Lakeview Stewardship Collaborative Forest Landscape Restoration Project

Ecological, Social, and Economic Monitoring Report: 2012–2019

JULIA OLSZEWSKI AND AUTUMN ELLISON

SPRING 2021

About this project

The Collaborative Forest Restoration Program requires that all forest collaborative groups receiving funding conduct ecological, social and economic monitoring. The report presents the results of analyses on the ecological, social, and economic monitoring data for the Lakeview Stewardship group from fiscal years 2012 to 2019.

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About Lake County Resources Initiative:

Lake County Resources Initiative (LCRI) aims to bring Lake County, Oregon both economic and environmental prosperity through biophysical monitoring and renewable energy. LCRI serves as the facilitator of the Lakeview Stewardship Group, and employs the Chewaucan Biophysical Monitoring Team.

About the Ecosystem Workforce Program:

The Ecosystem Workforce Program is a bi-institutional program of University of Oregon's Institute for a Sustainable Environment and the College of Forestry at Oregon State University. We conduct applied social science research and extension services at the interface of people and natural resources. ***More information: http://ewp.uoregon.edu.***

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Table of Contents:

Common Acronyms:

CBH	Canopy Base Height
CBMT	Chewaucan Biophysical Monitoring Team
CFBH	Crown Fuel Base Height
CFLR(P)	Collaborative Forest Landscape Restoration (Program)
CWD	Coarse Woody Debris
DBH	Diameter at Breast Height
DWD	Downed Woody Debris
FRCC	Fire Regime Condition Class
FSDMP	Forest Soil Disturbance Monitoring Protocol
FWD	Fine Woody Debris
GNN	Gradient Nearest Neighbor
ICO	Individuals, Clumps and Openings
LCBH	Live Crown Base Height
LCRI	Lake County Resources Initiative
RMRS	Rocky Mountain Research Station
USFS	United States Forest Service
WCF	Watershed Condition Framework

Introduction

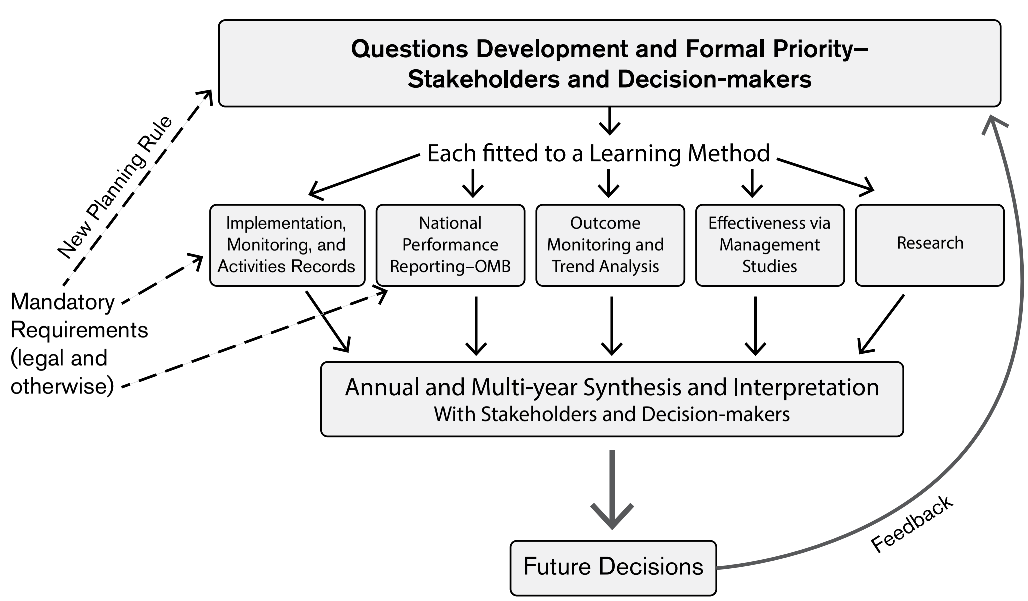
"Multiparty monitoring has the potential to be a valuable component of landscape-scale restoration and the CFLRP. Groups have designed their strategies with the intention of promoting knowledge generation and learning, maintaining or promoting accountability and trust among stakeholders, reducing uncertainty regarding landscape-scale and long-term effects of restoration, and supporting the development of adaptive management frameworks that facilitate changes in project planning and implementation in response to monitoring information." (Schultz et al., 2014)

The Collaborative Forest Landscape Restoration (CFLR) Program was established in the Omnibus Public Land Management Act of 2009 to promote the collaborative, science-based ecosystem restoration of priority forest landscapes. The program uses a competitive process to allocate funding to landscape-scale restoration projects that are proposed by the USDA Forest Service (Forest Service) and collaborators on national forest lands. Goals of the program include encouraging ecological, economic, and social sustainability; leveraging local resources with national and private resources; reducing wildfire management costs; and providing local economic benefits in rural communities (USDA Forest Service, n.d.).

The Lakeview Stewardship Collaborative Forest Landscape Restoration Project was awarded funding in 2012. The project was proposed by the Lakeview Stewardship Group (LSG), a public lands forest collaborative that formed in 1998 to guide and advise the Forest Service on the management of the Lakeview Federal Stewardship Unit. The CFLR project encompasses over 650,000 acres on the Fremont-Winema National Forest and is designed to improve forest health and reduce wildfire hazard while contributing to the social and economic wellbeing of local communities.

Monitoring of both ecological and socioeconomic project outcomes is a central component of the CFLR Program, and all funded projects are required to develop and conduct multiparty monitoring plans (Omnibus Public Land Management Act, 2008). The intent is to set up an adaptive management framework to evaluate the success of restoration methods as shown in Figure A below (DeMeo et al., 2015). Collaborative groups and the Forest Service can use monitor-

Figure A Adaptive management framework to facilitate a monitoring process



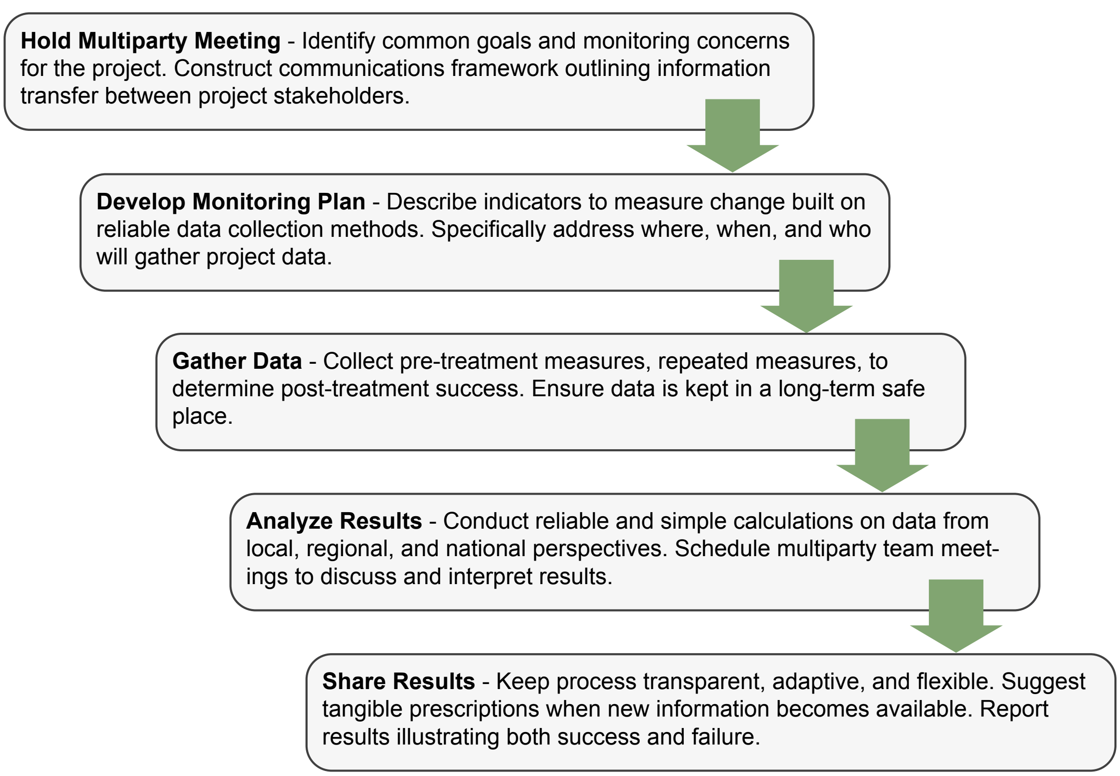
ing information on project outcomes to help determine whether project objectives are being met or if future changes need to be made to better meet goals.

In July of 2012, the LSG held a workshop to identify monitoring questions of interest. They also identified criteria that they applied to each question to determine which made it into the final plan, ultimately establishing 14 ecological, social, and economic questions to be included in the Lakeview Stewardship CFLR Monitoring Plan. These questions were reviewed and approved by the full collaborative group in February 2013, and a Science Team was convened to develop the appropriate methodology to answer each question. The final monitoring questions included nine ecological questions and five socioeconomic questions.

This report represents an analysis of ecological, social, and economic monitoring data for restoration activities conducted by the Lakeview Stewardship Group (LSG) from 2012 to 2019. The treatments analyzed here include commercial thinning, pre-commercial thinning, aspen release, stream enhancements, and prescribed/wildland fire. The socioeconomic monitoring questions analyze the impact that restoration treatments have for the local economy and beyond while considering the socioeconomic context and trends of the area. The results, recommendations, and lessons learned are presented here for the benefit of all collaborative members, and will be used to inform subsequent restoration activities and monitoring efforts as shown in Figure B, below.

The monitoring data used in this report comes from a variety of sources, and many different people have contributed to the analysis; a true multiparty effort. Future monitoring will include the newly-developed Common Monitoring Strategy in addition to questions selected by the collaborative itself. More information on the Common Monitoring Strategy can be found at the links in the resources box on Page 5.

Figure B Overview of the CFLRP Multiparty Monitoring Process



Resources:

Common Monitoring Strategy:

- **Monitoring in the Next Round of Collaborative Forest Landscape Restoration Projects.** Available at: https://www.fs.fed.us/restoration/documents/cflrp/CFLRP_monitoring_strategy_20201214.pdf
- **Core CFLRP Monitoring Questions and Indicators.** Available at: https://www.fs.fed.us/restoration/documents/cflrp/CFLRP_monitoring_questions_core_indicators_20201214.pdf

Lakeview CFLR Project Monitoring Plan:

- Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_60.pdf

References

Demeo, T., Markus, A., Bormann, B., & Leingang, J. (2015). Tracking Progress: The Monitoring Process Used in Collaborative Forest Landscape Restoration Projects in the Pacific Northwest. Ecosystem Workforce Program, University of Oregon. Working Paper #54. Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_54.pdf.

Omnibus Public Land Management Act of 2009 Title IV--Forest Landscape Restoration, Public Law No. 111-11, S.2593 (2008). https://www.congress.gov/bill/110th-congress/senate-bill/2593/text.

Schultz, C. A., Coelho, D. L., & Beam, R. D. (2014). Design and governance of multiparty monitoring under the USDA Forest Service's Collaborative Forest Landscape Restoration Program. *Journal of Forestry*, 112(2), 198–206.

USDA Forest Service. n.d. Collaborative Forest Landscape Restoration Program Overview. Available at: https://www.fs.fed.us/restoration/CFLRP/overview.shtml.

Lakeview Stewardship Group members meet up to discuss projects and see results on the ground during a 2018 field tour. Photo courtesy of Autumn Ellison, University of Oregon.

Biophysical Monitoring

"The monitoring program .... goals are to collect relational indicator information from the landscape, from tree top to below ground on the same site; using equipment and methodologies that are relevant, sensitive, relatively inexpensive, standardized, repeatable, and usable; and to create a relational database that allows anyone to query inventory information from the watershed, in order to gauge rates of watershed repair over time." (Lakeview CFLR Monitoring Plan, 2015)

Overview Table 1. Summary of Biophysical monitoring questions, goals, indicators, and conclusions and recommendations

Question	#	Goal	Indicator	Conclusions and Recommendations
How effective are fuels treatments at reducing fire risk?	1.1	To quantify the effectiveness of fuels treatments on fire growth and behavior.	Modeled fire growth and behavior	▪ Predicted fire behavior appeared to decrease following treatment, but continued monitoring with a more comprehensive sampling plan is recommended in future projects. Additional monitoring is recommended in prescribed burns. ▪ Pile/burn treatment appeared effective in mitigating a potential increase in surface fire behavior due to residual treatment slash. ▪ The decrease in live vegetation appeared to influence fire behavior more than the increase in fine surface fuels. This balance will change over time, so continued monitoring will be necessary to track trends in post-treatment surface fuel dynamics.
	1.2	Estimate fire program management cost savings and risk reductions for the CFLR project area	Expected suppression costs with and without treatment	▪ Use of the software tool R-CAT was discontinued, so the calculations couldn't be performed as outlined in the question. The collaborative must decide if an alternative method of addressing this question is desired. ▪ One potential approach would be to use the Risk Reduction Index developed by the Colville National Forest.
What are the effects of fire and/or mechanical treatments on tree survival/mortality by diameter class, changes in ladder fuels, and fuel loading pre/post treatment?	2.1	To quantify the effects of prescribed fire and mechanical treatments on vegetation	Mortality, Forest Structure and Fuel Loading	▪ Pile/burn treatment appeared effective in mitigating a potential increase in surface fuel build-up from residual treatment slash. ▪ Longer-term monitoring will be necessary to assess trends in mortality and surface fuel dynamics. ▪ Treatment appeared to result in a lift in canopy base height when saplings were removed, but continued monitoring with a more comprehensive sampling plan is recommended in future projects. Additional monitoring is recommended in prescribed burns.
What is the effect of the treatments on moving the Forest Landscape toward a more sustainable condition that includes scale and intensity of historic disturbances?	3.1	To assess whether treatments have resulted in sustained or improved resiliency/resistance to insect, disease, and drought	Projection of a stand's resistance to wildfire, insects and disease, drought based on past radial growth and other stand data	▪ CSE data was not gathered as specified in the monitoring plan, so general vegetation data gathered by the CBMT was used instead. The collaborative may consider alternative measures of resistance/resilience in future projects. ▪ In some thinning treatments, residual basal area appeared to be above targets established in silvicultural prescriptions. ▪ In some thinning treatments, diameter distributions appeared high in smaller size classes. ▪ Multi-age or variable density prescriptions may be considered.
	3.2	To quantify and compare the scale and intensity of current restoration treatments to historic disturbances	Change in Fire Regime Condition Class (FRCC) rating	▪ Treatments have been effective at vegetation restoration, but so far only a small fraction of the total vegetation departure has been addressed. ▪ Wildland fire at severity levels consistent with historical fire regimes appears to be the most effective method of restoration.
	3.3	To quantify and compare the effects of prescribed fire and mechanical treatments to the historic disturbance regime	Fire frequency	▪ Under the historic fire regime, 126,000 acres should have burned between 2011 and 2019. In that time, 26,500 acres were burned in prescribed fires, and 71,000 acres were burned in large wildland fires for a total of 97,500 acres. ▪ The majority of acres burned were in wildland fire, indicating that prescribed fire alone has not come close to matching the historical regime. ▪ Recommendations include supporting efforts to remove barriers to prescribed burning, increasing the use of managed fire, and monitoring fire severity extent in addition to acres burned.

Biophysical Monitoring Questions Overview Table, continued

Question	#	Goal	Indicator	Conclusions and Recommendations
What is the historical spatial pattern within the Lakeview Stewardship landscape? How well are treatments mimicking historical spatial patterns?	4.1	To understand historic spatial patterns that will help with future pre-scription writing	Individuals, clumps and openings	▪ An attempt to contract with The Nature Conservancy (TNC) to gather this data as specified in the monitoring plan fell through. ▪ Information on historical spatial patterns in similar dry forest types can be used to inform prescription writing.
	4.2	To achieve fine scale mosaic pattern across the landscape that existed historically	Individuals, clumps and openings	▪ An attempt to contract with TNC to gather this data as specified in the moni-toring plan fell through. ▪ A LiDAR data analysis revealed too few large clumps and too few large open-ings were left following thinning treatments. ▪ Future thinning treatments should focus on leaving larger clumps and larger openings.
What are the site-specific effects of restoration treatments on focal species habitat within the project area?	5.1	To incorporate fine-res-olution habitat suitability for nesting WHWO into silvicultural prescrip-tions and thereby guide ecosystem restoration projects within the range of the species	Levels of tree clustering, stand densities, and tree characteris-tics, and the density and size of openings	▪ An attempt to contract with TNC to gather this data as specified in the moni-toring plan fell through. ▪ The LSG may make another attempt to contract with TNC or use an alternate method such as LiDAR data analysis.
	5.2	To verify the effective-ness of restoration treatments for improving habitat for white-headed woodpeckers	White-headed woodpecker oc-cupancy, nesting, and success	▪ This indicator is being addressed by the Rocky Mountain Research Station (RMRS). ▪ Nests were generally found in large-diameter ponderosa pine and aspen in low-density ponderosa pine forest or aspen stands adjacent to pine forest. ▪ White-headed woodpecker (WHWO) detections have increased but nest detections have decreased. ▪ More WHWO and nest detections have taken place in untreated areas than treated areas. ▪ RMRS plans to continue monitoring in order to further study these trends.
	5.3	To quantify and compare the effects of prescribed fire and mechanical treatments to the historic disturbance regime	Fire frequency	▪ Under the historic fire regime, 126,000 acres should have burned between 2011 and 2019. In that time, 26,500 acres were burned in prescribed fires, and 71,000 acres were burned in large wildland fires for a total of 97,500 acres. ▪ The majority of acres burned were in wildland fire, indicating that prescribed fire alone has not come close to matching the historical regime. ▪ Recommendations include supporting efforts to remove barriers to prescribed burning, increasing the use of managed fire, and monitoring fire severity extent in addition to acres burned.
What are the effects of restoration treatments on focal species habitat across the CFLR Project Ar-ea?	6.1	To improve and maintain habitat for white-headed woodpeckers (WHWO) at the stand and land-scape scale	Amount of WHWO habitat within CFLR Project Area	▪ The RMRS is responsible for addressing this indicator. RMRS personnel will be conducting a habitat suitability analysis using the 2017 GNN data within the next couple years. The results will be reported when received.
	6.2	To improve habitat for fish and wildlife species within aspen, stream, and riparian areas	Total acres of aspen or riparian habitat in which co-nifer reduction oc-curred and the total number of miles of stream enhanced due to in-stream improvements	▪ Conifer reduction took place in 6,386 acres of aspen habitat and 44.5 acres of riparian habitat. ▪ 22.8 miles of stream enhancement projects were conducted.

Biophysical Monitoring Questions Overview Table, continued

Question	#	Goal	Indicator	Conclusions and Recommendations
How are riparian and upland treatments impacting ground vegetation and soils?	7.1	To quantify vegetation composition and response before and after small tree thinning and prescribed fire within riparian corridors	Riparian vegetation species composition, bare ground and ground cover, riparian and streamside vegetation cover, age class, extent of riparian vegetation	▪ The CBMT found that three years after conifer removal in the West Drews Aspen project, understory vegetation had responded positively but there was no observed increase in aspen regeneration. The LSG agreed to continue monitoring in West Drews to see if there was a delayed aspen regeneration response. ▪ South Warner Aspen sites were monitored one year following treatment, but this was too soon to observe a vegetation response to conifer removal. Continued monitoring is recommended in all aspen sites.
	7.2	Estimate fire program management cost savings and risk reductions for the CFLR project area	Expected suppression costs with and without treatment	▪ Forest Soil Disturbance Monitoring Protocol surveys conducted by the Fremont-Winema soil scientist showed that soil disturbance was within the standards of detrimental impact for the following: ▪ One year and three years following commercial thinning by cut-to-length tethered forwarder on steep slopes harvest in Deuce Pilot. ▪ One year following commercial thinning by feller-buncher and skidder in Crooked Mud Honey Lil Stewardship. ▪ Eight years following commercial thinning by feller-buncher and rubber-tired skidder in Abe. ▪ The CBMT found that soil compaction in skid trails from grapple logging in Olde was not high enough to be of concern, especially when compared to soil compaction in burned areas from the Barry Point fire.
How are projects (road closures, upland and riparian treatments, etc.) impacting water quality?	8.1	To maintain those watersheds currently rated as “good” and to improve to “good” in those watersheds currently rated as “fair”	Watershed Condition Framework (WCF) ratings	▪ The WCF structure is in the process of being revised, so there is no current official WCF rating. The most recent assessment was completed in 2016. ▪ Of the 65-sub-watersheds in the Stewardship Unit, 22 were rated as functioning properly and 43 were rated as functional-at-risk. ▪ CFLR projects have resulted in improvements to some sub-watersheds, but likely not enough to shift ratings from functional-at-risk to functioning properly. ▪ Improvements in WCF ratings could be made by addressing stream temperature, but this would involve resource-intensive operations that would be difficult to carry out on a large scale.

	8.2	To quantify the miles of road decommissioned across the entire CFLR project area and within riparian zones	Miles of road decommissioned and reduction in road density in the 6th field watersheds within the CFLR project area and within riparian areas	▪ Some road decommissioning has taken place, but not enough to make a change in the WCF rating.
				▪ Obstacles to road decommissioning include the following:
				  ▪ Public desire to access remote areas.
				  ▪ Access for firefighters.
				  ▪ Turnover and lack of funding for engineering staff.

	8.3	To determine how restoration projects impact stream temperature	Stream temperature	▪ Average stream temperature is increasing in some areas and decreasing in others. ▪ The factors affecting stream temperature are numerous, so it is difficult to identify with any certainty which factors are contributing to stream temperature trends.
How are projects (road closures, upland and riparian treatments, etc.) impacting water quality?	9.1	To minimize the oc-currence of new invasive plant sites and/or expansion of existing sites	Number of new invasive plant sites discovered and/or expansion of existing invasive plant sites within or immediately adjacent to vegetation management activities	▪ Invasive species surveys in areas of concern were never conducted. ▪ Almost no new infestations were observed in general post-treatment vegetation monitoring, but this monitoring did not necessarily take place in areas of concern. ▪ Invasive species surveys should be conducted in areas of concern in future restoration projects.

Recommendations and Lessons Learned from the First Round of CFLRP Monitoring

Ecological Monitoring Plan Development

- For each question, be specific about the indicator and how it will be measured.
  - » Indicators such as fire behavior, mortality and fuel loading were identified in Q1 and Q2, but no instructions were given on how they were to be measured.

- For each indicator, consider the feasibility of gathering and reporting the data.
  - » CSE data was never collected and invasive species surveys were not conducted.
  - » Efforts to contract with The Nature Conservancy for data on forest structure fell through.
  - » WCF indicators were not an accurate reflection of restoration work accomplished.

- Establish desired conditions and benchmarks to define what constitutes success, and what constitutes trigger points for adaptive management.
- Establish a monitoring oversight committee that meets regularly.
  - » Ensure data gathering remains on schedule.
  - » Address unforeseen issues with data gathering for any given indicator.

- National Indicators such as WCF and FRCC can be beneficial in that they involve minimal resources and expense on the part of individual collaboratives. However, they are subject to change, or may be discontinued entirely. If one of these indicators is used, it is important to keep track of the status so adjustments can be made as necessary.
- Analysis and reporting are more difficult when questions with similar themes are not grouped together.
  - » Habitat indicators were spread across multiple different questions.
  - » Fine-scale horizontal forest structure was addressed in two different questions.
  - » Q7 covers two unrelated indicators: riparian vegetation and upland soils.
- Analysis and reporting would be easier if indicators, not just overall questions, are given consideration in terms of order and organization.
  - » The resistance and resilience indicators from Q3 would fit with the forest structure/fuel loading/mortality indicators from Q2 since all concern stand-level forest conditions and susceptibility to disturbance.
  - » The fire regime indicators from Q3 would fit with the fire behavior/risk reduction indicators from Q1.
  - » The results calculated for Q2 also serve as the inputs for fire behavior modeling in Q1. It would have been more effective to position the discussion of fuel loading prior to the discussion of fuel loading effects on predicted fire behavior.

Field data collection

- Develop a comprehensive sampling plan with appropriate stratification and sufficient landscape coverage to draw reliable conclusions.
  - » Identify all the different forest types (e.g. ponderosa vs mixed conifer) to monitor.
  - » Identify all the different management methods (e.g. CT, PCT, Rx Fire) to monitor.
  - » Identify the number of plots needed based on expected variation and how much of a change should be detectable.
  - » Define how plot locations will be generated or selected.
  - » Define the plot naming convention. Ideally this would include references to both project area and treatment name. This makes data organization and analysis much easier.
  - » Forest Service specialists should share prescribed burn units and thinning unit pools once finalized so that pre-treatment data can be collected in a timely fashion.
  - » Focus on getting an adequate number of pretreatment plots rather than instituting a treated vs. untreated sample scheme after treatment.

- Field data-gathering protocols should not be so time-consuming as to prevent a sufficient number of plots from being observed.
  - Balance the amount of data collected in plots with desired landscape coverage.
  - Do not include protocols that do not address the monitoring questions.
  - Use appropriately sized field crews: two crews of four or five can accomplish more than one crew of eight to ten.
  - Do not worry about recording stumps and felled trees to try to reconstruct pre-treatment measurements. Concentrate on planning pre-treatment visits so there aren't any post-treatment plots without pre-treatment visits.

- Electronic field data collection would help prevent conversion and transcription errors.

- Field visits have always been a critical component of forest collaboration. These field visits allow stakeholders to see first-hand the results of restoration activities. The LSG has traditionally conducted field visits at each annual meeting. Field visits, however, were not specified in the original LSG monitoring plan. Field visits to restoration project sites should be identified as a form of ecological monitoring.

CBMT crew members at work in the field. Photo courtesy CBMT.

Question 1

How effective are fuels treatments at reducing fire risk?

Goal 1.1:
To quantify the effectiveness of fuels treatments on fire growth and behavior.

Indicator 1.1:
Modeled fire growth and behavior.

Analysis 1.1: Modeled Fire Growth and Behavior

The Monitoring Plan suggests two programs, FlamMap and Farsite, as options for modeling fire growth and behavior. However, these programs have a spatial component to modeling potential fire spread, and require continuous spatial data. BehavePlus (Heinsch & Andrews 2018) was selected for this analysis since it was a better fit for the discrete, plot-based monitoring data collected by the Chewaucan Biophysical Monitoring Team (CBMT).

No specific fire behavior variables of interest were identified in the Monitoring Plan, so two surface fire and two crown fire variables were selected. The surface fire variables are flame length and rate of spread (ROS). These two variables are used as basic quantifiers of fire behavior (Fulé et al., 2001). The crown fire variables are passive crown fire ROS and transition ratio. Passive crown fire ROS refers to spread of fire in the canopy as trees torch from a surface fire as opposed to spreading from crown to crown. A transition ratio of 1 is considered the threshold of when crown fire changes from unlikely to likely. A higher transition ratio represents a higher likelihood of transition from surface fire to crown fire (Heinsch & Andrews 2010).

While low-intensity surface fire was common in the historical fire regimes for Eastside forests, crown fires were rare and isolated (Hessburg et al., 2005). Ideally, forest restoration efforts would result in a lower probability of surface fire transitioning to crown fire (Agee & Skinner 2005). Both crown fire variables were selected in order to assess this probability. No weather scenarios were specified, so 80^{th}, 90^{th}, 95^{th} and 98^{th} were selected in order to represent a range of fire weather scenarios from moderate to most severe. The weather scenarios were calculated using Fire Family+ software (Jolly & Heinsch 2019) with weather data from the Coffee Pot and Summit Remote Automated Weather Stations (RAWS) between 2012 and 2019. RAWS data was accessed through the Kansas City Fire Access Software (KCFAST) online portal (Barnes et al.). Coffee Pot RAWS data was used for the Deuce and Jakabe harvests, and the Summit RAWS data was used for Crooked Mud Honey (CMH) Lil Stewardship.

Any exercise in fire modeling is dependent on the accuracy of the inputs (McHugh 2006). Many of the inputs used in this analysis were calculated from plot averages from each project area. In many cases, the fuel loading results were inconclusive due to not enough plots being observed in a given project area. See Appendix 1A (pages 138-139) for maps of each project area and plot distribution. Since the modeled fire behavior reflects averages and does not include the variation, the results may not accurately reflect the change in fire risk.

Surface inputs calculated from the monitoring data include downed woody debris (DWD) loading and surface vegetation loading. Crown inputs include canopy base height (CBH) and crown bulk density (CBD). The BehavePlus software requires crown fuel base height as opposed to live crown base height. CBD inputs were estimated using the tables and results from Scott & Reinhardt (2005) and Reinhardt et al. (2006), and were primarily based on basal area ranges. Since CBD was based on a range instead of an average, it is less likely to be affected by variation. Most of the input variables will be addressed in greater depth in Question 2.

Deuce Pilot

Inputs

Deuce Pilot was a commercial thinning treatment (Figure 1.1). The change in average DWD loading was minimal and the error overlapped pre- and post-treatment, so the actual change in DWD is not clear. The change in average 1-hr fuel loading appears minimal, but the change in average 10-hr and 100-hr fuels could potentially be a large increase or a large decrease. While the average live surface fuel loading dropped, the extent of the variation makes it unclear whether there was a large drop or a small drop. While the average CBH lifted, it is unclear how much of a lift actually occurred.

Figure 1.1 Fire behavior modeling inputs for Deuce Pilot calculated from field data (n = 7). Project-level averages are shown with standard error about the mean.

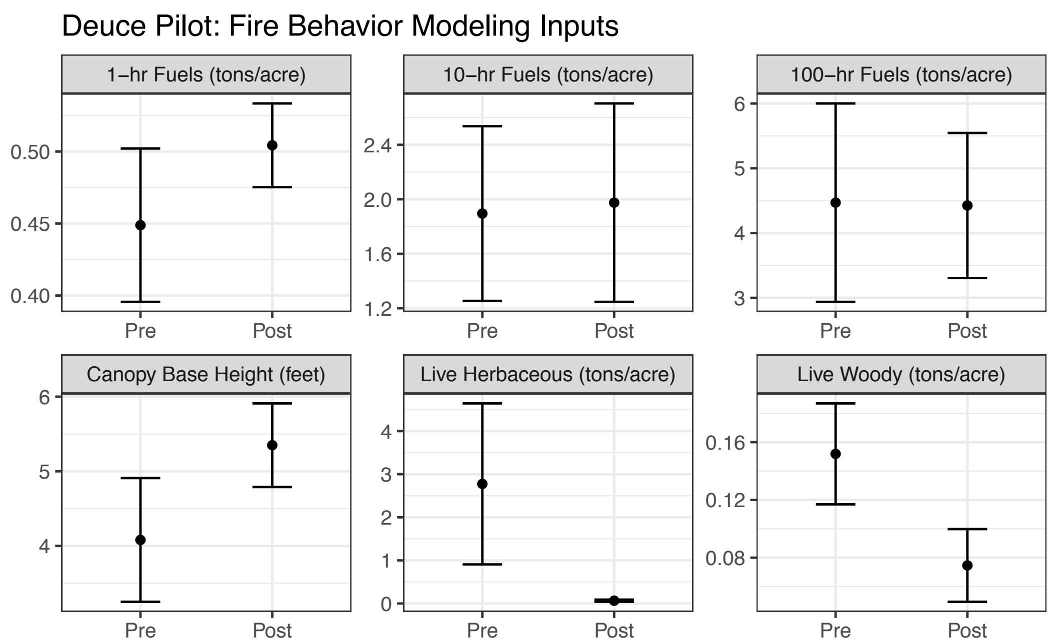


Figure 1.2 Crew members measuring vegetation and fuel loading following the Deuce Pilot commercial thinning treatment. Photo courtesy of CBMT.

Results

Fire ROS is measured in chains per hour. This may not be a familiar measurement to many. One chain is equivalent to 66 feet. With two exceptions, the model predicted a decrease in fire behavior in all fire behavior variables and weather scenarios following treatment. See Table 1.1 and Figure 1.3 for results. The drop in average live fuel loading outweighed the slight increase in average 1-hr and 10-hr fuel loading, as indicated by the predicted decrease in surface fire behavior following treatment. This is consistent with observed fire behavior and physical characteristics of surface fuels in general (Anderson 1982). The likelihood of transition dropped in all four scenarios, and transition to crown fire changed from likely to unlikely in the 90th and 95th percentile weather scenarios. The only predicted increase in fire behavior was in the 80th percentile weather scenario, where the surface and crown fire ROS increased. In the milder weather, the increase in surface fuel may have had more of an effect on fire spread than the weather.

Table 1.1 Fire behavior modeling results for Deuce Pilot, pre-treatment and post-treatment for four different fire weather scenarios.

	80th Percentile		90th Percentile		95th Percentile		98th Percentile		
Output Variable	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Units**
Surface Fire ROS	5.7	7.4	14.2	10.1	18.8	11.9	24.2	14.3	chains/hr
Surface Fire Flame Length	2.8	2.6	4.4	3.1	5.1	3.4	5.8	3.8	feet
Passive Crown Fire ROS	5.7	7.4	28.3	10.1	117	11.9	157	17.3	chains/hr
Transition Ratio	0.66	0.46	1.84	0.64	2.92	0.80	3.89	1.03	*NA*
Transition to Crown Fire?	No	No	Yes	No	Yes	No	Yes	Yes	*NA*

Figure 1.3 Results from fire behavior modeling for Deuce Pilot, pre-treatment and post-treatment. The dotted line at Y = 1 on the Transition Ratio graph represents the threshold for likelihood of transition from surface fire to crown fire.

Deuce Olde

Inputs

Deuce Olde was a pre-commercial thinning treatment with the goal of enhancing Late Old Structure (LOS). Fuel loading inputs are shown in Figure 1.4. The average DWD loading increased in all three size categories; though by different amounts. The increase in average 1-hr fuel loading was miniscule, in 10-hr loading was slightly larger (about one ton/ac), and in 100-hr was nearly six tons/acre. Due to the variation, the actual extent of the increase was not clear. The average live surface fuel loading dropped, but the potential drop could have been large or small. While the average CBH lifted, the overlap in variation shows that it is not clear whether there was actually a lift, or if so, how much.

Figure 1.4 Fire behavior modeling inputs calculated from field data for Deuce Olde (n = 4). Project-level averages are shown with standard error about the mean.

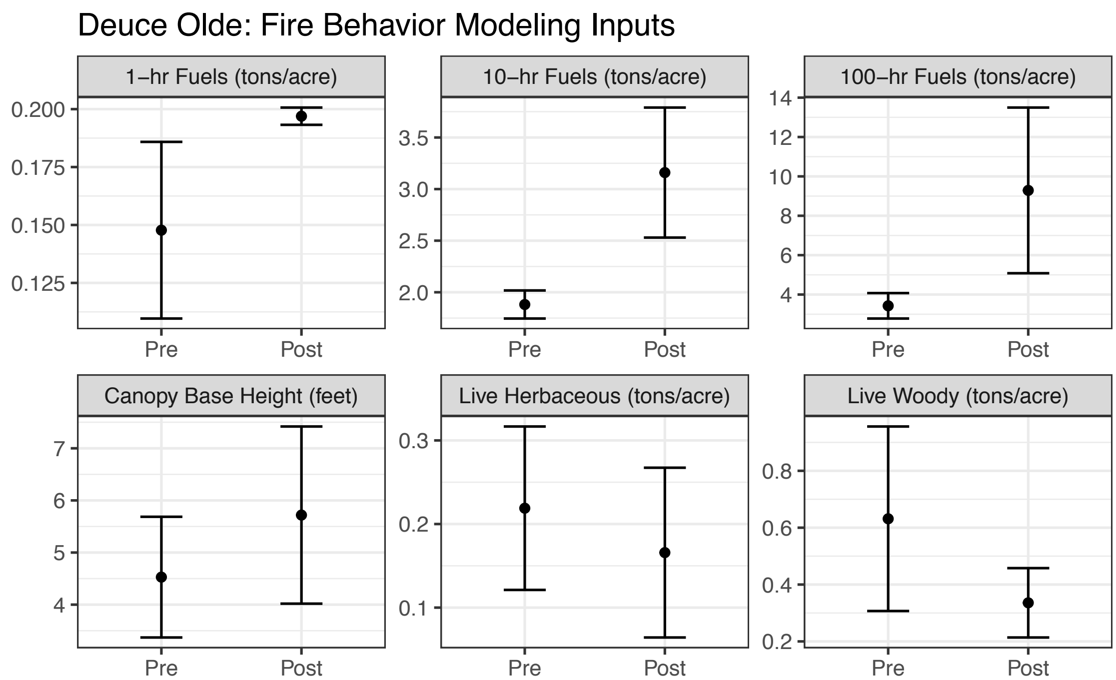


Figure 1.5 Pre-treatment and post-treatment photos in the Deuce Olde pre-commercial thinning treatment. Photo courtesy of the CBMT.

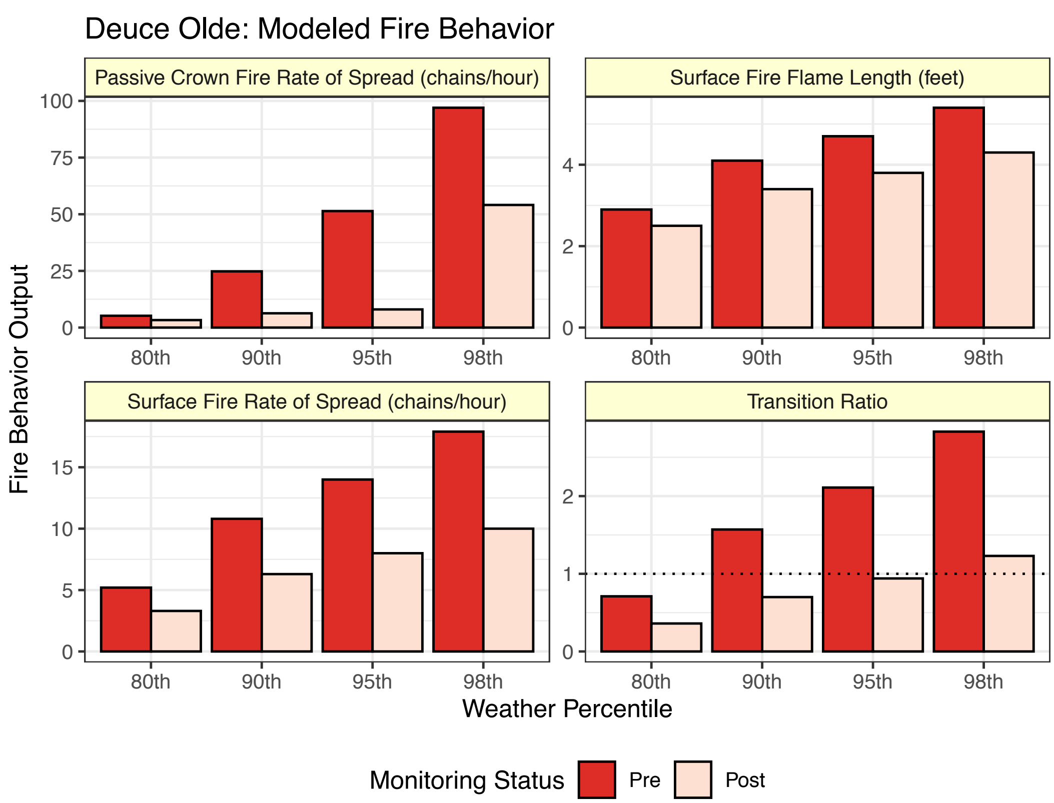
Results

The model predicted a decrease in fire behavior in all fire behavior variables and weather scenarios. See Table 1.2 and Figure 1.6 for results. The decrease in average live surface fuel loading outweighed the increase in average DWD loading regarding surface fire ROS and flame length, as seen in Deuce Pilot. The transition ratio decreased in all four weather scenarios, and the transition to crown fire changed from likely to unlikely in the 90th and 95th percentile weather scenarios. There was a greater decrease in passive crown fire ROS than in other variables.

Table 1.2 Fire behavior modeling results for Deuce Olde, pre-treatment and post-treatment for four different fire weather scenarios.

	80th Percentile		90th Percentile		95th Percentile		98th Percentile		
Output Variable	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Units**
Surface Fire ROS	5.2	3.3	10.8	6.3	14.0	8.0	17.9	10.0	chains/hr
Surface Fire Flame Length	2.9	2.5	4.1	3.4	4.7	3.8	5.4	4.3	feet
Passive Crown Fire ROS	5.2	3.3	24.8	6.3	51.4	8.0	97.0	54.1	chains/hr
Transition Ratio	0.71	0.36	1.57	0.70	2.11	0.94	2.83	1.23	*NA*
Transition to Crown Fire?	No	No	Yes	No	Yes	No	Yes	Yes	*NA*

Figure 1.6 Results from fire behavior modeling, pre-treatment and post-treatment for Deuce Olde. The dotted line at Y = 1 on the Transition Ratio graph represents the threshold for likelihood of transition from surface fire to crown fire.



Jakabe

Inputs

The plots analyzed here represent several different pre-commercial thinning treatments within the Jakabe planning area. Inputs are shown in Figure 1.7. While the average DWD loading increased, the variation makes it unclear whether there was actually a change in 1-hr and 10-hr fuel loading. The increase in 10-hr fuels could have been anywhere from none to over four tons/ac. The average 100-hr fuel loading increased following harvest, but it is unclear by how much. Average CBH lifted, but only by about half a foot. Live surface fuel loading fell slightly, but the variation is wide enough that it is unclear whether there was a change or by how much.

Figure 1.7 Fire behavior modeling inputs calculated from field data for the Jakabe planning area (n = 4). Project-level averages are shown with standard error about the mean.

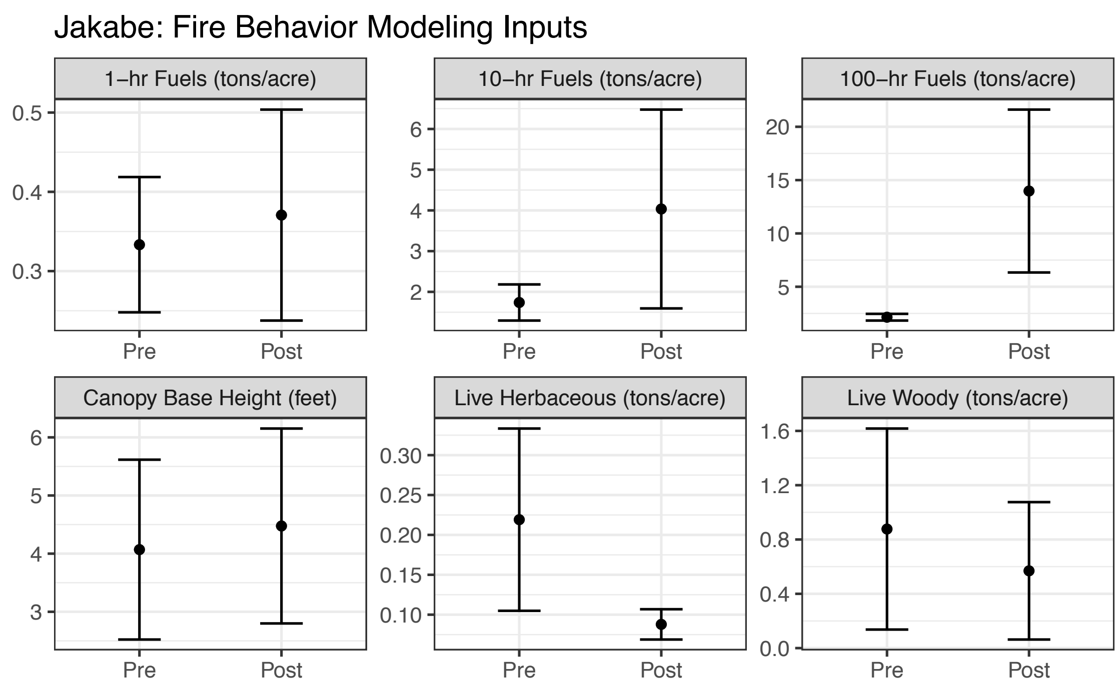


Figure 1.8 Pre-treatment (left) and post-treatment (right) photographs in the Jakabe Swamp pre-commercial thinning treatment. Decrease in understory vegetation is apparent on the left side of the post-treatment photo. Photos courtesy of the CBMT.

