Meadow Smith and Cooney-McKay Restoration and Fuels Reduction Projects:

What Did We Learn?

Cory Davis

Monitoring Coordinator, Southwestern Crown Collaborative

December, 2015

Executive Summary:

The Meadow Smith and Cooney-McKay projects were two of the initial projects identified for implementation under the Southwestern Crown of the Continent Collaborative (SWCC) Forest Landscape Restoration Project (CFLRP). Several monitoring projects were conducted, pre- and post-treatment, within specific treatment units or across the entire project area including monitoring of: potential fire behavior, fuel loads, old-growth vegetation, tree spatial patterns, the local bird community, and carnivores. Most of the vegetation and fuels objectives were met for both projects, and wood products were provided for local contractors at the same time. Effects on wildlife were less clear. We discuss the outcomes of the projects and provide some recommendations for improving planning documents and monitoring for future projects.

Contents

Introduction 3
- Meadow Smith Project Description 3
- Cooney McKay Project Description 4

Monitoring Projects 7
- Landscape-Scale Fire Modeling 7
- Meadow Smith Stand-Level Old-Growth Monitoring 8
- Cooney-McKay Stand-Level Fuels Monitoring 11
- Meadow Smith Stand-Level Tree Spatial Heterogeneity 14
- Meadow Smith Bird Community Monitoring 17
- Carnivore monitoring 18
- Economic Summary 21

Discussion 21
- Were Objectives Met? 21
- Trade-offs across resources 23

Literature Cited 24

Appendix A. Vegetation treatments for Meadow Smith and Cooney McKay 25

Introduction

The Meadow Smith and Cooney-McKay projects were two of the initial projects identified for implementation under the Southwestern Crown of the Continent Collaborative (SWCC) Forest Landscape Restoration Project (CFLRP). Treatments were conducted in 2010-2013 with funding from the CFLR Program. We combined discussion of both projects in this report because they geographically overlapped (see Figure 1) and were conducted at similar times, though with differing objectives.

Several monitoring projects were conducted within specific treatment units or across the entire project area. Here, we summarize the monitoring efforts and review their findings. We also draw conclusions about the effectiveness of the projects and suggest some management recommendations for future projects. More detailed reports on many of these monitoring projects can be found at http://www.swcrown.org/monitoring/.

Meadow Smith Project Description

The Meadow Smith (MS) project was originally developed in the late 1990s. The MS Draft Environmental Impact Statement (EIS) was completed in August of 1999 and the Final EIS in February 2000. The Record of Decision was signed in February 2000.

The MS project area is approximately 10 miles north of Condon, Montana on the east side of the upper Swan Valley (Figures 1 and 2). The western portion of the project area falls within the Wildland-Urban Interface (WUI). Most of the treatment units are in the valley bottom or the lower slopes of the mountains between elevations of 1100 to 1500 m. Tree species include western larch (*Larix occidentalis*), ponderosa pine (*Pinus ponderosa*), lodgepole pine (*Pinus contorta*), Douglas-fir (*Pseudotsuga menziesii*), subalpine fir (*Abies lasiocarpa*), grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmannii*), western redcedar (*Thuja plicata*), and trembling aspen (*Populus tremuloides*).

Fire history of the project area as described in Larson et al. (2012):

The study area experienced a mixed-severity fire regime prior to Euro-American settlement (Antos and Habeck 1981; Freedman and Habeck 1985; Arno et al. 1995). Fires, primarily of low and moderate severity, burned with mean return intervals of 18–31 years (Freedman and Habeck 1985; Arno et al. 1995); fire-free intervals before 1900 ranged from 9 to 66 years (Arno et al. 1995). Occasional high-severity fire events were a component of the historical fire regime, with stand replacement events occurring at intervals of 150–400 years (Arno et al. 1995). Frequent fires historically maintained dominance of the long-lived, fire-tolerant species ponderosa pine and western larch relative to less fire-tolerant tree species. Cohorts of shade-intolerant ponderosa pine and western larch established following historical fires, while scattered individuals and groups of these fire-resistant trees survived even stand-replacement fires, leading to a complex age and size structure within stands and across the landscape (Antos and Habeck 1981; Arno et al. 1995). Fires were excluded from the study sites during the 20th century (Arno et al. 1995) and continuing to the present.

The primary objectives of the MS project as listed in the Final EIS were to:

- Increase the presence of open-grown, large-tree ponderosa pine and western larch forests in the Upper Swan Valley.
- Increase, in the long-term, large-tree forest block size. Through forest management, enhance the ability for young ponderosa pine and western larch stands to develop into large tree forests; eventually, those young tree stands will mature and connect with adjacent mature and old growth forests creating larger continuous forest blocks.
- Lower the risks of loss of mature large-tree forests to insects, diseases, and lethal fire.

- Return fire, in the form of prescribed fire (Photos 1 and 2), as a process of forest succession.

Vegetation treatments are described in Appendix A. In addition to the vegetation treatments, planned road work included building of temporary roads (3.3 miles) and road reclamation or removal (2.9 miles).

Cooney McKay Project Description

The Draft EIS for the Cooney McKay project was issued in December 2007 and the Record of Decision in April 2008. Alternative 3 was chosen from the Draft EIS which removed any treatments in old-growth stands. The project area is similar to that of the Meadow Smith project as the units are mixed geographically. Almost all units fall within the WUI (Figure 1). A total of 802 acres were identified for treatment with a timber harvest volume estimated at 3,385 MMBF. Treatment summary is presented in Appendix A and shown in Figure 2.

The Purpose and Need for the Cooney-McKay project were described in the EIS (Chapter 1, p. 1-4) as:

1. Forest Health:
    - Improve and/or maintain the general health, resiliency, and sustainability of forest vegetative communities;
    - Reduce the growing risk for insects and chronic disease infestation.
2. Hazardous Fuels Reduction:
    - Reduce forest fuels buildup adjacent to public and private lands;
    - Provide a safer environment for the public and firefighters should a wildfire occur within the proposed treatment areas;
    - Increase the probability of stopping wildfires on NFS lands before they burn onto private lands.
3. Provide commercial and personal-use wood products for the local communities.

