscape Restoration Project: Social and Economic Monitoring Report for 2011. 59 p.

Mattor, K., T. Snee, T. Cheng, J. Schaefers, K. Ng, J. Howie, and K. Lyon. 2013. Colorado Front Range Collaborative Forest Landscape Restoration Project: Social and Economic Monitoring Report for 2012. Fort Collins, CO: Colorado Forest Restoration Institute, Colorado State University. 60p.

**f. Development of an adaptive management process to incorporate ecological monitoring and other knowledge-development activities into the restoration treatment cycle:**

Aplet, G., Brown, P., Briggs, J., Mayben, S., Edwards, D., and T. Cheng. 2014. Collaborative Implementation of Forest Landscape Restoration in the Colorado Front Range. Colorado Forest Restoration Institute, Colorado State University, Technical Brief CFRI-TB-1403, Fort Collins, CO. 9 p.

**g. Summary of silvicultural work and general progress of the CFLR:**

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.

Underhill, J., Rudney, A., Dickinson, Y. and Thinnes, J. 2013. Silviculture of the Front Range Landscape Restoration Initiative. Silviculture Matters. Society of American Foresters National Convention, Oct. 23-27, Charleston, SC.

Briggs, J.S. 2013. Research, monitoring, and progress toward desired conditions in the Front Range CFLRP, 2011-13. Invited talk at the Regional CFLRP Workshop, USFS Regions 2 and 3, Montrose, CO. October 29-30, 2013.

Ziegler, J., Hoffman, C., Battaglia, M.A. 2014. Evaluating restoration treatments: Are we creating heterogeneous stands and mitigating fire hazard? International Association of Wildland Fire and Association for Fire Ecology, Large Wildland Fires: Social, Political, and Ecological Effects. Missoula, MT, May 2014.

Underhill, J., Dickinson, Y.L., Rudney, A. and Thinnis, J. 2014. Silviculture of the Colorado Forest Restoration Initiative. *Journal of Forestry* 112(5):484-493

Dickinson, Y.L. and the Landscape Restoration Subgroup of the Front Range Roundtable. 2014. The first four years of a collaborative forest landscape restoration project on Colorado's Front Range: successes and lessons learned. XXIV IUFRO World Congress 2014, Sustaining Forests, Sustaining People: The Role of Research, Oct 5-11, Salt Lake City, UT.

Dickinson, Y.L. and the Landscape Restoration Subgroup of the Front Range Roundtable. 2014. Achieving "groupy-clumpy" in restoration projects: Innovative silviculture and monitoring in the Front Range Collaborative Forest Landscape Restoration Project. XXIV IUFRO World Congress 2014, Sustaining Forests, Sustaining People: The Role of Research, Oct 5-11, Salt Lake City, UT.

Lewis, P. L., R. Addington, S. Mayben et al. 2014. Upper Monument Creek Restoration Initiative: Summary Report and Collaborative Recommendations. Nature Conservancy, Colorado Forest Restoration Institute, and the Pike and San Isabel National Forests.