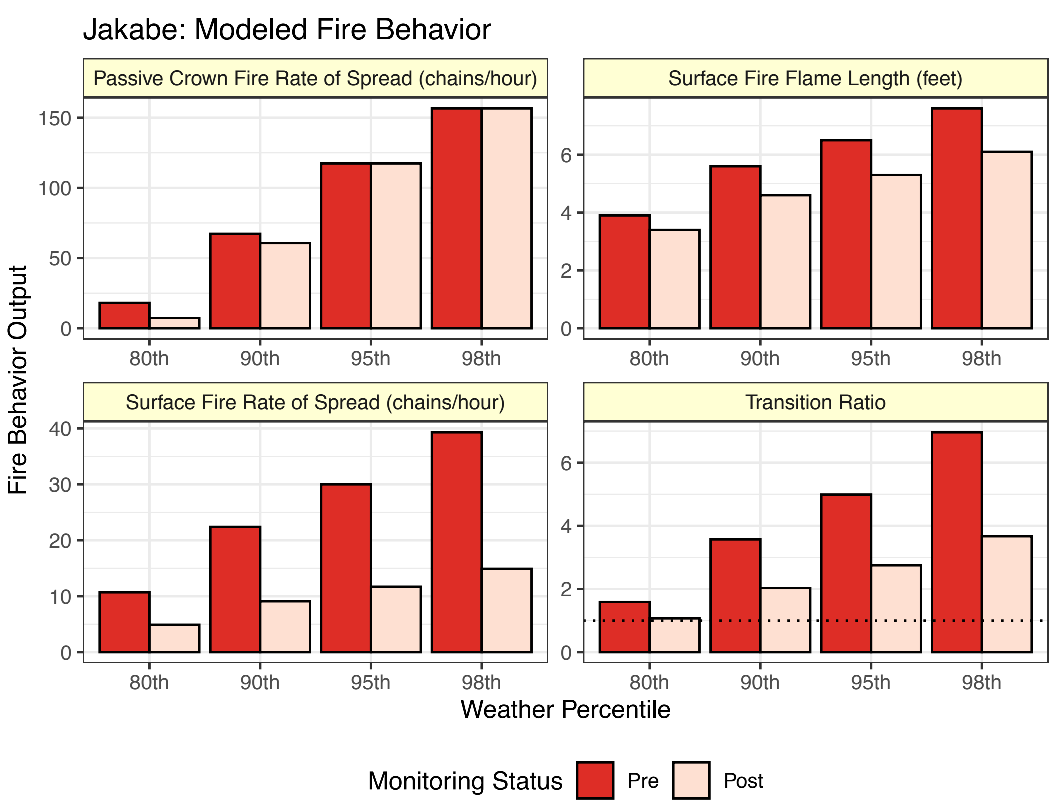
Results

Predicted fire behavior decreased all categories and weather scenarios with the exception of passive crown fire ROS, which decreased in the two less extreme weather scenarios but increased in the two more extreme weather scenarios. See Table 1.3 and Figure 1.9 for results. There was a slight decrease in predicted surface fire flame length. While the transition ratio decreased in all four weather scenarios following treatment, transition remained likely in all four scenarios. The decrease in predicted fire behavior was likely driven by the decrease in live fuel loading and the lift in average CBH, which outweighed the increase in average DWD loading. It is important to note the amount of variation in the inputs and the limited number of plots (n = 4) to represent the entire planning area, so these results may not represent the actual conditions throughout the treatment units.

Table 1.3 Fire behavior modeling results for Jakabe, pre-treatment and post-treatment for four different fire weather scenarios.

	80th Percentile		90th Percentile		95th Percentile		98th Percentile		
Output Variable	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Units**
Surface Fire ROS	10.7	4.9	22.4	9.1	30.0	11.7	39.3	14.9	chains/hr
Surface Fire Flame Length	3.9	3.4	5.6	4.6	6.5	5.3	7.6	6.1	feet
Passive Crown Fire ROS	18.1	7.3	67.3	60.7	117	117	157	157	chains/hr
Transition Ratio	1.59	1.07	3.57	2.03	4.99	2.75	6.96	3.67	*NA*
Transition to Crown Fire?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	*NA*

Figure 1.9 Results from fire behavior modeling, pre-treatment and post-treatment for Jakabe. The dotted line at Y = 1 on the Transition Ratio graph represents the threshold for likelihood of transition from surface fire to crown fire.



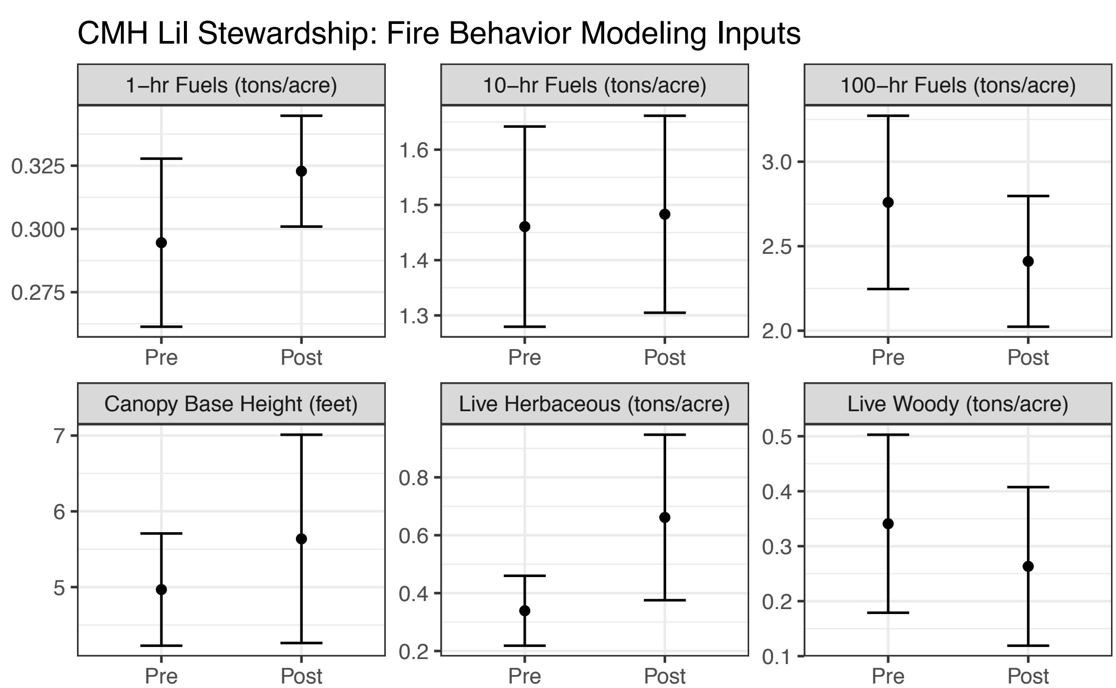
Crooked Mud Honey Lil Stewardship

Inputs

Lil Stewardship was a commercial thinning treatment with units scattered throughout the North Warner Mountains, a different biophysical setting than Deuce or Jakabe. Inputs are shown in Figure 1.11. There was little change in the average DWD loading in all three categories, and the variation makes it unclear whether there was an increase or decrease. There is a slight lift in the average CBH, but the variation makes it unclear whether a lift actually occurred. The average live herbaceous surface fuel loading increased, while the average live woody surface fuel loading decreased, with a net increase in overall average live surface fuel loading. Even factoring in the variation, the change in all inputs was very limited, so there is not likely to be much of a change in fire behavior, whether it is a slight increase or slight decrease.

Figure 1.10 Post-treatment panorama photo from CMH Lil Stewardship commercial thinning treatment. A slash pile is visible in the background. Crew members gathering data are visible to the right. Photo courtesy of the CBMT.

Figure 1.11 Fire behavior modeling inputs calculated from field data from CMH Lil Stewardship (n = 13). Project-level averages are shown with standard error about the mean.



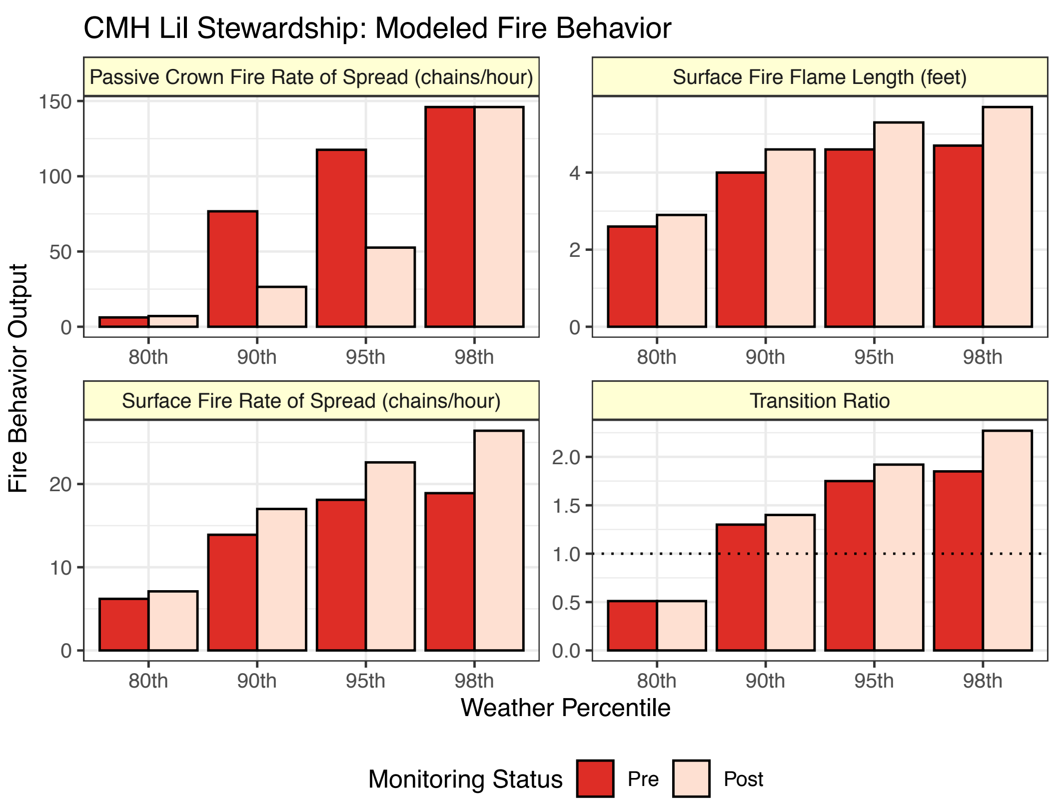
Results

The model predicted a slight increase in fire behavior in most, though not all, weather scenarios and fire behavior variables. However, due to the variation in the input variables, this could just as easily be a slight drop. See Table 1.4 and Figure 1.12 for a depiction of the results. The only decrease in predicted fire behavior was in passive crown fire ROS in the 90th and 95th percentile weather scenarios. The slight lift in average CBH was not enough to offset the increases in average surface fuel loading.

Table 1.4 Fire behavior modeling results for CMH Lil Stewardship, pre-treatment and post-treatment for four different fire weather scenarios.

	80th Percentile		90th Percentile		95th Percentile		98th Percentile		
Output Variable	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Units**
Surface Fire ROS	6.2	7.1	13.9	17.0	18.1	22.6	18.9	26.4	chains/hr
Surface Fire Flame Length	2.6	2.9	4.0	4.6	4.6	5.3	4.7	5.7	feet
Passive Crown Fire ROS	6.2	7.1	76.7	26.5	118	52.6	146	146	chains/hr
Transition Ratio	0.51	0.51	1.30	1.40	1.75	1.92	1.85	2.27	*NA*
Transition to Crown Fire?	No	No	Yes	Yes	Yes	Yes	Yes	Yes	*NA*

Figure 1.12 Results from fire behavior modeling, pre-treatment and post-treatment for CMH Lil Stewardship. The dotted line at Y = 1 on the Transition Ratio graph represents the threshold for likelihood of transition from surface fire to crown fire.



Recommendations/Conclusions

Only one project (CMH Lil) exhibited an increase in predicted surface fire behavior given the increases in fine surface fuels. Average DWD loading, one of the main fuel drivers of surface fire behavior, either increased or showed little change post-treatment for all projects. Average loading of live surface fuels, the other main fuel driver of surface fire behavior, decreased following treatment in all projects except for CMH Lil. Since the live vegetation had a greater effect on fire behavior than DWD, it is likely that the slash removal methods used following treatment were effective in reducing fire risk from activity fuels.

The observed decrease in loading from live vegetation may be due to disturbance from harvesting activities, and is consistent with research observations (Vaillant et al., 2013). In the years following treatment, surface vegetation is likely to increase due to the increase in sunlight reaching the forest floor (Roloff et al., 2005). Research has shown that slash may decrease over time following thinning-only treatments, but litter and duff loading show little change (Stephens et al., 2012). Continued monitoring will be necessary to determine how surface fuel dynamics affect predicted fire behavior in the years following treatment, so longer-term revisits are recommended in the years following treatment. Fuel loading will be addressed in greater depth in Question 2.

All the treatments analyzed here involved mechanical thinning that had not been followed up with prescribed fire at the time of monitoring. Following a mechanical thinning treatment with a prescribed burn, which would likely take place under moderate weather conditions (80th percentile or lower), would reduce the surface fuel load and lift the canopy base height (Stephens et al., 2009). Such an outcome would reduce the predicted fire behavior risk. For example, a lower surface fuel load would produce lower flame lengths, which would be less likely to spread surface fire to a canopy with a higher base (Agee & Skinner 2005). Prescribed fire has taken place since post-treatment monitoring in some of these areas, and additional prescribed fire is planned for others. It is recommended that monitoring be conducted before and after prescribed fire in order to assess changes in fire behavior risk. A few plots have been installed in prescribed fire locations, but more are needed to conduct a formal analysis.

While data analysis suggests that the average fuel load decreased and average CBH increased in most cases, it is recommended that a more comprehensive sampling scheme be implemented in future restoration projects. A more intensive sample would account for the expected variation and allow results to be reported with greater confidence. For instance, both Jakabe and Deuce Olde contained only four revisited plots each. Additional plots would be necessary to determine whether the variation was due to the small sample size or the inherent variation across the landscape.

Acknowledgements

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Question 1.2

How effective are fuels treatments at reducing fire risk?

Goal 1.2:
Estimate fire program management cost savings and risk reductions for the CFLR project area.

Indicator 1.1:
Expected suppression costs with and without treatment.

Analysis 1.2: Expected suppression costs with and without treatment

This portion of Question 1 calls for the use of the Wildland Fire Risk and Cost Management Tools package, or "R-CAT." R-CAT is collection of software tools designed to allow CFLRP groups to quantify long-term wildland fire management cost savings as a result of restoration (Stockman & Gebert, 2010). Upon investigating the use of R-CAT to address this question, it was found that no one familiar with R-CAT worked for the Fremont-Winema National Forest, and R-CAT was phased out by CFLRP after being deemed ineffective (C. Shuffield, T. DeMeo, L. Buchanan, personal communication, April 27, 2020). Therefore, this question cannot be answered as specified in the original monitoring plan. If there is continued interest in answering this question, one possibility would be to look into the "Risk Reduction Index" used by the Colville National Forest.

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Question 2

What are the effects of fire and/or mechanical treatments on tree survival/mortality by diameter class, changes in ladder fuels, and fuel loading pre/post treatment?

Goal 2.1:
To quantify the effects of prescribed fire and mechanical treatments on vegetation.

Indicator 2.1:
Mortality, Forest Structure, and Fuel Loading.

Analysis 2.1: Mortality, Forest Structure and Fuel Loading

This indicator is addressed with field data collected by the Chewaucan Biophysical Monitoring Team (CBMT). Plot locations were either generated randomly in GIS or determined by selecting a random bearing and distance from the road access point within a treatment unit, but there was not a systematic sampling plan. Each season, the monitoring crew would go into the field and observe as many plots as time allowed. Plots were divided by individual treatment project, but were not stratified by additional factors such as forest type or plant association.

Two thinning treatments in the Deuce planning area contained enough pre-harvest and post-harvest plots to conduct an analysis: Pilot and Olde. The Pilot commercial thinning treatment was conducted in the winter and spring of 2014/2015 using a feller-buncher. The Olde pre-commercial thinning treatment was conducted in the winter/spring of 2015/2016 with the goal of enhancing Late Old Structure (LOS). Depending on the unit, either a chainsaw or a "slash buster" was used.

There were not enough plots in any one thinning treatment in the Jakabe planning area to conduct an analysis by individual treatment. Instead, plots from multiple PCT treatments (Ben Young, Coffeepot and Swamp) were combined. These treatments were conducted in both 2014 and 2015. One thinning treatment from the Crooked Mud Honey (CMH) planning area was completed with enough pre-treatment and post-treatment plots to conduct an analysis. Lil Stewardship, a commercial thinning treatment using tractor logging, was conducted from 2016-19. See Appendix 1A (pages 138-139) for maps of the project areas and plot locations.

Changes in Ladder Fuels/Forest Structure

Ladder fuels refer to a continuous vertical fuel continuity structure that would allow a surface fire to spread to tree crowns and turn into a crown fire. One of the goals of hazard fuel reduction is to increase the space between the ground surface fuels and base of the tree canopy so that crown fire initiation becomes less likely (Agee & Skinner, 2005). The Monitoring Plan did not identify an indicator for ladder fuels, and the CBMT did not record any explicit observations of ladder fuels.

There are many potential methods of quantifying vertical fuel continuity, and these can be quite complicated due to the nature of both surface and aerial fuels (Menning & Stephens, 2007). Crown base height (CBH) is a measure of vertical fuel continuity, and refers to the vertical distance between the ground surface and the base of the tree crown (typically the lowest live branches). Achieving a lift in CBH is one of the principal goals of restoration in dry mixed conifer forests (Agee & Skinner 2005). In terms of fire risk, a lower CBH increases the likelihood that a surface fire will spread to a tree's crown (i.e. "torching"). In dry mixed conifer forests, smaller, younger trees generally have a lower crown base height, so removal of smaller trees is recommended to lift the crown base height and therefore decrease vertical fuel continuity (Fiedler et al., 1998).

Crown fuel base height (CFBH) is a measurement similar to live crown base height (LCBH), and represents vertical distance to the lowest ignitable material on a tree, usually dead needles. Dead needles are not considered part of a tree's live crown, but they are still capable of spreading fire (Keane, 2006). Both LCBH and CFBH were recorded in the field, so both LCBH and CFBH were used in this analysis. CFBH was not recorded for saplings, but saplings generally haven't reached a competition stage where vegetation on lower branches dies off, so LCBH is likely also CFBH for most saplings.

Live Crown Base Height (LCBH)

Methods:

The average live crown base height was calculated for each pre-treatment and post-treatment plot in the four project areas. The plot results were averaged to produce a project area average. The standard error was calculated for each pre-treatment and post-treatment average. A paired t-test was performed for each project area to estimate the change in LCBH following treatment. Results are shown in Table 2.1 and

Figure 2.1 Example of a lift in canopy base height following commercial thinning treatment in Deuce Pilot. Photos courtesy of the CBMT.

Table 2.1 LCBH measurements (feet): pre-treatment, post- treatment, estimated change, lower and upper confidence interval. (One CMH Lil plot was excluded because all trees were removed).

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	6.6	0.8	6.3	0.9	-0.36	-1.7	0.98	7
CMH Lil Stewardship	6.9	0.6	10.2	2.0	**3.3**	0.78	5.9	12
Pre-Commercial Thinning Treatment								
Deuce Olde	9.9	1.8	13.4	1.0	**3.5**	1.4	5.6	4
Jakabe	8.6	3.1	10.2	3.8	1.6	-0.70	3.9	4

Figure 2.2. In Deuce Olde, the average CBH rose by 3.5 feet. In CMH Lil Stewardship, the average LCBH rose 3.3 feet. The t-test found evidence of these lifts in LCBH, though in CMH Lil this could potentially be very small, since the 80% confidence interval indicates the actual change could be as low as 0.78 ft. In Deuce Pilot and Jakabe, the average LCBH was unchanged by treatment. The t-test did not find evidence of a change since the 80% confidence intervals included zero, indicating the LCBH could have risen or dropped. The confidence interval for Deuce Pilot is fairly narrow, indicating that any change would likely have been small. The confidence interval for Jakabe is wider, indicating that the LCBH could have either dropped slightly or lifted up to four feet. Estimated differences for both LCBH and CFBH are shown in Figure 2.3.

Figure 2.2 Pre/Post average live crown base height and crown fuel base height in feet in with standard error about the mean for the four project areas used in this analysis.

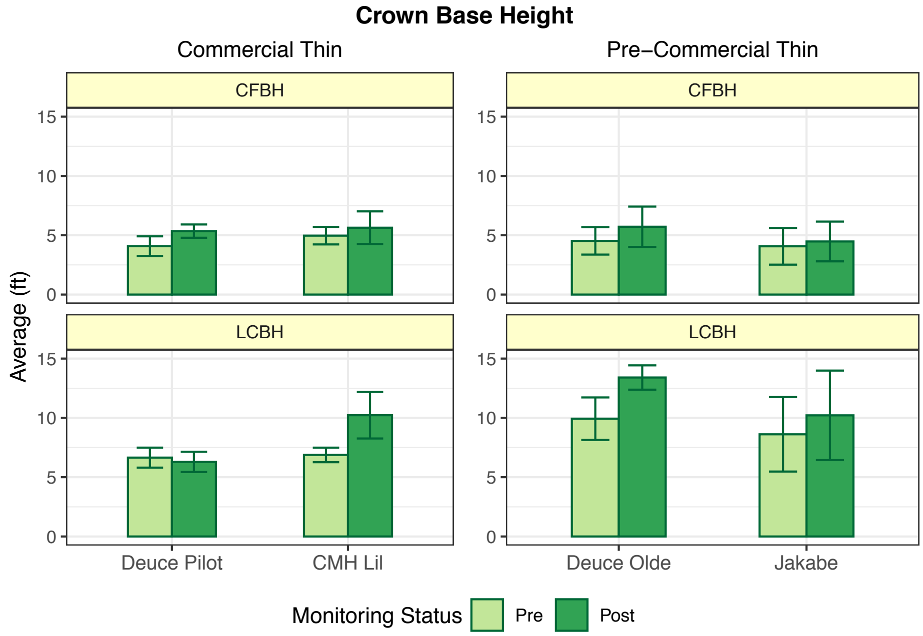
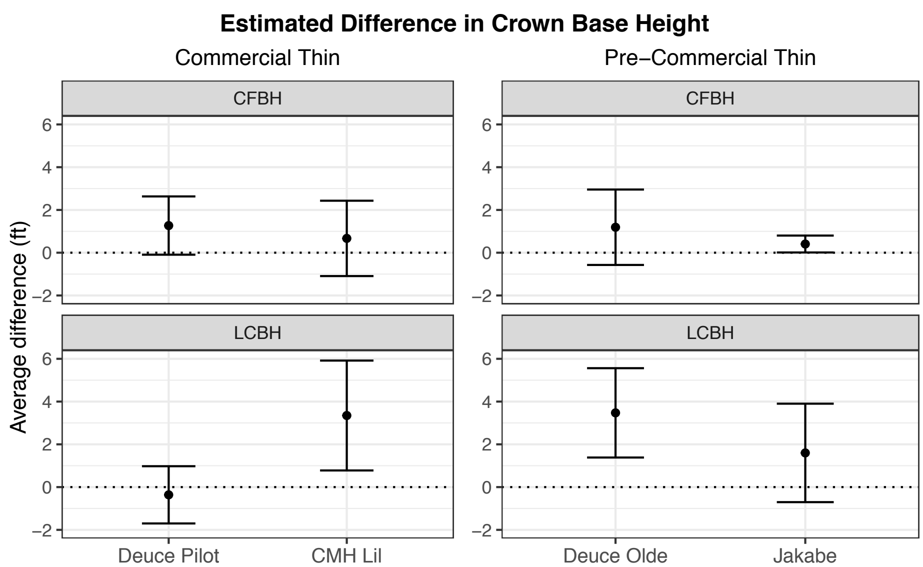


Figure 2.3 Estimated difference in LCBH and CFBH following treatment for each project area. Error bars represent the 80% confidence interval. The dashed line at Y = 0 indicates no change. A positive number indicates a lift in CBH, and a negative number indicates a drop in CBH.



Crown Fuel Base Height (CFBH)

Methods:

The average crown fuel base height was calculated for each pre-treatment and post-treatment plot in the four project areas. The plot results were averaged to produce a project area average. The standard error was calculated for each pre- treatment and post- treatment average. A paired t-test for unequal variation was performed for each project area to estimate the change in CFBH following treatment. Results are shown in Table 2.2 and Figure 2.3.

The only lift in CFBH detected was so small that it was not likely to make much of a difference in fire behavior. In Jakabe, the average lift in CFBH was approximately five inches. The t-test found evidence of this lift, but the confidence interval was very narrow with the upper limit being less than one foot. In Deuce Pilot, Deuce Olde and CMH Lil Stewardship, the average CFBH was unchanged by treatment. The t-test did not find evidence of a change in CFBH since the 80% confidence interval for all three included zero, indicating the CFBH could have either risen or dropped.

Diameter at Breast Height (DBH)

Since there was little to no observed lift in CBH, it should be asked whether there was an increase in average DBH following treatment. While lifting average CBH is a goal of restoration, this is accomplished by removing smaller trees. The removal of smaller trees would result in an increase in DBH following harvest. Table 2.3 shows the observed changes in average DBH. In most cases, the change in average DBH is consistent with the change in average CBH.

In Deuce Pilot, the average DBH dropped following harvest. This is consistent with the lack of change observed in LCBH or CFBH. The drop in DBH is likely due to relatively few saplings being removed, as seen in Table 2.8 in the Mortality section. If more trees are removed in larger DBH classes than in smaller DBH classes, then the average DBH will drop. This is a concerning result, since it shows an increase in hazard rather than a reduction. It is possible that some future management action was planned to remove the saplings, and hadn't taken place before monitoring. The other commercial thinning treatment, CMH Lil Stew-

Table 2.2 CFBH measurements (feet): pre-treatment, post-treatment, estimated change, lower and upper confidence interval. (One CMH Lil plot was excluded because all trees were removed).

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	4.1	0.83	5.3	0.56	1.3	-0.09	2.6	7
CMH Lil Stewardship	5.0	0.74	5.6	1.4	0.67	-1.1	2.4	12
Pre-Commercial Thinning Treatment								
Deuce Olde	4.5	1.2	5.7	1.7	1.2	-0.57	3.0	4
Jakabe	4.1	1.5	4.5	1.7	**0.41**	0.01	0.80	4

Table 2.3 DBH (inches): pre-treatment, post-treatment, estimated change, lower and upper confidence interval for all four project areas. (One CMH Lil plot was excluded because all trees were removed).

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	7.4	1.6	3.6	0.51	-3.8	-6.6	-1.0	7
CMH Lil Stewardship	5.1	0.74	13.5	2.7	8.4	5.2	11.6	12
Pre-Commercial Thinning Treatment								
Deuce Olde	8.9	0.94	12.7	1.4	3.8	0.61	7.1	4
Jakabe	9.6	1.7	10.3	1.9	**0.69**	-0.83	2.2	4

ardship, included a cut/skid/deck agreement with the operator so that small, non-commercial trees were removed as well.

Deuce Olde showed evidence of an increase in average DBH which is consistent with the observed lift in LCBH, though there was no observed change in CFBH. Jakabe showed no evidence of change in DBH, which is consistent with the lack of evidence for a change in LCBH or CFBH. There was evidence of an increase in DBH in CMH Lil, which is consistent with the evidence for a lift in LCBH, though there was no evidence for a change in CFBH.

Ladder Fuels Recommendations

That the monitoring data did not detect much of a change in crown base height indicates that either there was not much of a change or that not enough plots were installed to detect a change. For example, the confidence interval for the change in CMH Lil LCBH (range of likely values for actual change in LCBH) stretched from less than one foot to nearly six feet. A CFBH lift less than one foot would not likely have much of an effect on fire behavior, while a lift of six feet could have a considerable effect. Continued monitoring is recommended in future CT and PCT treatments with a more intensive sampling scheme as described in Question 1.

If the thinning treatments alone did not result in a lift in CBH, following up with a prescribed burn could lift the CBH. Prescribed fire has been shown to have a more uniform and consistent effect on lifting canopy base height than thinning alone (Schwilk et al., 2009). As of this report, prescribed burns have been conducted in Deuce and Jakabe, but none yet in Crooked Mud Honey. A handful of plots have been placed following prescribed burns across Deuce and Jakabe, but not enough to conduct a formal analysis.

It is recommended that pre-burn and post-burn monitoring be conducted in future prescribed fire treatments. While additional plots can be placed in prescribed burns that have already taken place, pre-burn plots are necessary to quantify the change as a result of the burn. Prescribed burns can be extremely variable in terms of effects, so any burn unit monitored must have an adequate spatial distribution of plots.

Fuel Loading

For the purposes of this analysis, fuel loading is taken to mean accumulation of dead woody or leafy material on the ground surface. Downed woody debris (DWD) refers to dead twigs, branches or logs on the forest floor. DWD can be divided into two size classes: fine (FWD) and coarse (CWD). The cutoff between the two size classes is generally considered to be a cross-sectional diameter of 3" (Brown, 1974). FWD, with a smaller surface area to volume ratio, ignites more easily and is quicker to burn out, contributing to fire spread. CWD, with a larger surface area to volume ratio, ignites less easily but burns longer, contributing to fire effects or soil burn severity (Lutes & Keane, 2006).

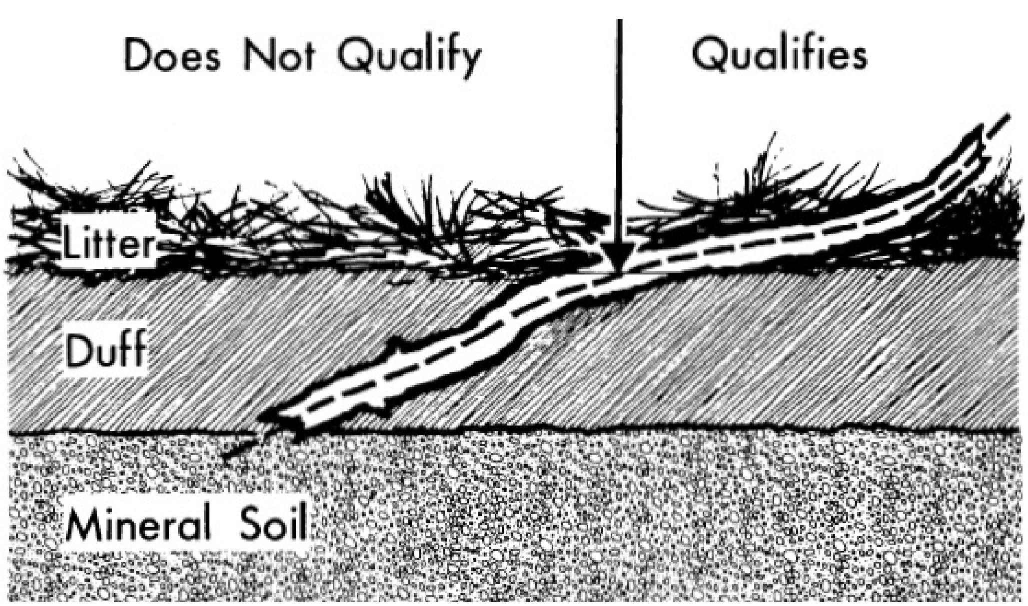
FWD is further divided into three size classes. Each size class is based on the time it takes for a fuel particle to respond to changes in relative humidity (Bradshaw et al., 1984). The FWD classes are 1-hour, 10-hour, and 100-hour. The CWD class is 1000-hr.

Fuel loading of DWD is calculated in weight per unit area. This analysis uses the measure of tons per acre. Measurement and analysis are conducted in accordance with protocols in the Handbook for Inventorying Downed Woody Material (Brown, 1974). In the field, particles in each size category are counted along a transect. These counts are then input in formulas to calculate the total fuel loading. Since the FWD influence on fire behavior differs from CWD, the fuel loading from each category was calculated separately.

DWD generally does not decrease immediately following harvest due to the slash that results from felling and limbing trees, but management actions such as piling and burning slash can be used to minimize the increase in surface fuels following harvest (Graham et al., 2004). In all four treatments analyzed here, slash was piled following harvest and burned a year later. All post-treatment observations used in this analysis were taken within the year following treatment, and can be used to evaluate the effectiveness of slash removal methods. Longer-term revisits will be necessary in order to study the change in DWD levels over time as the result of a thinned canopy and prescribed fire

Also included in the category of surface fuel loading are litter and duff. Litter consists of recently fallen leaves and needles, and duff consists of partially decomposed leaves and needles. Like FWD, litter contributes to surface fire spread. Like CWD, duff contributes to fire effects. Like DWD, litter loading can be expected to increase following harvest as a result of the slash. However, piling and burning will not always reduce the litter resulting from slash. Prescribed fire is generally considered the most effective way to reduce litter and duff levels (Graham et al., 2004).

Figure 2.4 Illustration of surface fuels: DWD, litter and duff. Diagram adapted from Brown (1974).



Fine Woody Debris

Methods:

The FWD loading was calculated for each plot using equations from Brown (1974), and averaged for each project area. The standard error was calculated for each pre-treatment and post-treatment average. A paired t-test was performed for each project area to estimate the change in FWD loading following thinning treatment. Results are shown in Table 2.4 and Figure 2.6.

In all four projects, the average FWD loading was unchanged by treatment. The t-test did not find evidence of a change in FWD loading since the 80% confidence interval for all four projects included zero, indicating the FWD loading could have either risen or dropped. The confidence intervals for the two commercial thinning treatments were narrow, indicating that any change would have been small and therefore unlikely to have a large effect on influence fire behavior. The confidence intervals for the two pre-commercial thinning treatments were wide, indicating the change could have been anywhere from a small decrease to a large increase. The averages, an increase of 7.2 tons/ac in Deuce Olde and 14.2 tons/ac in Jakabe, are both large enough to contribute to an increase in fire behavior. Estimated differences for both FWD and CWD are shown in Figure 2.7.

Table 2.4 FWD loading in tons/acre: pre-treatment, post-treatment, estimated change, lower and upper confidence interval.

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	6.8	2.2	6.9	1.6	0.09	-2.6	2.7	7
CMH Lil Stewardship	4.5	0.61	4.2	0.43	-0.30	-1.4	0.8	13
Pre-Commercial Thinning Treatment								
Deuce Olde	5.5	0.74	12.6	4.7	7.2	-0.02	14.4	4
Jakabe	4.2	0.65	18.4	10.1	**14.2**	-3.0	31.4	4

Figure 2.5 Fine woody debris seen in a plot in Deuce Pilot. Photo courtesy of the CBMT.

Figure 2.6 Pre/Post average DWD loading in tons/ac with standard error about the mean for the four planning areas used in this analysis.

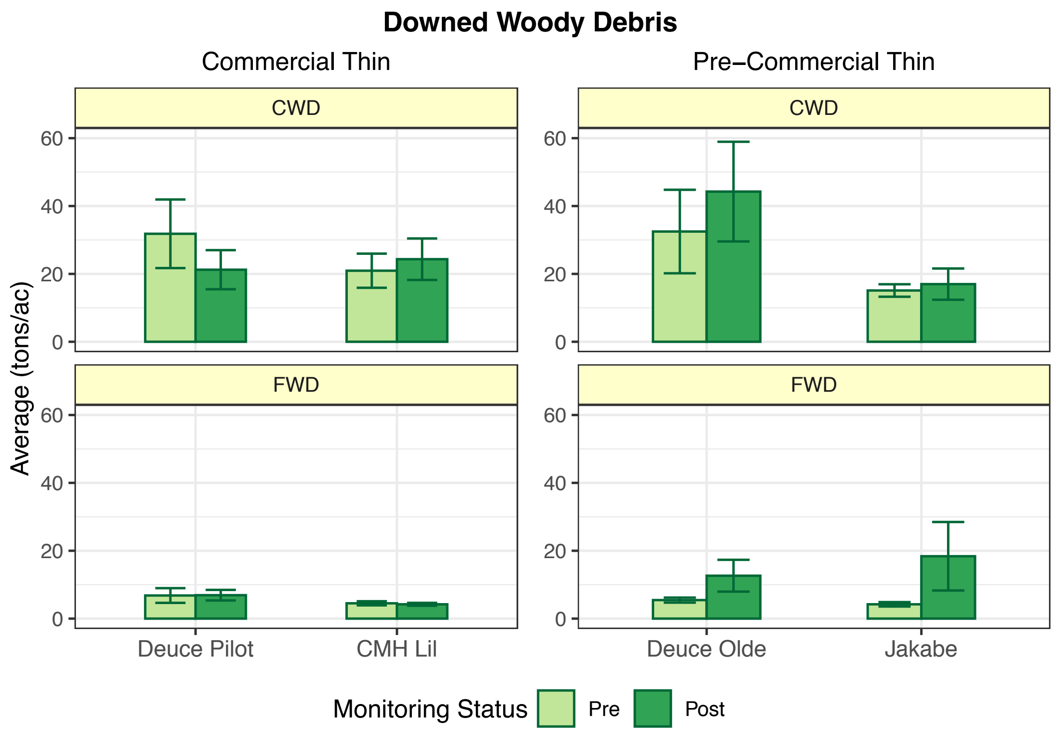
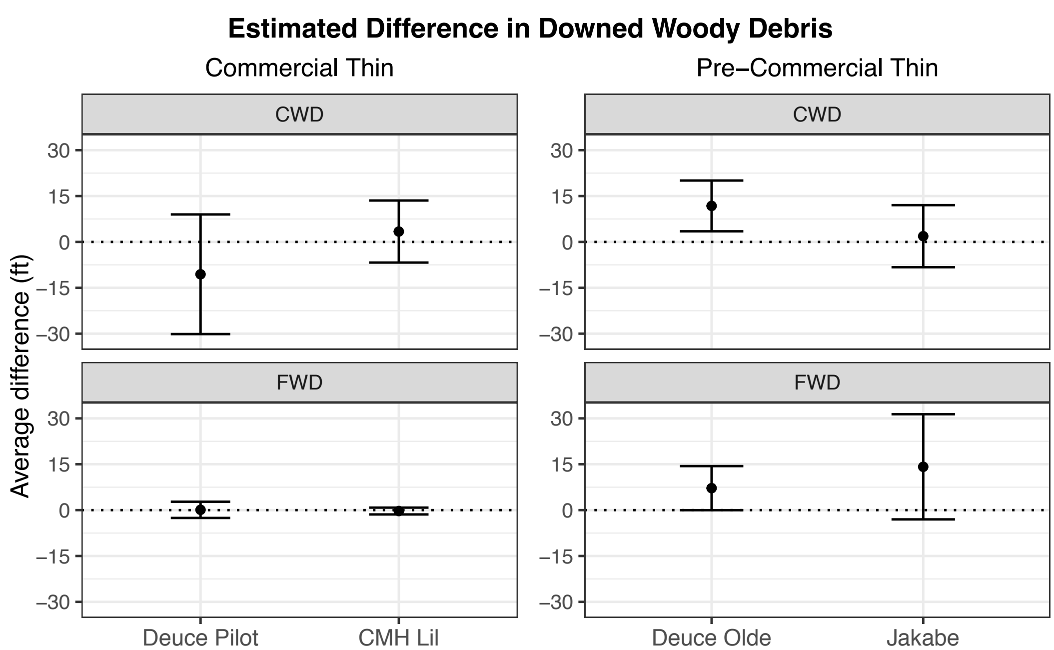


Figure 2.7 Estimated difference in DWD following thinning treatment for each project area. Error bars represent the 80% confidence interval. The dashed line at Y = 0 indicates no change. A positive number indicates an increase in DWD, and a negative number indicates a decrease in DWD.



Coarse Woody Debris

Methods:

The CWD loading was calculated for each plot using equations from Brown (1974), and averaged for each project area. The standard error was calculated for each pre-harvest and post-harvest average. A paired t-test for unequal variation was performed for each project area to estimate the change in CWD loading following thinning treatment. Results are shown in Table 2.5 and Figure 2.7.

The average CWD loading increased by 11.8 tons/ac. The t-test found evidence of this increase, though it could have been as small as 3.5 tons/ac or as large as twenty tons/ac. The average CWD loading for the other three project areas was unchanged by treatment. The t-tests did not find evidence of a change in CWD loading since the 80% confidence interval included zero, indicating the CWD loading could have either risen or dropped. The confidence intervals for all three projects were so wide that it was not clear whether there was a small effect or a large effect.

DWD Recommendations

It is important to note that immediate post-treatment results are only part of monitoring the effectiveness of restoration treatments on fuel loading. While minimal change in fuel loading is desirable immediately following treatment, the fuel loading should drop from the pre-treatment baseline in the years following treatment to be truly considered successful. The results used in this analysis are from the year immediately following treatment, so it is recommended that follow-up observations be conducted at 5 years post-treatment.

Table 2.5 CWD loading in tons/acre: pre-treatment, post-treatment, estimated change, lower and upper confidence interval.

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	31.8	10.1	21.2	5.8	-10.6	-30.1	9.0	7
CMH Lil Stewardship	20.9	5.0	24.3	6.1	3.4	-6.8	13.5	13
Pre-Commercial Thinning Treatment								
Deuce Olde	32.5	12.3	44.3	14.7	11.8	3.5	20.1	4
Jakabe	15.1	1.8	17.0	4.6	**1.9**	-8.3	12.0	4

Figure 2.8 CWD crossing a transect in Jakabe Ben Young pre-commercial thinning treatment. Photo courtesy of the CBMT.

Both of the commercial thinning treatments, Deuce Pilot and CMH Lil, showed a minimal change in FWD loading. The range of potential differences is close enough to zero that the LSG may feel comfortable accepting the effectiveness of pile and burn treatments for commercial harvests in mitigating an increase in FWD immediately following harvest. FWD appeared to increase in both PCT treatments, but as noted in Question 1, continued monitoring of fuel loads with a more intensive sampling scheme is recommended in future thinning treatments.

It is also worth noting that the PCT treatments analyzed here were conducted in 2015 and 2016, four to five years prior to this report. PCT methods may have changed in the interim. Another consideration is that this analysis reflects the results of mechanical thinning only. As with change in crown base height, prescribed fire could contribute to lower fuel loading (Graham et al., 2004), and the same prescribed fire monitoring recommendations apply. CWD can be a component of wildlife habitat, so there may be interest in leaving a certain amount of CWD. Prescribed burning can be scheduled in the spring to reduce fine fuels and spare coarse fuels if desired, since coarse fuels will retain more moisture in the spring than in the fall (Estes et al., 2012).

Litter

Methods:

Litter depth measurements were taken at ten spots along the transects in each plot. The depth measurements were averaged at the plot level and converted to tons per acre using a bulk density of 2.75 lb/ft3 (FFI Team, 2018). Plot-level loading was averaged to produce a project-level average. The standard error was calculated for each pre-harvest and post-harvest average. A paired t-test for unequal variation was performed for each project area to estimate the change in litter loading following treatment. Results are shown in Table 2.6 and Figure 2.9.

The average litter loading was unchanged by treatment in all four project areas. The t-tests did not find evidence of a change in litter loading since the 80% confidence interval included zero, indicating the litter loading could have either risen or dropped. The confidences intervals are narrow enough that any change would likely have been small. Estimated differences for both litter and duff are shown in Figure 2.11

Duff

Methods:

Duff depth measurements were taken at ten spots along the transects in each plot. The depth measurements were averaged at the plot level and converted to tons per acre using a bulk density of 5.5 lb/ft3 (FFI Team, 2018). The plot-level loading was averaged to produce a project area average. The standard error was calculated for each pre-harvest and post-harvest average. A paired t-test for unequal variation was performed for each project area to estimate the change in duff loading following treatment. Results are shown in Table 2.7 and Figure 2.11.

Table 2.6 Litter loading in tons/acre: pre-treatment, post-treatment, estimated change, lower and upper confidence interval. (One Deuce Olde plot was excluded due to lack of post-treatment observations).

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	1.7	0.36	2.0	0.38	0.30	-0.37	0.98	7
CMH Lil Stewardship	3.0	0.37	2.7	0.43	-0.29	-0.96	0.37	13
Pre-Commercial Thinning Treatment								
Deuce Olde	1.8	0.75	2.3	0.88	0.51	-1.3	2.3	3
Jakabe	1.8	0.85	3.1	1.35	**1.3**	-0.93	3.6	4

Figure 2.9 CWD crossing a transect in Jakabe Ben Young pre-commercial thinning treatment. Photo courtesy of the CBMT.

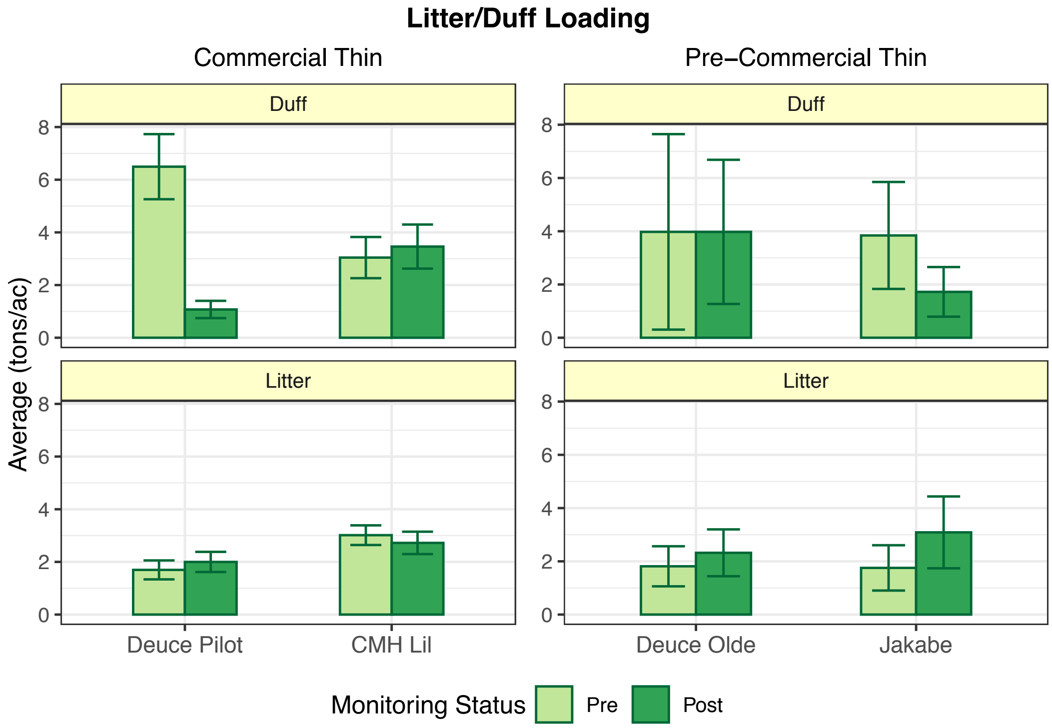
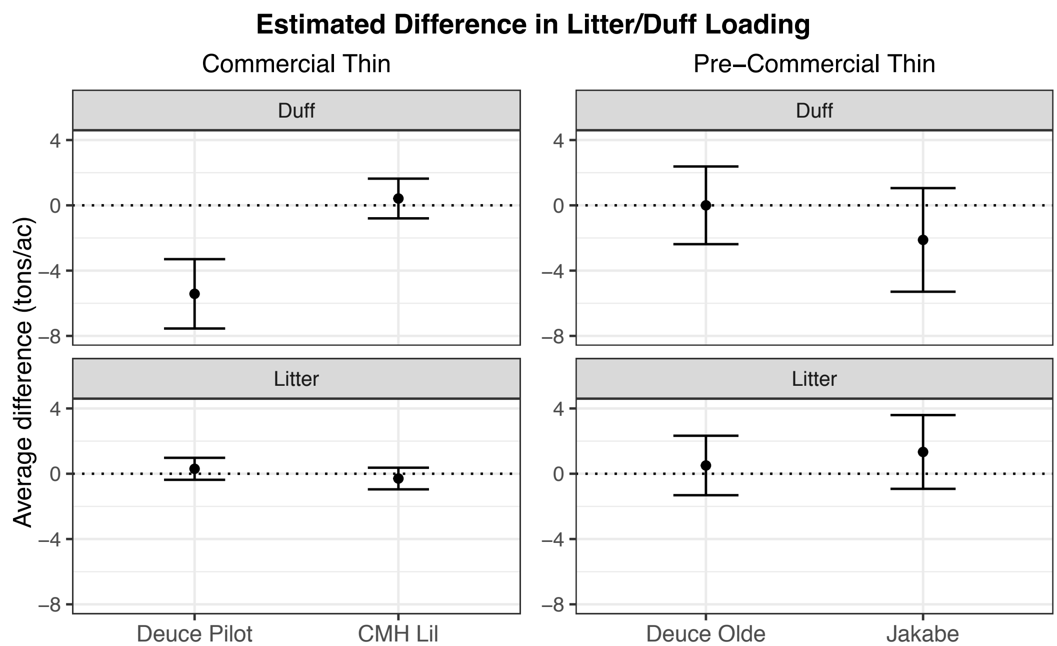


Figure 2.10 Example of litter on the forest floor seen in a plot in Deuce Pilot. Photo courtesy of CBMT.