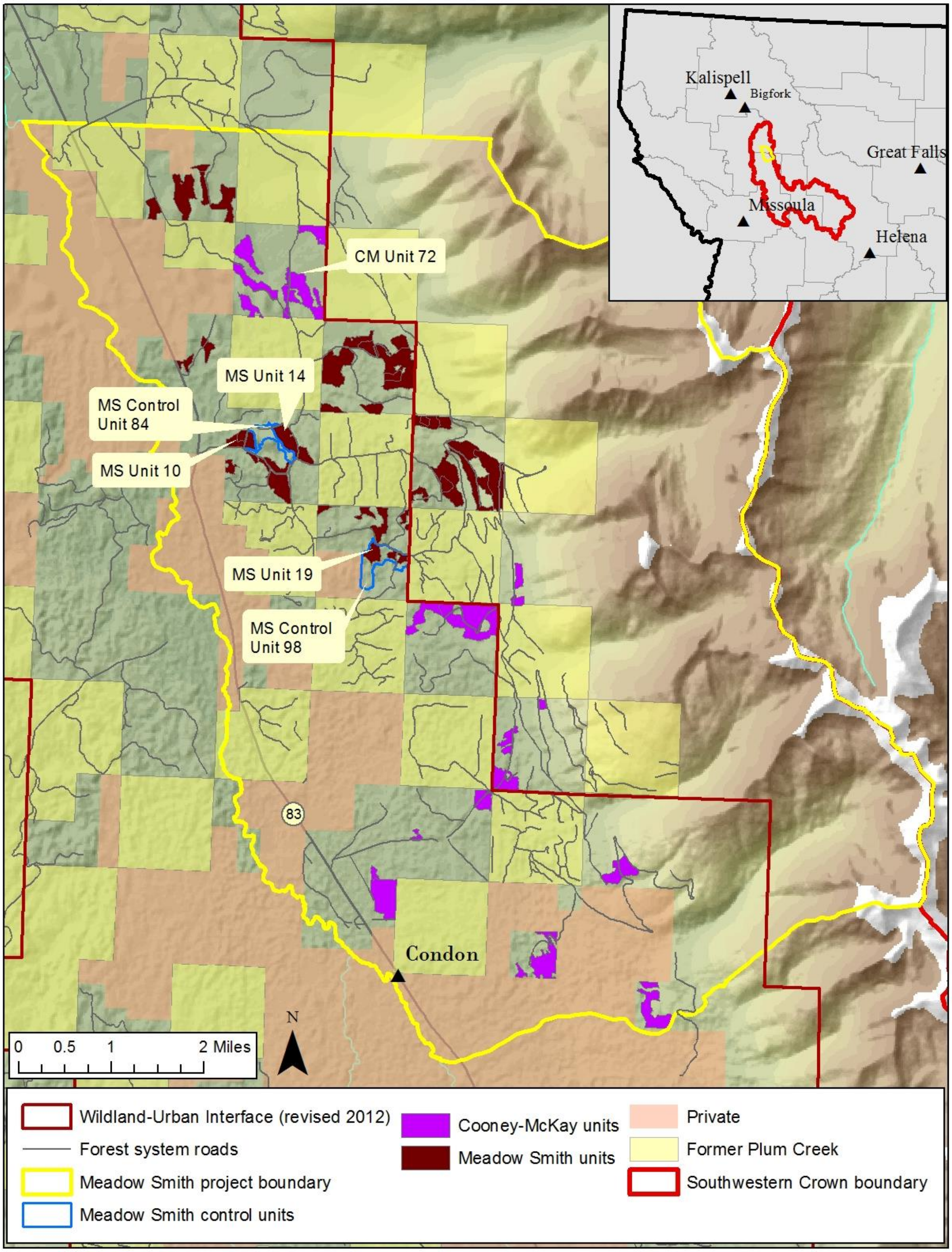


Figure 1. *Location of Meadow Smith and Cooney-McKay units discussed in this document.*

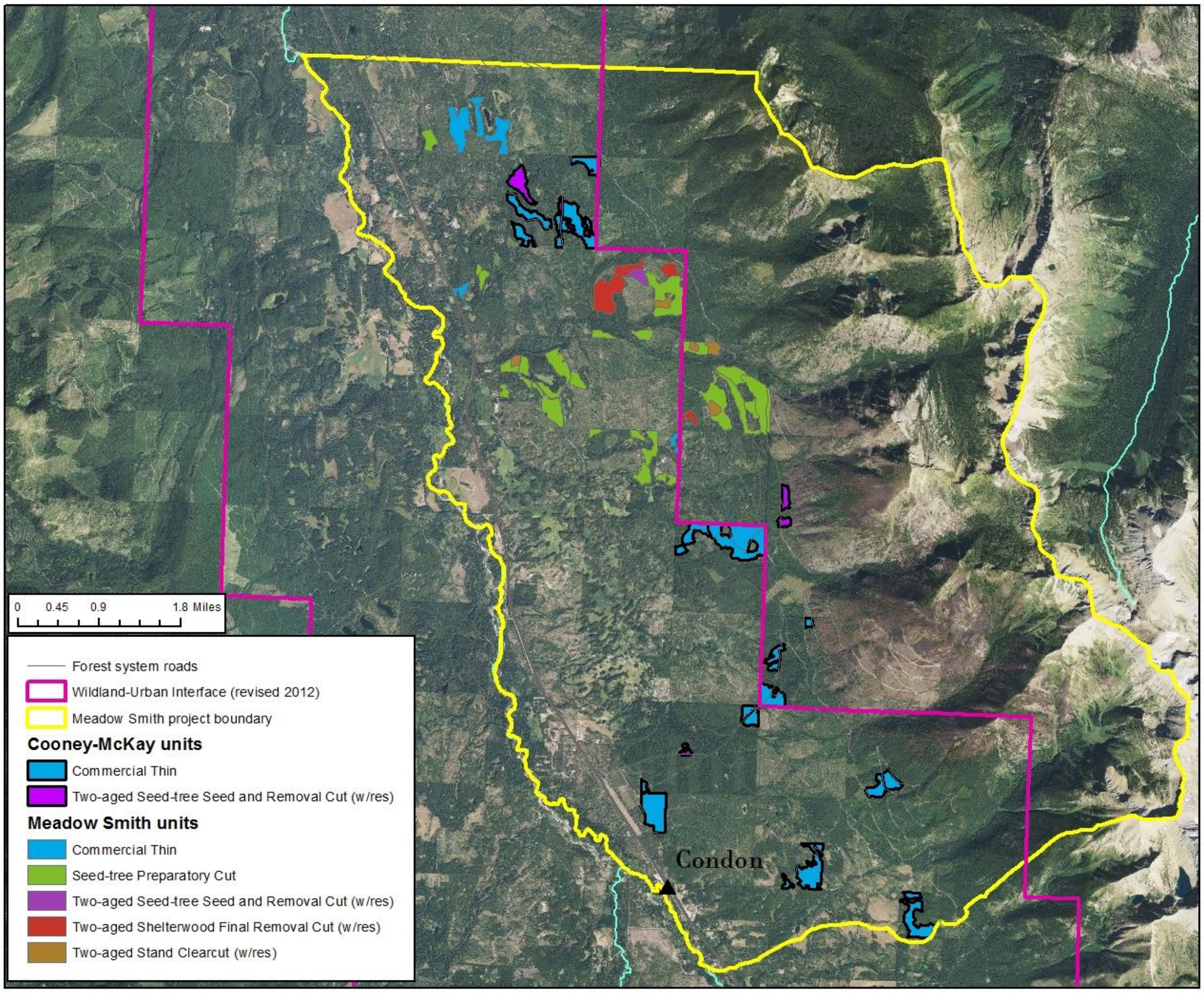


Figure 2. *Aerial image of Meadow Smith and Cooney-McKay treatment units with unit prescriptions.*

Photos 1 and 2. *Understory burn in Meadow Smith unit 30 (May 24, 2012).*

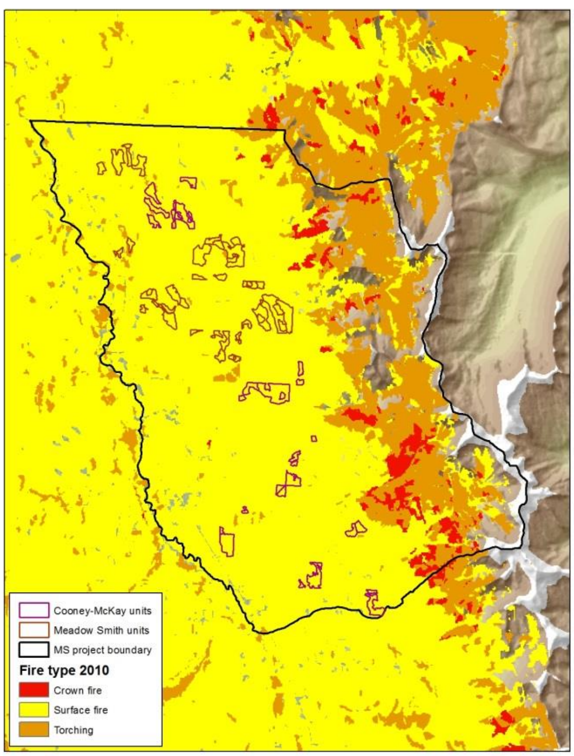
Monitoring Projects

Landscape-Scale Fire Modeling

The US Forest Service's Fire Modeling Institute at the Rocky Mountain Research Station created maps of potential fire type and flame lengths for all Forest Service lands in the SW Crown landscape in 2010 and, with treatment units, in 2014. The maps were created using the program FlamMap. The analyses were run under 97th percentile weather and fuel moisture conditions, which are associated with potential for large fire growth. Wind values were kept constant, ranging from 5-8 mph in the valley bottoms to 16-24 mph along ridgetops with isolated winds of 32 mph. In order to compare 2010 and 2014, spotting potential was set to zero. The pixel resolution was 30 m. The vegetation data used was a combination of inventory plots and Regional VMap.

Under these conditions, almost all of the MS project area and the treatment units were mapped as surface fires pretreatment in 2010 (Figure 1). Similarly, flame lengths were in the 0-4 ft range (Figure 2) under which fire fighters can be placed on the ground to actively fight fires. Both conditions remained the same in 2014, after treatments.

a.



b.

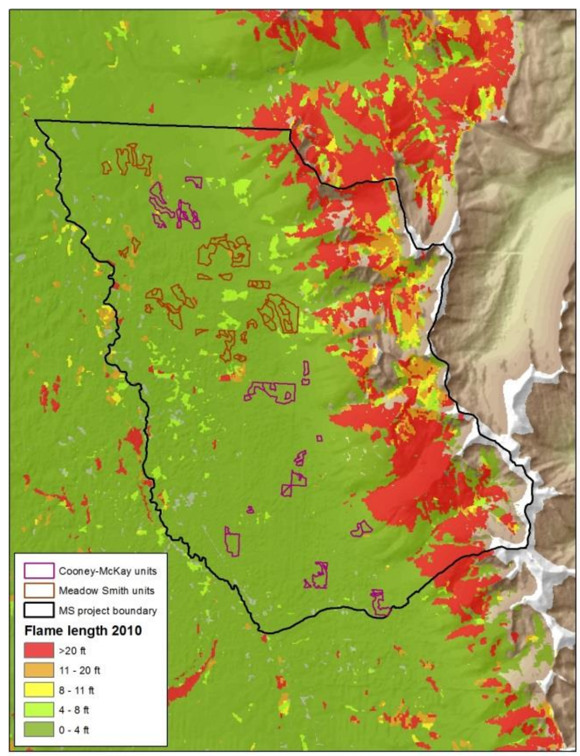


Figure 3. Fire type (a) and flame length (b) for the Meadow Smith project area in 2010.

Conclusions:

- The FlamMap analyses do not show fire behavior as a primary need for treatments for either project. Fire behavior was not the primary goal for the Meadow Smith project, though it was one of the goals for the Cooney McKay project.

- The Swan Lake Ranger District may have used a different set of fuels data (likely LANDFIRE), if they conducted fire behavior analyses pre-treatment. They may have shown different results based on specific stand data.
- However, these results do not preclude the usefulness of treatments to maintain surface fire within the treated areas and the multiple ecological benefits of reintroducing fire within fire-adapted ecosystems that had an extensive fire-free period prior to treatment. The treatments in old growth stands will reduce the likelihood of the existing large trees succumbing to fire in the near future. In addition, during the Condon Mountain Fire in 2012, one of the Meadow Smith units was used as an anchor point for suppression efforts.

Management Recommendations Fire Modeling

- **Provide fire behavior model results, pre- and (estimated) post-treatment, in NEPA documents when one of the primary needs for the project is to reduce fire risk.**
- **Also, show how the placement of treatment units will alter fire behavior and provide for resource protection.**

More information at: http://www.swcrown.org/wp-content/uploads/2014/11/Fire-Modeling.pdf

Meadow Smith Stand-Level Old-Growth Monitoring

The Northern Region of the Forest Service (Region 1) is particularly interested in increasing resilience of old-growth and mature forest stands. Since this was also one of the goals of the Meadow Smith project and there were stands which met the Green et al. (1992) definition of old growth, the Region 1 Inventory and Monitoring Program installed monitoring plots in the project area. Specifically, 18 monumented control plots were installed in two non-treatment areas of stands 98 and 84, and 37 monumented treatment plots were installed in treatment units 10 and 14 (both part of stand 84), and unit 19 (part of stand 98). All of these units are within the WUI. The units were mechanically harvested during the winter of 2010-2011. Unit 10 received an understory burn in 2012 and units 14 and 19 were burned in 2013. The monitoring questions addressed by the project are in Table 1.

Table 1. *Monitoring questions of the old-growth monitoring project at Meadow Smith.*

Question
1. Does the stand still meet R1 old growth definitions as defined in Green et al. after treatment?
1a. Does it continue to maintain those characteristics?
1b. How does the vigor of the old growth trees change over time?
2. Did the activity reduce potential for stand replacing fire? How long was it reduced?
3. Did the activity reduce susceptibility to bark beetles? How long was it reduced?
4. What are the current carbon stores and how did the treatment affect the ability of the stand to reserve carbon over time?
5. Did vegetation respond as desired? Are the grass, forbs, and shrubs those that would be typically found under the characteristic disturbance regimes?
6. How do the treatment areas compare to unmanaged areas over time (i.e. controls)?

The stand-level silvicultural objectives as described in the prescriptions were to:

- Promote open, large-tree stands with fire-resistant species where they historically existed, especially longer-lived early-seral species such as western larch, ponderosa pine, and occasional Douglas-fir.

- Maintain and improve the health of desired leave trees by thinning densely-stocked stands. Trees to be removed may include diseased, insect-infested, dead, damaged, downed, and shade-tolerant trees.
- Maintain the dominance of shade-intolerant tree species and diverse understory vegetation by periodically thinning or underburning.
- Move towards Late-Seral Old Growth characteristics.

Results:

Results of pre- and post-treatment monitoring are shown in Tables 2-4.

Tree retention goals were mostly met (Table 2). The one unit (14) that fell short experienced a severe wind event that knocked down many trees post-treatment. One unit did not meet goals for snags, but it had very few snags to begin with.

Crowning index was reduced to low in all 3 stands which means a high (>40mph) wind speed is needed to move a fire into and carry a crown fire (Table 3). Torching index was not changed in any of the units. It remained low in one unit meaning a high wind speed (> 40 mph) is needed. In the high unit, a low wind speed (0-15mph) could still cause torching. One unit remained moderate (15-40mph wind speed). Fire type was not changed in any of the units. One of them remained passive crown and the other two units were surface fire pre-treatment and remained so. The fire weather parameters (i.e., fuel moisture conditions, wind speeds, and temperatures) used in this modeling were values standardized at the Regional level of the Forest Service and may not always accurately reflect site-specific conditions (see R1 FSVeg Reports and Utilities User's Guide, p. 42: available at http://www.fs.fed.us/nrm/fsveg/).

Insect hazard rating was lowered in most units (Table 4). However, a few units remained a moderate hazard, likely because of the continued presence of some large trees.

Table 2. *Old-growth (OG) stand characteristics pre-treatment and post-treatment (i.e. post mechanical thinning and prescribed burn). Numbers in parentheses are targets for meeting old growth criteria.*

Unit (T/C)[a]	Meas	OG type[b]	Trees/acre meeting min. criteria[c] (10)	Live BA/acre > 5" DBH (80 ft/acre)	OG?	Snags/ac ≥ 9" (6[d])	Woody debris pieces/ac (>9" DBH)
10 (T)	Pre	PSME	15.0	154.2	Yes	**6.8**	21.7
	Post	LAOC	15.0	84.2	Yes	**4.4**	38.7
14 (T)	Pre	PSME	**12.7**	**130.8**	**Yes**	24.7	74.4
	Post	LAOC	**9.3***	**54.4***	**No**	6.7	196.1*
19 (T)	Pre	PIPO	13.0	140.8	Yes	5.3	6.4
	Post		12.3	91.5	Yes	3.0	34.0
84 (C)	Pre	LAOC	13.3	125.0	Yes	22.7	40.7
	Post		13.3	114.2	Yes	26.7	40.7
98 (C)	Pre	PIPO	14.7	137.4	Yes	13.3	17.4
	Post		13.7	133.5	Yes	11.3	17.4

[a] Treatment (T) or Control (C) unit.
[b] As defined in Green et al. (1992, 2011 edition); PSME = Douglas fir, LAOC = Western larch, PIPO = Ponderosa pine.
[c] Minimum criteria: 180 years old, 21" DBH.
[d] Silvicultural prescription called for 6 snags 12-20" DBH and 2 snags >20" DBH.
* A post-treatment wind event fell many trees in the stand, lowering the standing tree values and increasing the woody debris considerably.

Table 3. *FVS potential fire behavior indices by stand/ measurement at Meadow Smith.*

Unit	Meas	Crowning index[a]	Torching index[a]	Fire type
10 (T)	Pre	**M**	L	Surface
	Post	**L**	L	Surface
14 (T)	Pre	**M**	H	Passive
	Post	**L**	H	Passive
19 (T)	Pre	**H**	M	Surface
	Post	**L**	M	Surface
84 (C)	Pre	H	L	Passive
	Post	H	L	Passive
98 (C)	Pre	H	H	Surface
	Post	H	H	Surface

[a] Wind speed necessary to sustain an active crown fire or cause torching. L = low (>40 mph)), M = moderate (15-40 mph), H = high (<15 mph).