Table 2.7 Duff loading in tons/acre: pre- and post-treatment, estimated change, lower and upper confidence interval.

Project	Pre	+/-	Post	+/-	Change	Lower CI	Upper CI	# Plots
Commercial Thinning Treatment								
Deuce Pilot	6.5	1.2	1.1	0.33	-5.4	-7.5	-3.3	7
CMH Lil Stewardship	3.0	0.78	3.5	0.84	0.42	-0.80	1.6	13
Pre-Commercial Thinning Treatment								
Deuce Olde	4.0	3.7	4.0	2.7	0.0	-2.4	2.4	3
Jakabe	3.8	2.0	1.7	0.93	**-2.1**	-5.3	1.1	4

Figure 2.11 Estimated difference in litter/duff loading for each project area following thinning. Error bars represent the 80% confidence interval. The dashed line at Y = 0 indicates no change. A positive number indicates an increase in loading; a negative number indicates a decrease in loading.



Litter and Duff Recommendations

The estimated differences and variation in litter loading were generally close enough to zero that the effect on fire behavior is likely minimal. The variation in the duff measurements was greater than in the litter measurements, but not overly so. The data did not show any reason to be concerned about an increase in litter and duff levels as the result of commercial or pre-commercial thinning treatment. However, the long-term goal of restoration is to reduce litter and duff loading, and as with DWD, success will not be apparent immediately following harvest. Longer-term revisits will be necessary to observe the long-term results of litter and duff loading. In addition, monitoring plots are recommended in prescribed fire treatments, since prescribed fire has been shown to be effective in preventing a buildup of litter and duff (Graham et al., 2004).

Monitoring of surface fuels including DWD, litter and duff has value beyond assessing the effectiveness of restoration treatments. Fire management personnel may be interested in information on fuel loading in order to plan for wildland fire suppression or prescribed burning. Therefore, even if the LSG is satisfied with the monitoring results for fuel loading, the fire and fuels staff of the Fremont-Winema NF may be interested in continuing to monitor fuel loading.

Survival and Mortality by Diameter Class

This portion of Question 2 concerns the effect of treatments on tree survival and mortality by diameter class. Unlike a measure such as crown base height, results will not necessarily be noticeable immediately following treatment. As of this report, the only revisits conducted were immediately following harvest, so no longer-term trends would be apparent yet.

In the Monitoring Plan, no target distributions were established by diameter at breast height (DBH) class beyond the requirement of the Eastside Screens that all trees with a DBH over 21” be retained. No measure of success was established in terms of mortality increasing, decreasing, or staying the same outside of the retention of trees protected under the Eastside Screens. For these two reasons, a formal statistical analysis was not conducted for this indicator. Standard error about the mean was calculated in order to show the amount of variation, but error bars were not depicted on the graphs. This analysis will focus primarily on changes in snag distribution by DBH class. Additional conclusions regarding the impact of restoration on forest health can be drawn from DBH distributions of live trees, but these are addressed in Question 3.

Methods:

In each plot, trees and snags were measured in a 0.1-acre circular plot, and saplings were measured in a 0.01-acre circular plot. Measured trees and snags were divided into 4-inch DBH classes, and the average number of stems per acre in each DBH class was calculated for each plot. The plot totals were then averaged to the project level.

Deuce Pilot

There were no snags observed in the sapling (0” – 4”) DBH class before or after treatment. In the smaller non-sapling DBH classes, the average number of snags per acre fell slightly following treatment. In the larger DBH classes, there were so few snags that an overall increase or decrease was difficult to detect. Results are shown in Table 2.8.

Figure 2.12 shows the distribution of snags and large trees by DBH class. Saplings were excluded because the number of live saplings was so great that including them in the graph would obscure the results in the other DBH classes, and there were no snags observed in the sapling DBH class. One white fir tree with DBH greater than 21” was removed in the observed plots, but an amendment was granted for the Deuce project allowing removal of white fir with DBH greater than 21” in certain situations.

Table 2.8 Average stems per acre and standard error about the mean for live trees and snags by DBH class before and after treatment in Deuce Pilot (n = 7 plots).

	Pre-Treatment				Post-Treatment			
	Live Trees		Snags		Live Trees		Snags	
DBH Class	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-
0-4 in	574	322	0	0	430	86	0	0
4-8 in	80	28	4	3	31	15	1	1
8-12 in	47	16	6	3	21	6	4	3
12-16 in	34	7	1	1	27	8	1	1
16-20 in	13	5	1	1	7	3	1	1
20-24 in	4	2	1	1	3	2	1	1
24-28 in	1	1	0	0	0	0	0	0
28+ in	3	2	1	1	3	2	0	0

Deuce Olde

No snags were observed in the sapling (0" – 4") DBH class before or after treatment. The average number of snags per acre in the smaller non-sapling DBH classes did not change following treatment. No snags were observed pre-treatment or post-treatment in the larger DBH classes. Results are shown in Table 2.9.

Figure 2.14 shows the distribution of snags and large trees by DBH class. Saplings were excluded because the number of live saplings was so great that including them in the graph would obscure the results in the other DBH classes. In addition, no snags were observed in the sapling DBH class.

Figure 2.12 Average stems per acre by DBH class for live trees and snags before and after treatment in Deuce Pilot, excluding saplings (0"-4" DBH).

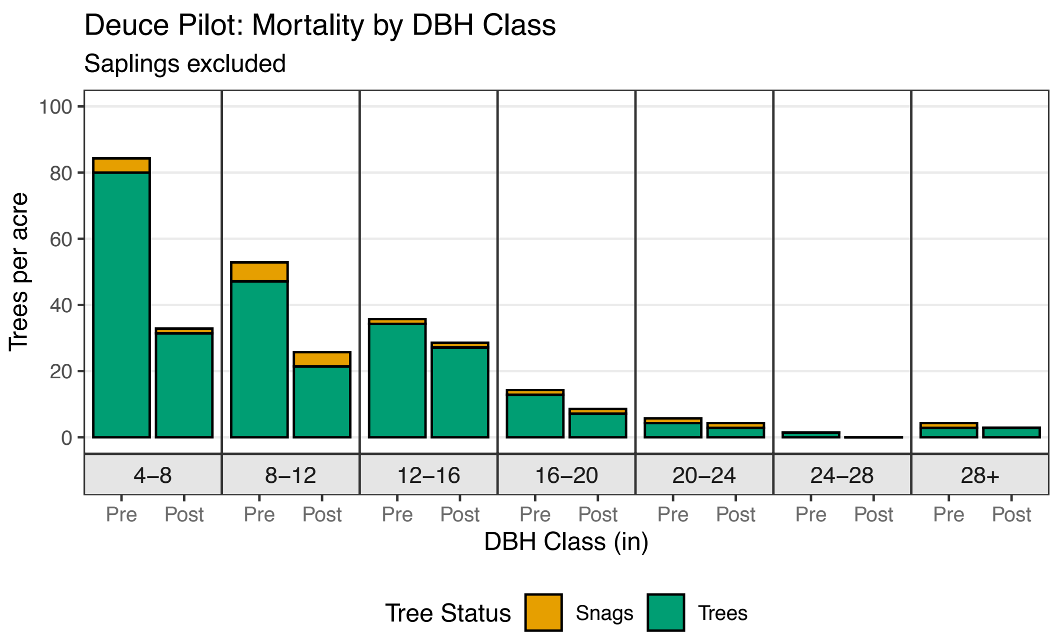
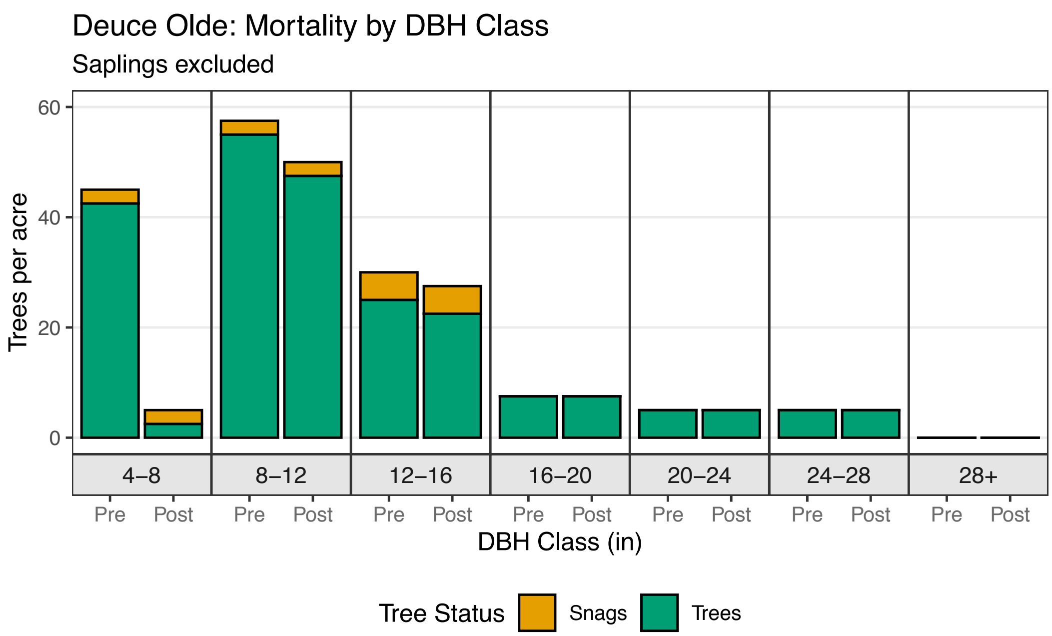


Table 2.9 Average stems per acre and standard error about the mean for live trees and snags by DBH class before and after treatment in Deuce Olde (n = 4 plots).

	Pre-Treatment				Post-Treatment			
	Live Trees		Snags		Live Trees		Snags	
DBH Class	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-
0-4 in	50	50	0	0	0	0	0	0
4-8 in	43	22	3	3	3	3	3	3
8-12 in	55	12	3	3	48	14	3	3
12-16 in	25	6	5	5	23	6	5	5
16-20 in	8	5	0	0	8	5	0	0
20-24 in	5	3	0	0	5	3	0	0
24-28 in	5	5	0	0	5	5	0	0
28+ in	0	0	0	0	0	0	0	0

Figure 2.13 Snag in Deuce Olde precommercial thinning treatment. Photo courtesy of the CBMT.

Figure 2.14 Average stems per acre by DBH class before and after treatment for live trees and snags in Deuce Olde, excluding saplings (0”- 4” DBH).



Jakabe

No snags were observed in the sapling (0" – 4") DBH class before or after treatment. Little change was observed following treatment in the smaller non-sapling DBH classes. Few snags were observed in the largest DBH classes. Results are shown in Table 2.10. Figure 2.15 shows the distribution of snags and live trees by DBH class.

Table 2.10 Average stems per acre and standard error about the mean for live trees and snags by DBH class before and after harvest in the Jakabe harvests (n = 4 plots).

	Pre-Treatment				Post-Treatment			
	Live Trees		Snags		Live Trees		Snags	
DBH Class	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-
0-4 in	50	50	0	0	0	0	0	0
4-8 in	85	24	8	8	63	34	8	8
8-12 in	38	18	3	3	35	19	3	3
12-16 in	33	16	3	3	30	17	3	3
16-20 in	8	8	5	3	8	8	5	3
20-24 in	8	9	0	0	18	9	0	0
24-28 in	5	5	0	0	5	5	0	0
28+ in	0	0	0	0	0	0	0	0

Figure 2.15 Average stems per acre by DBH class for live trees and snags in Jakabe before and after treatment.

Crooked Mud Honey Lil Stewardship

The average number of snags fell following treatment in the smaller DBH classes, including saplings. No snags were observed in the larger size classes. Results are shown in Table 2.11.

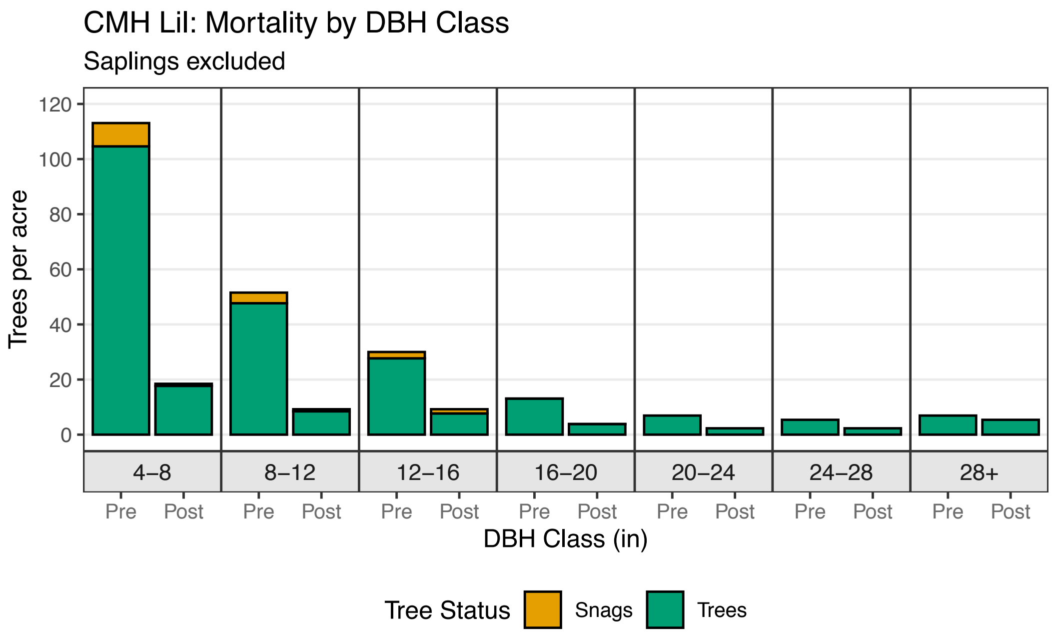
Figure 2.17 shows the distribution of snags and large trees by DBH class excluding saplings. The number of live saplings was so great that including them in the graph would obscure the results in the other DBH classes. In addition, an average of only one sapling snag per acre was observed prior to treatment; this would not show up on a graph. Six white fir trees with DBH greater than 21" were removed in the observed plots, but an amendment was granted for the CMH project allowing removal of white fir with DBH greater than 21" in certain situations.

Table 2.11 Average stems per acre and standard error about the mean for live trees and snags by DBH class before and after treatment in Crooked Mud Honey Lil Stewardship (n = 13 plots).

	Pre-Treatment				Post-Treatment			
	Live Trees		Snags		Live Trees		Snags	
DBH Class	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-	Stems/ac	+/-
0-4 in	535	128	1	1	47	22	0	0
4-8 in	105	16	8	6	18	6	1	1
8-12 in	48	8	4	4	8	2	1	1
12-16 in	28	5	2	2	8	3	2	2
16-20 in	13	3	0	0	4	2	0	0
20-24 in	7	2	0	0	2	1	0	0
24-28 in	5	2	0	0	2	1	0	0
28+ in	7	3	0	0	5	2	0	0

Figure 2.16 Pre/post-treatment view of a snag in CMH Lil Stewardship. Photo courtesy of the CBMT.

Figure 2.17 Average stems per acre by DBH class for live trees and snags before and after treatment in Crooked Mud Honey Lil Stewardship, excluding saplings (0”-4” DBH class).



Mortality Recommendations

With only immediate post-treatment revisits, no conclusions can be drawn about the long-term effects of management on survival and mortality by DBH class. It is recommended that revisits be conducted at five years following harvest in order to observe the long-term effects of thinning projects on tree survival and mortality by DBH class. For Deuce Pilot, the fifth year following treatment is the same year this report was compiled. Deuce Olde, Jakabe and Crooked Mud Honey will reach five years post-treatment in the years following this report.

It is important to note that the treatments analyzed here represent mechanical thinning only. Prescribed burning will have a different effect on tree survival and mortality by DBH class than commercial and pre-commercial thinning, since mortality can be delayed. Therefore, it is recommended that pre-burn, post-burn, and five-year follow-up visits be conducted in future prescribed burns.

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Question 3.1

What is the effect of the treatments on moving the Forest landscape toward a more sustainable condition that includes scale and intensity of historic disturbances?

Goal 3.1:
To assess whether treatments have resulted in sustained or improved resiliency/ resistance to insects, disease, and drought.

Indicator 3.1:
Projection of a stand's resistance to wildfire, insects and disease, and drought based on past radial growth and other stand data.

Analysis 3.1: Resilience and Resistance

The Monitoring Plan called for the collection of Common Stand Exam (CSE) data to address this question. CSE data can be entered into the FSVeg software program, which includes a suite of tools for assessing stand health and condition (USDA USFS NRM 2015). The collection of CSE data never took place, so this question cannot be analyzed as originally intended. The existing monitoring data collected by the crew can be used to address this question, but not with the tools that would have been available with CSE data and FSVeg software. Pre-treatment radial growth data has been collected, but post-treatment radial growth will not be collected until longer-term revisits are conducted. No specific indicators of resilience or resistance to disturbance are provided for this question, and "other stand data" is not specified. For this analysis, residual basal area was used to assess resistance and diameter distributions were used to assess resilience.

Resistance refers to a forest's ability to withstand the effects of disturbance without significant impact (DeRose & Long, 2014). Stocking levels are commonly used as indicators of susceptibility to disturbance, since stocking affects the amount of resources available to trees. Trees with fewer resources available are less likely to survive disturbance-induced stress. Stands with stocking levels higher than their historical rage of variation (HRV) or higher than supported by site productivity become more vulnerable to disturbances such as wildland fire, insects and disease (Hessburg et al., 2015). There are multiple ways to quantify stocking levels, and basal area is used here. Basal area (BA) refers to the total cross-sectional area at breast height of all trees in a stand. It is used because most silvicultural prescriptions set residual BA targets for harvest based on the stocking level a given site can support. The results presented here may be used to assess whether BA targets are being met.

Resilience refers to a forest's ability to recover or regrow following a disturbance (DeRose & Long, 2014). One method of assessing stand resilience is by age/ size class distribution. A stand with trees across multiple age classes is more likely to recover following a disturbance than a stand with trees in one age class (O'Hara 2006, O'Hara & Ramage, 2013). If mature trees are lost, then younger trees can grow and replace them. If young trees are lost, then mature trees can provide a seed source for regeneration. The inclusion of multiple age classes in a single stand will naturally lead to a concern about the presence of vertical fuel continuity (i.e., ladder fuels); however, as long as gaps and horizontal distance are maintained between individuals and clumps of each age class, the fuel continuity issue can be avoided (Moghaddas et al., 2010). Since age is difficult to determine in the field, diameter at breast height (DBH) is generally used as an indicator of age. Each project in this analysis was assessed for a sustainable DBH class distribution.

As mentioned earlier, this indicator was addressed with data collected by the Chewaucan Biophysical Monitoring Team (CBMT). Plot locations were either generated randomly in GIS, or determined by selecting a random bearing and distance from the road access point within a harvest unit. Each season, the monitoring crew would go into the field and observe as many plots as time allowed. Plots were divided by individual treatment project, but not stratified by additional factors such as forest type or plant association.

Two thinning treatments in the Deuce planning area contained enough pre-harvest and post-harvest plots to conduct an analysis: Pilot and Olde. The Pilot commercial thinning treatment was conducted in the winter and spring of 2014/2015 using a feller-buncher. The Olde pre-commercial thinning treatment was conducted in the winter/spring of 2015/2016 with the goal of enhancing Late Old Structure (LOS). Depending on the unit, either a chainsaw or a "slash buster" was used.

There were not enough plots in any one thinning treatment in the Jakabe planning area to conduct an analysis by individual treatment. Instead, plots from multiple PCT treatments (Ben Young, Coffeepot and Swamp) were combined. These treatments were conducted in both 2014 and 2015. One thinning treatment from the Crooked Mud Honey (CMH) planning area was completed with enough pre-treatment and post-treatment plots to conduct an analysis. Lil Stewardship, a commercial thinning treatment using tractor logging, was conducted from 2016-19. See Appendix 1A (pages 138-139) for maps of the project areas and plot locations.

Resistance: Basal Area

Residual BA targets were set by project and specified in the Environmental Assessment (EA) document. For the Deuce planning area, targets were set by forest type. The target BA range for ponderosa pine forest was 30 – 50 ft^2/ac, and the target BA range for mixed conifer forest was 40 – 60 ft^2/ac. Both Deuce Pilot and Deuce Olde are mixed-conifer forests composed primarily of ponderosa pine and white fir, with some lodgepole pine and sugar pine as well. For both of these harvests, the target residual BA range of 40 – 60 ft^2/ac was used. The EA also specified that variation in residual BA is expected throughout the project area, consistent with the HRV. Therefore, a considerable amount of error about the mean for the post-harvest BA is expected.

Jakabe BA targets also differed by forest type. The target BA range for ponderosa pine forest was 20 – 40 ft^2/ac, and the target BA range for mixed conifer forest was 30 – 50 ft^2/ac. The Jakabe pre-commercial thinning treatments monitored fall in mixed conifer forest, so the 30-50 ft^2/ac target residual BA range for mid-seral mixed conifer was used.

CMH Lil Stewardship is located in the North Warner mountains, a different ecological setting from Deuce and Jakabe. At a higher elevation, the site productivity is higher. As a result, the potential stocking levels are higher. The target BA range for ponderosa pine forest was 40 – 70 ft^2/ac, and the target BA range for mixed conifer forest was 60 – 90 ft^2/ac. The prescriptions specified that some areas would not reach target BA due to the number of trees with DBH greater than

Figure 3.1 Pretreatment and post-treatment photos from a plot in Deuce Pilot. Photos courtesy of CBMT.

21”. Additional units were added after the initial prescription had been released. These were mixed conifer forest with a target BA range of 40 – 60 ft^2/ac.

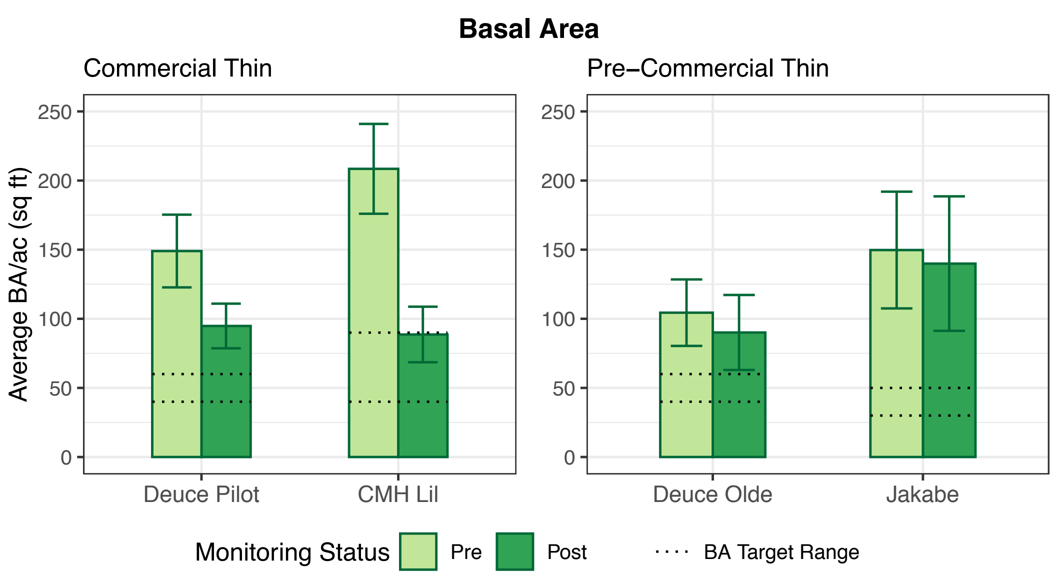
Since the monitoring question asks whether restoration resulted in a resilient/resistant forest structure, the post-treatment basal area (as opposed to change in basal area) is addressed here. BA results are shown in Table 3.1 and Figure 3.2. In the pre-commercial thinning treatments, the target residual BA range will not likely be reached because only small trees are being removed.

The average residual BA in Deuce Pilot was 95 ft^2/ac. When the standard error is considered, the average could have been as low as 79 ft^2/ac or as high as 111 ft^2/ac. The entire range is above the upper BA target. The average residual BA in Deuce Olde was 89 ft^2/ac. When the standard error is considered, the average could have been as low as 69 ft^2/ac or as high as 109 ft^2/ac. The entire range is above the upper BA target. The average residual BA in Jakabe was 140 ft^2/ac. When the standard error is considered, the average could have been as low as 91 ft^2/ac or as high as 189 ft^2/ac. The entire range is above the upper BA target. The average residual BA in CMH Lil Stewardship was 90 ft^2/ac. When the standard error is considered, the average could have been as low as 63 ft^2/ac or as high as 117 ft^2/ac. The average residual BA is at the upper end of the range, and the error possibly places the average within the target range.

Table 3.1 Average basal area per acre (ft^2/ac): pre-treatment, post-treatment, and target residual BA range. The CMH range is a composite of ranges for different forest types.

Project	Pre	+/-	Post	+/-	Change	# Plots	Target BA Range
Commercial Thinning Treatment							
Deuce Pilot	149	26	95	16	-54	7	40 – 60 ft^2/ac
CMH Lil Stewardship	104	24	90	27	-14	13	40 – 90 ft^2/ac
Pre-Commercial Thinning Treatment							
Deuce Olde	208	32	89	20	-119	4	40 – 60 ft^2/ac
Jakabe	150	42	140	49	-10	4	30 – 50 ft^2/ac

Figure 3.2 Pre/Post average BA in ft^2/ac with standard error about the mean for the four planning areas used in this analysis. Dashed lines represent the range of target residual BA.



The range provided for CMH Lil is actually a composite of three ranges, since the CMH Lil plots fall into three different prescriptions. One is a prescription for mixed conifer forest type, one is a prescription for ponderosa pine forest type, and the third is for a subsequent add-on of mixed conifer forest type. Results are shown in Table 3.2 and Figure 3.4.

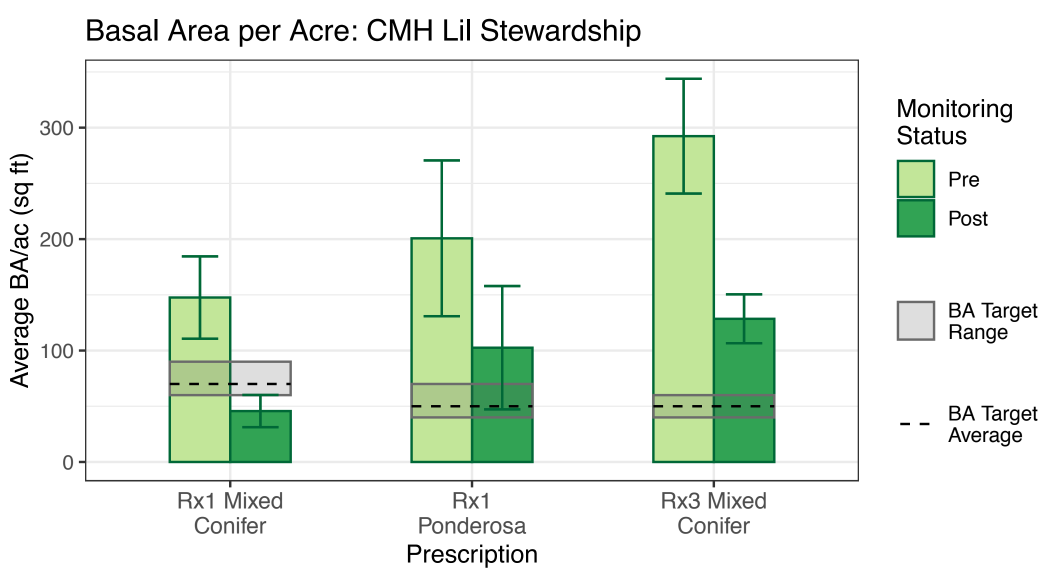
In the mixed conifer units of Rx1, the residual basal area was below the target range. In the mixed conifer units of Rx3, the residual basal area was above the target range. In the ponderosa units of Rx1, the average residual basal area was above the target range, although the variation shows that some units were within range.

Table 3.2 Average basal area per acre (ft^2/ac): pre-harvest, post-harvest, and target residual BA range for the three different CMH Lil Stewardship prescriptions.

Prescription	Pre	+/-	Post	+/-	Change	# Plots	Target BA Range
Rx1 Mixed Conifer	148	37	46	14	102	5	60 – 90 ft^2/ac
Rx1 Ponderosa	201	70	103	55	98	4	40 – 70 ft^2/ac
Rx3 Mixed conifer	292	52	128	22	164	4	50 – 70 ft^2/ac

Figure 3.3 Pretreatment and post-treatment photos from a plot in CMH Lil. Photos courtesy of CBMT.

Figure 3.4 Pre/Post average BA in ft^2/ac with standard error about the mean for the three CMH Lil prescriptions. Dashed lines represent target average BA, and the shading represents target BA range.

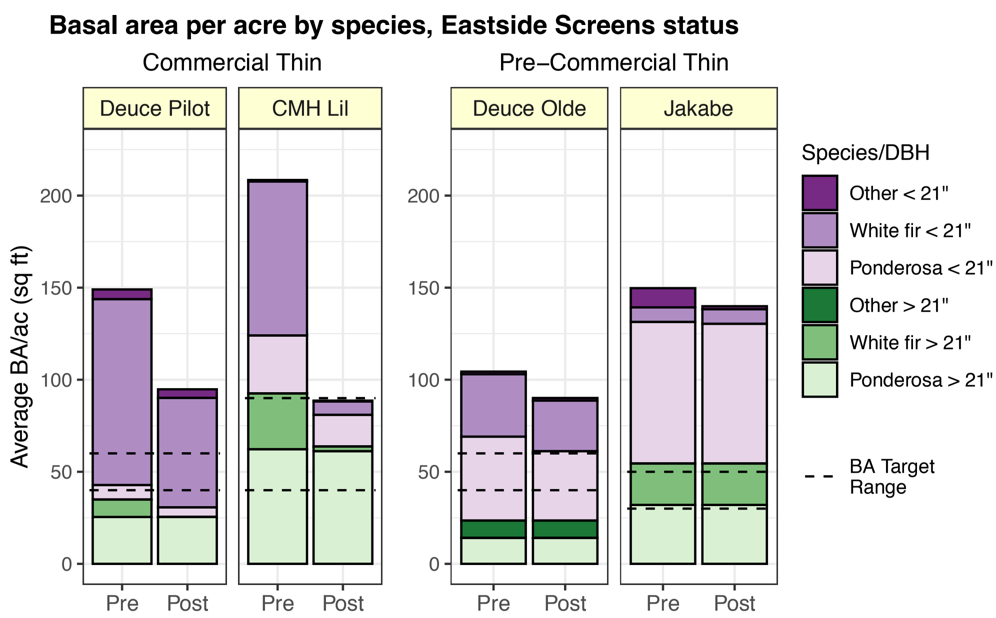


Since the Eastside Screens prevent the harvest of any tree over 21” in DBH, it is worth checking how much of the residual basal area was in trees protected by the Eastside Screens. Figure 3.5 shows a breakdown of basal area divided into trees over and under 21” DBH. Basal area is also divided by species, since forest plan amendments have been made to harvest shade-tolerant, fire-intolerant tree species over 21” DBH such as white fir. One item of concern unrelated to the Eastside Screens is the amount of BA left in small white fir in Deuce Pilot. Leaving a large amount of small shade-tolerant, fire-intolerant trees is not consistent with restoration goals.

In the mixed conifer units of Rx1, the residual basal area was below the target range. In the mixed conifer units of Rx3, the residual basal area was above the target range. In the ponderosa units of Rx1, the average residual basal area was above the target range, although the variation shows that some units were within range.

It is important to remember that the structure of Eastside ponderosa pine and mixed conifer forests are inherently variable. While some areas may have higher concentrations of large trees that prevent a target BA from being reached, this may be offset by leaving a lower BA in other areas. This is explicitly stated in the Deuce EA and the CMH prescriptions. There is much more discussion to be had on this subject, and it is not the intent of this report to delve deeply into the Eastside Screens, especially considering the small sample size. However, the data show that it could be wise to agree on guidelines for how to proceed if the concentration of large trees consistently prevents target basal areas from being reached. The residual large ponderosa alone extends well into the target range for CMH Lil. Leaving behind an even-aged distribution, even if it is entirely fire-tolerant large ponderosa pine, is not a sustainable forest structure over the long term.

Figure 3.5 Pre/Post average BA in ft²/ac, separated by species and by Eastside Screen protected status.



Resistance: Distribution by DBH Class

Methods:

Trees in each plot were divided into four-inch DBH classes, and the number of trees was counted in each class. The plot totals were then averaged to the project level. Each distribution was assessed as to whether it represented a sustainable age class distribution. The desired distribution is an "inverse J-curve," with successively fewer stems in each larger DBH class (O'Hara 2004). This mimics historical disturbance processes, where the initial regeneration cohorts would be reduced over the years by periodic disturbances (O'Hara & Ramage, 2013). Multi-age management, in contrast to even-age management, seeks to manage for multiple age classes rather than one age class. The inverse J-curve is one example of multi-age management. A silvicultural prescription aimed at replicating this inverse J-curve would specify removal of the appropriate number of trees in each DBH class (Tappeiner et al., 2015). Such an approach simultaneously treats the ladder fuel concerns while making a stand more resilient and consistent with the historical range of variability (Bailey & Covington 2002).

For each project in this analysis, a sample inverse J-curve was developed based on the target residual BA range, and overlaid on each graph of DBH distributions. A flatter curve was chosen to allow for fewer saplings and more large trees, which is consistent with restoration objectives. A steeper curve would allow more saplings and fewer large trees. Such a curve does not need to be targeted exactly in order to be successful. Some variation is expected due to the heterogeneous nature of these forest types.

Deuce Pilot

The sapling DBH class was graphed separately from the mature trees DBH classes (Figure 3.6 and Figure 3.7) because the scale required for the large number of saplings made the mature DBH classes difficult to interpret. In Deuce Pilot, outside of saplings, more trees were removed in smaller DBH classes. This leaves a desirable, resilient age/size structure. However, that improvement is more than offset by the retention of almost all saplings. Leaving the best 5% of the saplings, in terms of individual vigor and spatial location relative to openings, would result in a DBH distribution close to the "inverse J-curve" sought for multi-age management. In addition, the retention of so many saplings leaves vertical fuel continuity in place, making it easier to transmit a surface fire to the canopy. Perhaps more trees could have been removed from the 8- to 12-inch and 12- to 16-inch size class. This would have brought the residual BA closer to the target range. It is possible that an additional management action was planned to remove the saplings, but hadn't taken place before the plots were revisited. One white fir tree with DBH greater than 21" was removed in the observed plots, but an amendment was granted for the Deuce project allowing removal of white fir with DBH greater than 21" in certain situations.

Figure 3.6 Average stems per acre (n = 7 plots) by DBH class for live trees in Deuce Pilot, excluding saplings (0"-4" DBH). Superimposed points represent recommended stocking levels under a sample multi-aged management prescription.

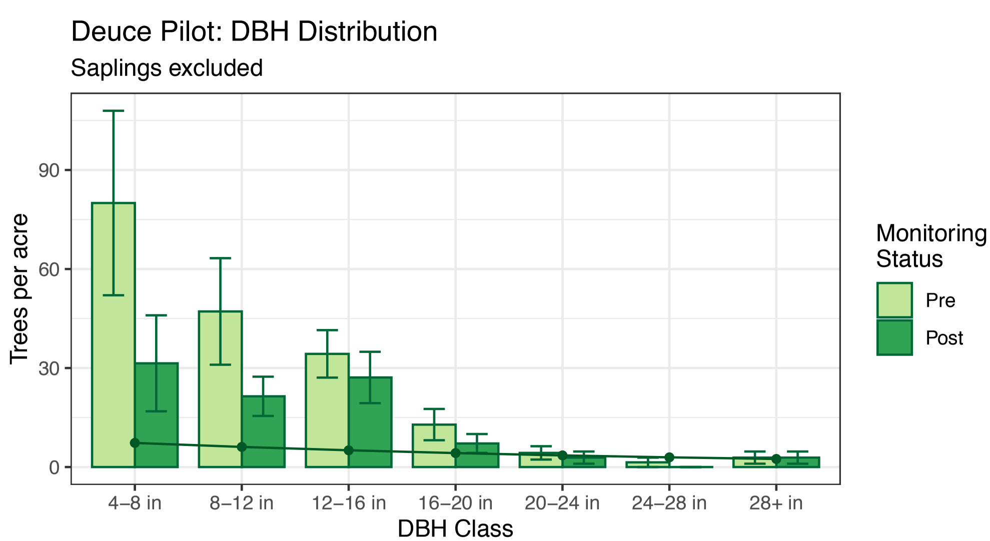


Figure 3.7 Average stems per acre (n = 7 plots) in the sapling (0" – 4") DBH class for live trees in Deuce Pilot. The superimposed point represents the recommended stocking level under a sample multi-aged management prescription.

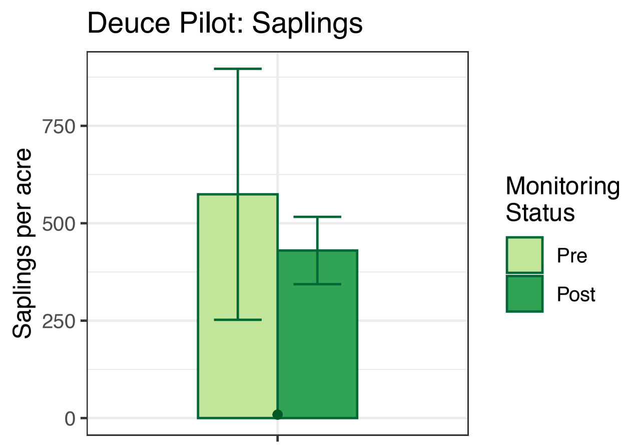


Figure 3.9 Average stems per acre (n = 4 plots) in the sapling (0" – 4") DBH class for live trees in Deuce Olde. The superimposed point represents the recommended stocking level under a sample multi-aged management prescription.

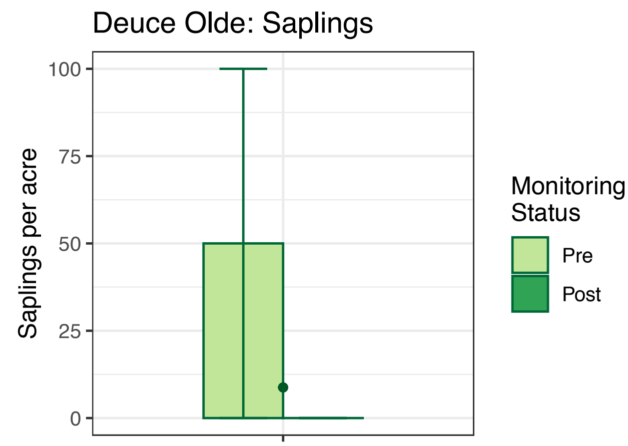
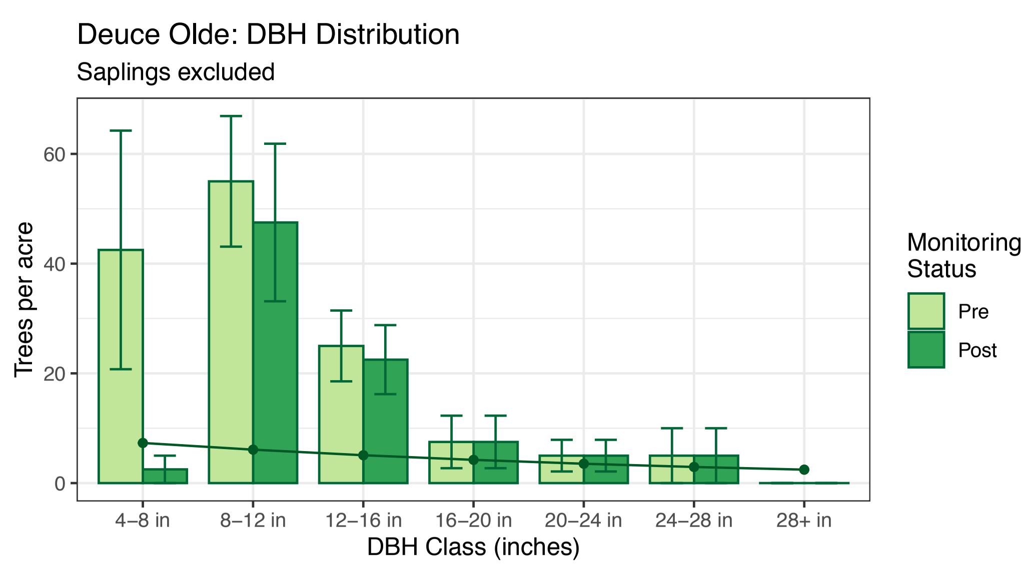


Figure 3.8 Average stems per acre (n = 4 plots) by DBH class for live trees in Deuce Olde, excluding saplings (0"-4" DBH). Superimposed points represent recommended stocking levels under a sample multi-aged management prescription.



Deuce Olde

This DBH distribution shows that more trees could be removed from the 8- to 12-inch and 12- to 16-inch size class (Figure 3.8). This was a pre-commercial thinning treatment, however, so trees in these DBH classes wouldn't be harvested. No saplings were observed following treatment (Figure 3.9). While this disrupts the vertical fuel continuity, it does not lead to long-term stand resilience and a sustainable age/size class distribution. Even in an old-growth stand, some saplings are needed to grow into small trees, and small trees are needed to survive to maturity. While the goal is to preserve old growth habitat, a stand with only older trees is more vulnerable to disturbance than a multi-aged stand.

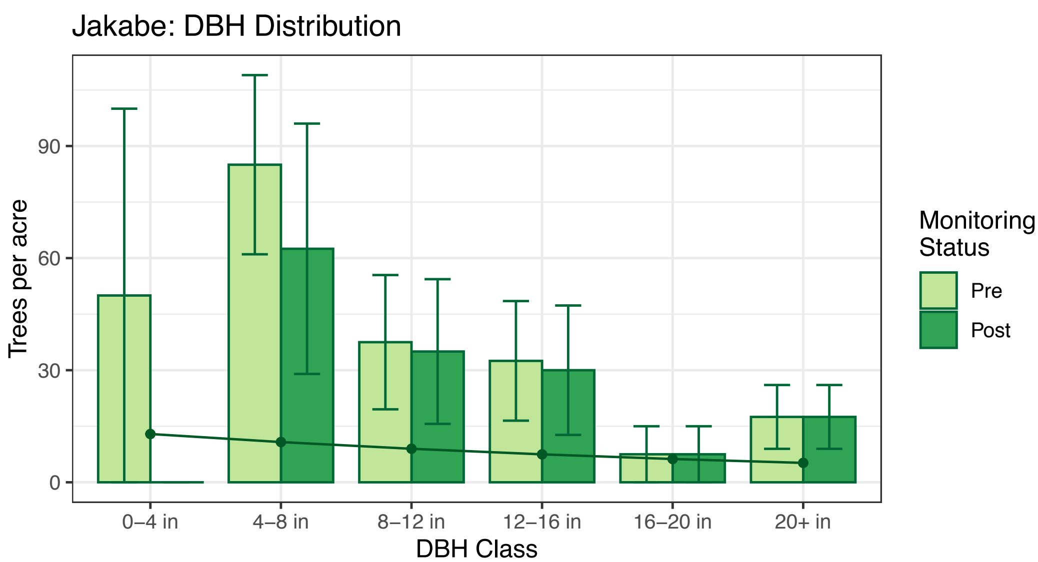
Jakabe

As a pre-commercial thinning treatment, little change in the number of trees in the larger size classes would be expected, as seen in Figure 3.12. And while the number of saplings would be expected to drop, zero saplings were observed following treatment. This would result in a lower fire risk, but it does not contribute to stand resiliency. There should be at least some saplings left to provide for long-term replacement of older trees. A clump of saplings growing in a gap separate from the rest of the overstory would not necessarily serve as ladder fuels.