Table 4. *Insect risk hazard rating (MPB = Mtn pine beetle, LP = lodgepole, WPB=western pine beetle, PP=ponderosa pine, SBW=spruce budworm, DFB=Douglas-fir beetle) from Forest Vegetation Simulator (FVS).*

Unit	Meas	MPB LP Haz	MPB/WPB PP Haz	Combo MPB Haz	SBW Haz	DFB Haz
10 (T)	Pre	**M**	M	M	**M**	**M**
	Post	**0**	M	M	**L**	**L**
14 (T)	Pre	**M**	**M**	M	**H**	**M**
	Post	**0**	**L**	M	**L**	**L**
19 (T)	Pre	**M**	**H**	H	M	**M**
	Post	**0**	**M**	H	M	**L**
84 (C)	Pre	0	M	M	H	M
	Post[a]	0	M	M	H	M
98 (C)	Pre	M	M	H	M	M
	Post[a]	0	M	H	M	M

[a] Only measured after post-mechanical thinning of treatment units not post-burn.

Conclusions:
Q1: Does the stand still meet R1 old growth definitions as defined in Green et al. after treatment? Units 10, 19 = Yes; Unit 14 = No, however trees in this unit are expected to meet criteria after a few years of growth.
Q1a: Does it continue to maintain those characteristics? Yes, at least through 2 years post-treatment.
Q1b: How does the vigor of the old growth trees change over time? No growth measurements will be taken until the next post-treatment measurements. Trees are expected to show increased vigor.
Q2: Did the activity reduce potential for stand replacing fire? How long was it reduced? Only 1 of 3 stands (14) rated as carrying a crown fire prior to treatment and it was reduced to a surface fire post-treatment. Crowning potential was reduced to low, though torching potential was unchanged. We will continue to monitor to determine how long it was reduced.
Q3: Did the activity reduce susceptibility to bark beetles? How long was it reduced? Yes, susceptibility to bark beetles was reduced in most units (Table 4). We will continue to monitor to determine how long it was reduced.
Q4: What are the current carbon stores and how did the treatment affect the ability of the stand to reserve carbon over time? Carbon storage data was not estimated.
Q5: Did vegetation respond as desired? Are the grass, forbs, and shrubs those that would be typically found under the characteristic disturbance regimes? Could not measure understory because of timing of measurements. We will monitor going forward.
Q6: How do the treatment areas compare to unmanaged areas over time (i.e. controls)? Fire behavior potential and insect hazard were largely unchanged in the control areas during this time period. We will continue to monitor going forward.
Overall: The stand-level vegetation objectives were largely met.
The plot-level data only partially confirm results from the fire modeling. Some units modeled as low risk for crown fire; however some units showed a high crowning index and a passive crown fire type prior to treatment. In a separate study (K. Stover, University of Montana thesis), the author found that 24% of measured plots in the project area were predicted to burn as passive crown fire and 76% as surface fire, pretreatment. They used individual plot data in fire models to better estimate within-stand heterogeneity in fuel loads instead of stand means. The heterogeneity in canopy fuels was expected to decrease substantially post-treatment, reducing crown fire behavior potential for all plots.

Management Recommendations Old Growth

- Review results and models to determine why torching indices remained high post-treatment. This may partially be due to weather parameters used in models.
- Continue to monitor every five years to determine duration of treatment effects.

More information at: http://www.swcrown.org/wp-content/uploads/2014/11/Old-Growth.pdf

Cooney-McKay Stand-Level Fuels Monitoring

The purpose of this project is to monitor the effects of treatments on fuel loads, to observe how long the effects last, and to explore if silvicultural objectives were met. Two sites were selected for monitoring, one control and one treatment. The control (stand id 0110020601P0084) had 8 plots installed in the fall of 2011; the treatment unit (stand id 0110020601P0072) had 15 plots installed at the same time. Mechanical treatment was completed in the winter of 2011/2012, and the unit was not planned for underburning. The 15 treatment unit plots were re-measured in the summer of 2012. All data is loaded into FSVeg.

Table 5*. Monitoring questions for the Cooney-McKay Fuels project.*

Question
1. Are fuel objectives met at the stand level on treatments in the WUI?
2. How does fire behavior change immediately post-treatment and how is it expected to behave over time within the stand?

The Cooney-McKay stand-level silvicultural objectives and desired conditions from the prescriptions were:

Trees to retain:

- Promote wind-firm, shade-intolerant, fire-resistant species where they historically existed, especially long lived, seral species such as ponderosa pine, western larch, and Douglas-fir.
- Retain a portion of understory conifer trees to provide species and structural diversity.
- Maintain and improve the health, vigor, and growth of residual trees by thinning densely-stocked stands.
- Retain and protect all hardwood and rare (western red cedar, white pine, juniper, and hemlock) tree species where feasible.

Canopy cover:

- Maintain thermal cover for white-tailed deer winter range by retaining canopy cover of at least an average of 50% for the stand.
- Canopy cover will range from 30-70 % with some trees in an open grown condition.

Snags:

- Snag Retention: At a minimum six snags per acre that are 12 to 20 inches DBH shall be left.
- In addition to the 12-20 inch snags retained above, all snags greater than 20 inches DBH shall be left where feasible.

Insect and Disease:

- Stand conditions should facilitate resilience to endemic insects and diseases as measured using R1 Hazard Ratings in FVS. High and moderate hazard areas are more likely to experience significant mortality if insect populations are present and the weather is favorable.

Fuel and fire behavior:

- Reduce fuel loadings and alter distribution to allow for less severe fire, lower surface fire intensity, and less canopy fire than existing conditions would support.
- Provide a safer environment for firefighters and the public by creating defensible conditions for initial attack fire suppression activities.
- Where available retain down woody material at 5 – 10 tons/ac preferably in the largest and longest piece sizes.

Results:

Objectives for tree retention were largely met (Table 6), although basal area was lowered slightly below target. Depending on which objective was targeted (i.e. 50% or 30-70%), canopy cover target may have been met. Objectives for snags appear to be met, although specific sizes were not reported. Hazard ratings were lowered for the Douglas-fir beetle, but all other stand ratings remained moderate or high for insects (Table 7). Incidences of tree disease were lowered considerably for all disease types (Table 8). Crowning and torching indices were increased, meaning a stronger wind speed is needed to cause crowning and torching. The fire type was reduced from passive crown fire to a surface fire. However, not surprisingly, fine fuel loads increased immediately after treatment.

Table 6. *Stand characteristics at Cooney-McKay and modeled beetle hazard class, pre- and post-treatment. Targets, if provided, are in parentheses.*

Unit	Meas	Dominance type	Basal area (100-200[a])	BA wtd ave DBH	TPA (150-300[a])	Canopy cover (30-70%)	Snags/ acre (6)	BA wtd ave age (60-110)
CM-72	Pre	PSME-PIPO-LAOC	**138**	16.3	**401**	47	16	117
	Post	PIPO-LAOC-PSME	**95**	17.9	**267**	32	10.7	122

[a]: Targets for a late seral stand.

Table 7. *Hazard ratings by number of measurement plots (out of 15) based on tree characteristics.*

Insect	Meas	0	Low	Moderate	High	Stand rating
Douglas-fir beetle	Pre	1	2	11	1	**M**
	Post		6	8	1	**L**
Ponderosa pine Mtn Pine Beetle/White PB	Pre	4		7	4	M
	Post	4	1	8	2	M
Lodgepole pine beetle	Pre	6		8	1	M
	Post	10		5		M
Combined beetle hazard	Pre			6	9	**H**
	Post	2		5	8	**H**

Table 8. *Number of different measurement plots (out of 15) with observations of disease.*

Unit	Meas	Dwarf mistletoe	Armillaria root disease	Heart/stem rot	Blister rust
CM-72	Pre	5	8	3	2
	Post	1	2	1	1

Table 9. *Fuel characteristics and FVS fire behavior indices by measurement at Cooney-McKay.*

Unit	Meas	1-hr	10-hr	100-hr	1000-hr	Duff/ litter	Crowning index[a]	Torching index[b]	Fire type[c]
CM-72	Pre	0.1	0.9	1.5	22	29.5	**46**	**0**	**Passive**
	Post	0.4	2.4	1.9	9.8	22	**61**	**506**	**Surface**

[a]: Wind speed needed to move a fire from a surface fire to a crown fire.
[b]: Wind speed needed to cause torching.

Conclusions:
Q1: Are fuel objectives met at the stand level on treatments in the WUI? Quantifiable fuel objectives were not set. 1-, 10-, and 100-hr fuel loads increased and 1000-hr and duff/litter loads decreased. For the largest pieces, post-treatment amounts were on the high end (9.8 tons/acre with target of 5-10).

Q2: How does fire behavior change immediately post-treatment and how is it expected to behave over time within the stand? Wind speed needed to carry a surface fire into the crown or to carry a crown fire was increased although only from 46 to 61 mph. Wind speed needed to cause torching index increased dramatically. The fire type went from passive crown fire to surface fire thus meeting the goals for increased safety for firefighters and public in this stand.
Tree retention and snags: General silvicultural prescriptions for tree retention were met as were the quantifiable goal for snags.
Canopy cover: 50% average canopy cover was not met pre- or post-treatment and the average (32%) barely fell within the range of 30-70% for within stand conditions.
Insect and disease resilience: The combined beetle class hazard remained high post-treatment suggesting goals for resilience to insects were not met. However, incidences of disease were reduced substantially.
Wildlife Habitat: FVS wildlife habitat models were not reported because they were developed for east side conditions and are unreliable for stand conditions in the Swan Valley. The opening of the stand should encourage increases in shrub density, which should benefit ungulates and grizzly bears.

Management Questions/Recommendations Fuels

- If fuel management and fire behavior are the primary objectives of the project, include quantifiable goals and fire behavior model targets in the NEPA document and prescriptions.
- Review if fine fuel loadings are acceptable. Why was unit not designated for a prescribed understory burn?
- Can canopy cover goals be met when fuels/fire are primary objective? Should they be?
- Review why insect resilience goals were not met. Again, were there quantifiable goals?

More information at: http://www.swcrown.org/wp-content/uploads/2014/11/Fuels-Monitoring.pdf

Meadow Smith Stand-Level Tree Spatial Heterogeneity

Faculty at University of Montana's College of Forestry and Conservation were interested in determining how the spatial patterning of trees within stands restored through current thinning practices compared to that of similar old-growth reference sites. Spatial patterns can influence tree recruitment and mortality, snow accumulation, wind patterns and fire behavior, and wildlife habitat (see Larson et al. 2012 for references). One of the goals of the MS project was to open up stands with large ponderosa pine and western larch by removing many of the shade-tolerant understory trees. This study would answer questions regarding the effects of restoration thinning on spatial aspects of forest structure. Methods and results are discussed in detail in Larson et al. (2012).

Larson et al. (2012) used stem map plots in three MS units (units 10, 14, and 19) identified as meeting old-growth standards according to Green et al. (1992). All trees > 10 cm DBH were mapped within 1.0 ha (100 m^2) plots after units had been marked for treatment, but not yet treated. Prescriptions for all three MS units as described in Larson et al.:

> The prescription consisted of a leave tree marked low thinning to a residual basal area of 18.6 $m^2 \cdot ha^{-1}$. All ponderosa pine, western larch, western redcedar, and trembling aspen were designated for retention, as were all Douglas-fir >53.3 cm DBH. Lodgepole pine and small-

diameter Douglas-fir, subalpine fir, and grand fir were prioritized for removal. No explicit direction was provided in the prescription with respect to desired within-stand spatial structure or spatial arrangement of leave or cut trees.

In addition to comparing the pre- and post-treatment stand structure, the post-treatment stands were compared to those of old-growth reference stands that originated and were maintained through natural disturbance events. The tree spatial patterns in the three MS units were compared to reference sites first stem mapped in 1992 by Arno et al. (1995). The reference stands were similar old-growth ponderosa pine/western larch/mixed conifer stands also located in the Swan Valley. These stands had not previously been logged. Table 10 describes the study hypotheses, the basis for these hypotheses, and the results from the stand comparisons.

Table 10. *Hypotheses, their basis, and results about the effects of restoration thinning on forest structure (adapted from Table 1 in Larson et al. 2012).*

<table>
<tr><th>Hypothesis</th><th>Basis for hypothesis</th><th>Results</th></tr>
<tr><td>1. Restoration treatment retained a nonrandom selection of trees from the pre-treatment population.</td><td>The prescription called for retention of ponderosa pine, western larch, and large-diameter trees.</td><td>Rejected: The spatial arrangement of trees left following treatment did not differ from a random sample drawn from the pretreatment pattern of cut and leave trees.</td></tr>
<tr><td>2. Restoration treatment preferentially released leave trees: cut trees were more likely to be located near leave trees than near other cut trees.</td><td>A treatment objective was to increase or maintain leave tree vigor; fuel reduction and restoration guidelines recommend removal of understory trees to improve old (large) tree vigor and reduce the hazard of crown fire.</td><td>Rejected: Cut trees were more likely to be located near other cut trees than near leave trees. The treatment did reduce the absolute number of trees growing within a 9 m radius of leave trees. This result suggests that the marking crew may have showed a slight preference for removing clumps of small-diameter trees, retaining leave trees in clumps, or both.</td></tr>
<tr><td>3. Restoration treatment decreased the level of spatial aggregation relative to pre-treatment, fire-excluded conditions.</td><td>Understory trees established during the fire suppression era typically exhibit strong spatial aggregation; low thinning should reduce the overall aggregation created by suppression-era tree establishment.</td><td>Confirmed.</td></tr>
<tr><td>4a. Thinning treatments restored global spatial patterns similar to reference conditions.</td><td rowspan="2">Because live pre-settlement trees were present and designated for retention, treatment likely restored characteristic spatial patterns by removing small-diameter trees that established since the onset of fire exclusion.</td><td>Confirmed.</td></tr>
<tr><td>4b. Thinning restored local spatial patterns: a mosaic of openings, tree clumps and widely spaced trees comparable with reference conditions.</td><td>Confirmed.</td></tr>
</table>

Conclusions (from Larson et al. 2012):
Under certain circumstances, current thinning practices can restore spatial aspects of old-growth forest structure in unlogged, fire-excluded mixed-conifer forests.
Retaining pre-suppression trees in thinning treatments may be sufficient to restore characteristic spatial patterns in some unlogged, fire-excluded forests where many live pre-suppression trees remain.
Characteristic spatial patterns may not be restored if treatments retain too many small-diameter trees (North et al. 2007) or if post-suppression trees have grown to relatively large sizes and are retained during treatment due to arbitrary diameter limits.
In some cases, creating a particular post-treatment spatial pattern requires a trade-off with respect to leave tree size structure or species composition and vice versa.
Restoration of spatial heterogeneity with thinning at sites where most pre-suppression trees have died or have been removed by past logging presents a silvicultural challenge. Such situations will require incorporation of spatial information in descriptions of desired conditions, silvicultural prescriptions, and tree marking guidelines, including measures to ensure that treatments do not inadvertently homogenize forest spatial structure (Larson and Churchill 2008).
Application of the Green et al. (1992) minimum basal area standards to set restoration targets is not likely to restore the diversity of old-growth forest structure in northern Rockies forests, nor is it likely to restore the ecological functions arising from the cross-scale spatial heterogeneity characteristic of active fire regime forests (Larson and Churchill 2012). Application of the Green et al. (1992) minimum basal area criterion as a restoration target at the treatment unit scale, and especially at the project scale (i.e., across multiple treatment units), could result in uncharacteristically homogenous conditions relative to the natural variation of active fire regime old-growth structure.

Management Recommendations   Tree Spatial Patterns

From Larson et al. (2012):

- As a general rule, managers should deliberately address spatial pattern when crafting restoration treatment objectives and prescriptions, in addition to traditional forest composition and structure attributes.
- Managers should not be compelled to target an average or minimum definition of old-growth structure with restoration treatments. Rather, managers should be encouraged to develop site-specific targets and prescriptions based on ecological principles and site-specific data (Moore et al. 1999). This may lead to a situation where local data suggest an old-growth structure inconsistent with the Green et al. (1992) regional descriptions, highlighting the need for flexibility when developing old-growth restoration prescriptions and the need for a more nuanced scientific definition of old-growth in the northern Rockies.
- Treatments need not recreate a specific reference spatial pattern. Rather, the natural variation of spatial reference conditions from historical and contemporary active fire regimes defines an envelope of characteristic patterns. Spatial reference conditions can be judiciously used in this context to develop restoration targets and evaluate treatment outcomes, as they are an expression of intact pattern–process relationships (Moore et al. 1999; Larson and Churchill 2012).