Figure 3.10 Multiple age/size classes in Deuce Olde following treatment. Photo courtesy of CBMT.

Figure 3.11 Even age/size class in Jakabe Ben Young post-treatment. Photo courtesy of the CBMT.

Figure 3.12 Average stems per acre (n = 4 plots) by DBH class for live trees in Jakabe harvests. Superimposed points represent recommended stocking levels under a sample multi-aged management prescription.



Crooked Mud Honey Lil Stewardship

Many trees were removed in the smaller DBH classes, which is a desirable result. The DBH class distribution adheres well to the desired inverse J-curve (Figure 3.14). A large number of saplings were removed, but enough were left to provide for long-term stand survival (Figure 3.15). Overall, the resulting DBH class distribution appears to be consistent with historical and sustainable forest structure. Six white fir trees with DBH greater than 21" were removed in the observed plots, but an amendment was granted for the CMH project allowing removal of white fir with DBH greater than 21" in certain situations.

Figure 3.13 Multiple age/size classes in a CMH Lil stand post-treatment. Photo courtesy of the CBMT.

Figure 3.14 Average stems per acre (n = 13 plots) by DBH class for live trees in CMH Lil Stewardship, excluding saplings (0”- 4” DBH). Superimposed points represent recommended stocking levels under a sample multi-aged management prescription.

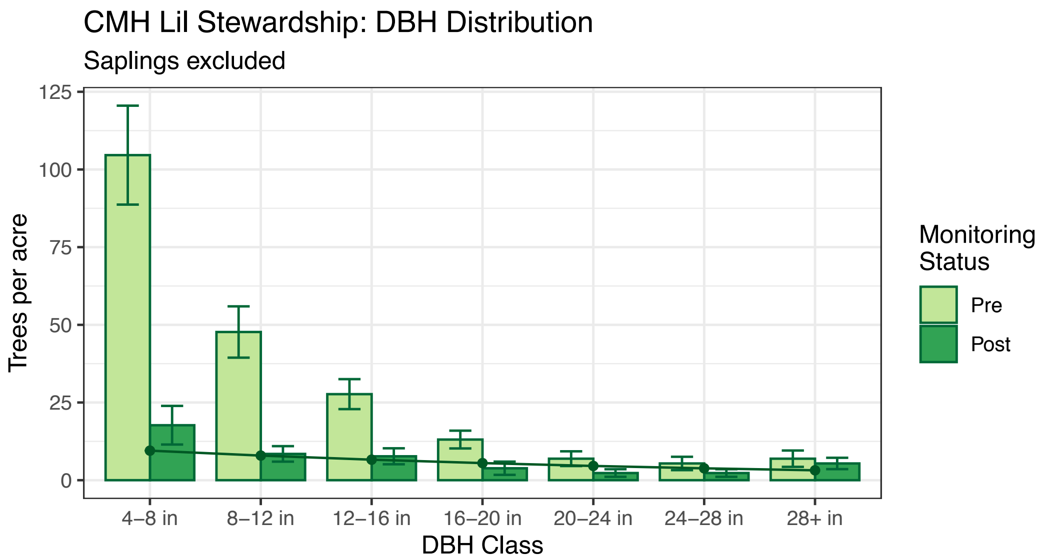
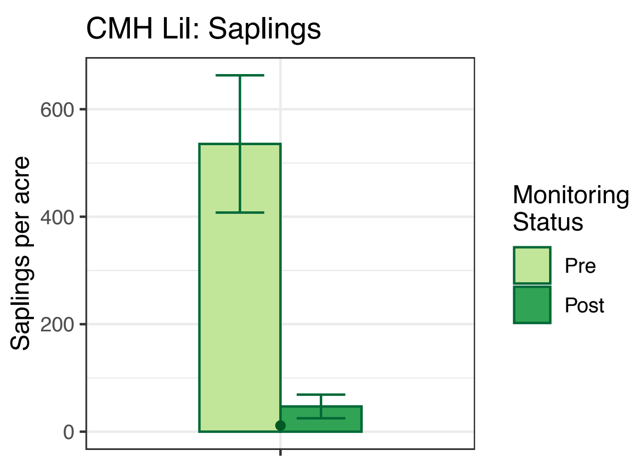


Figure 3.15 Average stems per acre (n = 13 plots) in the sapling (0” – 4”) DBH class for live trees in CMH Lil Stewardship. The superimposed point represents the recommended stocking level under a sample multi-aged management prescription.



Recommendations/Conclusions

While the results from CMH Lil showed a resilient stand structure, the average residual basal area was at the high end of the target range, indicating that high stocking levels may lessen resistance to disturbance in subsequent years. In the other three thinning projects, there was generally a large amount of residual small trees following thinning. It is important to note that the pre-commercial thinning treatments would not be expected to have much of an effect on basal area since only small trees were removed. Deuce Pilot was a commercial thinning treatment, however, and the residual basal area was well above the target range. The LSG may want to consider adopting multi-age prescriptions (O'Hara & Ramage, 2013), in which target stem counts are set by DBH class, or variable density prescriptions, which are designed to increase within-stand heterogeneity (Knapp et al., 2017).

The collaborative may consider adopting alternative indicators for resistance and resilience in light of CSE data collection being infeasible. Such an indicator should allow for data collection either through field plots, remote sensing, or another method that can adequately capture the variation throughout the landscape. Basal area and diameter distributions were used here because they were easily calculated from the vegetation monitoring data, but other options exist. Resistance and resilience are broad concepts and not easily quantified (DeRose & Long, 2014), so the collaborative must decide on indicators that are both meaningful and practical.

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Question 3.2

What is the effect of the treatments on moving the Forest landscape toward a more sustainable condition that includes scale and intensity of historic disturbances?

Goal 3.2:
To quantify and compare the scale and intensity of current restoration treatments to historic disturbances.

Indicator 3.2:
Change in Fire Regime Condition Class (FRCC) rating.

Background

The conception of ecological departure in the Pacific Northwest (PNW) Region has evolved since the FRCC work of 2003-2010 (Barrett et al., 2010). Beginning in 2012, the US Forest Service PNW Region Ecology Program (Region 6) collaborated with The Nature Conservancy in developing a refined method of characterizing ecological departure. This approach features current data layers and methods to determine how to move landscapes towards a natural range of variation (NRV). Estimates of the specific seral stage changes in watersheds and the order in which they should occur can now be produced (Haugo et al. 2015, DeMeo et al. 2018).

This method uses Gradient Nearest Neighbor (GNN) forest structure data produced by the LEMMA project (LEMMA, Ohmann & Gregory 2002) and updated every five years. CFLR activities were implemented in the Lakeview Federal Stewardship Unit (LFSU) beginning in 2012, so the analysis of the 2012 GNN data provides a pre-restoration measure of vegetation departure. A second departure analysis was completed using the GNN data released in 2017. A comparison of the 2012 and 2017 GNN data captures all CFLR restoration completed in the LFSU between 2012 and 2017.

The departure analysis methods are described in Haugo et al. (2015), and a brief summary is provided here. First, the biophysical setting (BpS), or appropriate historical forest type, was established for all forested areas in Region 6 using LANDFIRE data (LANDFIRE 2020). Next, the cumulative area of departure from the BpS (as shown by the GNN data) was calculated for each landscape unit. Landscape units varied by historical fire regime. Fire management personnel consider the entire LFSU to be Fire Regime 1 (0-35 years), for which departures are calculated by 10-digit/5th level hydrologic unit (watershed). Finally, the amount and type of restoration needed to return the entire landscape to its BpS was calculated. Restoration types include disturbance, disturbance + succession, and succession only. Disturbance refers to a management activity such as thinning or prescribed fire. It is also important to note that wildland fires and their management are a significant source of disturbance on the landscape. Succession denotes allowing a forested area to grow into a later successional stage. In some cases, disturbance followed by succession (disturbance + succession) is recommended, such as when a mid-seral closed seral stage is thinned and maintenance prescribed burns follow. During this phase of prescribed burning, succession of the overstory is proceeding.

Methods:
The departure totals for watersheds with a majority of forested area within the LFSU were extracted for this analysis. Some of the watershed boundaries extend beyond the LFSU, but the forested area within these watersheds does not extend much past the LFSU boundary. Watersheds without a majority of forested area in the LFSU were excluded. The total area need-

ing active restoration (disturbance and disturbance + succession) in 2012 and 2017 was calculated for each watershed with a majority of forested area within the LFSU. A map of the selected watersheds is shown in Figure 3.16. To calculate the change in area needing disturbance, the 2012 GNN-detected totals were subtracted from the 2017 GNN-detected totals. These results are shown in Table 3.3.

The amount of restoration that occurred in each watershed was calculated using ArcMap 10.8 GIS software (ESRI, 2020). Results are shown in Table 3.4, and a map of restoration treatment by watershed is shown in Figure 3.17. The total area of CFLR thinning treatment and prescribed burning treatment was calculated for each watershed. Areas that were burned following a thin were calculated separately from thinning-only or burn-only area. The area burned in the Barry Point Fire in 2012 was included in the restoration totals.

The satellite imagery on which the 2012 GNN analysis was based was taken around the beginning of August, near the start of the Barry Point fire. Since the data is based on a composite of images, it would be difficult to ascertain the exact range of dates used (M. Gregory, personal communication, January 2021). However, the likelihood of any of the burned area being captured is so low (any images with smoke would have been rejected) that the Barry Point Fire will be treated as occurring entirely after the 2012 data was captured. This is supported by the comparatively high (relative to other watersheds) increase in succession need and reduction in disturbance need in the Barry Point watersheds.

Table 3.3 5th field (HUC 10) watersheds in the LFSU and amount of detected restoration need in acres. “Disturbance” includes both disturbance only and disturbance plus succession. Restoration refers to thinning, prescribed burning, or wildland fire occurring between 2012 and 2017. A negative change represents a drop in acres needing restoration. A positive change represents an increase in acres needing restoration. Change in disturbance need is in bold for watersheds with extensive restoration activities between 2012 and 2017.

Watershed Name	Disturbance Needed 2012	Disturbance Needed 2017	Change in Disturbance Needed	Succession Needed 2012	Succession Needed 2017	Change in Succession Needed	Restoration 2012-2017
Anna River-Summer Lake	6702	5860	-842	3347	4458	1111	
Crooked Creek	14695	14721	26	83	100	17	
Deep Creek	37391	36742	-649	0	136	136	South Warner Aspen
Drews Creek-Frontal Goose Lake	49607	46536	-3070	12	963	951	West Drews Aspen, Barry Point Fire
Dry Creek-Frontal Goose Lake	9678	6357	-3320	705	2603	1898	Barry Point Fire
Honey Creek	12999	12850	-149	0	29	29	
Lower Chewaucan River	17731	17747	16	142	378	236	
Middle Chewaucan River	14555	13456	-1099	3262	3833	571	Deuce, Jakabe
North Fork Willow Creek-Willow Creek	10227	8172	-2055	1015	2065	1050	Barry Point Fire
Thomas Creek	45559	44631	-927	0	0	0	
Upper Chewaucan River	42935	41519	-1417	1946	1846	-100	Deuce, Jakabe
Willow Creek-Frontal Goose Lake	10198	10218	20	0	0	0	
Total Acres	**272275**	**258810**	**-13466**	**10513**	**16410**	**5897**	

Figure 3.16 Map of watersheds with a majority of forested area falling within the boundaries of the Lakeview Federal Stewardship Unit.

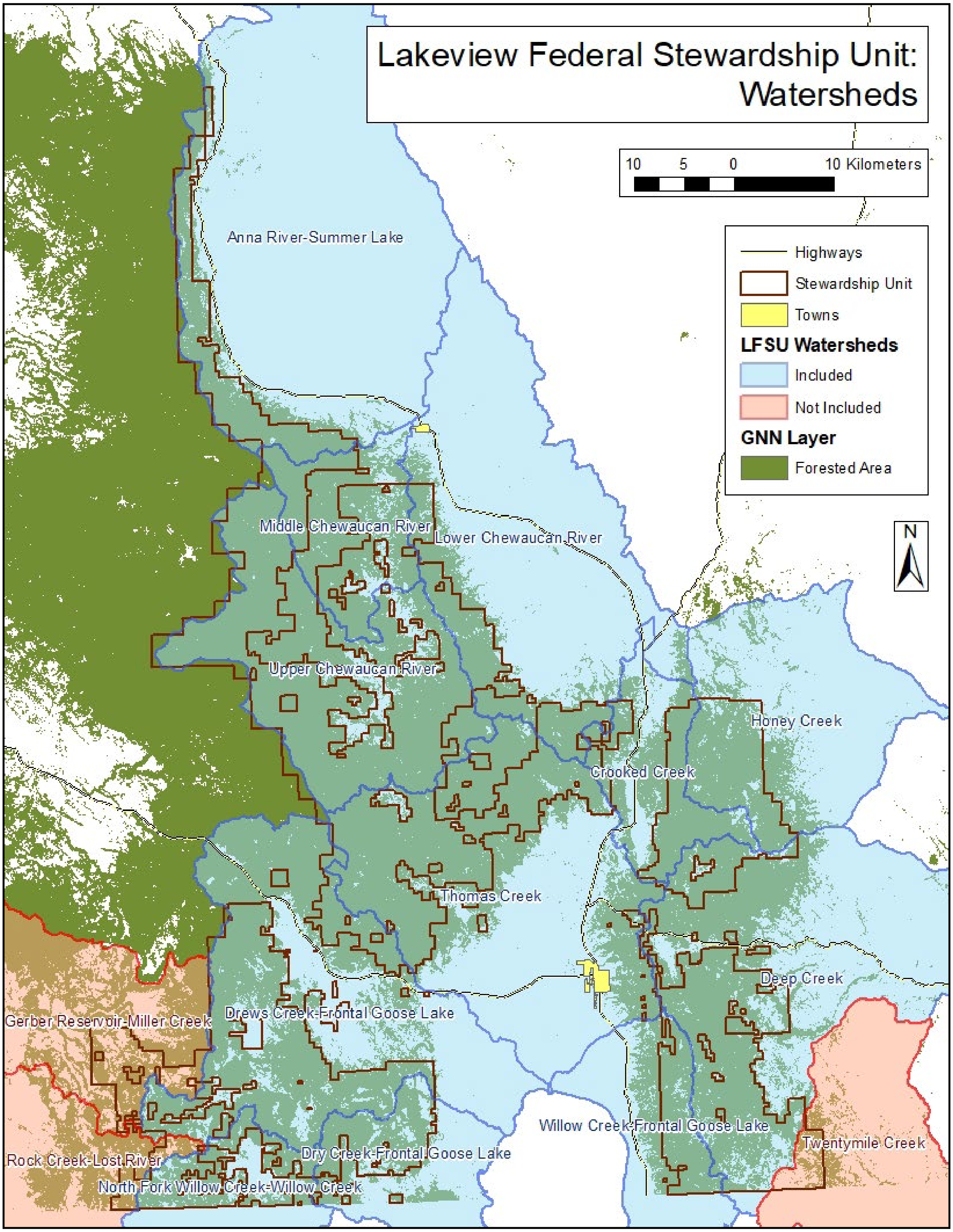

Figure 3.17 Map of restoration activities in the Lakeview Federal Stewardship unit between 2012 and 2017. Activities include thinning, prescribed burning, thinning followed by burning, and wildland fire.

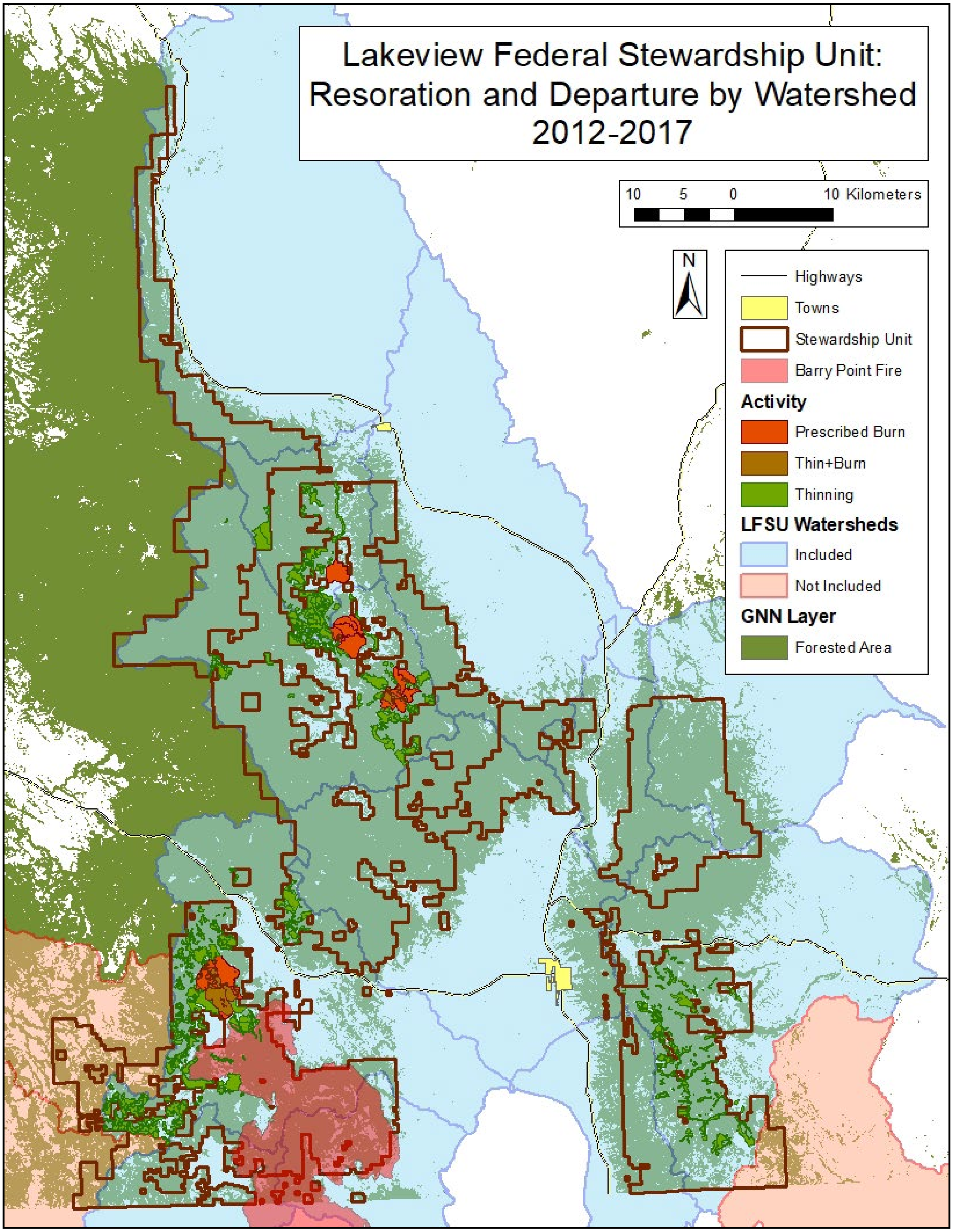

Table 3.4 Total acreage of restoration activities by watershed occurring in the LFSU between 2012 and 2017.

Watershed Name	Prescribed Burn	Thinning	Thin + Burn	Barry Point Fire	Total acres
Anna River-Summer Lake	0	0	0	0	0
Crooked Creek	0	0	0	0	0
Deep Creek	0	4,569	0	0	4,569
Drews Creek-Frontal Goose Lake	2,181	12,208	2,023	23,730	40,142
Dry Creek-Frontal Goose Lake	0	0	0	16,048	16,048
Honey Creek	0	0	0	0	0
Lower Chewaucan River	0	242	0	0	242
Middle Chewaucan River	3,054	7,133	74	0	10,261
North Fork Willow Creek-Willow Creek	0	59	0	3,103	3,162
Thomas Creek	0	680	0	0	680
Upper Chewaucan River	4,954	6,331	540	0	11,825
Willow Creek-Frontal Goose Lake	0	0	0	0	0

Analysis 3.2

Per the departure analysis, all watersheds experiencing extensive restoration activities (defined as 1,000 acres or greater) or large wildland fire showed a reduction in acres needing active restoration treatment. Figures 3.19-3.22 show the treatment by individual watershed. While it is encouraging that restoration activities have resulted in a decrease in active restoration need, the acres restored are still a fraction of the remaining acres needing active restoration. A comparison of actual restoration acres and GNN-predicted restoration needs is shown in Table 3.5.

The three watersheds with the greatest drop in detected restoration need contained a portion of the Barry Point Fire footprint. The Drews Creek-Frontal Goose Lake watershed (Figures 3.18, 3.19) also contained the highest acreage of active restoration projects, so it is difficult to determine which portion of the detected decrease in restoration can be attributed to the projects as opposed to the fire. However, Dry Creek-Frontal Goose Lake experienced a similar decrease in restoration need with half the extent of active restoration projects, so it is likely that the fire played more of a role in reducing the detected restoration need.

Both the Deuce and Jakabe restoration projects were distributed across the Upper Chewaucan and Middle Chewaucan watersheds rather than occupying a majority of a single watershed. Had the amount of restoration conducted across the two watersheds been concentrated in one watershed, a greater decrease in restoration need may have been detected. Projects focused specifically on watershed restoration may involve planning at the watershed scale (see Question 8), but projects oriented toward fire regime restoration may not align with watershed boundaries. One potential approach to unite these two objectives could be the use of Potential Operational Delineations, or PODs (Thompson et al., 2016). Many forests have begun planning strategic fire risk reduction around PODs, so identification of vegetation departure at the POD level could help prioritize restoration activities.

Another factor influencing the total acres restored is that a fair amount of forested area in each watershed lies outside the forest boundary, and is therefore not subject to restoration efforts of the Lakeview Stewardship Group (Table 3.6). These areas would register as needing restoration even though the Forest Service itself cannot conduct restoration on these lands. Moving toward an all-lands approach to restoration could help address this issue (Leavell et al., 2018).

It is possible that error in the GNN analysis is influencing the results, but a discussion of the technical process is beyond the scope of this report. Potential sources of error are currently being investigated by Region 6. It is also possible that the areas identified as needing restoration by GNN analysis process are not the same as the areas identified as needing restoration by the consensus of the Lakeview Stewardship Group. The Region 6 methods identify ecological departure, whereas forest restoration planning is generally driven by a desire to minimize potential fire effects in priority areas. Therefore, factors beyond the amount of vegetation departure may influence the decision of where to conduct restoration. These factors could include proximity to residences or values such as wildlife habitat, water sources, or designated Late-Old Structure. In a collaborative environment with stakeholders representing a variety of values, ecological departure is one of multiple priorities to be addressed (Urgenson et al., 2017). It is also possible that some areas identified by the departure analysis as needing restoration are protected and therefore unsuitable for active restoration (Barros et al., 2017).

Table 3.5 Total acres restored in the LFSU between 2017 and the amount of active restoration needed as determined by the GNN departure analysis. A negative change indicates a decrease in restoration needed, and a positive change indicates an increase in restoration needed.

Watershed Name	Total acres restored	Change in need (GNN)	Restoration 2012-2017
Anna River-Summer Lake	0	-842	
Crooked Creek	0	26	
Deep Creek	4,569	-649	South Warner Aspen
Drews Creek-Frontal Goose Lake	40,142	-3070	West Drews Watershed, Barry Point Fire
Dry Creek-Frontal Goose Lake	16,048	-3320	Barry Point Fire
Honey Creek	0	-149	
Lower Chewaucan River	242	16	
Middle Chewaucan River	10,261	-1099	Deuce, Jakabe
North Fork Willow Creek-Willow Creek	3,162	-2055	Barry Point Fire
Thomas Creek	680	-927	
Upper Chewaucan River	11,825	-1417	Deuce, Jakabe
Willow Creek-Frontal Goose Lake	0	20	

Figure 3.18 Before (top) and after (bottom) restoration in the West Drews Watershed Restoration and Vegetation Management Project, in the Drews Creek/Frontal Goose Lake watershed. (Courtesy of the CBMT).

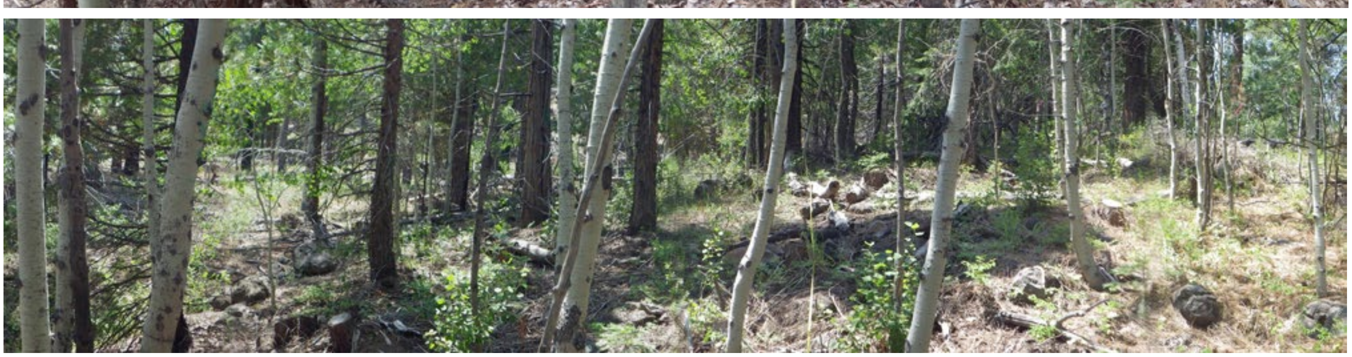

Figure 3.19 Restoration activities in the Drews Creek/Frontal Goose Lake watershed between 2012 and 2017.

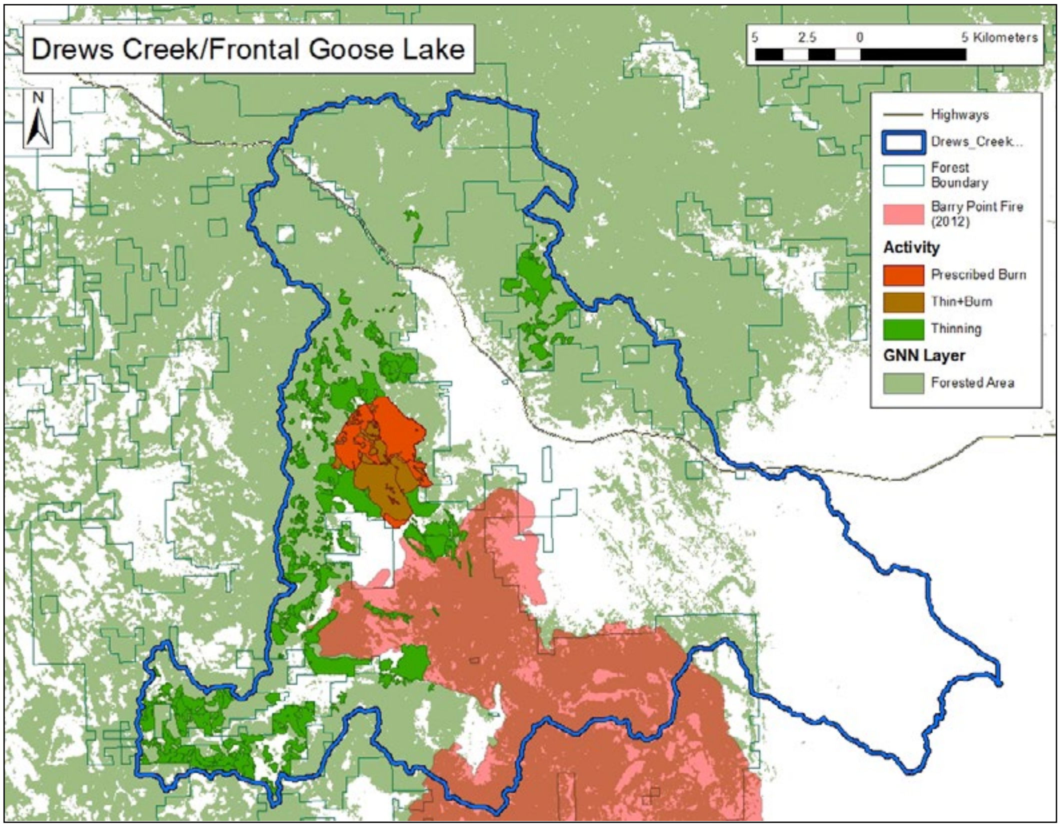

Figure 3.20 Restoration activities in the Upper Chewaucan River watershed between 2012 and 2017.

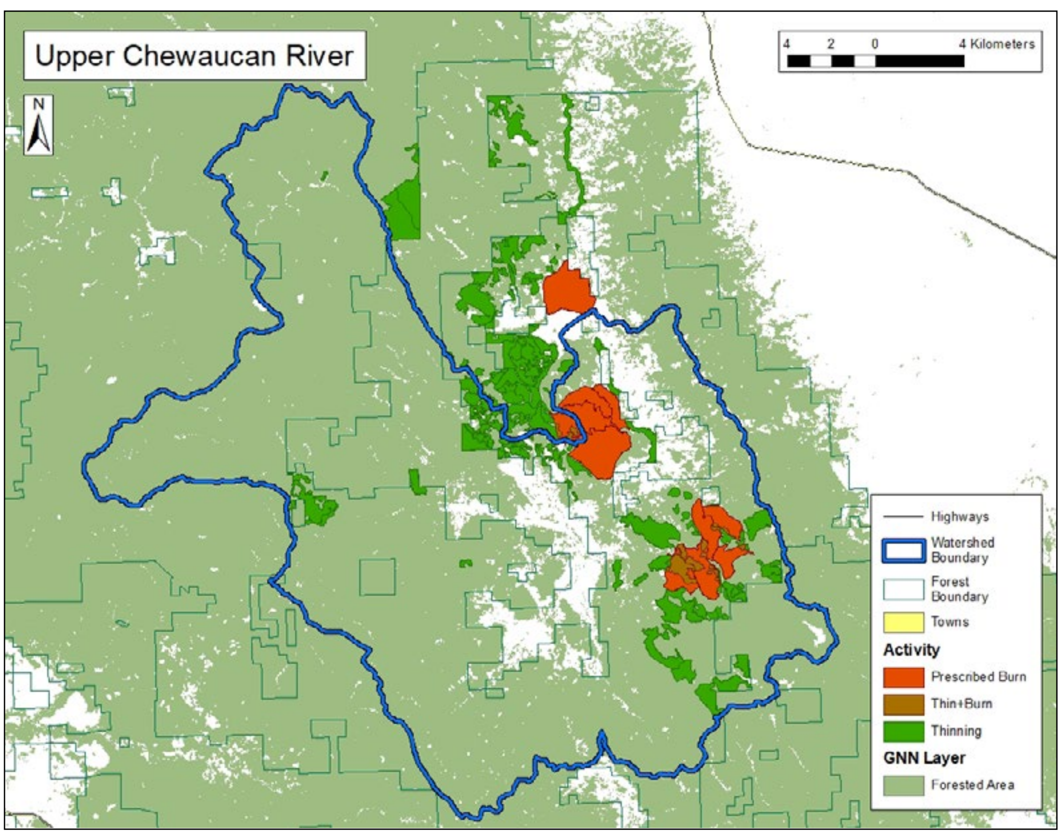

Figure 3.21 Restoration activities in the Middle Chewaucan River watershed between 2012 and 2017..

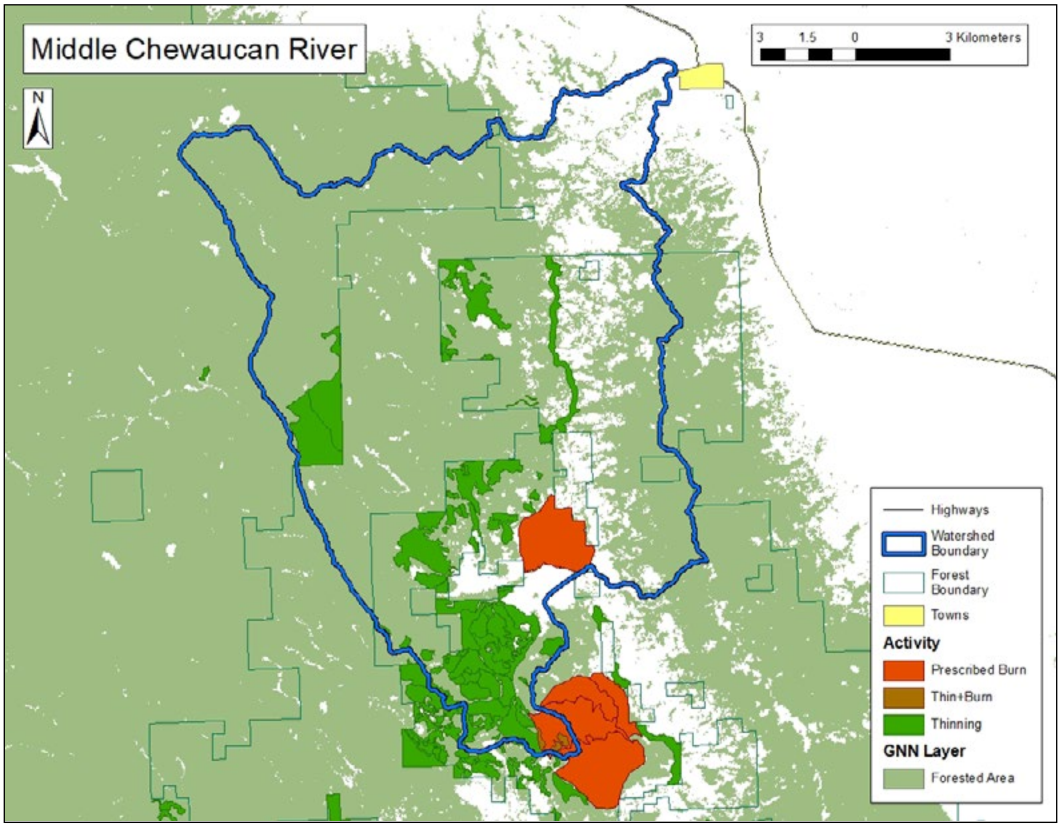

Figure 3.22 Restoration activities in the Deep Creek watershed between 2012 and 2017

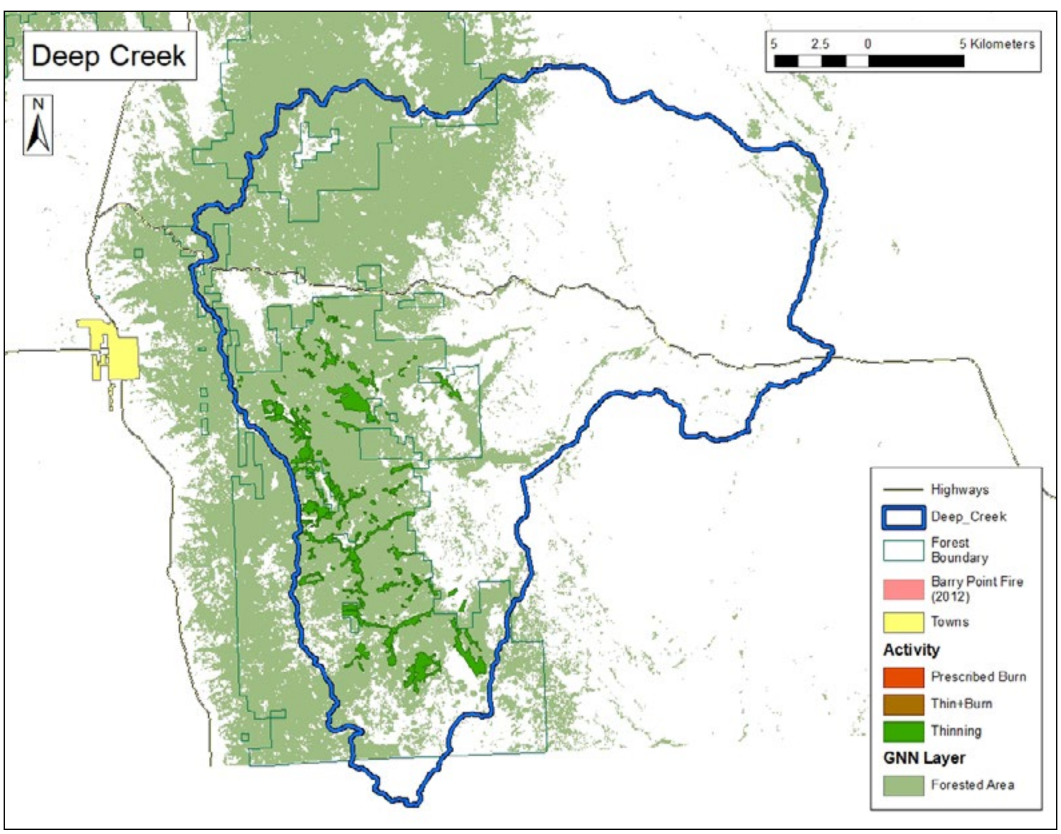

Table 3.6 Area by ownership by watershed in the Lakeview Federal Stewardship Unit.

Watershed Name	USFS acres	Non-USFS acres
Anna River-Summer Lake	25,393	5,961
Crooked Creek	19,355	11,789
Deep Creek	47,521	31,059
Drews Creek-Frontal Goose Lake	77,678	21,928
Dry Creek-Frontal Goose Lake	13,410	5,469
Honey Creek	20,464	9,171
Lower Chewaucan River	20,798	13,439
Middle Chewaucan River	26,690	14,452
North Fork Willow Creek-Willow Creek	13,747	5,278
Thomas Creek	55,828	39,467
Upper Chewaucan River	85,703	21,850
Willow Creek-Frontal Goose Lake	12,920	7,842

Recommendations/Conclusions

The results underscore the need to increase the pace and scale of restoration. The two GNN analyses took place five years apart. In five years, the restoration activities that took place in the Stewardship Unit only registered a modest decrease in the area detected as departed from historical biophysical settings. While these activities have provided benefits at the stand scale, in five years there was only a modest effect at the landscape scale. This is not to imply that these treatments were ineffective, only that restoration of a landscape takes a long time. Restoration activities have been successful in mitigating severe wildland fire behavior (Kalies & Kent, 2016).

As seen in this analysis, wildland fire appears to be the most effective method of landscape-scale restoration. If wildland fire is necessary to restore landscape structure, function, and composition, the landscape conditions must promote fire severities consistent with historical fire regimes. Increases in the amount of area burned at high severity in forests adapted to primarily low-severity fire can lead to loss of forest cover and other adverse effects (Tepley et al., 2017). The Barry Point Fire is an example, having burned extensively at high severity and leaving extensive shrub fields in previously forested areas (A. Markus, personal communication, November 2020). With climate change, these shrub fields may persist rather than return to forest cover; this is a topic into which research continues (Tepley et al., 2018). Increasing the pace and scale of restoration will require continued collaboration and cooperation by a wide range of stakeholders across all lands and all ownerships (Leavell et al., 2018, Spies et al., 2017), and increased use of fire.

Acknowledgements

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Question 3.3

What is the effect of the treatments on moving the Forest landscape toward a more sustainable condition that includes scale and intensity of historic disturbances?

Goal 3.3:
To quantify and compare the effects of prescribed fire and mechanical treatments to the historic disturbance regime.

Indicator 3.3:
Fire frequency.

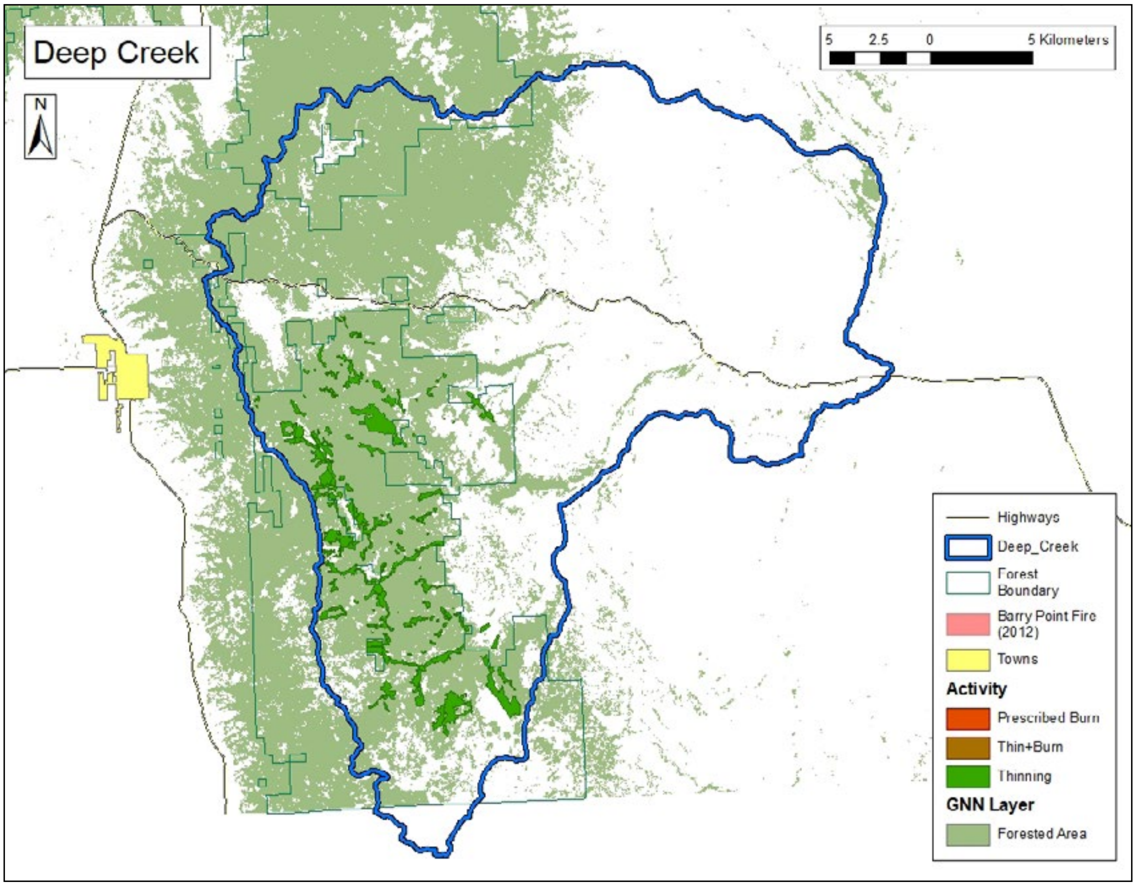
Analysis 3.3

The Lakeview Federal Stewardship Unit (LFSU) is approximately 490,000 acres in size. Assuming a 35-year Mean Fire Return Interval (MFRI), 14,000 acres would have burned annually. The 35-year MFRI used here is the average MFRI across all the forest types in the LFSU (C. Shuffield, personal communication, July 7, 2020). In the nine years since the implementation of CFLRP, a total of 126,000 acres should have burned within the LFSU. Since 2011, 26,500 acres have burned in prescribed fires and 71,000 acres have burned in large wildland fires (Barry Point and Watson Creek) for a total of 97,500 acres burned. See Table 3.7 for a comparison and Figure 3.23 for a map showing the burned areas. This is 28,500 acres below what would have burned historically in a nine-year time period. The 97,500 acres burned over nine years in the LFSU translates to an average of about 10,800 acres burned per year. This is approximately 3,200 acres fewer per year than the 14,000 acres that would have burned historically.

Table 3.7 Historic and present-day acres burned over a nine-year time span.

	Historic	Present	Difference
Total acres burned	126,000	97,500	-28,500
Annual acres burned	14,000	10,800	-3,200
Wildland fire total acres	*NA*	71,000	*NA*
Prescribed fire total acres	*NA*	26,500	*NA*

Figure 3.23 Map of all prescribed and wildland fire in the Stewardship Unit since 2011. CFLRP designation was received in 2012.



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Recommendations

Of the total area burned in the LFSU over the observed time period, over two-thirds was from wildland fires. The total acreage of prescribed fire represents approximately 21% of the projected historical nine-year total. This is not an unusual outcome for a western forest. Throughout the US West, the Forest Service has not generally been able to conduct prescribed fire on a scale comparable to historical fire regimes (Kolden 2019). Due to factors such as limited resources (Schultz et al., 2019) and limited burn windows (Miller et al., 2019), it is often difficult to conduct enough prescribed burning to match the historical fire regime for a given area.

The Oregon Prescribed Fire Council is currently spearheading efforts to amend Oregon State laws to lessen the regulatory hurdles to prescribed burning. Smoke management regulations have already been adjusted (Burns 2019) and a certified prescribed burn boss certification has been proposed (Matonis 2020). If these efforts are successful, there may be an increase in prescribed burning opportunities in the coming years. The LSG should be aware of these efforts and support them if possible.

Another potential method of reaching historical fire regime targets is managed fire. Also known as wildland fire use, managed fire refers to wildland fires that are allowed to burn for resource benefit when conditions permit rather than being immediately suppressed. Though the use of prescribed fire has been limited, managed fire provides an opportunity to maintain fire on the landscape at larger scales than prescribed fire (Barros et al., 2018). Managed fire is recommended as a method of restoration in addition to prescribed fire.

One aspect of fire regimes that is not captured in the reporting of total acres burned is percentage of fire by severity class. Severity class is commonly used to define fire regimes (Perry et al., 2011). One of the concerns leading to restoration efforts is an increased amount of high-severity fire in forest types with a historical fire regime composed primarily of low-severity fire (Reilly et al., 2017). Tracking the percentage of area burned by severity class compared to the historical fire regime is recommended for future monitoring efforts.

Acknowledgements

Many thanks to Chaylon Shuffield, Fire Ecologist and Fuels Planner for the Fremont-Winema National Forest, for his assistance in compiling the acres burned totals.

Question 4

What is the historical spatial pattern within the Lakeview Stewardship landscape? How well are treatments mimicking historical spatial patterns?

Goal 4.1:
To understand historic spatial patterns that will help with future prescription writing.
Indicator 4.1:
Individuals, clumps and openings (ICO).