Meadow Smith Bird Community Monitoring

The Avian Science Center (ASC) at University of Montana was contracted by the Flathead National Forest and Northern Region to monitor birds at Meadow Smith to determine whether changes in stand structure were accompanied by changes in ecological function. Methods and results are discussed in detail in Hutto et al. (2014). The authors conducted bird point counts at eight sites in the MS project area. Four sites included clusters of points within treatment and control sites, while the other four sites were control sites only. Surveys were conducted up to three years prior to treatments (2008-2010) and two years following treatment (2011 and 2012). Bird communities were compared pre- and post-treatment. Post-treatment communities were also compared to "reference sites" drawn from a large pool of point count data from similar old-growth stands throughout the region. Only species which were detected on at least 25 points and within 100 m of the points were used in the analysis.

Results: 24 species were used in the analysis. The relative abundance of six species changed significantly between pre- and post-treatment: "Cassin's Vireo (*Vireo cassinii*), Black-capped Chickadee (*Poecile atricapillus*), Golden-crowned Kinglet (*Regulus setrapa*), and Ruby-crowned Kinglet (*Regulus calendula*) declined relative to controls, whereas relative abundances of Red-naped Sapsucker (*Sphyrapicus nuchalis*) and Northern Flicker (*Colaptes auratus*) increased relative to controls" (Hutto et al. 2014).

Based on comparisons with reference sites: "the bird community composition associated with the Treatment-After sites did not move perceptibly toward the bird community composition expected if the sites were restored to resemble or emulate the bird community composition typical of mesic mixed-conifer old-growth, dry mixed-conifer old-growth, or ponderosa pine old-growth stand types that occur elsewhere across the USFS Northern Region. Moreover, there were no noticeable gains in bird species more typical of drier mixed-conifer old-growth forests (e.g., Dusky Flycatcher [*Empidonax oberholseri*], Townsend's Solitaire [*Myadestes townsendi*], Mountain Bluebird [*Sialia currucoides*], Williamson's Sapsucker [*Sphyrapicus thyroideus*], Cassin's Finch [*Haemorhous cassinii*])."

Conclusions (from Hutto et al. 2014):
The absence of a significant change in bird community composition after treatment probably reflects the fact that, despite being thinned to match target structural old-growth conditions, the forest is functionally unchanged.
If the stands were still within the historical natural range of variation [prior to treatment], then the need to ''restore'' the forest to a condition different from the existing forest condition was not well justified in this instance.
It is possible that two years may not have been long enough after treatment to see an effect.
It is also possible that the treatment unit sizes were too small, and that changes in bird community composition might have been apparent if treatments were larger. Assessing treatment effects on the abundance or occurrence of birds through the use of small treatment units can be problematic because the surrounding landscape matrix is likely to affect the occurrence and abundance of bird species within these small areas… If the lack of bird response is because the treatment plots were too small to attract species that would otherwise be associated with more open stands, then the treatments were unsatisfactory on that basis alone.
The resulting bird community in treated forest patches indicates that the restoration activity created something more akin to an impoverished version of what the forests harbored prior to treatment.
The lack of bird community response in this instance suggests that the need for ''forest restoration'' may not have been a strong justification for the Meadow Smith project. In the Seeley–Swan Valley of western Montana, especially near the Wildland-Urban Interface (WUI), protection and enhancement

of the local economy may be sufficient justification for a fuels-reduction timber harvest. In fact, based on the relatively unchanged bird community from before to after harvest, this particular project would have been labeled a success had ''fuels reduction'' been the formal justification for harvest.

Management Questions/Recommendations Bird Community

- Be clear about desired stand conditions, what you are restoring to, and why you are restoring to those conditions. Is the stand outside of its natural range of variation or is there a shortage of the "restored" forest type in the landscape?
- Review why the stand did not change functionally for this wildlife community. Is that acceptable? Should monitoring be repeated again in year 5 or 10?
- Acknowledge likely trade-offs to wildlife, if expected, in the NEPA document.
- Review and justify treatment sizes to reach functional goals.
- Ecological effects monitoring (monitoring that looks at whether there is an unintended ecological consequence of a management activity) is important to understand whether the ecological integrity of a system is compromised by a management activity.
- "When the stated management goal is some kind of ''restoration'' activity, monitoring should include not only treatment and control sites, but designated reference sites as well. The use of a statistically rigorous BACI [Before-After-Control-Impact] approach permits one to separate treatment effects from the effects of time, but treatment and control plots alone cannot tell us whether the restoration activity actually achieved the goal of movement toward a stated restoration target." (Hutto et al. 2014)

Carnivore monitoring

The Wildlife Working Group of the SWCC started systematic monitoring of carnivores across the SW Crown landscape in 2012. The primary objective of monitoring forest carnivores in the SW Crown of the Continent is to facilitate and coordinate the adaptive management of wolverines, Canada lynx, and fisher by agency managers across the landscape. This monitoring project was designed to provide a baseline of the current distribution of the focal species in the SW Crown and to allow for tracking changes in that distribution over time. Systematic carnivore surveys were not started until after the MS project was implemented so results are post-treatment only. The progress report on the first 3 years of monitoring can be downloaded at: http://www.swcrown.org/wp-content/uploads/2014/11/2012-2014-SWCC-Carnivore-Monitoring-Report-Final.pdf.

The SW Crown carnivore project uses non-invasive survey methods to maximize the ability to detect multiple species across a large landscape in an efficient and cost effective manner. Snow track surveys and DNA collection methods (hair snares and bait stations) have been used for the past three years. In addition, a subset of bait stations was equipped with motion-sensor photo or video cameras to capture the activity of individuals at bait stations. In order to standardize the approach across the SW Crown, a 5 x 5 mile grid was overlaid on the entire landscape and surveys and bait stations were deployed systematically in these grid cells. Field seasons were started in the beginning of January and ran through the end of March. DNA samples were processed by the Rocky Mountain Research Station and identified to species and individual.

Results: Across all three years (2012-2014), 82 of the 129 grid cells that at least partially fall within the SW Crown were surveyed. Lynx were detected in a total of 36 grid cells from 2012-2014. DNA samples identified 18 unique Canada lynx, including 13 males and 5 females. All but two (<2%) lynx observations were above 4,200 feet, even though we had many surveys and bait stations below this elevation. During the survey period, wolverines were detected in a total of 38 grid cells and DNA samples identified 15 unique wolverines: 6 males and 9 females. Wolverines were detected at elevations ranging from 3,346-7,567 feet.

Track surveys and bait stations were deployed in the MS project area all three years of monitoring (Figure 4). No lynx were detected within the project area. This is not surprising since most of the project area is below 4,100 feet, which is the lower elevation of most lynx winter habitat (Squires et al. 2010). Lynx prefer higher elevation spruce-fir forests which are not common in the project area. Lynx were detected on the west side of the Swan Valley from the project area. However, based on detection patterns it is more likely that individuals would cross the valley to the north or south of the project area.

Wolverines were detected in the southeast quadrant of the project area in 2014 on a track survey above 4, 000 feet. Marten were detected in multiple years in all but the northeast quadrant of the project area, which is the highest elevation portion of the project area. Bobcats were detected in the northwest and southeast quadrants of the project area in multiple years post-treatment. No fishers were detected in the project area.

No bait stations were deployed within treated unit boundaries and track surveys are conducted along roads. Consequently, it is not possible to say whether carnivores were using the treatment units. However, track detections of wolves, mountain lion, and martens were found on roads adjacent to treatment units.

Conclusions:
Lynx and wolverine are unlikely to use much of the project area because of its lower elevation and forest types.
Several carnivore species (wolves, marten, and mountain lions) continued to use the project area post-treatment.
If bait stations were placed in treatment units, they would likely draw carnivores from outside of the units because of the small size of the treatment units.
It is difficult to draw conclusions about the effects of treatments on species with large home ranges, especially when treatment units are small. The larger goal of the carnivore monitoring is to monitor presence and distribution of these species at the landscape scale over the course of the CFLR program.

Management Recommendations Carnivores

- Conduct pre-treatment carnivore surveys in the project area even if results cannot be tied directly to effects of treatments. Knowing if species used the area pre- and post-treatment is still important.
- Prey surveys, especially snowshoe hare, may be more effective at detecting impacts to carnivores at the treatment unit scale.