Goal 4.2:
To achieve fine scale mosaic pattern across the landscape that existed historically.
Indicator 4.1:
Individuals, clumps and openings (ICO).

Analysis: Indicator 4.1

Research has shown that prior to widespread fire suppression, dry forests in the western U.S. tended toward a heterogeneous pattern of widely spaced individual trees, tree clumps of varying sizes, and gaps of varying sizes (Larson & Churchill, 2012). Ecological benefits of this arrangement include resistance to pathogens such as insects and root disease, providing adequate sunlight for regeneration of shade-intolerant trees, greater snow retention leading to higher summer soil moisture, and natural fire breaks (Churchill et al., 2018).

The Monitoring Plan called for The Nature Conservancy (TNC) to oversee collection of data for this indicator. Due to issues with the contracting process, this data was never collected. However, this data may be obtained from other sources. Research has shown that spatial patterns of individual trees, clumps of trees and openings historically fell within a range, so adhering to the exact historical pattern of a given area is not strictly necessary for restoration as long as the resulting pattern is close (Larson & Churchill, 2012). Therefore, historical ranges for similar forest types should provide sufficient guidance for the forests of the Lakeview Federal Stewardship Unit (LFSU).

Recommendations: Indicator 4.1

Multiple historical reconstruction studies have been conducted in dry Eastside forests similar to those within the LFSU. Historical ranges from these studies may be used as a guide for planning silvicultural prescriptions and evaluating the results of completed thinning treatments. Historical clump ranges are summarized in a guide produced by TNC in conjunction with the University of Washington (UW) (Churchill et al., 2016). A table with suggested ranges is included in Figure 4.1.

Table 4.1 Summary of clump proportions from 4 historical reference datasets. Values are the percent of trees in each clump size. The datasets include 10 plots in the Eastern Cascades of Washington, 12 plots on the western half of the Colville National Forest in North-Central Washington, 14 plots on the Malheur National Forest in North-Central Oregon, and 12 plots on Winema National Forest in South-Central Oregon. Plots range from 7 to 12 acres in size and were reconstructed to pre-fire suppression conditions (1890-1880). Plots represent a range of site conditions from dry ponderosa pine plant associations to dry Douglas-fir, grand fir, white fire, and sub-alpine fire associations. Contact the authors for more detailed information for each area.

		Clump (bin) Size (number of trees)					
Clumping level	**Clump distance**	**1**	**2-4**	**5-9**	**10-15**	**16-20+**	**TPA**
Eastern Washington Cascades							
High	20' – 6m	.22	.38	.24	.10	.06	40-60+
Medium	20' – 6m	.30	.42	.11	.17		25-40
Low	20' – 6m	.45	.43	.12			15-25
Western Colville National Forest							
High	20' – 6m	.13	.27	.28	.13	.19	40-60+
Medium	20' – 6m	.21	.35	.32	.09	.04	25-40
Low	20' – 6m	.38	.44	.14	.04		15-25
Malheur National Forest							
High	20' – 6m	.15	.25	.25	.10	.25	40-60+
Medium	20' – 6m	.20	.35	.35	.08	.02	25-40
Low	20' – 6m	.35	.45	.15	.05		15-25
Winema National Forest							
High	20' – 6m	.20	.30	.20	.15	.15	40-60+
Medium	20' – 6m	.25	.35	.20	.10	.10	25-40
Low	20' – 6m	.30	.35	.25	.10		15-25

Analysis: Indicator 4.2

The monitoring plan called for The Nature Conservancy (TNC) to produce stem maps. Due to issues with the contracting process, the data was never collected. LiDAR data collected in 2018 was used instead. All units in the Deuce Pilot commercial thinning treatment and 53 units in the Crooked Mud Honey (CMH) Lil Stewardship commercial thinning treatment were completed prior to the LiDAR acquisition. No field data was used in this analysis, but LiDAR analysis methods have been shown to be successful in the absence of field verification. (Kane et al., 2014).

Methods:

The LiDAR portion of this analysis was conducted using FUSION software (McGaughey 2020). FUSION's "TreeSeg" function uses a LiDAR-based canopy height model (CHM) to identify tree locations from canopy high points. This process identifies primarily dominant and co-dominant trees and may miss some smaller trees below the canopy, but this is an accepted limitation of LiDAR. Research studies have used this process to analyze spatial patterns with the understanding that some small trees will not be accounted for (Jeronimo et al., 2018, Jeronimo et al., 2019).

Methods for analyzing ICO patterns are described in the TNC/UW guide (Churchill et al., 2016) and in Churchill et al. (2017). Clump sizes and locations can be identified using GIS software such as ArcMap (ESRI, 2020). A clump is defined as a collection of trees within one crown length of each other. While crown width varies by tree, a generally accepted average crown width used in ICO analyses is 20 ft or 6 m (Churchill et al., 2013, Churchill et al., 2016). Clump distribution is characterized by proportion of total trees in each clump size. For this analysis, clump proportions were calculated for each treatment unit in Deuce Pilot and CMH Lil Stewardship completed before the LiDAR acquisition. The individual units were then averaged over each project area.

Openings are characterized as areas at least one crown radius away from a tree in all directions. Churchill et al., (2016 & 2017) use two methods of classifying openings: by size and by distance from the nearest tree. While no reference data is available for distributions of openings for the LFSU, the reference data for the Blue Mountains used by Churchill et al. (2017) and for the Sierra Nevada used by Jeronimo et al. (2019) represent similar forest types and can be used as a guide. As with the clumps, the opening distributions were calculated for each unit and then averaged over each project area.

Results

Clumps

The "High" clumping level was used for this analysis, and results are shown in Table 4.2. The Western Colville, Malheur, and Winema were judged to be similar forest types to those found in the LFSU, so their ranges were combined and used as a reference.

The proportion of trees in each clump size was similar between Deuce Pilot and CMH Lil Stewardship. In both project areas, the proportion of individual trees and trees in the 2-to-4-tree clump size exceeded the historical range. In all clump sizes of 5 trees or greater, the observed proportion was less than the historical range.

Openings

The opening size distributions differed slightly between Deuce Pilot and Lil, but were consistent relative to the historical ranges. Results are shown in Table 4.3. These ranges were taken from the ponderosa pine forest type in the Blue Mountains of northeastern Oregon (Churchill et al., 2017). While they may not exactly reflect historical ranges in the LFSU, the species composition and ecological setting are similar enough that it should be a reasonable approximation. The number of openings is calculated per four hectares in order to match the historical reconstruction plot sizes used by Churchill et al. (2017).

Table 4.2 Average proportion of trees in each clump size and standard error for Deuce Pilot and CMH Lil Stewardship, with difference between observed proportion and historical range.

Clump size	Clump proportion	Deuce Pilot proportion	Deuce Pilot +/-	Deuce Pilot difference	Lil Proportion	Lil +/-	Lil difference
Individual	0.13 to 0.20	0.30	0.03	+0.10	0.32	0.01	+0.12
2 to 4	0.27 to 0.30	0.36	0.03	+0.06	0.34	0.01	+0.04
5 to 9	0.20 to 0.28	0.15	0.01	-0.05	0.16	0.01	-0.04
10 to 15	0.10 to 0.15	0.08	0.02	-0.02	0.07	0.01	-0.03
16 to 20+	0.15 to 0.25	0.11	0.05	-0.06	0.11	0.01	-0.06

Table 4.3 Average number of openings in hectares and standard error by size class in Deuce Pilot and CMH Lil Stewardship treatment units, with difference between observed number and historical range.

Size class (ha)	Min	Max	Deuce Pilot avg openings	Deuce Pilot +/-	Deuce Pilot difference	Lil avg openings	Lil +/-	Lil difference
0 to 0.04	3	16	41.4	14.7	+25.4	55.8	4.92	+39.8
0.04 to 0.08	2	7	0.10	0.10	-1.90	0.13	0.05	-1.87
0.08 to 0.2	1	5	0.08	0.08	-0.92	0.12	0.08	-0.88
0.2 to 0.4	0	4	0.02	0.02	*in range*	0.04	0.03	*in range*
0.4 to 0.8	0	3	0.22	0.20	*in range*	0.17	0.11	*in range*
0.8 to 1.6	0	1	0.60	0.43	*in range*	0.06	0.04	*in range*
1.6 +	0	1	0.42	0.15	*in range*	0.26	0.03	*in range*

In both Deuce Pilot and Lil Stewardship, the average number of openings in the smallest size class far exceeded the historical range. In the next two larger size classes, the average number of openings were below the historical range. In the remaining four larger size classes, the average number of openings was within range, but the range included zero.

The distribution of openings by distance to nearest tree was similar between Deuce Pilot and Lil Stewardship. Results are shown in Table 4.4. The 0-to-3-meter distance represents the area under the tree canopy and the tree itself. The averages for both Pilot and Lil Stewardship fall in the middle of the historical range for this distance range, indicating that the number of trees is consistent with the number of trees historically.

The number of trees in the next shortest distance range, 3 to 6 meters, is above the historical range for both Deuce Pilot and Lil Stewardship. Both projects are within the range for 6 to 9 meters, and within the lower end of the 9-to-12-meter range. There were no openings detected in any of the longer distance ranges.

Table 4.4 Average proportion of unit area by distance in meters to nearest tree and standard error in Deuce Pilot and CMH Lil Stewardship treatment units, with difference between observed proportion and historical range.

Distance (m)	Min	Max	Deuce Pilot avg openings	Deuce Pilot +/-	Deuce Pilot difference	Lil avg openings	Lil +/-	Lil difference
0 to 3	0.14	0.39	0.25	0.02	*in range*	0.26	0.01	*in range*
3 to 6	0.27	0.44	0.48	0.01	+0.04	0.48	0.01	+0.04
6 to 9	0.16	0.28	0.2	0.01	*in range*	0.2	0.01	*in range*
9 to 12	0.03	0.18	0.05	0.02	*in range*	0.04	0.01	*in range*
12 to 15	0.01	0.09	0	0	-0.01	0	0	-0.01
15 to 18	0.01	0.04	0	0	-0.01	0	0	-0.01
18 to 21	0.01	0.03	0	0	-0.01	0	0	-0.01
21 to 24	0	0.02	0	0	*in range*	0	0	*in range*
24 +	0	0.02	0	0	*in range*	0	0	*in range*

Conclusions

Relative to historical clump ranges, Deuce Pilot and CMH Lil Stewardship contained a higher percentage of trees in small clumps and a lower percentage of trees in larger clumps. Relative to historical opening size distributions, both project areas had higher numbers of the smallest opening size, and lower numbers of the larger opening sizes. Relative to the historical percentage of openings by distance to nearest tree, both project areas had a higher percentage of area closer to trees, and a lower percentage of area further from trees. Taken together, the results for openings show too many small openings and not enough larger openings relative to historic ranges. Silvicultural prescriptions for future commercial thinning projects should focus on leaving larger clumps and larger openings, and monitoring for spatial patterns should continue. The Colorado Front Range Landscape Restoration Initiative, another CFLR-funded forest collaborative, has had success with prescriptions focused on creating heterogeneous forest structure (Underhill et al., 2014). Churchill et al. (2013) also offer guidance on developing ICO-based prescriptions.

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Question 5

What are the site specific effects of restoration treatments on focal species habitat within the project area?

Goal 5.1:
To incorporate fine-resolution habitat suitability for nesting white-headed woodpeckers into silvicultural prescriptions and thereby guide ecosystem restoration projects within the range of the species.
Indicator 5.1:
Levels of tree clustering, stand densities, and tree characteristics, and the density and size of openings.

Goal 5.2:
To verify the effectiveness of restoration treatments for improving habitat for white-headed woodpeckers.
Indicator 5.2:
White-headed woodpecker occupancy, nesting, and success.

Goal 5.3:
To quantify how restoration activities impact fish habitat.
Indicator 5.3:
Stream channel morphology, stream substrate composition, macroinvertebrate populations, riparian and streamside vegetation cover.

Analysis: Indicator 5.1

The Nature Conservancy (TNC) was to have overseen collection of data for this indicator. However, due to problems with the contracting process, this data was never collected.

Recommendations: Indicator 5.1

The data for this indicator may still be gathered. The LSG could revisit the original plan of contracting with TNC. TNC would then work with the CBMT to gather the necessary data on tree spatial patterns in the areas around white-headed woodpecker (WHWO) nest sites.

Analysis: Indicator 5.2

This indicator has been addressed annually by personnel at the Rocky Mountain Research Station (RMRS). The 2019 report (most recent) is included in the Supplemental Reports section and is summarized here.

- WHWO detections have increased each year since 2016.
- Nest detections in 2019 decreased from 2018, and are similar to the nest detection numbers from 2015-2017.
- Nests were generally found in large-diameter ponderosa pine and aspen.
- Nests have been found primarily in low-density ponderosa pine forest or aspen stands adjacent to pine forest.
- In 2019, there were 32 WHWO detections on control transects, and 8 WHWO detections on treatment transects.
- In 2019, there were 8 nests detected on control transects, and 1 nest detected on treatment transects. 5 nests succeeded and 4 nests failed.
- Detection surveys were conducted on 14 treatment transects and 13 control transects in 2019.

Recommendations: Indicator 5.2

Recommendations from the RMRS report include:

- RMRS will continue conducting WHWO and nest detection surveys.
- RMRS will assess the two remaining treatment transects (that had not been harvested prior to 2019) to determine whether additional vegetation data collection is necessary.
- Monitoring should be conducted in a prescribed burn that occurred in the fall of 2019.
- More investigation is needed as to why WHWO detections have increased but nest detections have not.
- More investigation is needed to understand the relative importance of ponderosa pine and aspen in nest site selection.

The following statement was provided by Vicki Saab and Jonathan Dudley of the RMRS:

"We have monitored 66 white-headed woodpecker nests during the years 2015-2020 on the Lakeview Stewardship [LS] CFLRP. This monitoring is part of a larger effort to evaluate woodpecker population changes in relation to forest restoration treatments on 3 CFLRP projects (Table 1). Our sample size of nests after treatments on the LS has been minimal (n=6) compared to nests monitored before treatments and in the untreated controls (n=60). To better understand treatment effects, we plan for one more year (2021) of nest monitoring in treatment units only to increase our post-treatment sample size of nests. This will require a 2-person field crew and 1 vehicle during May-August 2021, for an estimated cost of $30 K. The work will require field training and oversight, and data analysis and report writing by RMRS, for an estimated cost of $30 K. We are currently in the first phase of analyzing woodpecker population changes in relation to restoration treatments across the 3 CFLRP's. The additional nests monitored in 2021 will improve our evaluation and development of adaptive management recommendations."

Analysis: Indicator 5.3

The Monitoring Plan calls for stream channel cross-sections, Wolman pebble counts, macroinvertebrate sampling, streamside canopy cover, and photo point monitoring. The CBMT has not collected any data for this indicator since CFLRP implementation, having prioritized FIREMON and aspen plots (C. Thomas, personal communication, July 2, 2020). The Forest Service has conducted stream cross-section and photo point monitoring at select stream restoration project locations. The projects monitored are described in the following statement, provided by Richard Pyzik, Eastside Fish Biologist for the Fremont-Winema:

"The Chewaucan Aquatic Habitat Restoration Project goals were to improve fish and aquatic habitat conditions along the Chewaucan River by restoring stream channel/floodplain function and to improve riparian vegetation on private and federal lands. The project covered nearly 15 miles and was a collaborative effort by the Fremont-Winema National Forest – Paisley Ranger District, Lake County Watershed Council, O'Leary Ranch, Murphy Ranch, and J-Spear Ranch. The project used a variety of restoration methods to improve aquatic and riparian conditions including streambank stabilization, creation of gravel bars to decrease width to depth ratios, additions of large wood material, providing access to floodplains, and planting of riparian vegetation such as willows, cottonwoods, and sedges."

Monitoring photos from two locations, Jones Crossing and Strohm, are included in Figures 5.1 to 5.8. Both sets of photos show evidence of narrower, deeper stream channels, stable banks, and abundant riparian vegetation. Reports from two additional locations, Dog Creek and Wooley Creek, are included in the Supplemental Reports section. These reports include photos and stream cross-sections. The restoration activities monitored in these reports took place in 2014, and the most recent observations were taken in 2016. While the results shown in these reports are encouraging, the Monitoring Plan calls for measurements at least five years following improvements in order to gauge success.

Figure 5.1 Jones Crossing gravel bar/width to depth reduction site before in 2010.

Figure 5.2 Jones Crossing gravel bar/width to depth reduction site after implementation in 2010.

Figure 5.3 Jones Crossing gravel bar/width to depth reduction site in 2015.

Figure 5.4 Jones Crossing gravel bar/width to depth reduction site in 2020.

Figure 5.5 Strohm streambank stabilization and riprian restoration site before in 2012.

Figure 5.6 Strohm streambank stabilization and riparian restoration site after implementation in 2012.

Figure 5.7 Strohm streambank stabilization and riparian restoration site in 2016.

Figure 5.8 Strohm streambank stabilization and riparian restoration site in 2020.

Recommendations:
Indicator 5.3

More observations are needed before any recommendations can be made. The Forest Service monitoring will be continuing as specified in the following statement provided by Philip Gaines, the Fishery Program Manager for the Fremont-Winema:

"Stage Zero restoration is a technique which rehabilitates meadows and streams that have become degraded due to stream channel incision and loss of floodplain connectivity. Channel incision results in a lowering of the water table leading to the drying of wet meadows and conversion of riparian plant communities to upland grasses and forbs. Filling incised stream channels with large wood, boulders and soil raises water tables and increases floodplain re-connectivity. The goal is to construct a meadow/valley surface that is connected at base flow.

"Due to concerns about fish passage from the Oregon Department of Fish and Wildlife, the Forest agreed to monitor stream channel evolution after project implementation to better understand channel evolution over time. The proposed monitoring included photo points and establishment of long-term stream channel cross-sections to monitor channel evolution over time."

Acknowledgements

Indicator 5.2: Many thanks to Vicki Saab, Research Wildlife Biologist and Jonathan Dudley, Ecologist, of the Rocky Mountain Research Station for providing the analysis and report.

Indicator 5.3: Many thanks to Richard Pyzik, Eastside Fish Biologist for the Fremont-Winema National Forest and Philip Gaines, Fishery Program Manager for the Fremont-Winema National Forest for providing the analysis, reports and photographs.

Question 6

What are the effects of restoration treatments on focal species habitat across the CFLR Project Area?

Goal 6.1:
To improve and maintain habitat for white-headed woodpeckers (WHWO) at the stand and landscape scale.

Indicator 6.1:
Amount of WHWO habitat within CFLR Project Area.

Goal 6.2:
To improve habitat for fish and wildlife species within aspen, stream, and riparian areas.

Indicator 6.2:
Total acres of aspen or riparian habitat in which conifer reduction occurred and the total number of miles of stream enhanced due to in-stream improvements.

Analysis: Indicator 6.1

The Monitoring Plan calls for Mahalanobis and Maxent habitat suitability models to analyze change in white-headed woodpecker (WHWO) habitat following restoration activities. These models are run by Rocky Mountain Research Station (RMRS) personnel when Gradient Nearest Neighbor (GNN) data is updated, which is usually once every five years (LEMMA, Ohmann & Gregory 2002). The most recent GNN releases have been in 2012 and 2017. These provide pre-harvest and post-harvest depictions of changes in habitat suitability for CFLR activities completed prior to 2017. The results of the most recent model run by the RMRS are shown in Table 6.1 below. The model showed a shift away from low suitability toward moderate and high suitability, indicating that treatments have been successful in restoring WHWO habitat.

Table 6.1 Relative habitat suitability (acres; % of total) for WHWO nests in the Lakeview Stewardship CFLRP, 2012 and 2017.

	Relative Habitat Suitability[a]			
Year	Low	Moderate	High	Total
2012	213, 920; 60	75,101; 21	69,020; 19	358,041
2017	194,144; 51	98,624; 26	88,212; 23	380,980

[a] *HSI thresholds for determining suitability categories are based on Table 5.2 in Latif et al. (2018), low HSI<0.40, moderate HSI 0.40-0.49, and high HSI >0.49.*

Recommendations: Indicator 6.1

RMRS personnel did not provide any recommendations. WHWO habitat suitability monitoring will continue under the Common Monitoring Strategy.

Analysis: Indicator 6.2

The total area of aspen and aspen meadow in which conifer reduction occurred was 6,386 acres. See Table 6.2 for a breakdown of the conifer reduction acreage in aspen and aspen meadow habitat by project area.

The total area of riparian meadow in which conifer reduction occurred was 44.5 acres. See Table 6.3 for a breakdown of the conifer reduction acreage in riparian meadow habitat by project area.

The total length of stream enhanced due to on-stream improvements was 22.8 miles. See Table 6.4 for a breakdown of stream enhancement mileage by project area.

Table 6.2 Area by ownership by watershed in the Lakeview Federal Stewardship Unit.

Project Area	Aspen/Meadow Restoration
West Drews	1,128 acres
South Warner	2,900 acres
Crooked Mud Honey	2,358 acres
Total	**6,386 acres**

Table 6.3 Riparian meadow restoration acreage by project area.

Project Area	Riparian Restoration
Chewaucan River streambank stabilization & willow planting, sod/sedge mat transplant	20 acres
Grizzly Creek headcut repair and stream bank stabilization	5 acres
Wooley Creek headcut repair and streambank stabilization	5 acres
Dog Creek headcut repair and streambank stabilization	5 acres
Thomas Creek headcut repair	4.5 acres
Shoestring Creek headcut repair and streambank stabilization	5 acres
Total	**44.5 acres**

Table 6.4 Stream enhancement mileage by project area.

Project Area	Stream Restoration
Chewaucan River streambank stabilization & willow planting, sod/sedge mat transplant	4.0 miles
Willow Creek culvert replacement	1.3 miles
Grizzly Creek headcut repair and stream bank stabilization	2.0 miles
Wooley Creek headcut repair and streambank stabilization	0.5 mile
Dog Creek headcut repair and streambank stabilization	0.5 mile
Dairy Creek large wood placement	3.0 miles
Thomas Creek headcut repair	0.5 mile
Deer Creek culvert replacement	1.0 mile
Shoestring Creek headcut repair and streambank stabilization	2.5 miles
Elder Creek large wood placement	1.5 miles
Burnt Creek Large Wood placement	2.0 miles
Hay Creek Large Wood placement	2.0 miles
Upper Thomas Creek Large Wood placement	2.0 miles
Total	**22.8 miles**

Recommendations: Indicator 6.2

According to the Lakeview CFLR Project Monitoring Plan, the original CFLR proposal called for 65 miles of stream habitat to be restored or enhanced, and 26,000 acres of terrestrial habitat restored or enhanced by 2020. 22.8 miles of stream have been restored, which is 35% of the total identified in the proposal. The 6,430.5 acres of habitat restoration is 25% of the total identified in the proposal, and 1.3% of the total CFLR landscape area.

Acknowledgements

Many thanks to Vicki Saab, Research Wildlife Biologist and Jonathan Dudley, Ecologist, of the Rocky Mountain Research Station for providing the analysis and results; and many thanks to Amy Markus, Cohesive Strategy Coordinator for the Fremont-Winema National Forest, for providing the implementation totals for aspen, riparian and stream restoration.

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Question 7.1

How are riparian and upland treatments impacting ground vegetation and soils?

Goal 7.1:
To quantify vegetation composition and response before and after small tree thinning and prescribed fire within riparian corridors.

Indicator 7.1:
Riparian vegetation species composition, bare ground and ground cover, riparian and streamside vegetation cover, age class, extent of riparian vegetation.

Indicator 7.1 can be subdivided into five different indicators:

1. Riparian vegetation species composition
2. Bare ground and ground cover
3. Riparian and streamside vegetation cover
4. Riparian and streamside vegetation age class
5. Extent of riparian vegetation

Analysis 7.1

These indicators are addressed with data collected by the Chewaucan Biophysical Monitoring Team (CBMT). Since CFLR funding was instituted in 2012, small conifer removal treatments have been conducted in aspen stands in West Drews, South Warner, and North Warner. Commercial thinning treatments in Crooked Mud Honey Lil Stewardship have included aspen stands as well.

Small tree thinning in the West Drews Aspen (WDA) project took place in the winter of 2014/2015. 16 preharvest plots were installed prior to treatment in 2014, and 14 of these plots were revisited in 2018. The CBMT conducted an analysis of the WDA data following the revisits in 2018, and concluded that there was no observable increase in aspen regeneration following the small conifer removal. That report is included in Supplemental Reports section. In addition to the WDA small tree thinning plots, three plots were installed in 2012 following the Dent commercial harvest in 2012. These plots were revisited in 2014.
The LSG agreed at the 2018 annual meeting to continue monitoring in West Drews, since the revisits may have been too soon to capture the effects of conifer removal treatment. Five WDA plots are within prescribed burns that were conducted after the 2018 revisits. When follow-up visits are conducted, the prescribed burn results can be compared to the thinning-only results. The CBMT is still in the process of collecting aspen monitoring data in North Warner, including both the Lil Stewardship commercial thin treatments and the North Warner Aspen (NWA) project. Pre- and post-treatment monitoring has been conducted in the South Warner Aspen project area, and the results are analyzed and presented below.

The South Warner Aspen (SWA) treatment units and monitoring plot locations are shown in Figure 7.2. All units were treated to remove conifer less than 12” DBH by chainsaw. Five plots were placed prior to treatment in the southern portion of the South Warner Mountains in 2014 (Figure 7.3) and revisited in 2016 following small conifer thinning treatments conducted over the fall/winter of 2014/2015. Six plots were placed in 2014 immediately following small conifer thinning treatments in the northern portion of the South Warner Mountains (Figure 7.4). These plots were not visited prior to harvest. Because only the five southern plots had visits prior to the small conifer thinning treatment, only these five plots were included in the analysis here. See Figure 7.1 below for before/after photos from one of the SWA units. The northern plots and plots in other aspen projects will be analyzed when longer-term follow-up visits have been completed.

Figure 7.1 SWA Unit 26 before and after treatment. Photos courtesy of C. Cavanaugh, USFS.

Figure 7.2 Overview of South Warner Aspen harvest units and plots.

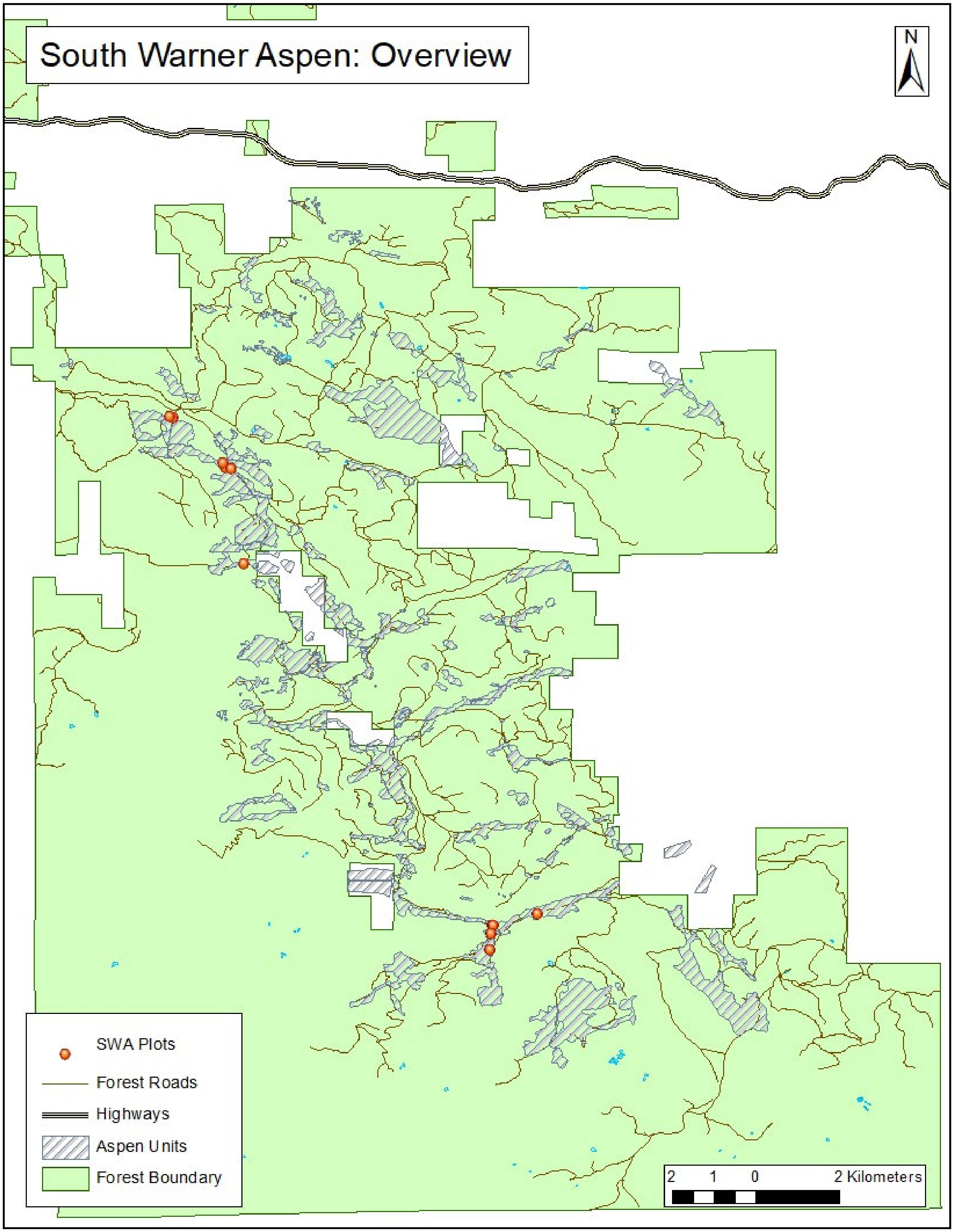


Figure 7.3 Harvest units and pre/post-harvest plots in the southern portion of the South Warner Aspen project area.

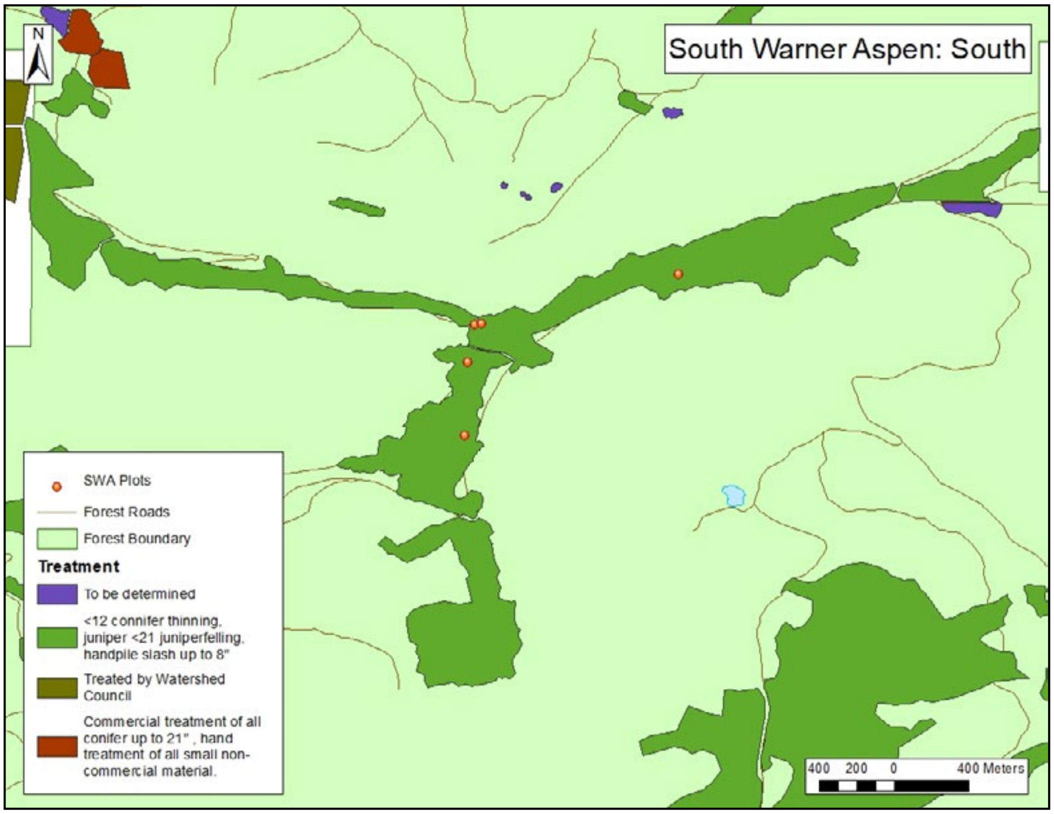
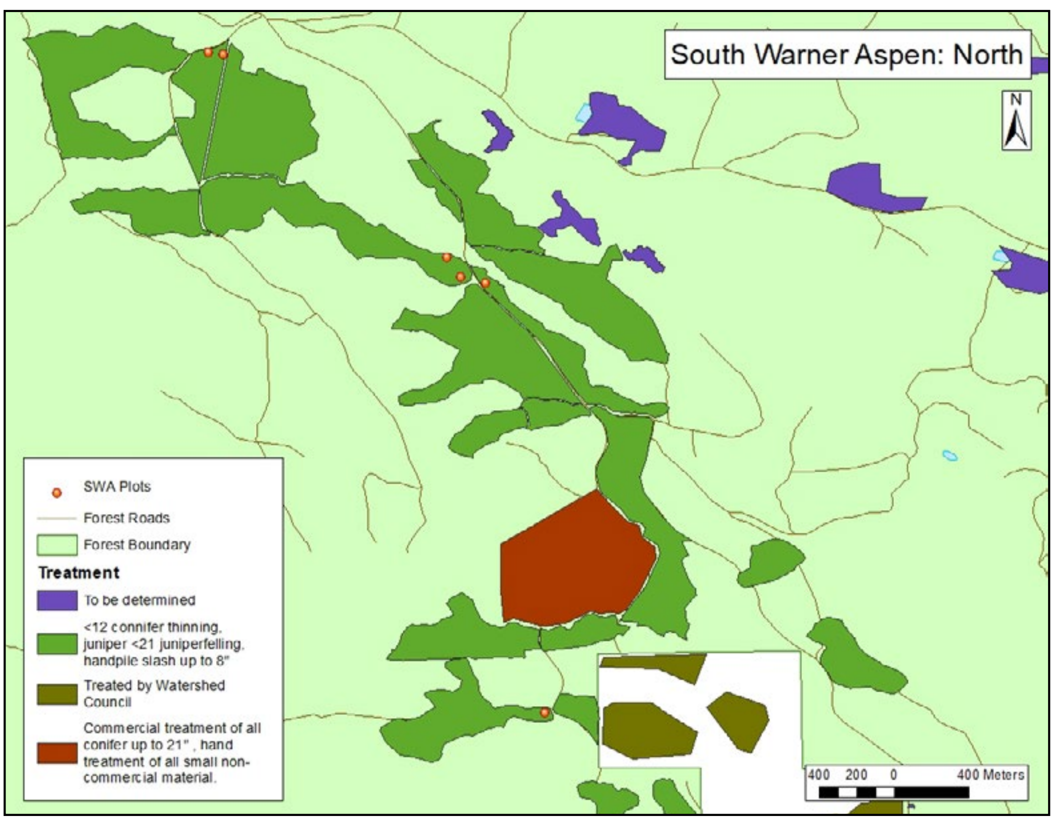


Figure 7.4 Harvest units and post-harvest plots in the northern portion of the South Warner Aspen project area.



Species Composition

The vegetation data used to address this indicator comes from the "greenline" protocol outlined in the Monitoring Plan. This line-intercept protocol measures vegetation along a 30-meter transect running through the center of the 10 m x 40 m rectangular plot. Percent cover is based on the length of the transect intercepted by each species. The percentages, shown in Table 7.1, represent the relative cover (percentage of total vegetation cover) of each species. Only species with a cover of 1% or greater pre- or post-treatment are included. A Bray-Curtis dissimilarity test was used to measure change in species composition following treatment. A dissimilarity close to zero indicates little change in composition, and a dissimilarity close to one indicates extensive change. The result was a dissimilarity of 0.23, indicating limited change in species composition following treatment.

Several species merit closer examination. The percent cover of white fir decreased, which is the expected result in a conifer thinning. The cover of ponderosa pine dropped by less than one percentage point, which is not an expected result of a conifer thin. It is understandable that white fir would be a higher priority for removal than ponderosa pine, but some decrease in ponderosa pine would be expected. It is possible that changes in the overstory were simply not detectable on the vegetation transect, or that there was limited small ponderosa pine available to cut.

Black cottonwood observations were combined with aspen observations because black cottonwood trees were mis-identified as aspen in one of the post-harvest plots. This mis-identification rendered the actual relative composition of aspen and black cottonwood unknown. This was discovered due to an apparent drop in black cottonwood observations despite the fact that black cottonwood was not targeted for removal. In addition, no other observations were made of a change in black cottonwood stocking. Both species occupy a similar ecological niche in that they would be expected to experience a regeneration pulse following conifer thinning and that their regeneration stems are desirable browse for ungulates (Endress et al., 2012). Therefore, combining the observations of two species does not fundamentally change the implication of the species composition in this analysis. The combined percent cover of aspen and black cottonwood increased following thinning, which is consistent with the goal of a conifer thin. This result doesn't necessarily indicate an increase in either species, since the relative portion of these two species could simply have increased due to the decrease in conifer species.

Of the remaining species, only two showed a change of greater than two percentage points. There was an increase of 2.6 percentage points in licorice-root cover and a decrease of 3.4 percentage points in slender phlox cover. No slender phlox was observed post-harvest in any plot. Licorice-root was identified to the genus level, (Ligusticum spp.) not to the individual species level.

Bare Ground and Ground Cover

The ground cover surveys in aspen plots are conducted in a similar fashion to the greenline protocol used for the species composition analysis. Ground cover percentage is calculated based on the length of the transect intercepted by a particular ground cover type. Live vegetation is included in the litter category, so there is no separate measurement for live vegetation.

The average ground cover percentages by type are shown in Table 7.2 and Figure 7.6. A Bray-Curtis dissimilarity test was used to measure the change in ground cover composition following treatment. A dissimilarity close to zero indicates little change in composition. The result was a dissimilarity of 0.05, indicating that ground cover composition in the observed plots showed almost no change following treatment.
There was a slight increase in average DWD cover, which isn't surprising following a small tree thinning. Very little bare ground was observed. The most extensive ground cover type observed was litter/vegetation. Little change was observed following harvest in any individual ground cover type, which is consistent with the Bray-Curtis result. This indicates that the small tree thinning method (lop and scatter) did not have a significant impact on ground cover composition. Ecological (as opposed to mechanical) effects will not likely be immediately apparent, and will require longer-term revisits to detect.

Table 7.1 Vegetation species composition before and after South Warner Aspen small conifer thinning treatment. Change is shown in percentage points.

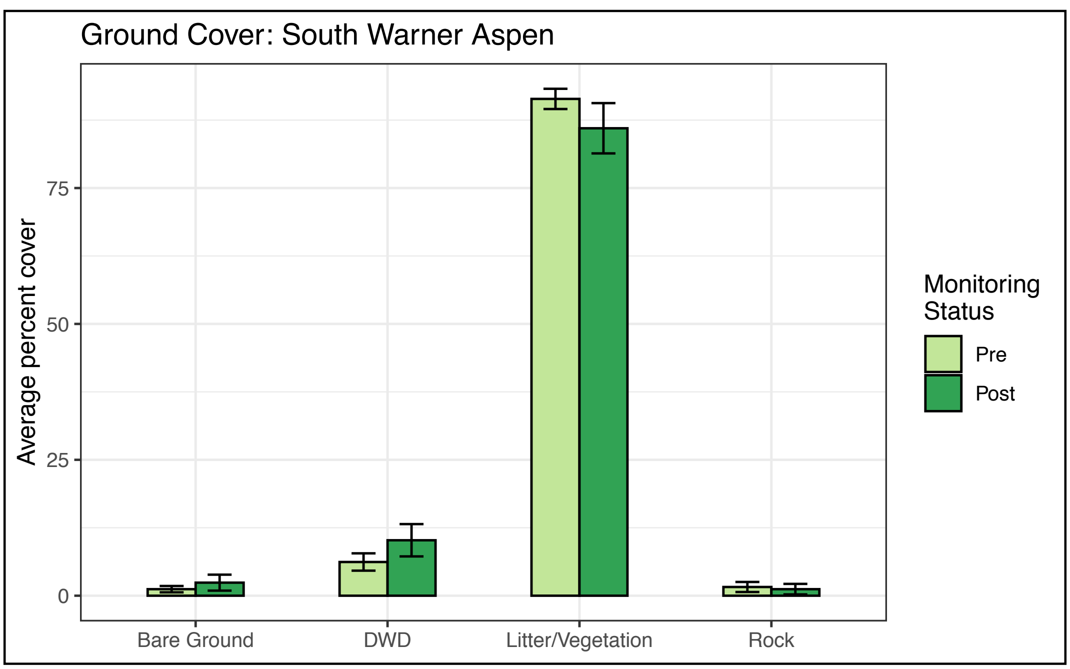
Species	Cover (%) Pre-harvest	Cover (%) Post-harvest	Change
white fir	15.9	5.8	-10.1
quaking aspen/black cottonwood	18.9	21.9	3.0
ponderosa pine	8.1	7.8	-0.3
sweet cicely	5.3	4.8	-0.5
licorice-root	5.2	7.8	2.6
common dandelion	4.1	2.6	-1.6
star-flower Solomon's seal	3.4	4.3	0.9
slender phlox	3.4	0.0	-3.4
Kentucky bluegrass	3.3	4.1	0.9
bentgrass	2.3	2.5	0.1
alpine groundsel	1.9	2.3	0.4
green corn lily	1.8	1.2	-0.5
common snowberry	1.6	1.9	0.4
small bluebells	1.5	2.5	1.0
American vetch	1.4	3.1	1.7
panicled bulrush	1.2	1.2	-0.1
fragrant bedstraw	1.2	2.2	1.1
common horsetail	1.1	1.4	0.3
houndstongue hawkweed	0.9	2.2	1.3
heartleaf arnica	0.8	1.6	0.8
common yarrow	0.8	1.0	0.2
western buttercup	0.7	1.3	0.6
sedge	0.5	1.7	1.3
blue-eyed Mary	0.2	1.6	1.4

Table 7.2 Average ground cover percentage by type for South Warner Aspen small conifer thinning treatments including standard error about the mean.

Ground Cover Type	Average Pre-Harvest (%)	+ / -	Average Post-Harvest (%)	+ / -
Bare Ground	1.2	0.6	2.4	1.5
DWD	6.2	1.6	10.2	3.0
Litter/Vegetation	91.4	1.9	86.0	4.6
Rock	1.6	0.9	1.2	1.0

Figure 7.5 Crew members measure vegetation and ground cover in a South Warner Aspen plot. Photo courtesy of the CBMT.

Figure 7.6 Ground cover percentage prior to and following small conifer thinning treatments in the South Warner Aspen project area.



Vegetation Cover

The greenline protocol data used in the species composition analysis was also used to calculate the overall vegetation cover. The same intercept totals were used but without differentiating at the species level. Absolute vegetation cover is used here; that is, the percentage of ground that was covered by vegetation as opposed to other ground cover types. Since multiple species can occur at different heights at the same spot on the transect, the total vegetation cover may be slightly overestimated, and the combined percent cover may add up to greater than 100.

For the purposes of the vegetation cover analysis, the species data was divided into two types: tree and understory. Understory consists of herbs/forbs and shrubs. Results are shown in Table 7.3 and Figure 7.7. The average percentage of tree cover dropped, which is expected following a small conifer thinning. The average percentage of understory vegetation cover dropped slightly. However, the variation in pre- and post-treatment average understory vegetation cover overlaps, as seen in Figure 7.7, and a Wilcoxon signed rank test did not detect a change in vegetation cover (p-value = 0.635, not significant at Đ = 0.1). The 80% confidence interval of (-18, 4) indicates the median vegetation change could be anywhere from an 18% decrease to a 4% increase. This indicates that the small tree thinning method (lop and scatter) did not have a significant impact on understory vegetation cover. Ecological (as opposed to mechanical) effects will not likely be immediately apparent, and will require longer-term revisits to detect. Tree cover will be analyzed in greater depth in the next section.

Vegetation Age Class

The indicator does not specify how to divide age classes, so the three age classes in which aspen stems are measured by the CBMT are used for this analysis. The three age classes are overstory trees, saplings and suckers. Aspen with a DBH of 10 cm or greater are considered overstory trees. Aspen at least 2 m in height but with a DBH of less than 10 cm are considered saplings. Aspen less than 2 m in height are considered suckers.

Since the revisits completed at the time of this analysis were approximately one year following harvest, the only changes in mature tree stocking are likely due to conifers removed in the harvest. Stem counts and basal area were analyzed for the overstory, since both reveal different aspects of tree stocking. Results are shown in Table 7.4 and Figure 7.8. Little change was observed in aspen stocking for either variable, which isn't surprising at only one year following small conifer removal. There was a greater decrease observed in average conifer stems than average conifer basal area, indicating that most of the conifer trees removed were small. This is expected from a small conifer harvest.

Table 7.3 Vegetation cover percentage by type prior to and following small conifer thinning treatments in the South Warner Aspen project area.

Vegetation Type	Average Pre-Harvest (%)	+ / -	Average Post-Harvest (%)	+ / -
Tree	49.0	7.1	33.2	9.1
Understory	65.4	13.9	59.8	9.2

Table 7.4 Average overstory basal area per acre (ft) and average stems per acre by tree species type before and after small conifer thinning treatments in the South Warner Aspen project area.

	Average basal area per acre (ft2)				Average stems per Acre			
Tree type	**Pre**	**+ / -**	**Post**	**+ / -**	**Pre**	**+ / -**	**Post**	**+ / -**
Aspen	24	13	25	14	122	55	124	57
Conifer	137	47	97	48	176	42	44	15

Figure 7.7 Vegetation cover percentage prior to and following small conifer thinning treatments in the South Warner Aspen project area.

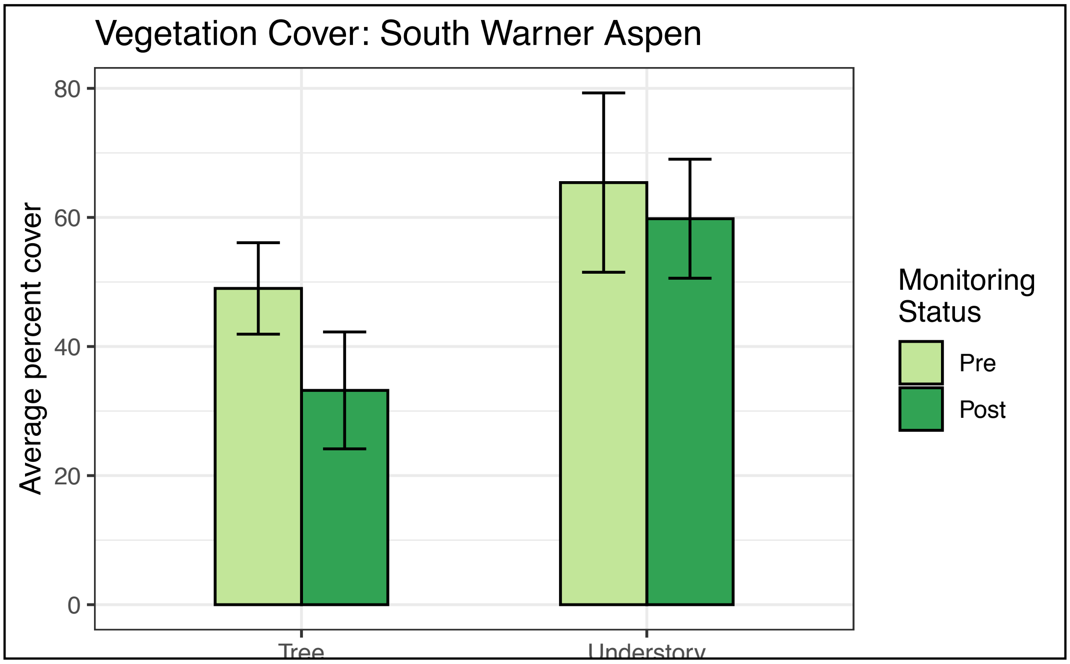
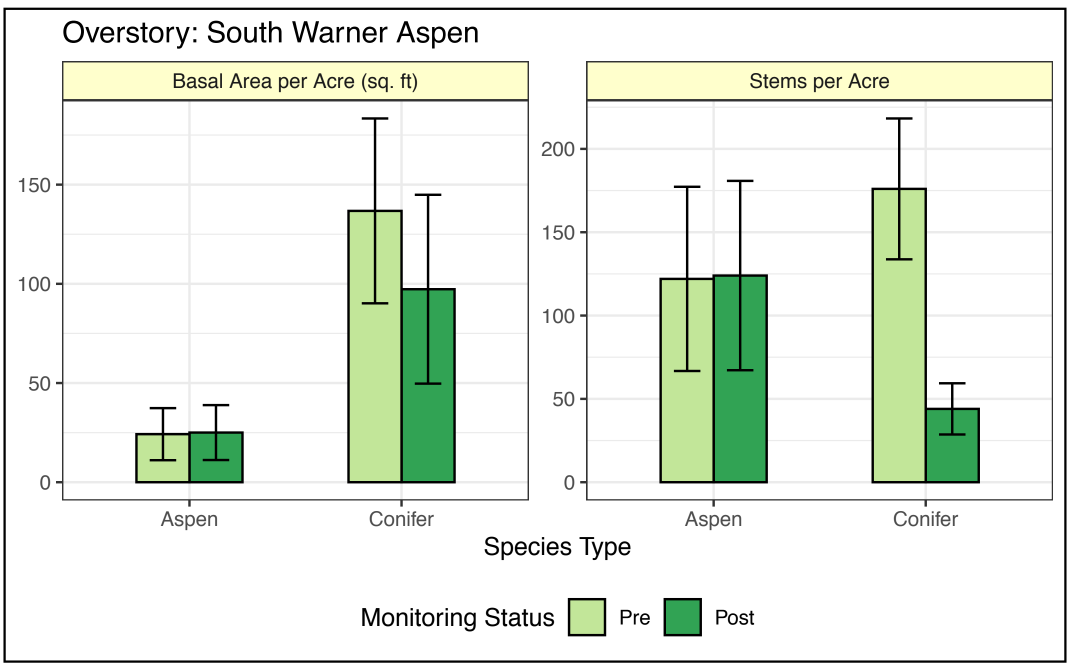


Figure 7.8 Changes in average overstory tree stocking by tree species type prior to and following small conifer thinning treatments in the South Warner Aspen project area.



The results for aspen regeneration observations are shown in Table 7.5 and Figure 7.9. The average numbers of both suckers and saplings showed little change. Since the revisits were conducted in the year immediately following harvest, an increase in suckers due to release from conifer competition is likely not yet evident. Longer-term revisits will be necessary before drawing any conclusions about an increase in aspen regeneration.

There is extensive variation in pre-harvest stocking in both overstory aspen and suckers. Studies have shown that pre-management aspen density is a predictor of aspen regeneration success following restoration activities (Jones et al., 2005, Krasnow et al., 2012). Therefore, it may be of interest in a follow-up analysis to compare results on the basis of initial aspen density.

In order to check for statistical evidence for a change in age class measurements, Wilcoxon signed rank tests were performed for each category. Results are shown in Table 7.6. The test did not find evidence of a change in median aspen basal area or aspen density. The confidence intervals were narrow, indicating any actual change would have been small. The test found evidence of a decrease in both median conifer basal area and density. The median conifer basal area dropped by 37.1 ft2/ac, and the median conifer density dropped by 125 stems/ac. The test did not find evidence of a change in median seedling and sapling counts following treatment. Both confidence intervals were extremely wide, indicating there was too much variation among the plots to detect a change.

Table 7.5 Average aspen regeneration counts per acre prior to and following small conifer thinning treatments in the South Warner Aspen project area.

	Pre-harvest		Post-harvest	
Age class	**Avg count/acre**	**+ / -**	**Avg count/acre**	**+ / -**
Saplings	390	196	426	183
Suckers	656	168	668	261

Figure 7.9 Changes in average regeneration counts per acre prior to and following small conifer thinning treatments in the South Warner Aspen project area.

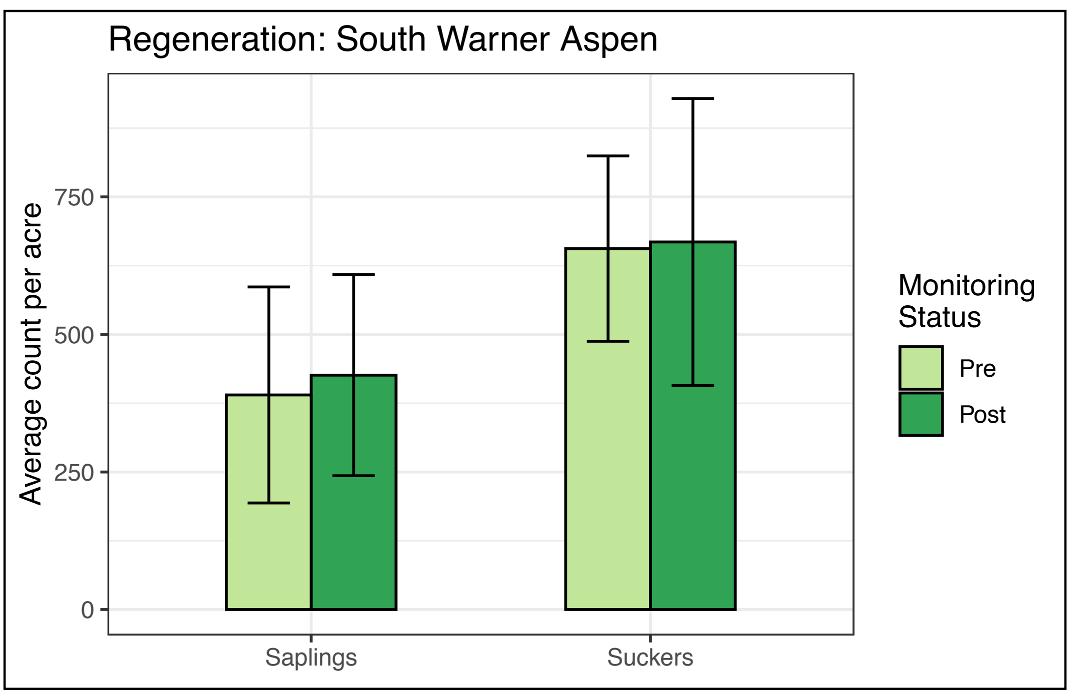


Table 7.6 Wilcoxon signed rank test results for all age classes with 80% confidence interval where possible. Significant test results ($p < 0.1$) are shown in bold.

Measurement	Units	Estimated median change	p-value	CI lower	CI upper
Aspen basal area*	ft^2/ac	1.4	0.789	-3.9	6.4
Aspen density†	stems/ac	5	1	5	5
Conifer basal area	ft^2/ac	**-37.1**	0.063	-55.6	-19.6
Conifer density	stems/ac	**-125**	0.063	-170	-90
Aspen Saplings	count/ac	30	0.279	-5	90
Aspen Suckers	count/ac	-15	1	-410	375

**A confidence level of 80% was not possible because two of the five plots had zero change in aspen basal area. A 60% confidence interval was used instead.*

†Calculating a confidence interval was not possible because three out of the five plots had zero change in aspen density

Figure 7.10 Crew members taking post-treatment measurements among aspen saplings. Photo courtesy of the CBMT.

Extent

Aspen stand extents were mapped in the South Warners in 2009 as part of a student project, several years prior to small conifer thinning treatments (C. Cavanaugh, personal communication, October 2020). Aspen stand sizes have not yet been remapped, as an increase in extent of aspen stands would not be noticeable for at least several years following treatment. Once the stands have been remapped, the change in extent may be calculated.

7.1 Recommendations

Aspen Sucker Height Monitoring

Current CBMT aspen sucker protocols focus on counting the number of new suckers appearing each year following treatment. If the number of suckers increases in each successive year following treatment, restoration is considered a success. Since aspen plots are not revisited yearly following treatment, the number of bud scars present on each sucker is used as a surrogate for age. This is actually not a common method of measuring aspen regeneration success. The most common method of assessing aspen restoration success in research studies and monitoring plans is sucker height (Jones et al., 2005, Krasnow et al., 2012, Strand et al., 2009). The only use of bud scars found in a brief literature review was to assess sucker height in prior years (Keigley & Frisina 2008, Painter et al., 2014). The advantage of measuring sucker height is to assess susceptibility to grazing and general sucker vigor. Two meters is generally considered the height at which suckers are safe from grazing (Shepherd et al, 2006), but some monitoring plans use heights as low as 1.5 m (Strand et al., 2009, Zeigenfuss et al., 2011). Under current CBMT protocols, heights are not measured below 2 m. Measuring sucker height is recommended since it would provide more detailed information on sucker survival rates, and sucker health (Frey et al., 2003).

Aspen Sucker Grazing Observations

Current CBMT protocols do not include observations of whether individual suckers show evidence of being grazed. Counting the number of suckers grazed is a common form of aspen regeneration monitoring (USDA Forest Service 2004, Zeigenfuss et al., 2011). The CBMT have recorded qualitative observations of whether grazing is present in a stand, but no quantitative data on the number of suckers grazed. Ungulate herbivory is known to be harmful to aspen stand health (Seager et al., 2013), so having data on the extent of ungulate herbivory would be valuable for assessing the success of aspen restoration measures. The Fremont-Winema NF has been managing grazing permits in order to alleviate browsing pressure on aspen stands (C. Cavanaugh, personal communication, April 2019), so data on the number of suckers grazed and whether there was evidence of deer, elk or cattle would provide insight into whether or not these methods have been successful.

Sampling Scheme

Aspen regeneration and vegetation response usually will not be apparent until at least several years following thinning. Five years is a commonly used interval in aspen monitoring plots (Strand et al., 2009, Zeigenfuss et al., 2011). All eleven of the SWA plots were visited within the year following harvest, but only one has had a longer-term revisit. Five years have passed following the original treatments, so it is recommended that all eleven plots be revisited, and aspen stand extents be remeasured.

A final recommendation is to conduct future aspen monitoring with a more intensive sampling scheme that involves placing more plots prior to treatment, covering more of the landscape, and monitoring in burned areas. The existing observations only capture mechanical thinning, and are somewhat limited in spatial coverage. The WDA plots, though not covered in this analysis, do have more extensive coverage than the SWA plots, but do not yet contain any observations in burns.

Figure 7.11 Panoramic photographs from a South Warner Aspen plot before and after small conifer thinning treatment. Photos courtesy of the CBMT.

Acknowledgements

Many thanks to Cheran Cavanaugh, Wildlife Biologist, Mike Reed, Forest Silviculturist, and Amy Markus, Cohesive Strategy Coordinator with the Fremont-Winema National Forest for providing review and feedback.

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Question 7.2

How are riparian and upland treatments impacting ground vegetation and soils?

Goal 7.2:
To quantify how restoration activities such as logging and prescribed fire impact soils.

Indicator 7.2:
Soil disturbance class.

Analysis 7.2

This indicator calls for the use of the Forest Soil Disturbance Monitoring Protocol (FSDMP). This protocol was developed by the Rocky Mountain Research Station (RMRS) and is designed to assess forest soil disturbance as a result of timber harvest activities (Page-Dumroese et al., 2009a & 2009b). Conducting these surveys is one of the regular duties of the Fremont-Winema National Forest soil scientist. Three such reports are being used to address this indicator. These reports are included in the Supplemental Reports section, and the results are summarized below:

Deuce Pilot 10: Cut-to-length tethered forwarder on steep slopes.

- In 2016, immediately following harvest, 15% of observation points in the survey showed detrimental impact from harvest activity, and 18% detrimental impact when roads were included. Both of these numbers are within the 20% standard of acceptable detrimental impact.
- In 2018, 13% of observations showed detrimental impact from harvest activity, and 16% when roads were included. The drop in percentage of detrimental impact shows that the soil is recovering.

Crooked Mud Honey Lil Stewardship 16 & 46: Feller-buncher and skidder.

- In Unit 16, 18% of observations showed detrimental disturbance. This is within the 20% standard of acceptable detrimental impact.
- In Unit 46, 10% of observations showed detrimental disturbance. This is within the 20% standard of acceptable detrimental impact.
- The two units are adjacent, and when the observations are combined the detrimental disturbance is 14%, which is also within the 20% standard of acceptable detrimental impact.

Abe 38 & 60: Feller-buncher and rubber-tired skidder.

- While the harvests occurred in 2009, prior to CFLRP, the same equipment has been used in CFLRP harvests. Also, it provides a longer-term analysis than is currently possible with CFLRP harvests.
- In Unit 38, 13% of observations showed detrimental disturbance, and 15% when roads and landings are included. This is within the 20% standard of acceptable detrimental impact.
- In Unit 60, 10% of observations showed detrimental disturbance, and 17% when roads and landings are included. This is within the 20% standard of acceptable detrimental impact.
- Soil impacts alone might have driven the detrimental disturbance percentage in Unit 38 above 20%, but vegetation regrowth in the disturbed areas showed that the soil disturbance did not have an adverse impact on vegetation.
- Concerns include J-roots in ponderosa pine regeneration in skid trails due to rocky, compacted soils.

Deuce Olde 3: Grapple piling on steep slopes.

- This analysis is not a FSDMP survey, but the results still address the goal.
- The CBMT compared soil compaction on skid trails in the unit to adjacent non-impacted soil, and to soil in a non-harvested area. These results were then compared to skid trails that had been burned in the Barry Point Fire.

- While there was some increase in compaction observed within the skid trails in Olde 3, the CBMT does not believe it is high enough to be concerning. See Figure 7.13.
- The CBMT analysis also showed that the compaction observed was similar to that which resulted from the Barry Point Fire, indicating that these impacts would be felt anyway if the area burned as a result of lack of restoration efforts. See Figure 7.14.
- This analysis was presented to the LSG in 2018.

Figure 7.12 CBMT soil compaction surveys on steep slopes in Olde 3. Photo courtesy of the CBMT.

Figure 7.13 CBMT analysis of compaction on skid trails, off skid trails, and in an unharvested area in Olde 3, which was grapple-piled on steep slopes.

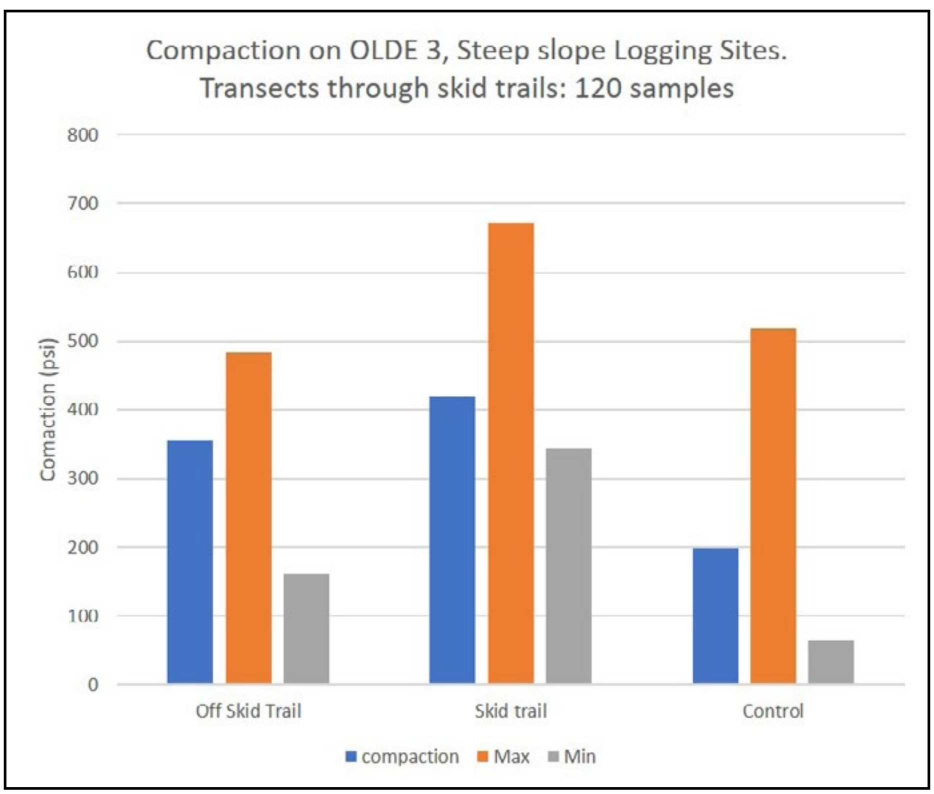
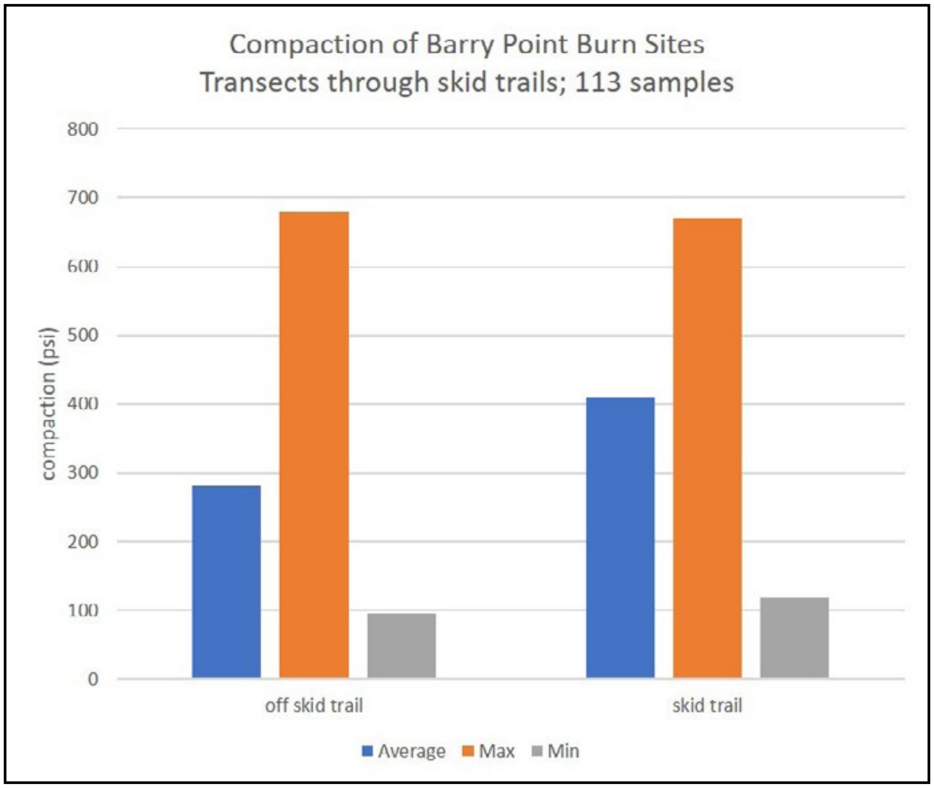


Figure 7.14 CBMT analysis of compaction on skid trails burned in the Barry Point Fire, as a comparison to the skid trails in Olde 3, which was grapple-piled on steep slopes.



7.2 Recommendations

The analyses presented here show that the soil impacts from mechanical treatment using cut-to-length tethered forwarder, feller-buncher/skidder, rubber-tired skidder, and grapple-logging are within acceptable limits. These units only cover a small fraction of the areas harvested under CFLRP, so LSG must decide if this evidence is satisfactory or if continued monitoring is desired. It is recommended that FSDMP surveys should continue to be reported to the LSG if harvest equipment other than those evaluated here is used.

The results presented here only represent mechanical thinning. Monitoring still needs to be conducted in prescribed burns in order to assess the effects of prescribed burning on soil. The soil scientist is planning to conduct a post-burn survey of Deuce Pilot 10 in the summer of 2020, and the results will be reported when received.

Regarding the methodology, the monitoring plan calls for the CBMT to conduct FSDMP surveys and report the results to the soil scientist. The crew did conduct some FSDMP surveys, and these were shared with the soil scientist. The soil scientist found that the data collected by the CBMT did not adhere to all aspects of the FSDMP, rendering this data of questionable value. The FSDMP states that the methods must not be altered, or the data loses its value (Page-Dumroese et al., 2009a & 2009b). It is likely that the individual who originally trained the crew did not do so effectively. This is not a reflection of the skills and abilities of the CBMT (who would be quite capable if trained properly), but of the advanced nature of the protocol. The soil scientist has recommended that only someone specially trained conduct this protocol. One option is for the Forest Service to hire a summer seasonal soil technician. Another option is for the soil scientist to work closely with one or two CBMT members to develop expertise in this protocol.

Acknowledgements

Many thanks to Gina Rone, Soil Scientist for the Fremont-Winema National Forest, for providing analysis and reports.

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Question 8

How are projects (road closures, upland and riparian treatments, etc.) impacting water quality?

Goal 8.1:
To maintain those watersheds currently rated as "good" and to improve to "good" in those watersheds currently rated as "fair.".
Indicator 8.1:
Watershed Condition Framework (WCF) ratings.

Goal 8.2:
To quantify the miles of road decommissioned across the entire CFLR project area and within riparian zones.
Indicator 8.2:
Miles of road decommissioned and reduction in road density in the 6th field watersheds within the CFLR project area and within riparian areas.

Goal 8.3:
To determine how restoration projects impact stream temperature.
Indicator 8.3:
Stream temperature.

The CFLR area is comprised of either some part or the whole of 65 sub-watersheds, a level of classification on which most Forest Service hydrologic project analyses are performed (sub-watersheds are about 10,000 to 40,000 acres in size). There have been three major projects implemented within the CFLR area: Abe (within the Auger/Camp and Bauers sub-watersheds), West Drews (within Dent/Drews and Hay sub-watersheds) and Crooked Mud Honey (within Upper Crooked, Lower Crooked, McDowell, Mud and Upper Camas sub-watersheds). Road density and proximity to water analyses will generally focus on these project areas which are outlined in Figure 8.2..

Analysis 8.1: Watershed Condition Framework ratings

The Watershed Condition Framework (WCF) rates a 6th field HUC watershed (aka a sub-watershed or hereon "subshed") on 12 indicators and 24 attributes across four process categories that are closely related to the health of aquatic ecosystems, including water quality. Figure 8.1 illustrates this structure.

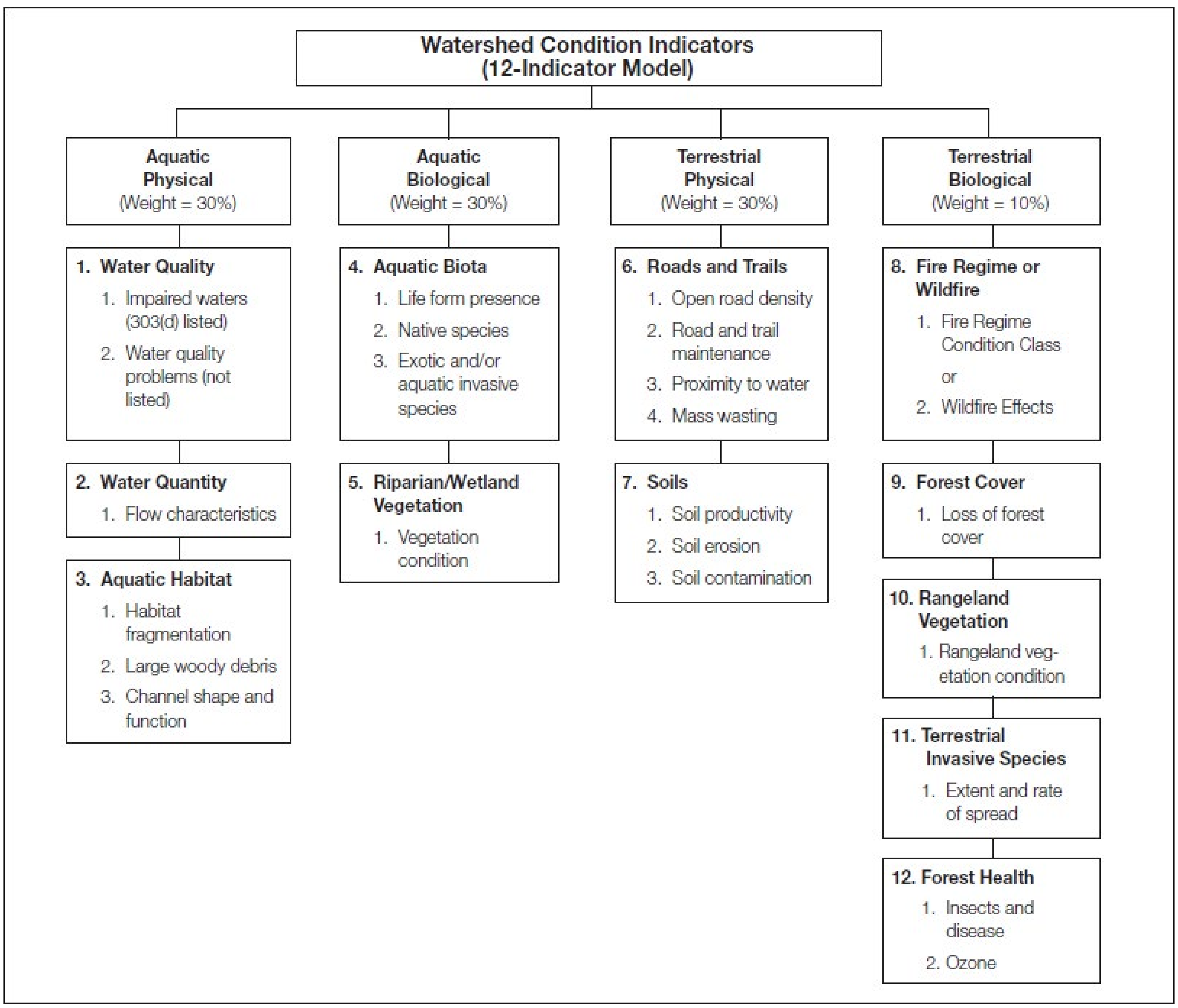
The original intent of the WCF was to reassess these subsheds every year when changes occur, then every five years for a more rigorous classification. The goal of assessing all subsheds every 2-3 years, while laudable, is not a very practical goal. Since its inception, many attributes have taken on more complex means of determination that lie outside the scope of forest analyses and rather lie at the Regional or National level. For example, in 2016 the Region developed a number of geodatabases and associated spreadsheets that include quantitative evaluations of water quality impaired waters (303d lists), fire regime condition class (FRCC), and the way that insects and disease affect forest health. This work culminated in the last effort to update the WCF ratings on this forest (2015-16).

The WCF was recently (2018) added to the Farm Bill, which will require a reevaluation and some changes to the current structure. Plans are in the works to make another Regional effort at updating the WCF after a review of the program is completed, currently scheduled sometime in 2021. This all culminates in not having a current up to date WCF rating. However, real improvements to some subsheds within the CFLR project area have been made since the project began and will be highlighted below.

Of the 65 subsheds that make up the CFLR project area (as of the 2016 assessments), 22 are functioning properly while 43 are functioning-at-risk (Figure 8.2). Acreage wise, 397,829 acres of the total 488,841 acres that make up the CFLR project area (81%) are in a functional-at-risk rating. Most of these subsheds have at least maintained their current rating while six are expected to improve toward a near functioning properly rating (at least on Forest Service administered lands) due to work done through the CFLR projects. However, none of them will likely achieve properly functioning status through these projects alone.

While some riparian restoration projects (addressing WCF indicator 3, Aquatic Habitat) were funded by and occurred within the CFLR project area, their scope was generally quite limited and were not the drivers putting the majority of subsheds within the project area into the "functional-at-risk" category rating. Attributes generally responsible for driving ratings to the at-risk level are those for water quality (303d listing, see Indicator 8.3 Stream Temperature), road and trail condition (see Indicator 8.2 Road Density and Proximity to Water), fire regime condition class (FRCC), forest cover and forest health. Of these attributes, only road and trail condition and FRCC are within a relative short-term ability for the Forest Service to control. This involves closing and/or decommissioning roads to reduce open road density, especially those that are within 300 feet of a stream channel or water body (see Indicator 8.2 Road Density and Proximity to Water) and carrying out prescribed fuels treatments.

Figure 8.1 General structure of the watershed condition classification model.

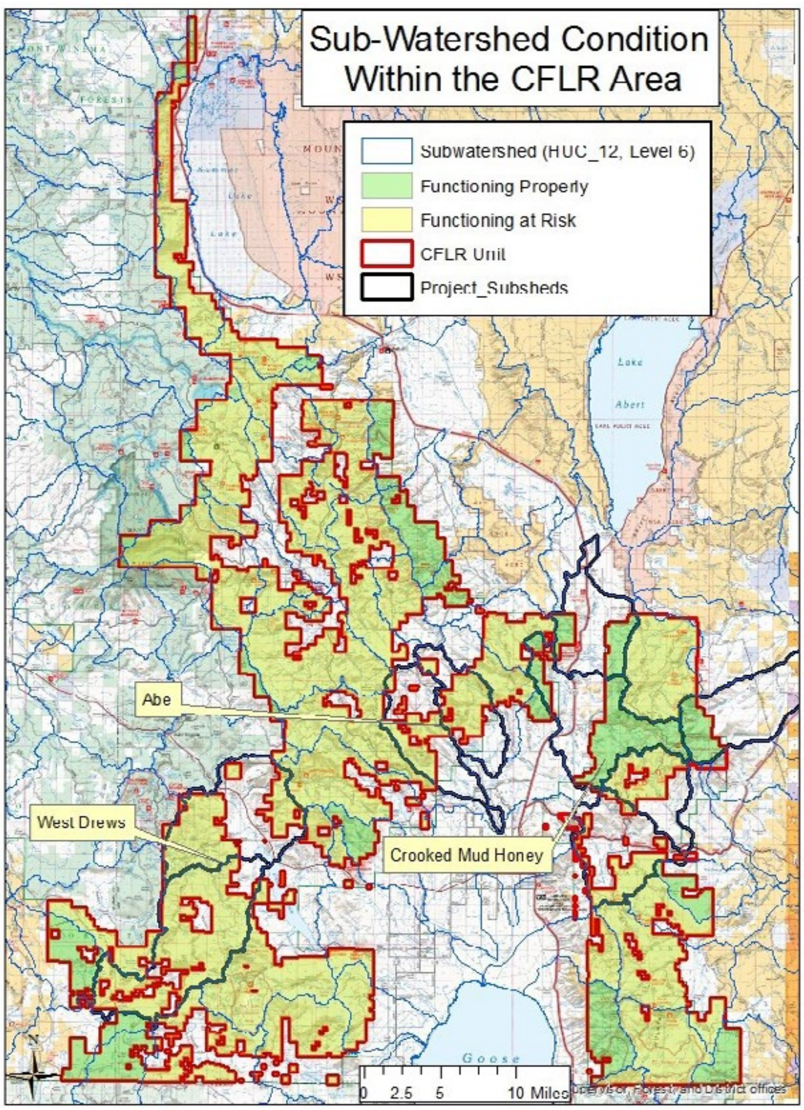


A closer look at the other drivers of at-risk subsheds reveals some blocks to improvements through CFLR projects. First, most of the subsheds have streams on the 303d list for water temperature issues. Getting these streams off the 303d list will likely involve high investments in time and money, planting streamside vegetation and narrowing stream channels over a long time period with no guarantee of success given climate change projections. Therefore, this important driver to watershed improvement will likely be hard to obtain.

Second, forest cover is one of the indicators that does not benefit from forest thinning efforts as generally more cover is considered good and drives the classification to a better rating. If anything, thinning could be considered to exacerbate the cover situation. However, note that from Figure 8.1, forest cover is only one of six indicators from the terrestrial biological processes which are only weighted at 10% of overall contribution, so thinning alone plays little role as a driver itself.

Third, a significant amount of work has been done in these subsheds to reduce fuels and therefore change the FRCC, but again this is but one indicator weighted lightly in the system of the WCF and so also plays little role as a driver. Finally, during the 2016 reevaluation a new scheme to evaluate forest health was initiated which drove many forest subsheds to poor condition for this indicator. Again, this factor plays a small role as a driver, but it has driven it in the wrong direction just the same.

Figure 8.2 Watershed Condition Class within the CFLN project area with specific projects outlined.



Analysis 8.2: Road Density and Proximity to Water

Road density and road proximity to water are among some of the more important considerations to watershed health that are under the control of land management. An open road density of less than one mile per square mile of subshed is generally considered a good rating, from 1-2.4mi/mi² is a fair rating and anything over 2.5mi/mi² is considered poor. These divisions are based mostly on the effects to wildlife rather than some watershed threshold, but fewer roads do equate to less sediment potential to find a stream. If 10% or less of those roads are within 300 feet of a stream or waterbody, the indicator is rated as Good, 11-25% gives a Fair rating, and over 25% is rated as Poor.

The amount of road decommissioning that has occurred throughout the entire CFLR area is about 83 miles, just 3.6% of the entire road system which is comprised of 1,061 miles of closed road and 1,246 miles of open road. Closed roads do not generally contribute to road density calculations as when roads are closed they should be hydrologically disconnected from streams and waterbodies; however, at the time of initial density calculations it was felt that there was enough clandestine use of closed roads on the forest to warrant accounting for them in some fashion. It was decided about 20% of closed roads are probably still being used to some extent and therefore density calculations include this percentage of closed roads.

Road density and proximity to water percentages both pre- and post-project are presented in Table 8.1. Most road closures and decommissioning have occurred within the Abe and West Drews projects, with about 37 miles of road addressed in Abe, 26.7 miles in West Drews and 4.5 miles for Crooked Mud Honey. For all projects' subsheds, in all but two cases the reduction of density is not enough to change the density rating, much less improve the watershed condition rating.

A "quick-and-dirty" calculation of the entire CFLR area gives a current road density of about 1.91 mi/mi², or a rating of "Fair". To give some perspective of the scale, all current closed roads and some 482 miles of open road (1,543 miles total) would need to be decommissioned in the CFLR area, OR some 867 miles of open road would need to be closed, OR some combination of closure/decommissioning in order to achieve a "Good" rating today. This demonstrates that

Table 8.1 Open road density and proximity to water values and ratings pre- and post-CFLR projects. Density is in miles per square mile; Ratings: 1=Good, 2=Fair, 3=Poor.

Sub-watershed Name	Project	Open Road Density-Pre	Road Density Rating-Pre	Open Road Density-Post	Road Density Rating-Post	Proximity to Water, %-Pre	Proximity to Water Rating-Pre	Proximity to Water, %-Post	Proximity to Water Rating-Post
Auger/Camp	Abe	2.1	2	1.9	2	6.7	1	18.8	2
Bauers	Abe	1.8	2	1.7	2	9.8	1	15.1	2
Dent Drews	West Drews	2.0	2	1.6	2	30.6	3	31.2	3
Hay	West Drews	2.4	2	2.3	2	11.0	2	16.3	2
Upper Crooked	Crooked Mud Honey	1.9	2	1.2	2	17.5	2	10.4	2
Lower Crooked	Crooked Mud Honey	1.6	2	0.6	1	10.6	2	9.5	1
McDowell	Crooked Mud Honey	0.1	1	0.1	1	38.0	3	38.0	3
Mud	Crooked Mud Honey	5.2	3	3.1	3	11.5	2	10.2	2
Upper Camas	Crooked Mud Honey	3.6	3	2.2	2	4.6	1	7.0	1

for this indicator to help improve watershed health, a much larger scale of decommissioning and closure will need to occur.

Road closure and decommissioning have been a challenge on the forest in the recent past. In general, the public is reluctant to close roads that give access to remote areas of the forest, and decommissioning takes out roads that could be accessed in the future to fight fire. In addition, shrinking budgets and difficulties in hiring and retaining engineering personnel have recently led the forest to abandon retention of road crews, leaving maintenance and other road work needing to be contracted. The forest is currently looking at various options to outsource this necessary work. What all the challenges boil down to is the amount of road closure and decommissioning that were planned in NEPA for the CFLR project area is progressing very slowly. This is affecting our WCF roads and trails condition indicators and slowing our progress toward getting our watersheds into proper functioning condition.

Analysis 8.3: Stream Temperature

Stream temperature is an important water quality indicator for the beneficial use of habitat and rearing of salmonid fish. Trout need cool water temperatures to thrive. The forest has streams listed by the Oregon Department of Environmental Quality (ODEQ) as being impaired (303d) by water temperature. The Fremont-Winema has a monitoring program used to help determine trends in water temperature. Figure 8.3 displays the streams within the CFLR project area that are currently on the 303d list for heightened water temperatures along with monitoring sites established by the Fremont-Winema. Some sites have only limited data while other sites are considered "long term" with recent records that span over at least six years.

A summary of data collection in the CFLR project area from 2012 (the institution of CFLR) to 2020 can be found in Appendix 8A (pages 140-143). Earlier data is also available upon request. This summary includes the monitoring station's name, what year data were collected, which ODEW standard the creek falls under, the maximum of the weekly average of the daily maximum temperature and the number of days of that year that exceeded that standard temperature. This summarized data can be graphed to help analyze yearly trends in water temperatures. For example, Figure 8.4 demonstrates an analysis for the Chewaucan River at an elevation of 5,120 feet (CH5120), where red dots indicate the yearly maximum water temperature (as a 7-day running average) and the grey bars showing the number of days during that year the daily maximum water temperature exceeded the ODEQ standard (the blue horizontal line).

Trendlines demonstrate a slow increase in yearly maximum over the 23-year span while the number of days exceeding the 20°C standard is rising dramatically. In contrast, Figure 8.5 demonstrates the decreasing trends in maximum temperatures and number of exceedance days on Thomas Creek at an elevation of 4,894 feet.

A clear linkage between any specific land management act and that effect on stream temperature is somewhat elusive with these data sets. Many factors will interact to affect stream temperature in complex ways, and the temperature monitoring the forest does is not geared toward determining the cause and effect of any one of them. What these data sets do help answer is, are we generally heading in the direction we would like to see. As demonstrated briefly here, in some places the answer appears to be no, in other places yes. More complex analyses of these data can be performed but are outside the scope of this report.

Acknowledgements

Many thanks to Don Kozlowski, Forest Hydrologist for the Fremont-Winema National Forest, for completing the analysis and report for Question 8 in its entirety.

Figure 8.3 Locations of water temperature monitoring stations on perennial waters within the CFLR project area, 303d temperature listed waters highlighted in red.

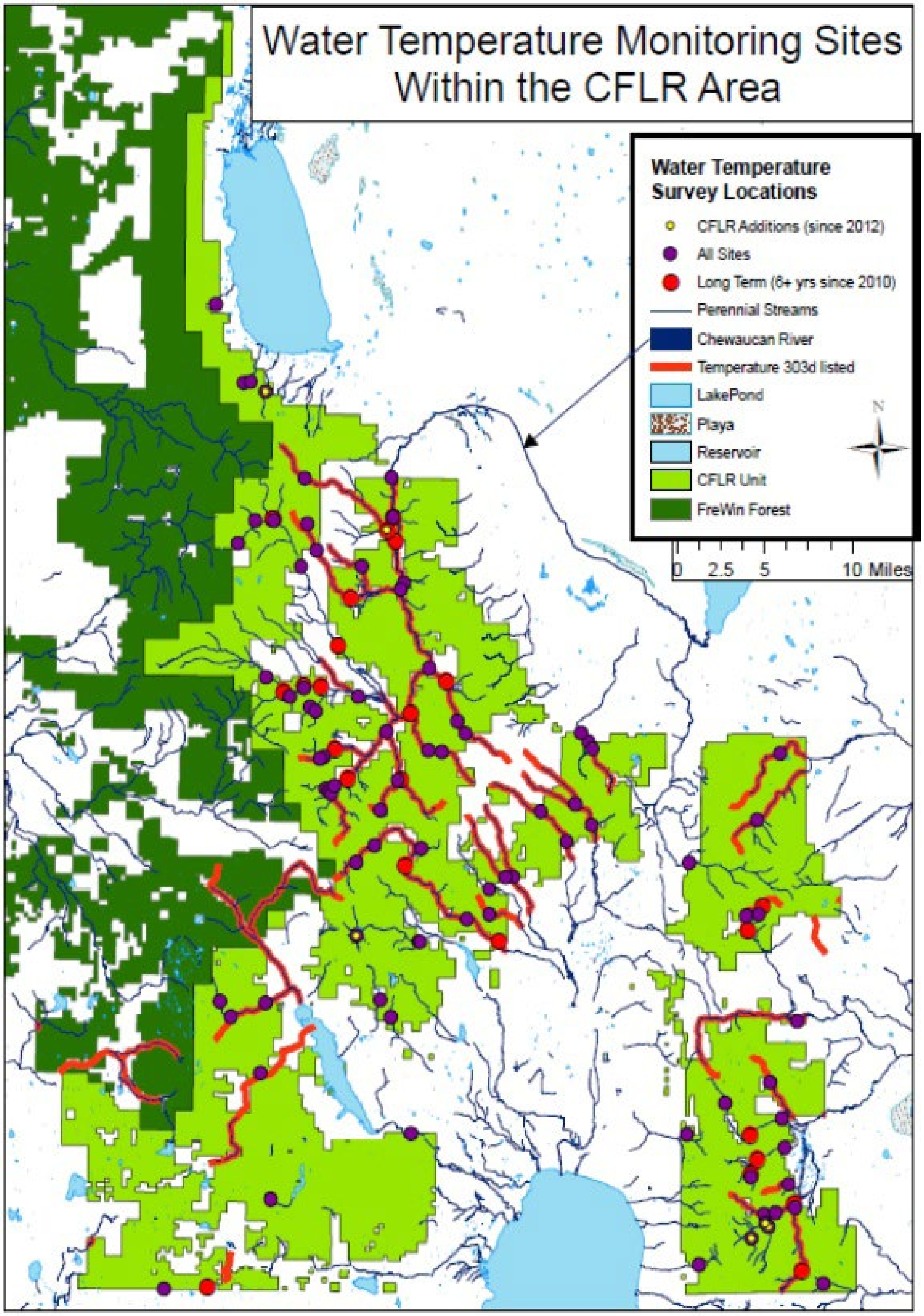


Figure 8.4 Trend in maximum averaged yearly temperature and number of days exceeding temperature standards at CH5120.