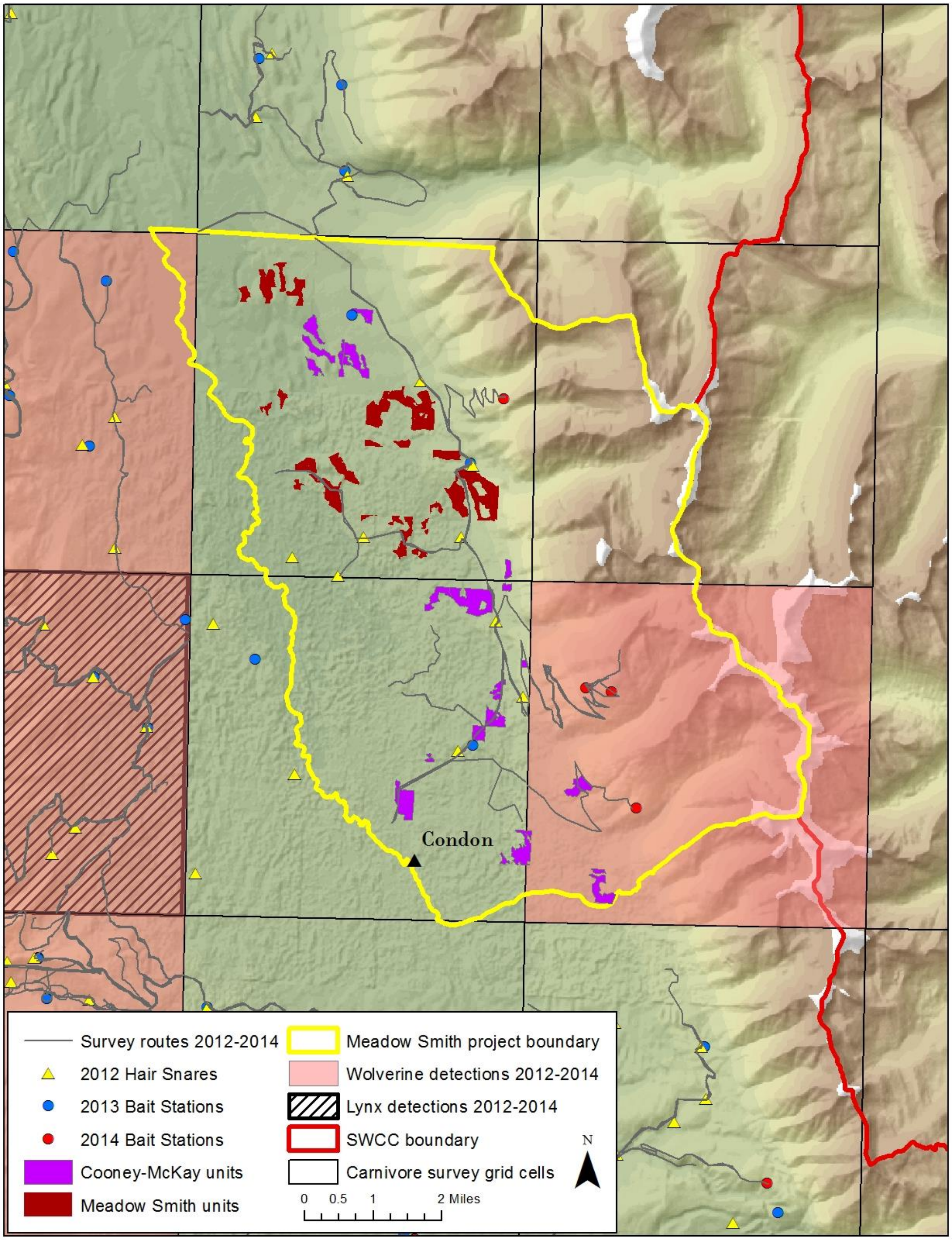


Figure 4. *Carnivore monitoring grid cells, locations of bait stations and hair snares, and lynx and wolverine grid cell detections.*

Economic Summary

The winning bid for the Meadow Smith timber sale estimated 27,575 tons of saw timber at $32.80/ton (based on market values at time of sale) for a total sale value of $904,460. No non-saw timber was included in the Meadow Smith sale.

The Cooney McKay project was put out to bid as a stewardship project. The winning bid estimated 16,586 tons of saw timber at $13.39/ton ($225,702 total) plus 9,011 tons of non-saw timber at $0.33/ton ($2,973.47 total) for a grand total of $228,675. In addition, Cooney McKay had six biddable restoration projects, including weed abatement and slash or fuels projects, at a total cost of $141,116.

The difference in timber value rates between projects was a result of differing market times. Being a local contractor was a best value criteria for both projects and both winning bids were from what the SWCC considers "local" contractors. Much of the funds from the Meadow Smith sale went back to the general treasury and only some of it remained with the local forest. Additional work was completed locally with the Cooney McKay stewardship project.

Discussion

Were Objectives Met?

Meadow Smith:

1. **Increase the presence of open-grown, large-tree ponderosa pine and western larch forests in the Upper Swan Valley.**

Result: From a tree standpoint, yes, this objective was met. The stand-level plot measurements show that the old-growth ponderosa pine and larch trees were maintained and the shade-tolerant species were largely removed, resulting in more "open-grown" stands. The spatial heterogeneity plots also showed that the distribution of the remaining trees was similar to reference conditions in naturally developed old-growth stands. We cannot say whether the understory conditions created are similar to naturally developed stands.

2. **Increase, in the long-term, large-tree forest block size. Through forest management, enhance the ability for young ponderosa pine and western larch stands to develop into large tree forests; eventually, those young tree stands will mature and connect with adjacent mature and old growth forests creating larger continuous forest blocks.**

Result: This was not determined in our monitoring. The stands monitored here already had trees large enough to qualify as "old growth." However, some of the other treated stands were probably not as old and may have been put on an old-growth trajectory. We did not have the data for adjacent stands.

3. **Lower the risks of loss of mature large-tree forests to insects, diseases, and lethal fire.**

Result: This objective was mostly met as threats from insects and fire behavior were lowered. Douglas fir beetle and spruce budworm hazard was reduced, pine beetle hazard was still moderate. Maintaining some large trees will always leave some susceptibility to insects and disease. Fire crowning hazard decreased in all units, but torching index was unchanged. Fire type was surface or passive crown prior to treatment and unchanged after. Flame lengths were mostly < 4 ft prior to treatment and unchanged after. FVS model results for disease were not provided for these stands.

4. Return fire, in the form of prescribed fire, as a process of forest succession.

Result: The prescribed fire was implemented successfully. Repeat burns will be needed in the future to maintain open conditions.

Cooney McKay:

1. Improve and/or maintain the general health, resiliency, and sustainability of forest vegetative communities.

Result: As a goal by itself, this statement is difficult to monitor and quantify. Health, resiliency, and sustainability can be subjective terms. When put in terms of quantifiable goals for insect, disease, and fire attributes, then success can be measured.

2. Reduce the growing risk for insects and chronic disease infestation.

Result: Beetle hazard was largely unchanged except for the Douglas-fir beetle which was lowered from moderate to low. Observations of disease were lowered considerably post-treatment.

3. Reduce forest fuels buildup adjacent to public and private lands.

Result: Fine fuels were increased post-treatment without an understory burn. However, risk of crown fire and torching was lowered and the fire type was reduced to a surface fire. Almost all residential private property was to the west of treatment areas and prevailing winds and general topography would most likely push fires upslope to the east. Former Plum Creek lands could be affected by fires to the east of treatment units, but most of this land is now being transferred to Forest Service ownership.

4. Provide a safer environment for the public and firefighters should a wildfire occur within the proposed treatment areas.

Result: This objective was met, although the initial threat to the public is difficult to quantify. During the Condon Mountain Fire of 2012, one of the treated Meadow Smith units was used as an anchor point for firefighters to engage the fire.

5. Increase the probability of stopping wildfires on NFS lands before they burn onto private lands.

Result: Risk of crown fire and torching was lowered and the fire type was reduced to a surface fire. Almost all residential private property was to the west of treatment areas and prevailing winds and general topography would most likely push fires upslope to the east. Former Plum Creek lands could be affected by fires to the east of treatment units, but most of this land is now being transferred to Forest Service ownership.

6. Provide commercial and personal-use wood products for the local communities.

Result: Over 44,000 tons of saw timber were provided to local mills. It is unclear the impact this had for the local communities.