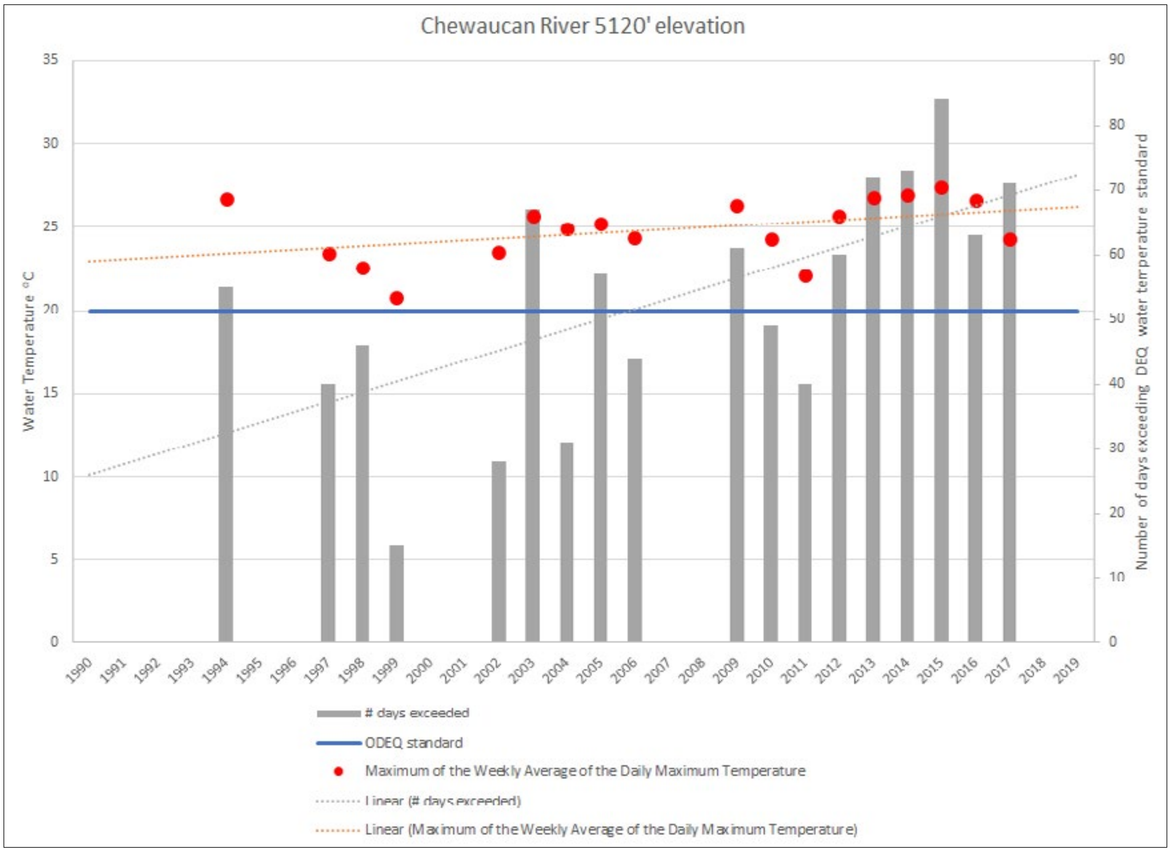
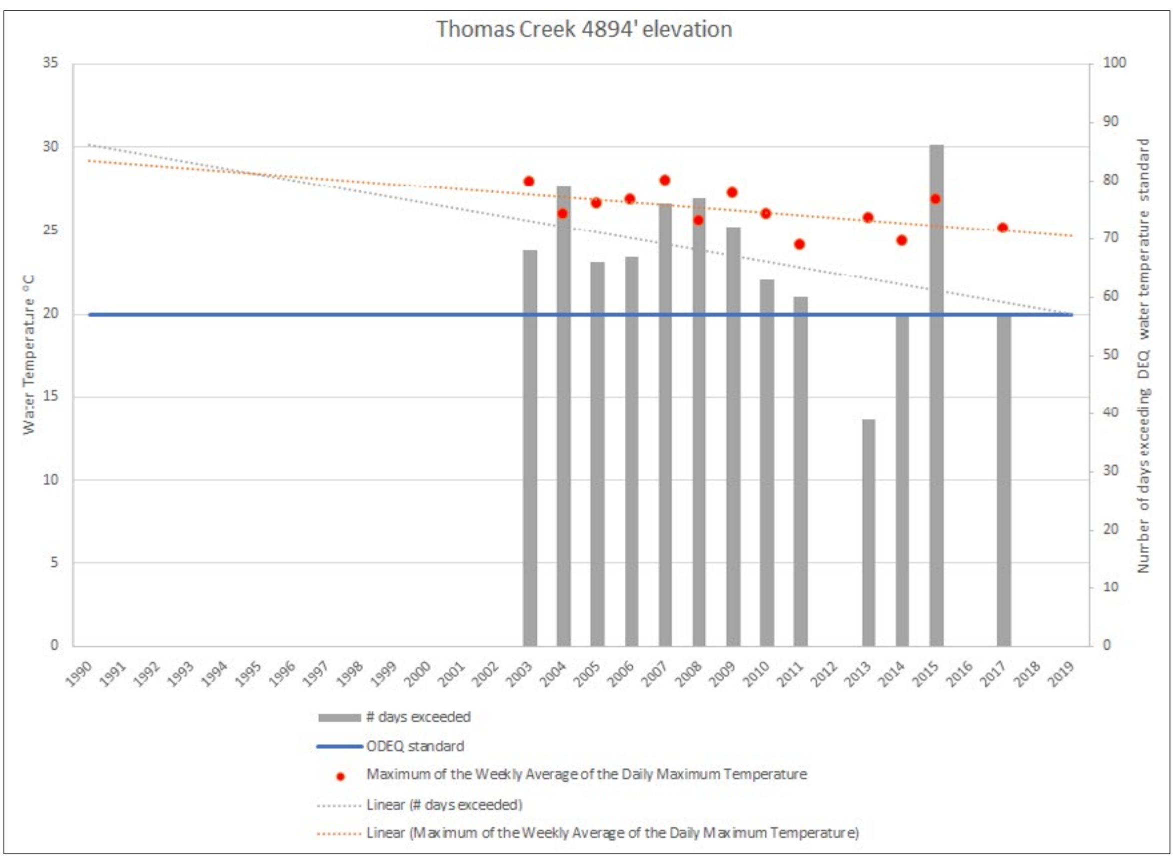


Figure 8.5 Locations of water temperature monitoring stations on perennial waters within the CFLR project area, 303d temperature listed waters highlighted in red.



Question 9

Are Forest Prevention Practices effective in minimizing impacts of management treatments (including prescribed fire) on invasive plant species (new and/or existing)?

Goal 9.1:
To minimize the occurrence of new invasive plant sites and/or expansion of existing sites.

Indicator 9.1:
Number of new invasive plant sites discovered and/or expansion of existing invasive plant sites within or immediately adjacent to vegetation management activities.

Analysis 9.1

This indicator addresses whether new invasive plant species are introduced or their existing sites expanded as a result of restoration treatments. Table 9.1 is a list of invasive species of concern in Lake County provided by the Lakeview office of the Oregon Department of Forestry.

The "Cover Frequency" FIREMON protocol used by the CBMT is a quadrat-based protocol designed to record cover, height and frequency of all types of surface vegetation. No instances of any of these plants were observed in any of the pre-treatment plots or immediate post-treatment plots in the Deuce Pilot commercial thinning treatments, the Deuce Olde pre-commercial thinning treatment, the Jakabe pre-commercial thinning treatments, or the Crooked Mud Honey Lil Stewardship commercial thinning treatments (40 plots pre-harvest, 34 plots post-harvest).

The "Greenline" protocol is a line-transect protocol used by the CBMT to record percent cover of all types of surface vegetation in aspen plots. One instance of one of these invasive plants was observed in a pre-treatment aspen plot in the West Drews Aspen and South Warner Aspen small conifer thinning treatments (21 plots pre-harvest, 31 observations of 28 plots post-harvest). One instance was found in an aspen stand following Crooked Mud Honey Lil commercial thinning treatments (8 plots post-harvest).

Table 9.1 Invasive plant species of concern for Lake County, Oregon

Common Name	Scientific Name
Dyers woad	*Isatis tinctoria*
Scotch thistle	*Onopordum acanthium*
White top	*Cardaria draba*
Hairy white top	*Cardaria pubescens*
Lens-podded white top	*Cardaria chalepensis*
Mediterranean sage	*Salvia aethiopis*
Canada thistle	*Cirsium arvense*
Yellow starthistle	*Centaurea solstitialis*
Dalmatian toadflax	*Linaria dalmatica*
St. John's wort	*Hypericum perforatum*
Medusahead	*Taeniatherum caput-medusae*
Musk thistle	*Carduus nutans*
Ventenata grass	*Ventenata dubia*
Spotted knapweed	*Centaurea stoebe*

Recommendations 9.1

It is encouraging that only two invasive species occurrences were found within the plots in the mechanical thinning and aspen conifer thinning treatments. However, these plots cover a relatively small percentage of the treated area and the protocols were aimed at observing general surface vegetation cover rather than explicitly looking for invasive species. It is also important to note that the results presented here only represent mechanical thinning and not prescribed fire. The Monitoring Plan called for invasive plant data collected by Forest Service personnel in addition to the CBMT field surveys. This data is currently being compiled and will be reported when it has been received.

The original instructions in the Monitoring Plan called for Forest Service personnel to identify areas of concern due to known occurrences of invasive species, and to have the CBMT survey those areas for invasive plants. Identification of priority areas for the CBMT to monitor was not done prior to this report, so it is not known whether the observed plots fell into areas of concern or whether existing infestations expanded. It is recommended that Forest Service personnel identify areas of concern for the CBMT to conduct surveys as called for in the Monitoring Plan.

Acknowledgements

Many thanks to Kasey Johnson of the Oregon Department of Forestry for providing the list of species of concern for Lake County and to Benjamin Goodin, Range and Invasives Program Manager for the Fremont-Winema National Forest for providing review and feedback

Lakeview Stewardship Group members discuss projects, potential treatment options, and future results on the ground during a 2019 field tour. Photo courtesy of Autumn Ellison, University of Oregon.

Socioeconomic Monitoring

"Socioeconomic monitoring helps the Forest Service and partners better understand the effects of their restoration activities on workers, communities, and economies." (Lakeview CFLR Monitoring Plan, 2015)

Five of the Lakeview Stewardship CFLR Project's monitoring questions are intended to assess socioeconomic conditions and outcomes from the project (Table A). These questions were developed and refined through a subcommittee that included Lakeview Stewardship Group (LSG) members and the Forest Service. The questions were designed: 1) to reflect the priorities of the group, 2) to include required CFLR measures, and 3) to be a "parsimonious set of measures that focus on the issues that matter" (Lakeview CFLR Monitoring Plan, 2015, p. 32).

The CFLR Monitoring Plan specified that a baseline assessment be performed to help provide context and history to some of the socioeconomic questions. The baseline assessment analyzed data for FYs 2007–11, prior to the start of the CFLR project in FY 2012, in an effort to estimate changes that could be attributed to the CFLR Program. Monitoring questions addressed in the baseline assessment are presented with both the baseline and FY 2012–19 monitoring results in the following pages.

Table A Social and economic monitoring questions and methods for the Lakeview Stewardship CFLR Project multiparty monitoring plan

Questions	Indicators
10. What is the socioeconomic context of the Lake County area?	(Measured both as baseline and change over time) ▪ Employment in various sectors ▪ Median household income ▪ Unemployment rate ▪ Poverty rate ▪ Number of students eligible for free and reduced lunch ▪ School enrollment ▪ School dropout rates
11. What are the overall economic impacts of the CFLR project?	Job and labor income creation and retention; direct/indirect/induced effects.
12. How much and what kinds of CFLR work are captured locally?	Project dollars (timber sales, contracts, agreements, etc.) captured by local businesses; types of work captured and not captured. Jobs and income associated with local companies. The importance of CFLR in the work of local businesses.
13. What are the costs, local capture, and treatment outcomes of different project implementation mechanisms?	Type of work completed through different implementation mechanisms; number of acres treated; amount of stewardship receipts reinvested in restoration; local capture of work implemented with different mechanisms. Qualitative responses from the Forest Service about the costs and benefits of different mechanisms and why they were used. Qualitative responses from contractors that are satisfied with how CFLR projects are implemented.
14. What are the total and matching funds in CFLR?	Use of direct CFLR funds; matching funds provided by the agency; contributed funds by partner organizations; leveraged funds.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in the socioeconomic monitoring reports listed under resources, below.

Resources

Lakeview CFLR Monitoring Plan:

Lakeview Stewardship Group. 2015. Lakeview Collaborative Forest Landscape Restoration (CFLR) Project Monitoring Plan. Ecosystem Workforce Program, University of Oregon. Working Paper #60. Available at: https://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_60.pdf.

Social and economic baseline analysis and FY 2012–13 monitoring results:

White, E.M., E.J. Davis, and C. Moseley. 2015. Social and Economic Monitoring for the Lakeview Stewardship Collaborative Forest Landscape Restoration Project. Ecosystem Workforce Program, University of Oregon. Working Paper #55. Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_55.pdf.

FY 2014–15 Social and economic monitoring results:

The FY 2014–15 social and economic monitoring report was authored by Stacey Rosenberg, Autumn Ellison, and Heidi Huber-Stearns. This report and the results it published were eventually incorporated into the following (FY 2016–17) report (below) based on updated methods for showing monitoring results.

FY 2016–17 Social and economic monitoring results:

Ellison, A. and H. Huber-Stearns. 2019. Social and Economic Monitoring for the Lakeview Stewardship Collaborative Forest Landscape Restoration Project: Fiscal Years 2016 and 2017. Ecosystem Workforce Program, University of Oregon. Working Paper #97. Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_97.pdf.

FY 2018–19 Social and economic monitoring results:

Ellison, A. 2021. Social and Economic Monitoring for the Lakeview Stewardship CFLR Project: Fiscal Years 2018–2019 Results and Perspectives. Ecosystem Workforce Program, University of Oregon. Working Paper #105. Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_105.pdf.

Question 10

What is the socioeconomic context of the Lake County area?

Goals:
To track key social and economic trends to keep perspective on the conditions in Lake County.

Indicators:
Measured both as baseline and change over time:

- Employment in various sectors
- Median household income
- Unemployment rate
- Poverty rate
- Number of students eligible for free and reduced lunch
- School enrollment
- Dropout rates

Context

Members of the LSG widely understood that large-scale demographic trends at the county level would not change as a result of the Lakeview Stewardship CFLR Project and activities. However, they felt that tracking this information over the course of the project could offer useful context for understanding local socioeconomic conditions in the area and could facilitate data-informed discussions in the collaborative group about local needs and potential project impacts. The socioeconomic indicators tracked for this question were selected by the LSG and are published in the Lakeview Stewardship CFLR Project Monitoring Plan (Lakeview CFLR Monitoring Plan, 2015).

Approach

We went to state and federal government websites to find data for the indicators, which we downloaded and summarized. Data sources are noted with each table and figure.

Baseline analysis

The baseline analysis noted the following:

"The population of Lake County has economic and social conditions that differ in several ways from the statewide averages (Table 10.1). Lake County has an older population, higher unemployment, and a greater percentage of residents in poverty than statewide averages. But dropout rates in Lake County schools are lower than the statewide average and the school district has experienced a slight increase in enrollment between the 2012/2013 to 2013/2014 academic years that is higher than the statewide average. The share of students eligible for free and reduced lunch is lower (2013/2014 school year) than statewide averages. Average household income in the county is about $13,000 less than the statewide average and 854 families in the County receive SNAP benefits.

State and federal government, wood products manufacturing, and retail trade account for the majority of employment in Lake County (Table 10.2 and Figure 10.1). Those employment patterns are generally consistent with patterns of employment found in other rural counties in Oregon. However, relative to statewide patterns, Lake County has greater reliance on employment in government, wood products manufacturing, and animal and crop production and less reliance on employment in financial and professional services." (White et al., 2015, p. 8)

Table 10.1 Baseline analysis: Comparison of key social and economic characteristics

Characteristics	Lake County	Oregon
Median age (2007-2011)	46.8	38.2
School enrollment (change from previous year—2012/2013 to 2013/2014)	+1.2%	+0.6%
Dropout rate (2012/2013)	2.3%	4.0%
Percent of students eligible for free and reduced lunch (2013/2014)	51.8%	53.7%
Median household income (August 2014)	$36,583	$49,850
Unemployment rate (August 2014)	9.5%	7.2%
Percent of population in poverty (2007-2011)	18.7%	14.8%
Families receiving SNAP benefits (2013)	854	44,618

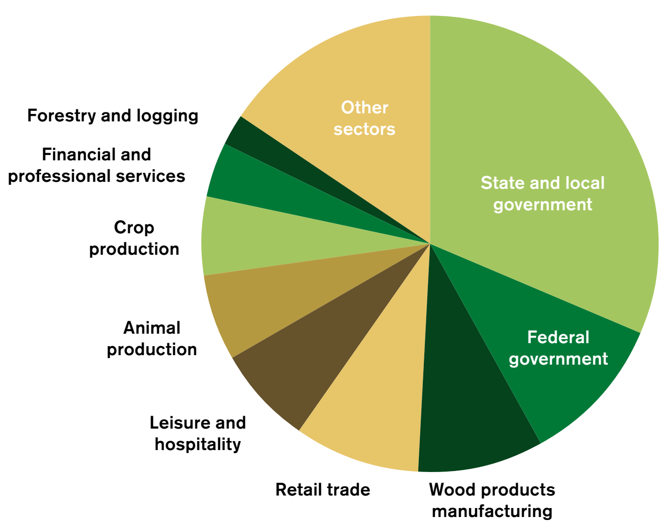
Sources: Oregon Department of Human Services, Oregon Department of Education, and Oregon Rural Explorer

Table 10.2 Baseline analysis: Top employment sectors in Lake County, 2013

Economic sector	Sector employment	Percent of Lake County employment	Percent of employment in Oregon
State and local government	738	32%	14%
Federal government	242	10%	2%
Wood products manufacturing	211	9%	1%
Retail trade	204	9%	11%
Leisure and hospitality	164	7%	10%
Animal production	140	6%	<1%
Crop production	134	6%	2%
Financial and professional services	92	4%	17%
Forestry and logging	<52	<2%	1%

Source: State of Oregon Employment Department

Figure 10.1 Baseline analysis: Employment in key economic sectors in Lake County, 2013



FY 2012-2019 monitoring results

Results

As expected, many of the social and economic indicators for Lake County did not change considerably between FY 2012–19 (Table 10.3). One exception was the considerable drop in the unemployment rate from 11.4 percent in 2013 to 5.0 percent in 2019. There were also small improvements in some indicators related to income and poverty, including an increase in the estimated median household income and reductions in the percent of the population in poverty and the number of families receiving SNAP benefits.

These changes mirrored statewide trends over the monitoring period. However, a consistent gap remained between Oregon State and Lake County averages for these indicators, with the county continuing to have greater poverty and unemployment than the statewide average. The estimated median income for the county was just 57 percent of the statewide median income in 2015-2019, with 7.1 percent more of the county population in poverty than the statewide population. These changes suggest that while the unemployment rate decreased considerably in Lake County between 2013 and 2019 following statewide and broader trends after the 2009 recession, stagnation in wages led to a greater income gap between the county and other parts of the state. The population and median age of county residents remained steady, and dropout rates in Lake County schools remained consistently lower than the statewide average during all the years of monitoring.

From 2011 to 2019, the estimated total nonfarm employment increased by 190 total jobs (Table 10.4). Much of the estimated employment growth occurred in government, which added a net 160 jobs. These government jobs were exclusively in local government, which added 170 jobs while state government jobs stayed the same and federal government jobs decreased by 10. This growth in government jobs further increased the gap between county and state reliance

Table 10.3 Comparison of key social and economic characteristics in Lake County, 2013–2019

Indicator	Lake County (FY 12-13 report)	Lake County (FY 14-15 report)	Lake County (FY 16-17 report)	Lake County (FY 18-19 report)	Oregon State (FY 18-19 report)
Population[1]	7,830 (2007–2011)	7,829 (2011–2015)	7,807 (2013–2017)	7,837 (2015–2019)	4,217,737 (2015–2019)
Median age[1]	46.8 (2007–2011)	48.3 (2011–2015)	48.8 (2013–2017)	48.6 (2015–2019)	39.7 (2015–2019)
Student enrollment[2]	+1.2% (2013/2014 change from previous year)	-0.25% (2014/2015 change from previous year)	-0.08% (2016/2017 change from previous year)	-0.58% (2018/2019 change from previous year)	+0.18% (2018/2019 change from previous year)
School dropout rate[2]	2.25 % (2012/2013 school year)	2.71 % (2015/2016 school year)	2.54% (2016/2017 school year)	1.43% (2018/2019 school year)	3.26% (2018/2019 school year)
Percent of students eligible for free and reduced lunch[3]	43% (2011–2012)	55% (2014–2015)	56% (2016–2017)	52% (2018–2019 data)	49% (2018–2019 data)
Median household income[1]	$33,611 (2009–2013)	$32,369 (2011–2015)	$32,769 (2013–2017)	$37,898 (2015–2019)	$67,058 (2015–2019)
Unemployment rate [4]	11.4% (August 2013)	7.5% (August 2015)	5.6% (August 2017)	5.0% (August 2019)	3.6% (August 2019)
Percent of population in poverty[1]	18.7% (2007–2011)	18.6% (2011–2015)	20.0% (2013–2017)	18.5% (2015–2019)	11.4% (2015–2019)
Number of families receiving SNAP benefits[1]	783 (2009–2013)	740 (2011–2015)	720 (20.4%) (2013–2017)	648 (18.4%) (2015–2019)	221,265 (13.4%) (2015–2019)

[1] Data source: U.S. Census Bureau, American Community Survey 5-Year Estimates. 2015–2019 estimates accessed April 2021 from: https://data.census.gov/cedsci/profile?q=ACSDP5Y2019.DP03%20Lake%20County,%20Oregon&g=0500000US41037.

[2] Data source: Oregon Department of Education. Accessed October 2019 from: https://www.oregon.gov/ode/reports-and-data/Pages/default.aspx.

[3] Data source: The National Center for Education Statistics (NCES). Data presented at: https://www.countyhealthrankings.org/app/oregon/2019/measure/factors/65/data.

[4] Data source: State of Oregon Employment Department. Seasonally adjusted rate. Report accessed April 2021 from: https://www.qualityinfo.org/ed-uesti/?at=1&t1=4101000000,4104000037~unemprate~y~2000~2021.

on government jobs that was noted in the baseline assessment: Government jobs accounted for 42 percent of Lake County employment in 2013 and 50 percent in 2019, while statewide empoyment in government stayed constant between 15-16 percent. Compared with statewide employment estimates, Lake County continued to have a considerably higher share of jobs at every level of government. It is important to remember that these estimates are for nonfarm employment only. Many Lake County residents work in agriculture and on land they own, and are not considered employees by the Oregon Employment Department. This consideration can skew how percentages of nonfarm employment appear when compared to geographies with less agricultural activity.

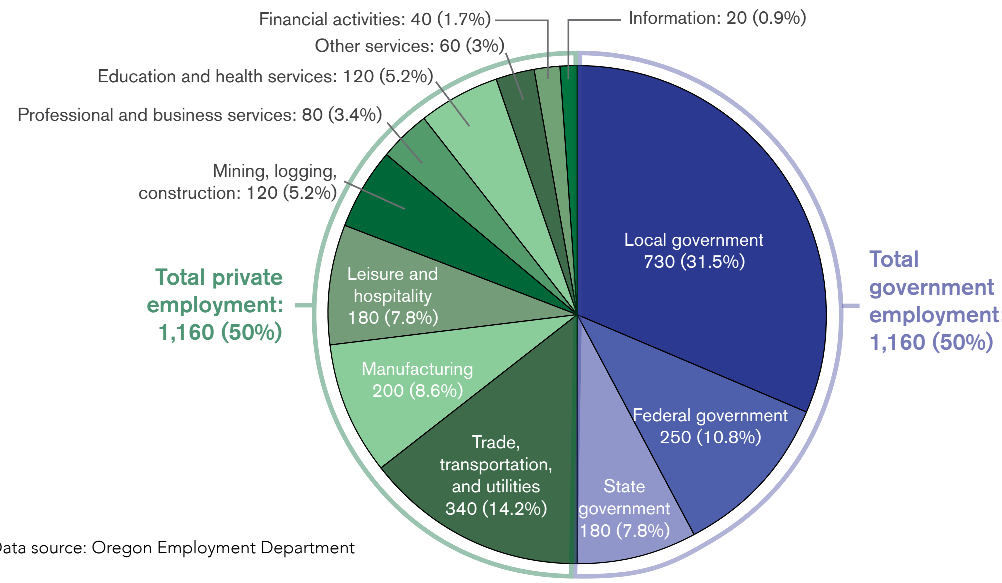
The estimated number of private jobs changed very little from 2011 to 2019, with an increase of only 30 jobs over the 8 years. The increase can be attributed almost entirely to modest increases in professional and business services (+20 jobs), education and health services (+20 jobs) and other services (+20 jobs), while estimated decreases occured in trade, tranportation, and utilities (-10 jobs), financial activities (-20 jobs), and leisure and hospitality (-10 jobs). The estimated number of jobs in mining and logging decreased by 10 while jobs in construction grew by 20. Still, mining and logging jobs accounted for an estimated 1.8 percent of total nonfarm employment in Lake County in 2019, considerably more than statewide 0.4 percent employment in mining and logging.

Table 10.4 Nonfarm employment estimates for Lake County, biennially 2011–2019, and Oregon State, 2019

	Lake County					Oregon
	2011	2013	2015	2017	2019	2019
Total nonfarm employment	**2,130**	**2,110**	**2,190**	**2,260**	**2,320**	**2,230**
Total private	**1,130**	**1,100**	**1,110**	**1,130**	**1,160 (50%)**	**84.7%**
Mining, logging, construction	110	100	110	120	120 (5.2%)	6.0%
Mining and logging	50	40	40	40	40 (1.7%)	0.4%
Construction	60	60	70	70	80 (3.4%)	5.6%
Manufacturing	200	230	220	200	200 (8.6%)	10.1%
Trade, transportation, utilities	340	310	320	350	330 (14.2%)	18.3%
Retail trade	240	210	210	230	240 (10.3%)	10.8%
Information	20	20	20	20	20 (0.9%)	1.8%
Financial activities	60	60	60	50	40 (1.7%)	5.3%
Professional & business services	60	60	70	70	80 (3.4%)	13.0%
Education and health services	100	110	100	90	120 (5.2%)	16.0%
Leisure and hospitality	190	170	150	170	180 (7.8%)	10.9%
Other services	50	50	50	60	70 (3.0%)	3.3%
Total government	**1,000**	**1,010**	**1,080**	**1,130**	**1,160 (50%)**	**15.3%**
Federal government	260	240	250	260	250 (10.8%)	1.5%
State government	180	180	200	200	180 (7.8%)	2.1%
Local government	560	590	630	670	730 (31.5%)	11.7%

Data source: Oregon Employment Department

Figure 10.2 Employment in key economic sectors in Lake County, 2019



Data source: Oregon Employment Department

Considerations

The intent of this measure to track social and economic conditions in the Lakeview Stewardship CFLR area over the course of the project was to provide context. Social and economic indicators are a reflection of broader conditions in rural places in Oregon and the state and national economy. Although the CFLR project may aid in improving some social and economic conditions, the CFLR project itself cannot overcome the effects of the economy and changing rural conditions. However, understanding these conditions provides a useful background for considering social and economic outcomes from the CFLR project.

In the future, the group could evaluate if these indicators still provide the type of context they are seeking to understand.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in four biennial socioeconomic monitoring reports. In particular: Eric M. White, Emily Jane Davis, and Cassandra Moseley contributed to monitoring question development and conducted the baseline assessment and first couple years of monitoring (FY 2012–13), Stacey Rosenberg contributed to FY 2014–15 monitoring efforts, and Autumn Ellison and Heidi Huber-Stearns have contributed to the past 6 years of monitoring (FY 2014–19).

References

Lakeview Stewardship Group. 2015. Lakeview Collaborative Forest Landscape Restoration (CFLR) Project Monitoring Plan. Ecosystem Workforce Program, University of Oregon. Working Paper #60. Available at: https://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_60.pdf.

White, E.M., E.J. Davis, and C. Moseley. 2015. Social and Economic Monitoring for the Lakeview Stewardship Collaborative Forest Landscape Restoration Project. Ecosystem Workforce Program, University of Oregon. Working Paper #55. Available at: http://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/WP_55.pdf.

Question 11

What are the overall economic impacts of the CFLR projects?

Goals:
To identify the effects of CFLR projects on employment and economic activity.

Indicators:
Measured both as baseline and change over time: Job creation and retention, labor income, and business sales. The direct/indirect/induced economic activity resulting in the local impact area.

Context

An important objective of the CFLR Program is to benefit local rural economies. This monitoring question is required for all CFLR projects, and it provides detail to local economic benefits by estimating the economic activity resulting from CFLR activities.

Restoration activities can create economic activity in multiple ways. Labor is required from planning projects to implementing and then monitoring them. Direct economic impacts are created through the jobs and wages that are supported by CFLR funding, including through the direct employment of Forest Service staff, through contracts to private businesses, and through agreements with NGOs and other entities. Economic impacts are also created indirectly through the purchase of material and supplies for projects, and by the spending of employees and businesses in nearby communities. This indirect spending contributes to jobs and wages in other sectors such as material suppliers, lodging, retail establishments, grocery stores, service providers like banks and accountants, and other general sectors of the economy. Finally, timber from restoration timber sales requires infrastructure and labor to process, and this too contributes to the total economic benefits from the project.

Approach

Because this is a required monitoring question for all CFLR projects, the Forest Service created and updated an economic impact analysis model to estimate economic impacts for each project and year. The *Treatments for Restoration Economic Analysis Tool* (TREAT), was developed by national forest economists specifically to standardize the approach to estimating the jobs and labor income that would be supported by restoration efforts across CFLR projects (USDA Forest Service, 2015).

TREAT estimates are created by Forest Service economists based on inputs from CFLR project coordinator(s) on the funding spent on different aspects of the project and considerations such as: the amount of funding used for Forest Service employees and for contracts with private businesses, estimates of how much of the contract dollars went to local versus nonlocal contractors, and commercial timber volume harvested and processed for different wood products as a result of project activities during each year. Job and labor income impacts are estimated for two different scenarios: those supported by direct CFLR/CFLN funds only, and those that are supported when full project funds, including matching funds, are considered. Additional details about how labor income and job estimates are defined in TREAT calculations are provided in the TREAT user guide (USDA Forest Service, 2015).

Baseline analysis

The baseline analysis noted the following:

"We used FPDS data and the economic model IMPLAN to characterize restoration contracting work in Lake County and to estimate the local economic impact of that work for the period 2007 to 2011. The Lakeview and Paisley ranger districts entered into contracts with local businesses worth about $50,000 per year in 2007, 2008, and 2011 and about $500,000 per year in the ARRA years of 2009 and 2010 (Table 11.1). In 2007, 2008, and 2011, Forest Service contracts with local businesses for restoration activities on the Lakeview and Paisley ranger districts supported about 1 annual job and about $27,000 in labor income—mostly for technical services—in Lake County. In the ARRA years, about 6 jobs were supported annually with about $175,000 in labor income each year in Lake County." (White et al., 2015, p. 15)

FY 2012-2019 monitoring results

Starting in FY 2015, the TREAT model for estimating job and labor impacts from CFLR projects was updated to improve the reliability of the estimates it produced. Updates were based on work completed by the Ecosystem Workforce Program to develop expenditure profiles of restoration firms that were more accurate than the generic sectors used in early TREAT versions. The updated model includes local economic impacts created from Forest Service employment to plan, implement, and monitor projects, as well as impacts from contracts with private businesses (separated into restoration contracts and contracts for monitoring) and from the timber harvesting and mill processing components of projects (USDA Forest Service, 2015). The updates to the TREAT model starting in FY 2015 were significant and comparison of the results from the first years of the Lakeview CFLR Project (FY 2012–14) with later years cannot be accurately made. For this reason, we report the FY 2012–14 estimates separately from FY 2015–17 estimates.

FY 2012–2014

CFLR/CFLN funds only: Prior to updates, TREAT analyses for FY 2012, 2013, and 2014 indicated that CFLR funds alone (not including matching funds) supported between 5.9 and 18 local jobs each year and created between $161,072 and $435,755 in local labor income each year (Table 11.2). These jobs and associated income were all from in-woods restoration work, as no commercial forest products were generated from activities paid for with CFLR funds. The relatively high number of local economic impacts in FY 2012 compared to the other years reflects a higher estimated portion of the contracting work awarded to local contractors– in FY 2012 it was estimated that 30 percent of funds (for both CFLR funds and matching funds, which are reported below) were awarded locally. Early socioeconomic monitoring work for this project suggested that this estimate was high, with actual local capture of restoration contract funds closer to ten percent or less. Estimates of local capture in the following years decreased as a result. The estimate for the percent of contract work awarded to local contactors was five percent in FY 2013 and seven percent in FY 2014; these lower estimates for local capture are reflected in the lower local economic impacts for FY 2013 and 2014, which are likely more realistic.

Table 11.1 Baseline analysis: Estimated jobs and income in Lake County from restoration contracting with locally-based businesses, 2007–11

Lake County economic effects	2007	2008	2009	2010	2011
Value of service contracts with local businesses	$58,418	$47,893	$520,489	$501,336	$59,377
Resulting annual jobs from contracts with local businesses	1	1	6	6	1
Resulting labor income from contracts with local businesses	$26,888	$24,162	$173,915	$179,501	$29,939

Source: Analysis using IMPLAN and contracting figures from the Federal Procurement Data System

Because the earlier TREAT model did not produce results that were considered accurate for the Lake County context, the authors of the first Lakeview socioeconomic monitoring report (FY 2012–13) used a different method to estimate economic impacts from CFLR/CFLN funds based on an economic model developed specifically for the Lake County economy (White et al., 2015). The alternative model and results were an important part of the monitoring effort that informed changes to the TREAT model from 2015 on. Using this alternative model for FY 2012–13 spending amounts, they found a much lower estimate of five local (Lake County) jobs supported from CFLR contracting with local businesses over the two years; however, if indirect impacts from spending in the community by nonlocal businesses for services and supplies were considered, this estimate of jobs created in the county increased to 12 (Table 11.3).

Although these estimates are likely more accurate than those included in the annual reports that were created through TREAT prior to updates, neither method is directly comparable with the results from TREAT analyses starting in FY 2015. In addition, neither method includes impacts from Forest Service employment–they include only impacts from contracts with private businesses for restoration services, while the updated 2015 TREAT does include impacts from agency employment. Finally, it is also important to note that such changes were expected as part of the CFLR monitoring process, which was "intended as a learning process among the collaboratives within an adaptive management context. The process is intended to explicitly provide opportunities for education, regrouping, reflection, and adaptation to meet changing needs and/or circumstances" (DeMeo et al., 2015).

CFLR/CFLN and matching funds: When including matching funds, TREAT analyses for FY 2012, 2013, and 2014 estimated that the CFLR project supported between 23 and 95 jobs each year and created between $866,000 and $5.2 million in labor income a year (Table 11.4). The relatively high number of sup-

Table 11.2 Local jobs and labor income supported in Lake County from CFLR/CFLN funds only, FY 2012–14 (using early version of TREAT prior to model updates in 2015)

	FY 2012		FY 2013		FY 2014	
Activity type	**Jobs**	**Labor income**	**Jobs**	**Labor income**	**Jobs**	**Labor income**
Commercial forest product processing	0	0	0	0	0	0
Other activities	**18 total** (16.1 direct; 1.9 indirect)	**$435,755 total** ($385,059 direct; $50,696 indirect)	**9.3 total** (8.3 direct; 1.0 indirect)	**$220,933 total** ($195,632 direct; $25,30 indirect)	**5.9 total** (4.8 direct; 1.1 indirect)	**$161,072 total** ($131,707 direct; $29,365 indirect)
Total	**18 jobs**	**$435,755**	**9.3 jobs**	**$220,933**	**5.9 jobs**	**$161,072**

Table 11.3 Total Lake County private sector jobs and income from the first two years of CFLR project service contracting (FY 2012–13), with impacts from locally-awarded contracts, as well as all awarded contracts (local and nonlocal) From White et al. 2015.

Economic effects	**Local impacts from contracts to Lake County businesses only**	**Local impacts from all contracts (local and nonlocal)**
Direct jobs from completing work	2.0	2.0
Direct income from completing work	$70,000	$70,000
Secondary jobs from suppliers, retailers, and service providers	3.0	10.0
Secondary income from suppliers, retailers, and service providers	$70,000	$191,000
Total jobs	**5.0**	**12.0**
Total income	**$140,000**	**$261,000**

Table 11.4 Local jobs and labor income supported in Lake County from CFLR/CFLN funds and matching funds, FY 2012–14 (using early version of TREAT prior to model updates in 2015)

	FY 2012		FY 2013		FY 2014	
Activity type	**Jobs**	**Labor income**	**Jobs**	**Labor income**	**Jobs**	**Labor income**
Commercial forest product processing	**35.8 total** (19.0 direct; 16.8 indirect)	**$1,832,882 total** ($1,199,130 direct; $633,752 indirect)	**11.4 total** (6.1 direct; 5.3 indirect)	**$584,848 total** ($382,626 direct; $202,222 indirect)	**87.3 total** (60.2 direct; 27.1 indirect)	**$5,022,893 total** ($3,897,848 direct; $1,125,045 indirect)
Other activities	**51.6 total** (46.4 direct; 5.2 indirect)	**$1,230,099 total** ($1,093,190 direct; $136,909 indirect)	**11.8 total** (10.6 direct; 1.2 indirect)	**$280,881 total** ($248,714 direct; $32,167 indirect)	**7.7 total** (6.3 direct; 1.4 indirect)	**$202,802 total** ($163,668 direct; $39,134 indirect)
Total	**87.5 jobs**	**$3,062,981**	**23.2 jobs**	**$865,728**	**95.0 jobs**	**$5,225,695**

ported jobs and labor income in FY 2012 is due to the overestimation of how much local capture of restoration contracts that local businesses captured, as noted in the prior section. The greater impacts in FY 2013 originate from a greater volume of commercial forest products generated from the project than in prior years.

FY 2015–2019

Starting in FY 2015, the updated TREAT model included local economic impacts created from Forest Service employment to plan, implement, and monitor projects, as well as impacts from contracts with private businesses (separated into restoration contracts and contracts for monitoring) and from the timber harvesting and mill processing components of projects.

CFLR/CFLN funds only: During FY 2015–17, Lakeview CFLR/CFLN funds alone (not including matching funds) supported between 19.0 and 263 total local jobs each year and created between $636,000 and $15.2 million in local labor income a year (Table 11.5). Job and labor estimates are considerably higher than for FYs 2018 and 2019 than previous years. The difference comes primarily from the use of direct CFLR/CFLN funds on activities that produced commercial timber harvest in FYs 18–19. In FYs 2015–17, estimated jobs and associated income supported with direct funds were generated from forest and watershed restoration contracts with private businesses, Forest Service monitoring and implementation activities, and contracted monitoring efforts. In these prior years, no commercial forest products were generated from activities paid for with direct funds. In constrast, in FYs 2018–19, CFLR-generated commercial harvest volume was generated from activities funded with direct dollars only (Table 11.6). Because all saw timber harvested from the national forest as part of the Lakeview Stewardship CFLR project is processed by the local Collins Pine Sawmill, differences in the commercial harvest volume between years leads to sizeable differences in local job and labor income estimates.

CFLR/CFLN and matching funds: Overall, total funding (direct plus matching funds) for the CFLR project supported between 60 and 289 annual jobs between FYs 2015–2019, and between $3.2 million and $16.3 million in associated annual labor income (Table 11.7). This economic activity was created through the harvest and processing of commercial timber product from restoration activities, as well as forest and watershed restoration contracts with private businesses, Forest Service monitoring and implementation, and contracted monitoring efforts.

Because commercial harvest volume was generated from activities supported with direct funds in FYs 2018–19 but not in FYs 2015–17, increases in the estimated and jobs and labor income were not as great when matching funds were considered in FYs 2018–19 compared to the prior years. As noted above, commercial harvest volume has a large impact on the total local economic impacts because all harvest volume for the Lakeview CFLR project is processed locally. This is because the project area for the Lakeview CFLR Project overlaps with the Sustainable Yield Unit that was active through FY 2019. Locally-based Collins Pine was the sole purchaser of timber sales in the Unit, and during FYs 2015–19, Collins Pine harvested 100 percent of the CFLR project-generated restoration timber sale

Table 11.5 Jobs and labor income supported in Lake County from CFLR/CFLN funds only, FY 2015–19

	FY 2015		FY 2016		FY 2017	
Activity type	**Jobs**	**Labor income** (2015 dollars)	**Jobs**	**Labor income** (2016 dollars)	**Jobs**	**Labor income** (2017 dollars)
Timber harvesting	0.0	0	0.0	0	0.0	0
Forest and watershed restoration	**0.6** (0.5 direct; 0.1 indirect)	**$38,653** ($33,645 direct; $5,007 indirect)	**0.7** (0.5 direct; 0.2 indirect)	**$9,881** ($5,661 direct; $4,220 indirect)	**0.2** (0.1 direct; 0.1 indirect)	**$4,842** ($2,013 direct; $2,829 indirect)
Mill processing	0.0	0	0.0	0	0.0	0
Forest Service monitoring and implementation	**17.7** (15.8 direct; 1.9 indirect)	**$620,142** ($563,831 direct; $56,311 indirect)	**19.6** (17.3 direct; 2.3 indirect)	**$611,683** ($552,255 direct; $59,428 indirect)	**20.0** (17.0 direct; 3.0 indirect)	**$611,683** ($552,255 direct; $59,428 indirect)
Contracted monitoring and commercial firewood	**0.6** (0.5 direct; 0.1 indirect)	**$37,245** ($32,092 direct; $5,153 indirect)	**2.1** (1.7 direct; 0.4 indirect)	**$76,931** ($64,856 direct; $12,075 indirect)	**0.5** (0.4 direct; 0.1 indirect)	**$19,748** ($15,157 direct; $4,591 indirect)
Total	**19.0 jobs**	**$696,039**	**22.4 jobs**	**$698,495**	**20.6 jobs**	**$636,274**

	FY 2018		FY 2019	
Activity type	**Jobs**	**Labor income** (2018 dollars)	**Jobs**	**Labor income** (2019 dollars)
Timber harvesting	**96.9 total** (71.8 direct; 25.1 indirect)	**$7,147,866** ($6,087,161 direct; $1,060,705 indirect)	**31.8 total** (27.1 direct; 4.8 indirect)	**$2,663,940** ($2,294,523 direct; $796,780 indirect)
Forest and watershed restoration	**2.5** (2.3 direct; 0.2 indirect)	**$9,484** ($4,866 direct; $4,618 indirect)	**2.4** (2.1 direct; 0.4 indirect)	**$24,371** ($15,236direct; $4,618 indirect)
Mill processing	**135.5** (78.3 direct; 57.2 indirect)	**$7,095,036** ($4,869,729 direct; $2,225,307 indirect)	**49.2** (29.5 direct; 19.7 indirect)	**$2,632,398** ($1,835,618direct; $796,780 indirect)
Forest Service monitoring and implementation	**26.5** (22.3 direct; 4.3 indirect)	**$908,462** ($778,518 direct; $129,944 indirect)	**17.5** (15.2 direct; 2.2 indirect)	**$601,476** ($538,705 direct; $62,771 indirect)
Contracted monitoring and commercial firewood	**1.6** (1.3 direct; 0.3 indirect)	**$51,753** ($44,822 direct; $6,913 indirect)	**2.2** (1.8 direct; 0.4 indirect)	**$68,400** ($58,868 direct; $9,532 indirect)
Total	**263 jobs**	**$15,212,584**	**103 jobs**	**$5,990,585**

Table 11.6 Volume of CFLR-generated commercial harvest used in TREAT analyses, FY 2015–19

FY	Commercial harvest volume, centum cubic feet (CCF)	Fund source(s) used for commercial harvest activities
2015	34,377.00 CCF	Matching funds only
2016	9,234.00 CCF	Matching funds only
2017	44,554.84 CCF	Matching funds only
2018	65,243 CCF	Direct funds only
2019	24,593 CCF	Direct funds only

Table 11.7 Jobs and labor income supported in Lake County from CFLR/CFLN funds and matching funds, FY 2015–19

	FY 2015		FY 2016		FY 2017	
Activity type	**Jobs**	**Labor income** (2015 dollars)	**Jobs**	**Labor income** (2016 dollars)	**Jobs**	**Labor income** (2017 dollars)
Timber harvesting	**53.4** (37.8 direct; 15.6 indirect)	**$3,590,801** ($2,972,759 direct; $618,042 indirect)	**12.8** (10.2 direct; 2.6 indirect)	**$1,048,438** ($820,479 direct; $227,959 indirect)	**62.0** (49.0 direct; 13.0 indirect)	**$5,084,644** ($4,156,959 direct; $927,685 indirect)
Forest and watershed restoration	**4.5** (4.0 direct; 0.5 indirect)	**$142,693** ($123,689 direct; $19,004 indirect)	**0.7** (0.5 direct; 0.2 indirect)	**$10,238** ($5,865 direct; $4,372 indirect)	**0.2** (0.1 direct; 0.1 indirect)	**$4,742** ($1,972 direct; $2,771 indirect)
Mill processing	**68.5** (41.3 direct; 27.3 indirect)	**$3,592,383** ($2,378,207 direct; $1,214,176 indirect)	**21.3** (11.1 direct; 10.2 indirect)	**$1,020,918** ($656,383 direct; $364,534 indirect)	**97.1** (53.5 direct; 43.6 indirect)	**$5,053,981** ($3,325,567 direct; $1,728,414 indirect)
Forest Service monitoring and implementation	**31.8** (27.7 direct; 4.1 indirect)	**$1,327,544** ($1,206,999 direct; $120,545 indirect)	**23.0** (19.0 direct; 4.1 indirect)	**$1,066,465** ($962,853 direct; $103,613 indirect)	**18.9** (17.4 direct; 1.4 indirect)	**$469,742** ($433,437 direct; $36,304 indirect)
Contracted monitoring and commercial firewood	**0.6** (0.5 direct; 0.2 indirect)	**$37,441** ($32,262 direct; $5,180 indirect)	**2.1** (1.7 direct; 0.4 indirect)	**$79,711** ($67,199 direct; $12,512 indirect)	**0.5** (0.4 direct; 0.1 indirect)	**$19,340** ($14,844 direct; $4,496 indirect)
Total	**159.0 jobs**	**$8,690,864,039**	**60.0 jobs**	**$3,225,770**	**178.6 jobs**	**$10,632,449**

	FY 2018		FY 2019	
Activity type	**Jobs**	**Labor income** (2018 dollars)	**Jobs**	**Labor income** (2019 dollars)
Timber harvesting	**96.9 total** (71.8 direct; 25.1 indirect)	**$7,147,866** ($6,087,161 direct; $1,060,705 indirect)	**31.8 total** (27.1 direct; 4.8 indirect)	**$2,663,940** ($2,294,523 direct; $796,780 indirect)
Forest and watershed restoration	**3.0** (2.8 direct; 0.3 indirect)	**$11,305** ($5,800 direct; $5,505 indirect)	**3.2** (2.7 direct; 0.5 indirect)	**$31,940** ($19,968 direct; $11,972 indirect)
Mill processing	**135.5** (78.3 direct; 57.2 indirect)	**$7,095,036** ($4,869,729 direct; $2,225,307 indirect)	**49.2** (29.5 direct; 19.7 indirect)	**$2,632,398** ($1,835,618direct; $796,780 indirect)
Forest Service monitoring and implementation	**51.7** (42.0 direct; 9.6 indirect)	**$2,042,565** ($1,750,401 direct; $292,164 indirect)	**36.9** (31.5 direct; 5.4 indirect)	**$1,463,285** ($1,310,573 direct; $152,712 indirect)
Contracted monitoring and commercial firewood	**1.5** (1.2 direct; 0.3 indirect)	**$48,103** ($41,675 direct; $6,428 indirect)	**2.1** (1.8 direct; 0.4 indirect)	**$67,563** ($58,148 direct; $9,416 indirect)
Total	**289 jobs**	**$16,344,875**	**123 jobs**	**$6,859,126**

volume, keeping all economic impacts from the timber harvesting component of the project local. In addition, because timber harvested for the CFLR project by Collins Pine was processed at their local mill in Lakeview, 100 percent of mill processing component of the Lakeview CFLR's activities was also performed locally. Thus, differences in commercial harvest volumes have a large impact on differences in economic impacts in the county. This degree of influence is evident when considering how much of the annual total economic impacts stem from timber harvesting and mill processing activities compared to other activity types, and by considering how different volumes for each year (Table 11.6) correlate with total economic impacts in corresponding years (Table 11.7).