Trade-offs across resources

Table 11. *Summary of effects on resources measured or mentioned in objectives for either project.*

Resource	Effect	Reason
Landscape fire behavior	0	Fire type and flame length were low to begin with, unchanged
Within-stand fire behavior	0/+	Meadow Smith: Risk of crowning was reduced, fire type and flame lengths unchanged (low prior). Cooney-McKay: risk of crown fire and torching was lowered and the fire type was reduced to a surface fire.
Old-growth trees	+	Risk of loss to fire was reduced and it is expected that remaining large trees will be "released"
Beetle hazard	0/+	Beetle hazard was reduced in many stands, though not all
Stand structure	+	Spatial heterogeneity resembles reference condition old-growth stands
Understory	?	Data not provided
Birds	-/0	Within first 2 years, no significant change in bird community toward old-growth species, a few species lost
Carnivores	?	Habitat may have been reduced for some, not changed for others, and may be improved for others
Economics	+?	Timber provided for local mills and contracts for stewardship work
Overall	**-/0/+**	

Summary of Management Questions/Recommendations

Planning Documents:

- Be explicit about Purpose and Need statements. If restoration is the goal, be clear why it needs to be restored and what you are restoring it to.
- Set quantifiable Desired Conditions (for fuels, fire behavior, insect resilience, etc.) and link prescriptions directly to those goals. It is difficult to monitor the "success" of a project without quantifiable goals.
- If fuel management and fire behavior are primary objectives, include quantifiable fire behavior model targets in the NEPA document, with pre- and post-treatment simulations. Also, show how the placement of treatment units will alter fire behavior and provide for resource protection.
- Acknowledge expected trade-offs to wildlife and their habitat, and other resources, in NEPA documents and why these trade-offs are acceptable. How long are they expected to last?

Monitoring and Project Review:

- Review fire behavior models and results to determine why torching indices remained high post-treatment.
- Continue to monitor vegetation every five years to determine duration of fuel treatment effects and continued effects on old growth.
- Review if fine fuel loadings are acceptable in Cooney McKay. Why was unit not designated for a prescribed understory burn?
- Can canopy cover goals be met when fuels/fire are primary objective? Should they be?

- Review why the stand did not change functionally for the bird community. Is that acceptable? Should monitoring be repeated again in year 5 or 10?
- Review and justify treatment sizes to reach functional goals.
- Conduct pre-treatment carnivore surveys in the project area even if results cannot be tied directly to effects of treatments. Knowing if species used the area pre- and post-treatment is still important. Prey surveys may be more effective at detecting impacts to carnivores at the treatment unit scale.
- Monitoring should include not only treatment and control sites, but reference sites as well.

Literature Cited

Antos, J.A., and J.R Habeck. 1981. Successional development in *Abies grandis* (Dougl.) Forbes forests in the Swan Valley, western Montana. *Northwest Science* 55: 26–39.

Arno, S.F., J.H. Scott, and M.G. Hartwell. 1995. Age-class structure of old growth ponderosa pine/Douglas-fir stands and its relationship to fire history. U.S. Forest Service Research Paper INT-PR-481.

Freedman, J.D., and J.R. Habeck. 1985. Fire, logging, and whitetailed deer interrelationships in the Swan Valley, northwestern Montana. *In* Fires' Effects on Wildlife Habitat — Symposium Proceedings. Edited by J.E. Lotan and J.K. Brown. U.S. Forest Service Gen. Tech. Rep. INT-GTR-186.

Green, P., J. Joy, D. Sirucek, W. Hann, A. Zack, and B. Naumann. 1992. Old-growth forest types of the Northern Region. U.S. Forest Service R-1 SES 4/92.

Hutto, R.L., A.D. Flesch, and M.A. Fylling. 2014. A bird's-eye view of forest restoration: Do changes reflect success? *Forest Ecology and Management* 327: 1-9.

Larson, A.J., and D. Churchill. 2008. Spatial patterns of overstory trees in late-successional conifer forests. *Canadian Journal of Forest Research* 38(11): 2814–2825.

Larson, A.J., and D. Churchill. 2012. Tree spatial patterns in fire frequent forests of western North America, including mechanisms of pattern formation and implications for designing fuel reduction and restoration treatments. *Forest Ecology and Management* 267: 74–92.

Larson, A.J., K.C. Stover, and C.R. Keyes. 2012. Effects of restoration thinning on spatial heterogeneity in mixed-conifer forest. *Canadian Journal of Forest Research* 42: 1505-1517.

Moore, M.M., W.W. Covington, and P.Z. Fulé. 1999. Reference conditions and ecological restoration: a southwestern ponderosa pine perspective. *Ecological Applications* 9(4): 1266–1277.

North, M., J. Innes, and H. Zald. 2007. Comparison of thinning and prescribed fire restoration treatments to Sierran mixed-conifer historic conditions. *Canadian Journal of Forest Research* 37(2): 331–342.

Squires, J.R., N.J. Decesare, J.A. Kolbe, and L.F. Ruggiero. 2010. Seasonal resource selection of Canada lynx in managed forests of the northern Rocky Mountains. *Journal of Wildlife Management* 74(8):1648-1660.

Stover, K.C. 2011. Heterogeneity of stand structure, fuels, and wildfire hazard in dry and moist old-growth ponderosa pine forests: Case studies from western Montana. M.S. Thesis. University of Montana.

Appendix A. Vegetation treatments for Meadow Smith and Cooney McKay

Table 1. Vegetation treatments proposed in the Meadow Smith project.

Activity	Acres	Description
Precommercial thin	330	Hand thinning within 8 mixed-conifer plantations, to favor ponderosa pine and western larch.
Commercial thin	340	Thinning, pruning, underburning, planting of western larch, and salvage of forest products from cut trees within 12 ponderosa pine plantations
	35	Thinning, planting of ponderosa pine and western larch, and salvage of forest products from cut trees within two lodgepole pine plantations.
Overstory removal	200	Overstory removal and precommercial thinning within 7 mixed-conifer plantations.
Intermediate harvest	100	Intermediate harvest within 4 mixed-conifer, mid seral forest stands, including: thinning from below of Douglas-fir and lodgepole pine, slashing unmerchantable Douglas-fir, jackpot burning logging slash, and underburning.
	10	Intermediate harvest within one mixed-conifer, mid seral forest stand, including: thinning from below of Douglas-fir and lodgepole pine, slashing unmerchantable Douglas-fir, and jackpot burning logging slash.
	270	Intermediate harvest within 18 late seral forest stands, including: regeneration harvest, slash unmerchantable trees, underburn, and plant ponderosa pine and western larch.
	400	Intermediate harvest within 28 late seral-old growth forest stands, including: regeneration harvest, slash unmerchantable trees, underburn, plant ponderosa pine and western larch.
Regeneration harvest	35	Regeneration harvest within one lodgepole pine, mid-seral forest stand.
Slash and underburn	60	Slashing of unmerchantable conifers, and underburn within two mixed-conifer, mid seral forest stands.
	234	Slashing unmerchantable conifers, and underburn within two late seral, old growth forest stands.
Underburn	30	Underburn and planting of ponderosa pine and western larch within two understocked plantations.
	10	Underburn within two understocked plantations.
	25	Underburn within one late seral forest stand
	45	Underburn for the purpose of precommercial thinning within one mixed-conifer plantation. (Note: this action is also included above as a precommercial thinning vegetation treatment).
	1,300	Underburning within forest stands designated for harvest of forest products. These burning treatments are included as part of the vegetation treatments described above.
Total unique acres	831	

Table 2. Treatment summary for the Cooney McKay project.

Commercial Harvest Treatments	
Commercial Thin	522 acres
Seed Tree	79 acres
Salvage	69 acres
Thin From Below	81 acres
Total Harvest Acres / Volume (MBF)	751 acres / 3217 MBF
Non-Commercial Harvest Treatments	
Pre-Commercial Thin	105 acres
Hand Planting (Occurring with Seed Tree Units)	79 acres
Restoration Planting	48 acres
Total Acres Treated Non-commercial (includes planting in Seed Tree Units)	232 acres
Total Acres of All Treatments	983 acres
Logging System	
Cable	4
Tractor	625
Forwarder	71
Cable/Tractor	51
Fuels Management	
Ecosystem Maintenance Burning	1805 acres
Grapple Pile/Burn/Chip	717 acres
Hand Pile/Lop and Scatter	105 acres
Underburn	34 acres
Fuels Treatment within Wildland Urban Interface (WUI)	497 acres
Fuels Treatment outside Wildland Urban Interface	2164 acres
Road Management	
Road Maintenance BMPs to meet Timber Sale Requirements	19.8 miles
Temporary Road Construction	1.25 miles