In contrast, the estimated local capture of contract dollars was much lower: the portion of contract dollars that were awarded to Lake County contractors was estimated to be six percent in FY 2015, seven percent in FYs 2016–17, nine percent in FY 2018, and five percent in FY 2019. Differences in contract spending between years therefore has much less of an impact on local economic impacts.

Considerations

When compared to estimates of local employment from the baseline analysis that was completed for Lake County, monitoring results to date have shown that spending on Lakeview CFLR project has had a considerable impact on local jobs and labor income in the county. Although changes in methodology between analyses and years prohibits a direct comparison of impacts across years, these changes were an important part of the monitoring process that ultimately contributed to a more accurate economic model that is now used for CFLR projects nationwide.

Regardless of changes in methodology, monitoring to date has shown that local economic impact from the Lakeview CFLR project tended to be greatest in projects that included timber harvesting and processing. These projects had a much greater impact on the local economy than projects that did not, and much of this local capacity for timber harvest and processing has come from Collins Pine. By contrast, forest and watershed restoration contracts tended to be captured by contractors outside the local area, meaning the majority of economic impacts from this work were estimated to leave the local economy.

However, even when contracts are awarded to nonlocal businesses, some economic impacts are still retained locally through the efforts required of agency personnel to formulate, administer, and monitor contracts. In the future, the group could a) continue to explore the opportunities, barriers, and potential pathways for increasing local business capture of restoration contracts, and b) discuss the dynamics around changing levels of local capture over the last decade and what, if any, implications this may have on ongoing contracting practices.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in four biennial socioeconomic monitoring reports. In particular: Eric M. White, Emily Jane Davis, and Cassandra Moseley contributed to monitoring question development and conducted the baseline assessment and first couple years of monitoring (FY 2012–13), Stacey Rosenberg contributed to FY 2014–15 monitoring efforts, and Autumn Ellison and Heidi Huber-Stearns have contributed to the past 6 years of monitoring (FY 2014–19).

Many thanks to Lindsay Buchanan for providing us with annual TREAT output data from the Forest Service for estimated economic impacts from the Lakeview CFLR project.

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Question 12

How much and what kinds of CFLR project work are captured locally?

Goals:

To identify the contributions of CFLR projects to local employment and economic activity.

Indicators:

Measured both as baseline and change over time:

- 12.1. Amount and percent of total project dollars (timber sales, contracts, agreements, etc.) captured by local businesses annually
- 12.2. Number and percent of jobs created associated with local companies
- 12.3. Business responses to annual interview/survey describing the importance of CFLR to their work; noting it is an opportunity that would not otherwise be possible.

Context

Restoration activities in CFLR projects may be accomplished through in-house Forest Service crews, service contracts with private businesses, timber sales for restoration-related byproducts, and partnerships with state agencies and non-profit organizations. As noted in the previous monitoring question, local capture of contracts is an important measure of local economic impacts. "Local capture" relates only to contracted work with businesses in Lake County. It is the percentage of the contracted funds that local businesses receive, and is an important measure of local economic impacts. Although contracts with nonlocal businesses can yield local impact through local purchases of supplies, materials, and living expenses, contracts with local businesses have a greater impact on local economies by directly employing and providing income to residents in the place where they both live and work.

Local capture of contract work depends on local contractor capacity for the types and amounts of work that are available. Local contractor capacity is dynamic and can change between years based on the presence, skills, and availability of local businesses. Local capture can reflect the ability of the local workforce to respond to agency contracting needs, and alignment of the agency's contracting decisions with local workforce capacity and needs. Local capture can also be influenced by a variety of factors that are difficult to change, however. For example, there may not be local businesses that can perform the work because they do not have the equipment, skillsets, or experience for the work that is needed. Thus, for certain types of work or contracts, there may not be any local contractors participating in bidding. Local businesses may also not be the right size for the scale of contracted activities, or able to complete the work efficiently or at the required rate. Agency managers also need to consider best value and other criteria in contracting decisions, which can lead to nonlocal contractors ultimately being awarded a contract even if there are local contractors in the bidding.

Approach

Indicator 12.1:

To determine how much of the different types of contracted work for the CFLR project were awarded to local and nonlocal contractors, we reviewed Forest Service records of service contracts that were awarded as part of the CFLR project during FY 2012 through 2019. We classified each contract by 1) the location of the business that it was awarded to and 2) the type of work that the contract was for. We classified work into five types: equipment-intensive (e.g. mechanical tree thinning, grapple piling), material-intensive (e.g. road work, culvert work), labor-intensive (e.g. forest tree planting, hand thinning), professional services (e.g. engineering design, special studies), and technical services (e.g. weed abatement, plant surveys, timber marking). Only those businesses located in Lake County or Bly, Oregon were classified as local for the analysis. Because some years had very little contract spending, we performed this analysis biennially, showing results for each 2-year portion of the project. In addition to CFLR-related service contracts, we reviewed: a) the commercial harvest volumes reported by the project and the amount of that volume awarded locally, and b) stewardship contract task orders, which include timber sale and service contract components, resulting from the CFLR project.

In addition to the baseline analysis for local contractor capacity for the years 2007-2011, researchers performed additional analyses at the start of the CFLR project. This includes a summary of contract value and work type that local contractors performed for the Forest Service, regardless of where the work was performed, from FY 2004-2013, and a summary of recent timber purchasers on the forest. This information offers additional context to the monitoring question and is available in Appendix 12a (page 144).

Indicator 12.2:

The number of jobs created associated with local companies is covered through the updated methodology of the previous monitoring question; these results are not repeated here.

Indicator 12.3:

We conducted interviews with Forest Service staff, Lakeview Stewardship Group collaborative members, CFLR project partners, and monitoring team members that have been involved in different aspects of the project between November 2019 and April 2021. The results of these interviews are reported in greater depth in the FY 2018-19 socioeconomic monitoring report (Ellison, 2021). Key insights relevant to this monitoring question are summarized under Indicator 12.3 results.

The town of Lakeview on a summer day, 2019. Photo courtesy of Autumn Ellison, University of Oregon.

Baseline analysis

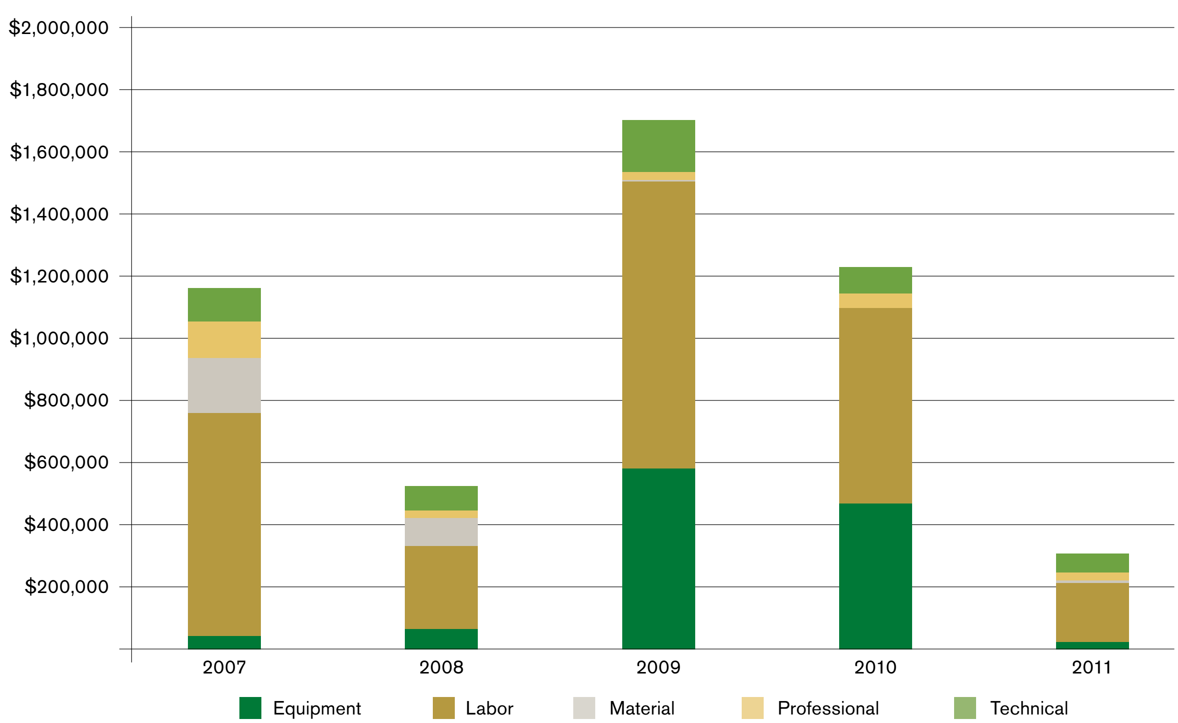
The baseline analysis noted the following:

"Between 2007 and 2011, prior to the CFLR project, the Lakeview and Paisley ranger districts spent a total of about $5 million (about $1 million per year) on service contracts with local and non-local businesses for restoration in Lake County (Figure 12.1). Restoration contracting in Lake County was a bit more than half of the $9.7 million spent on restoration contracting by the entire Fremont-Winema National Forest between 2007 and 2011. However, the value contracted each year was variable with the greatest spending in 2009 and 2010 when spending was influenced by ARRA. Labor-intensive activities, such as hand thinning, tree planting, and hand piling, accounted for the greatest contract values each year. In total, more than 55% of the restoration activity contracted between 2007 and 2011 was for labor-intensive work.

About 75% of the total $5 million service contract value between 2007 and 2011 was awarded to non-local businesses (Table 12.1). Contracts for labor-intensive contract work were almost exclusively awarded to non-local businesses. Non-local businesses also captured most of the value for contracts for material intensive (e.g., road work, culvert work) and professional services (e.g., computer studies, engineering design). Local contractors captured the majority of contracts and contract value for equipment and technical service contracts. Most of the technical service contracts were for invasive weed treatment. A similar pattern of high local capture of equipment and technical service contracts is also found on other eastern Oregon national forests.

Local businesses awarded contracts were located primarily in Lakeview and Silver Lake. Locations of non-local businesses historically awarded restoration service contracts included Medford, Klamath Falls, and Salem (Figure 12.2). Those cities are home to a number of contractors that complete labor intensive Forest Service restoration work throughout Oregon, California, and Washington" (White et al., 2015, p. 18-19).

Figure 12.1 Baseline analysis: Restoration contracts on the Lakeview and Paisley Ranger Districts by worktype for the five-year period 2007–11



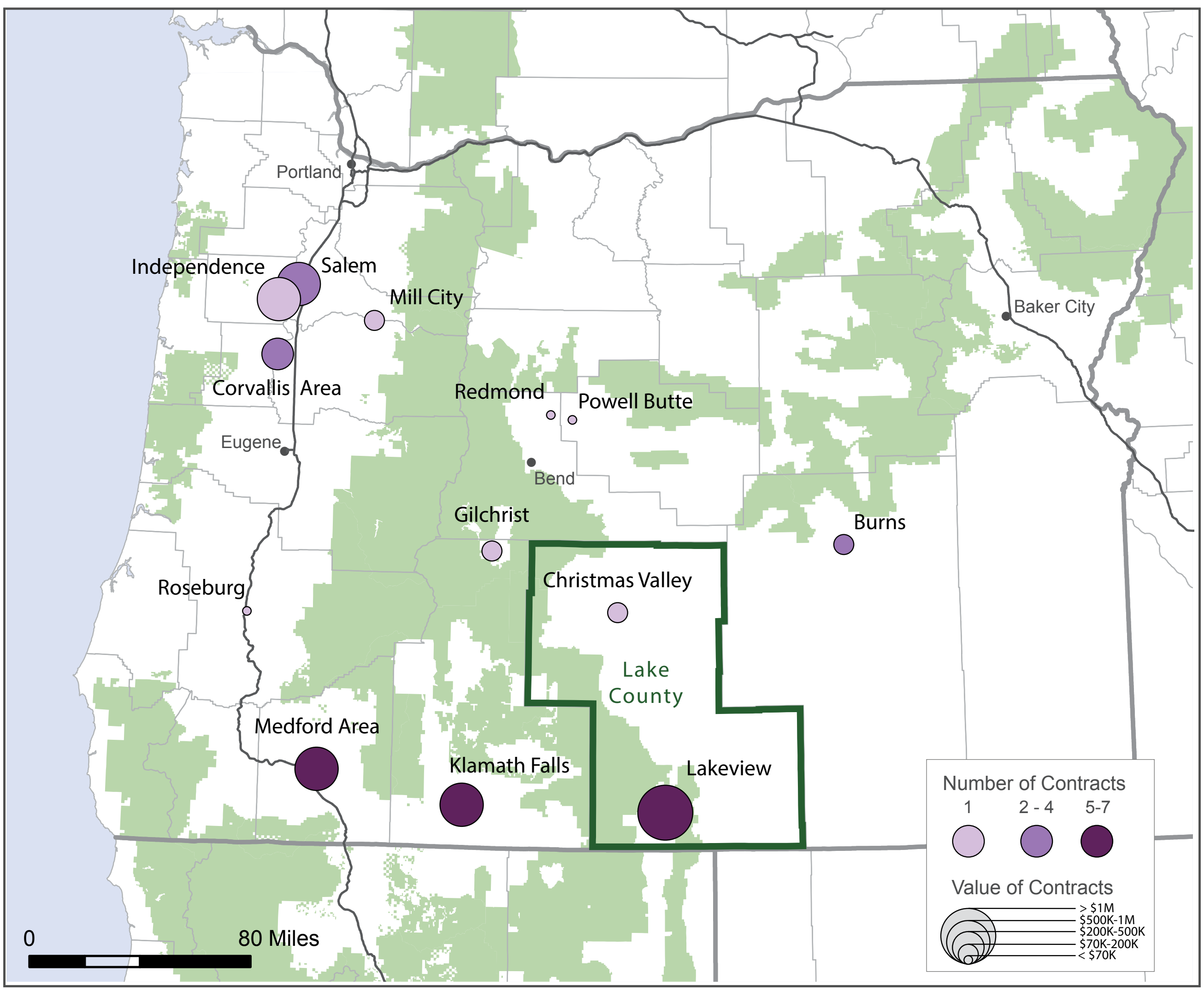
Source: Federal Procurement Data System records

Table 12.1 Baseline analysis: contracting for restoration work on Forest Service land in Lake County, Oregon, 2007–2011

	Total contracts	Contracts with local contractors	Total contract value	Contract value with local contractors	Local capture
Equipment	18	7	$1,194,814	$843,736	71%
Labor	64	1	$2,760,586	$11,655	0%
Material	6	1	$278,973	$11,765	4%
Professional	9	1	$241,760	$19,885	8%
Technical	38	28	$506,988	$300,475	59%
Total	**135**	**38**	**$4,983,121**	**$1,187,516**	**24%**

Source: Federal Procurement Data System records

Figure 12.2 Baseline analysis: Contractors for restoration work on Forest Service land in Lake County, 2007–2011



FY 2012-2019 monitoring results

Indicator 12.1: Amount and percent of total project dollars (timber sales, contracts, agreements, etc.) captured by local businesses

Service contracts:

To better understand how much and what types of contractor capacity exist in the local area, we created a list in FY 2015 of all locally-based businesses who have been awarded contracts (service contracts, fire suppression contracts, or timber purchases) with the Forest Service between FYs 2004–15. Although many of the contractors, especially those related to fire suppression and support, were not supported by CFLR funding, this list highlights local contractor capacity in Lake County and Bly, Oregon. The list is included in Appendix 12B (page 146).

In total, $12,470,050 in service contracts were awarded to businesses to complete restoration work as part of the Lakeview CFLR project between FY 2012–19. Figure 12.3 shows the distribution of this spending based on where recipient businesses were located. More than half of the total service contract dollars went to one business in Salem for tree thinning work. Lake County contractors were awarded a total of $675,255 of the service contract dollars, 5.4% of the total over the eight years. Local capture varied between years and the type of the work contracted.

In the first two years of the Lakeview CFLR Project (FY 2012–13), 11 percent of the service contract value for the project was awarded to local contractors; all of the local contractors' work was in equipment or technical-type work, no contract dollars in labor-intensive work, which was 82% of the contracted work value, went to local contractors. No material-, or professionally-intensive work was contracted during the two years (Table 12.2).

In FY 2014–15, five percent of CFLR service contract dollars were awarded to local contractors. Locally-awarded work was primarily for equipment-intensive work with some material-intensive work. Similar to the first two years, no contracts for labor-intensive work, which accounted for 94 percent of the CFLR contract spending, were awarded to local businesses.

During both the FY 2016–17 and FY 2018–19 analysis periods, none of the CFLR service contract dollars went to local businesses. Overall, local capture of restoration service contracts for the CFLR project was less than the local capture of contracts as measured during the baseline analysis. While there could be many reasons for this, one reason is likely the large proportion of contract dollars that were for labor-intensive work, which local contractors have not captured in any year since the project started. Labor-intensive work accounted for 96.6 percent of the total service contract dollars during FY 2016–17, more than previous years. In FY 2018–19 labor intensive work was a smaller proportion of total contracted dollars but still the majority (58 percent) of contract dollars, and overall contract spending was much less than in other years.

The lack of local capture of labor-intensive Forest Service contracts among Lake County businesses is not new or unique to this CFLR project, nor is it unique to forests across the region. The baseline analysis and related reviews of local contracting capacity (Appendix 12a) showed that while local contractors did complete some labor-intensive work in FY 2004–05, in the following years, local businesses did not capture labor-intensive restoration work for the Forest Service in Lake County or elsewhere. Prior to the start of the CFLR project in FY 2007–11, Lake County contractors received at least some of the other four types of restoration work contracted in Lake County (ranging from four to 71 percent for the different types), but none of the labor-intensive contract work in Lake County (Table 12.1). This ongoing lack of local capture, going back at least the last decade, suggests that there is little contracting capacity in Lake County specifically for the labor-intensive restoration work that makes up a large portion of the CFLR project work.

In addition, the lack of local capture for labor-intensive work during the CFLR project suggests that to date the project has not led to greater capacity being created among local contracting businesses for this type of work. The Fremont-Winema National Forest has attempted to increase the awareness of local contractors to contracting opportunities and procedures. In FY 2014, the Fremont-Winema NF held a workshop to provide information to local contractors on how to compete for contract funds and how to enroll in the

Figure 12.3 Distribution of restoration service contract dollars from the Lakeview CFLR Project, FY 2012–19

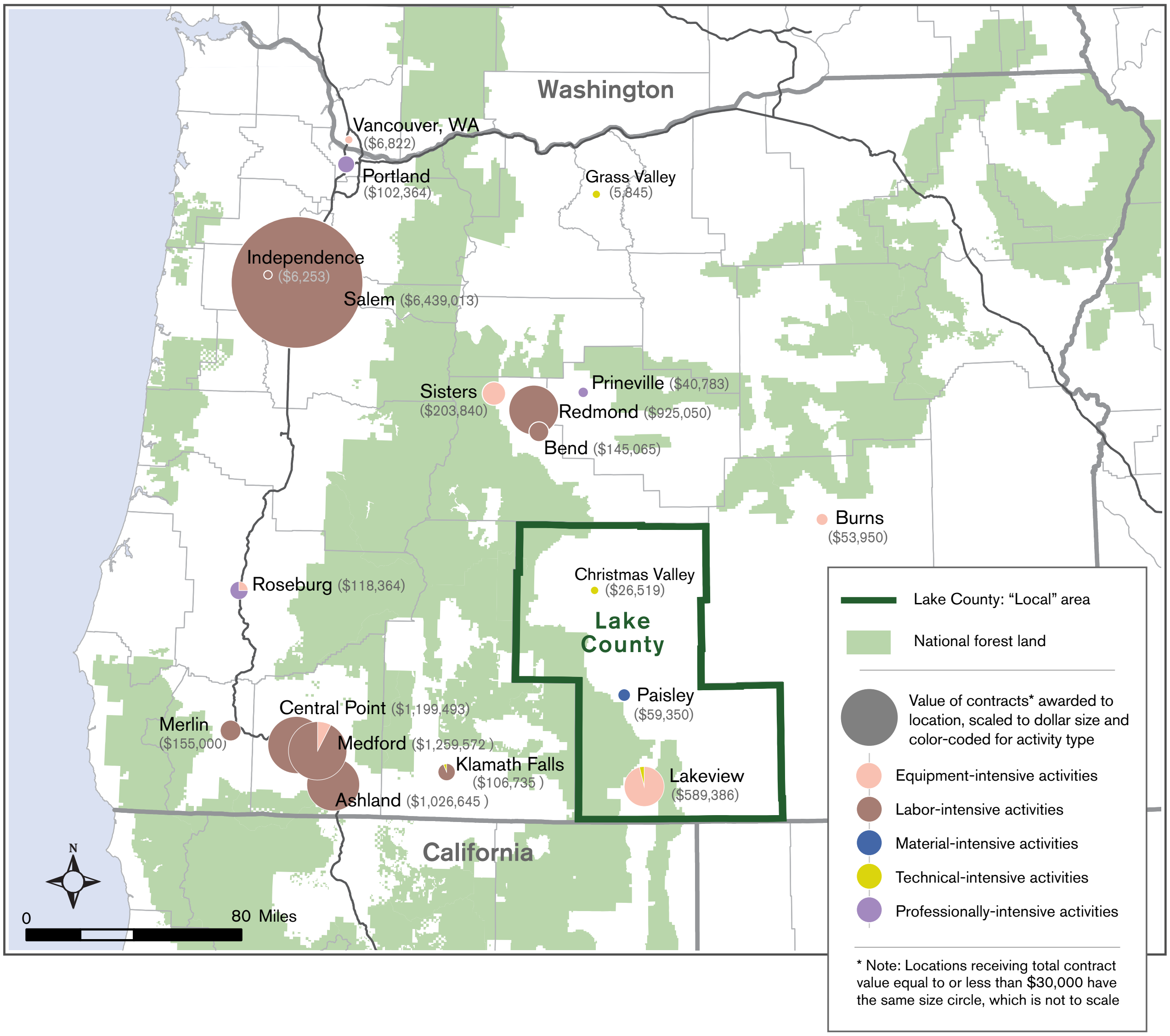


Table 12.2 Local capture of service contracts from the Lakeview CFLR Project, FY 2012–19

Contracted work type	2012–2013 total value	2012–2013 local capture	2014–2015 total value	2014–2015 local capture	2016–2017 total value	2016–2017 local capture	2018–2019 total value	2018–2019 local capture
Equipment-intensive	$625,722	$367,932 (59%)	$248,312	$198,832 (80%)	$52,657	-	-	-
Labor-intensive	$3,050,397	-	$4,846,213	-	$2,971,159	-	$292,974	-
Material-intensive	-	-	$59,350	$59,350 (100%)	-	-	$29,914	-
Professional-intensive	-	-	-	-	$45,217	-	$186,380	-
Technical-intensive	$55,909	$49,141 (88%)	-	-	$5,845	-	-	-
Total service contract value	**$3,732,028**	**$417,073 (11%)**	**$5,153,875**	**$258,182 (5%)**	**$3,074,879**	**$0**	**$509,268**	**$0**

Strategic Asset Management system. In FY 2016, Forest Service staff offered a no-cost workshop to contractors on how to make proposals more competitive. CFLR staff also engaged Acquisitions Management (AQM) staff to identify additional contracting instruments, timing, and size that could encourage more local contractors to bid on projects. In the Lakeview FY 2016 CFLR Annual Report however, staff noted that, "Through these efforts, however, we did not see any significant increases in local contractors successfully competing for CFLR contracts in the [Sustainable Yield] Unit this fiscal year" (USDA Forest Service, Fremont-Winema National Forest, 2016, p.16).

Even though local businesses captured few of the CFLR service contract dollars during the eight years of monitoring, many contracts were in relatively nearby communities, and 99.9% of all restoration service contract spending for the project went to businesses based in Oregon (Figure 12.3). Labor-intensive restoration work tends to be concentrated in a small number of contractors located in other parts of Oregon. The businesses that were awarded this work along the I-5 corridor may have been the closest contractors available to provide the labor-intensive work capacity that was needed.

Stewardship timber sales and service contracts

The Forest Service awarded a 10-year stewardship contract with Collins Pine, a business based in Klamath Falls with a sawmill in Lakeview, to conduct timber harvesting in the Lakeview Stewardship Unit. Since 2012, the Fremont-Winema National Forest has awarded task orders under this contract with timber sale and service components. The baseline analysis and initial years of monitoring indicated that Collins Pine relies mostly on local (Lake County and Bly, OR) contractors to complete their Forest Service timber harvesting. More recently, the ten-year review of the Lakeview Federal Sustained Yield Unit, which has the same boundaries as the CFLR project, showed that from FY 2010–18, 100 percent of all road-building labor and between 36–80 percent of the logging workforce used in the unit/CFLR landscape was local (Davis, 2019). Throughout the CFLR project, stewardship sales were awarded to Collins Pine under the stewardship contract, including the Pilot, Drill, Hay, and Lil Stewardship Sales.

Indicator 12.2: Number and percent of jobs created associated with local companies

The number of local jobs created by CFLR project spending under different scenarios is captured by the updated TREAT analyses that the Forest Service performs, and these results are covered in the previous monitoring question (starting page 111).

Indicator 12.3: Business responses to interviews describing the importance of CFLR to their work or noting it is an opportunity that would not otherwise be possible.

Because there was little local capture of CFLR service contracts, there were few businesses to interview. To further investigate dynamics around local capture and lack thereof, we instead relied on interviews with Forest Service personnel engaged in CFLR work, Lakeview Stewardship Group collaborative members, partners engaged in agreements through the CFLR project, and members of the biophysical monitoring team. A full writeup of interview findings is included in the FY 2018–19 socioeconomic monitoring report (Ellison, 2021). Below are key findings related to this monitoring question:

- Interviewees described a mismatch between the type of contracting capacity needed for the CFLR project activities and the type of work capacity available in the local area. They explained that the few local contractors in the area tended to do machinery-intensive work, while the CFLR relied extensively on large hand-thinning efforts.
- Interviewees also described how industry standards and competition for government contracts were a barrier to many local people. For instance, local residents expressed that they wanted to do contracting work only in the local area and not have to travel, which tends to not work well with the highly mobile nature of crew hand thinning work, which is often dispersed across the western US.
- Interviewees emphasized how the isolated location of Lakeview did still lead to indirect effects on the local economy because nonlocal contractors with winning bids for work tended to stay in the community and purchase supplies, food, and lodging for the entire summer season.

Considerations

The local capture analysis showed that local contractors appear to have been awarded less of the restoration service contract dollars on the CFLR project compared to the baseline analysis of local capture during the years FY 2007–11, and local capture of contracts has decreased as the project has progressed. However, all restoration timber sales and some associated service work were awarded through a 10-year stewardship contract to Collins Pine, which hires many local subcontractors for fieldwork and employs local residents to process timber at their Lakeview mill. In addition, a broad variety of agreements (covered in the next monitoring question) have engaged local entities in projects on the CFLR landscape.

Interviewees suggested that the work that is available through service contracts is primarily labor-intensive hand thinning; the baseline analysis showed that Lake County has not had local capture of this type of work well before the start of the CFLR project. Although this type of contract work does not appear to align with local contractor capacity, there are still considerations for local capture and its implications for the local economy:

1. Nonlocal contractors can still create indirect economic activity in rural communities. Local capture has a greater impact on the local economy through direct employment of local residents, but many contracts awarded to nonlocal contractors will result in contractors renting lodging, purchasing food and fuel, and even some equipment and supplies, locally. This is especially true for rural locations such as Lake County
2. Local capture depends on how "local" is defined. For this socioeconomic monitoring, Lake County and the town of Bly, Oregon are defined as local. Although just five percent of contracts were awarded to businesses in this local area, contracts were also awarded in neighboring Deschutes, Klamath, and Harney Counties.
3. Labor-intensive restoration work tends to be concentrated in a small number of contractors located in other parts of Oregon. The businesses that were awarded this work along the I-5 corridor may have been the closest contractors available to provide crews for the labor-intensive work capacity that was needed. So while this work was not conducted by local contractors, 99.9 percent of the contract dollars during the first eight years of the project went to Oregon-based businesses.

Going forward, this data can inform the collaborative's consideration of: 1) their definition of local; 2) potential engagement with additional local contractors; and 3) understanding of how, if at all, contracted work could better link to local or nearby businesses.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in four biennial socioeconomic monitoring reports. In particular: Eric M. White, Emily Jane Davis, and Cassandra Moseley contributed to monitoring question development and conducted the baseline assessment and first couple years of monitoring (FY 2012–13), Stacey Rosenberg contributed to FY 2014–15 monitoring efforts, and Autumn Ellison and Heidi Huber-Stearns have contributed to the past 6 years of monitoring (FY 2014–19).

Many thanks to the interviewees who offered their insights and perspectives on key project dynamics, socioeconomic contexts, and barriers to the capture of CFLR work locally.

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Question 13

What are the costs, benefits, and outcomes of different project implementation mechanisms?

Goals:

To evaluate the costs, local capture, and treatment outcomes of different mechanisms (service contracts, stewardship contracts, and agreements) for restoration work; particularly to 1) identify mechanisms that work best for local businesses, including Collins Pine; and 2) test if stewardship produces notably different outcomes.

Indicators:

Measured both as baseline and change over time:

- 13.1. For each type of mechanism (service contracts, stewardship contracts, and agreements):
  - 1. Range and median duration of projects
  - 2. Number of acres treated
  - 3. Costs per acre
  - 4. If businesses performing work were local
  - 5. For stewardship only: Dollar amount of retained receipts reinvested in restoration
- 13.2 Qualitative responses from Forest Service about the costs and benefits of different mechanisms and why used
- 13.3 Qualitative responses from contractors that are very satisfied or satisfied with how CFLR projects were implemented

Context

As noted throughout this report, CFLR project activities may be accomplished through a variety of implementation mechanisms, including with in-house Forest Service crews, through service contracts with private businesses, under timber sales for restoration thinning, and through partnership agreements with other agencies or NGOs. Each of these mechanisms can have different costs, benefits, and outcomes, and their implementation can affect the Forest Service as well as the feasibility for both local and nonlocal partners to participate.

The Forest Service identifies partnerships as key to the agency's accomplishments and getting needed restoration work done, noting in their partnership guide that, "Partnerships and collaboration can build long-term support and short-term momentum for projects. By pooling efforts, partners can add their capabilities to increase efficiency and results while reducing duplication" (USDA Forest Service, 2014). Partners can contribute capacity to CFLR objectives by providing funds for work or by providing in-kind contributions such as donated equipment or supplies, volunteer labor, or other goods and services that subsidize or expand restoration efforts. The Forest Service also engages in partnerships by using CFLR funds to pay other entities to complete work, which may result in cost savings or provide other benefits.

Approach

Indicator 13.1:
We reviewed the Forest Service's annual reports for the Lakeview CFLR Project. The annual reports provide an account of accomplishments during each fiscal year, as well as narratives that describe some of the mechanisms through which key accomplishments were completed. We provide examples of on-the-ground outcomes from the contracts with private businesses, which we analyzed in the previous monitoring question. We also provide examples of on-the-ground accomplishments from partnership agreements. These accomplishments come from partners' in-kind and funding contributions as well as from the use of CFLR funds to pay partners to accomplish work.

Indicators 13.1 and 13.2:
Between November 2019 and April 2021, we conducted interviews with 16 stakeholders involved in different aspects of the project, including Forest Service staff, Lakeview Stewardship Group collaborative members, CFLR project agreement partners, and monitoring team members. The results of these interviews are reported in greater depth in the FY 2018-19 socioeconomic monitoring report (Ellison, 2021). Key insights relevant to implementation mechanisms and their different costs and benefits are included as relevant throughout the monitoring results.

FY 2012-2019 monitoring results

Work in support of the CFLR project was accomplished with in-house Forest Service crews, through service contracts with private businesses, through a stewardship contract with Collins Pine, and through agreements and partnerships with outside organizations.

In-house Forest Service crews
The benefits provided by in-house Forest Service crews include employment and labor income provided by the agency to local empoyees; these benefits are captured in the TREAT local economic impact models covered in Question 11 (see page 111).

Service work within a stewardship contract
In stewardship contracts, the Forest Service "may 'trade goods for services' by applying the value of harvested forest products toward the value of restoration services" (Congressional Research Service, 2019). This is just one of the ways that work is accomplished and accounted for in a stewardship contract. CFLR annual reports track the service work that is accomplished through goods-for-services funding within stewardship contracts during each year. In FY 2012–19, over $1.5 million of service work was accomplished through goods-for-services funding in the stewardship contract (Table 13.1). The dollar amount of the service work accomplished through goods-for-services funding varied considerably between years, from $0 reported in FY 2018 to nearly $900,000 in FY 2012.

Service contracts:
Service contracts with private businesses were typically used for work that required specialized equipment or skills or for work that covers large areas (Table 13.2). Contracts for CFLR work were typically awarded for one year or less. Multi-year contracts were most likely to be awarded to nonlocal contractors, and were in several cases modified to include additional activities. Modifications have been used to a limited extent in contracts with local businesses, most often for invasive weed treatment.

Together, service contract work has resulted in thousands of acres of restoration treatments that were implemented for the project between FY 2012–19.

Table 13.1 Value of service work reported in annual reports as accomplished through goods-for-services funding in a stewardship contract, FY 2012–19

	2012	2013	2014	2015*	2016	2017	2018	2019
Service work accomplished through goods-for-services funding in a stewardship contract	$872,246	$3,042	$6,938	$376,776	$78,058	$88,537	$0	$81,280

Data source: Lakeview Stewardship CFLR annual reports.

* The 2015 Annual Report notes an additional $1,269,396 under "Total revised credit limit for open and closed contracts awarded and previously reported prior to FY15."

Figure 13.1 shows the footprint of acres treated during each year of the project, much of these treatment accomplishments were completed through restoration service contracts with contract implementation and administration through agency employees. Restoration activities included thinning work, hand piling, prescribed fire, meadow restoration efforts, invasive species removal, road maintenance, and survey work.

Agreements:

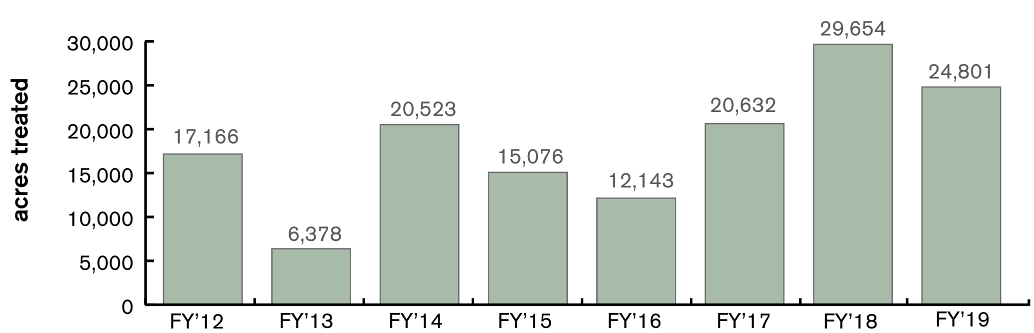
Agreements with non-profits and local entitites such as the Warner Creek Correctional Facility have been used to fund a variety of CFLR work such as ecological monitoring, trail maintenance, invasive weed removal, and other restoration efforts (Table 13.2). During the early years of the CFLR project, work most often completed via agreements were projects that were relatively smaller in scope that did not require specialized equipment, or were focused on monitoring. Much of the recreation work on the CFLR landscape over the last 8 years (e.g., trail maintenance, removing brush and downed trees, facility and grounds upkeep) has been accomplished through agreements with several different youth crews. CFLR funds have also been used as key matching funds to secure agreements with foundations such as the Mule Deer Foundation and the Rocky Mountain Elk Foundation for wildlife habitat work across the landscape. The Fremont-Winema NF also has used an agreement with Lake County Resource Initiative (LCRI) to help fund the Chewaucan Biophysical Monitoring Team, which has conducted pre-harvest, post-harvest, wildlife, and stream surveys, soil nutrient analyses, and worked to combine all data–including all protocols and changes in protocols–from 2002 onward in a single, searchable database. An agreement with the Lake County Cooperative Weed Management Area (LCCWMA) funds invasive weed treatments and monitoring across the CFLR landscape.

In FYs 2018 and 2019, agreements with other agencies have been used to accomplish prescribed fire work that is more specialized and larger in scale. Through agreements with the Bureau of Land Managment (BLM) and the Oregon Department of Forestry, contractors were hired for prescribed fire work through contracts administered through those agencies versus the Forest Service. A personnel agreement in FY 2019 with the BLM also supported a BLM employee working on invasive weed management on national forest lands in the CFLR Project area.

Many of the agreements used during each year of the CFLR project are the result of longstanding efforts and relationships with partners in the Lakeview CFLR project area. For example, the Forest Service has worked collaboratively with the LCCWMA for many years to identify, inventory, and treat populations of invasive weeds before they can become well-established and spread. CFLR funds have supported agreements with the LCCWMA throughout the course of the project, the LCCWMA has used these agreements to hire several Lake County contractors to treat and monitor extensive new areas for invasive weeds.

Agreements used to fund work on the CFLR landscape have also had key social and local economic benefits. For example, the Chewaucan Biophysical Monitoring Team (CBMT) began in 2002, and one of its goals is to provide Lake County students with natural resource field training. This group includes high school and college students that collect data and conduct monitoring activities with supervision from an adult crew leader trained in these activities. The CBMP has gathered ecological field data for the CFLR project area that help show conditions and trends over time, including

Figure 13.1 Footprint of acres treated under the Lakeview CFLR Project, FY 2012–19



Data source: Lakeview Stewardship CFLR annual reports

Table 13.2 Example outcomes from contracts and partner agreements reported by the Forest Service, FY 2012–19

FY	Contracts	Partner agreements
2012	▪ Pre-commercial thinning on 3,256 acres in Jakabe and Launch projects ▪ 3 miles of streambank stabilization and 15 acres of riparian restoration ▪ 315 acres of aspen restoration ▪ 1,171 acres of juniper thinning	▪ 67 sites established or resurveyed, new landscape monitoring sites established, and 500 plots completed by the Chewaucan Biological Monitoring Team ▪ 153 miles of trail restoration by Northwest Youth Corps, Central Oregon Intergovernmental Council, and others ▪ Material, fencing, and labor in the Chewaucan Aquatic Habitat Restoration project with local ranchers and landowners
2013	▪ Pre-commercial thinning of 376 acres in the Burnt Willow Environmental Assessment ▪ Pre-commercial thinning on 693 acres in the Jakabe project ▪ Pre-commercial thinning on 1,619 acres in Foster and Wooley Creek subwatersheds	▪ 68 sites established, 40 soil disturbance surveys, and stream water sampling completed by the Chewaucan Biological Monitoring Team ▪ 86 miles of trail restoration by Northwest Youth Corps, Central Oregon Intergovernmental Council, and others ▪ Five acres of hand piling of slash, 38 acres of juniper slash reduction, 138 acres of aspen enhancement, 10 acres of fuels treatment, and recreation site fence repair by Warner Creek Correctional Facility crews
2014	▪ WRZ multi-treatment/Jakabe fuels reduction on 1,775 acres ▪ Pre-commercial thinning of 1,367 acres in the Burnt Willow Environmental Assessment ▪ Fuels reduction thinning of 683 acres under the Deuce pre-commercial thinning project	▪ Warner Creek Correctional Facility performed 75 acres of hand-piling small diameter material in conifer stands and 160 acres of hand-piling cut material in aspen stands ▪ Central Oregon Intergovernmental Council restored and maintained 11.5 miles of trails, cleared paths for ADA-accessible recreation facilities, and installed a dock to mitigate lakefront erosion ▪ Northwest Youth Corps maintained 68 miles of recreation trails
2015	▪ West Drews Environmental Assessment pre-commercial thinning/juniper/piling project on 1,064 acres ▪ Coffee Pot fuels reduction project on 1,800 acres ▪ Dairy Creek large wood restoration project	▪ Central Oregon Intergovernmental Council constructed 2.7 miles of cattle exclusion fences, maintained 12 miles of trails, removed hundreds of hazardous trees, and conducted other recreation-oriented restoration activities ▪ Northwest Youth Corps bucked and cleared approx. 962 trees, repaired 25 drainage structures, and dropped and bucked 500 standing dead trees that were a hazard to public visitors ▪ Youth Conservation Corps manually treated 184.9 acres of invasive musk thistle
2016	▪ Thinning, piling, juniper removal, and prescribed fire on 2,084 acres of the West Drews Environmental Assessment project, leading to completion of a landscape-level project on the Lakeview Ranger District ▪ Aspen and meadow restoration on 1,007 acres of the South Warner Aspen Meadow Restoration Project ▪ Thinning treatments on 1,848 acres that completed the Coffee Pot Fuels Reduction Project ▪ 5,209 acres of small tree thinning as part of a timber sale awarded to Collins Pine under the Crooked Mud Honey Environmental Analysis project	▪ The Chewaucan Biological Monitoring Team, via an agreement with Lake County Resource Initiative: established 90 sites, revisited 37 sites, conducted soil condition class surveys to act as controls for the impact of logging and fire on steep slopes; and conducted 120 miles of stream monitoring that was subsidized by the Lake County Watershed Council ▪ The Warner Creek Correctional Facility completed 119 acres of hand-piling from prior pre-commercial thinning work and 20 acres of manual invasive treatments ▪ Northwest Youth Corps crews continued treatments on a 97-acre aspen stand and maintained 54 miles of trails, including brushing, adding trail markings, and constructing treadways and drainage structures ▪ An agreement with Lake County Cooperative Weed Management Area supported hiring two local contractors to treat 196.5 acres of invasive plants ▪ Ruby Pipeline Mitigation cost reimbursement funded 46.8 acres of invasive plants treatment ▪ Two Central Oregon Intergovernmental Council crews constructed 1,700' of new fence, repaired and maintained 13,500' of existing fence, maintained 23 miles of trail, and removed 100s of hazardous trees in developed recreation sites ▪ Youth Conservation Corps crews completed 10 miles of trail maintenance, 24 acres planting area maintenance, 4 miles of fence repair, and 270.7 acres of manual invasive plant removal in addition to assisting forest staff with riparian restoration, aspen restoration, recreation site vegetation management, and archeology surveys. ▪ Treatment projects to enhance habitat in the Warner Mountains were supported by the the Rocky Mountain Elk Foundation, Mule Deer Foundation, and Ruby Pipeline Mitigation Team
2017	▪ 429 acres of non-commercial thinning on the Crooked Mud Honey project were contracted ▪ The Deuce South and Northwest TSI Non-Commercial Thinning Contract was awarded but due to high fire activity has yet to be implemented ▪ Aspen and meadow resoration on 890 acres in the North and South Warner project areas ▪ Approximately 36 miles of road maintenance plus commercial harvest and small tree thinning on 3,750 acres on the Lakeview Ranger District as part of the intergrated resource stewardship contract with Collins Pine	▪ The Chewaucan Biological Monitoring Team, via an agreement with Lake County Resource Initiative, established 110 new sites and revisited 87 sites ▪ The Warner Creek Correctional Facility conducted 30 acres of hand-piling around osprey nests ▪ The Oregon Department of Forestry completed 19 acres of small tree thinning and hand piling under an agreement, with additional work to follow ▪ Northwest Youth Corps crews continued treatments on a heavily encroached 97-acre aspen stand, reconstructed 10 miles of trail, removed invasive weeds for 100 acres ▪ Youth Conservation Corps crews manually treated 129.1 acres of invasive species ▪ An agreement with the Lake County Cooperative Weed Management Area supported hiring two local contractors to treat 381.1 acres of invasive plants ▪ Ruby Pipeline Mitigation cost reimbursement funded 49.4 acres of invasive plants treatment ▪ Central Oregon Intergovernmental Council crews repaired 6 miles of fencing, maintained or reconstructed 30 miles of trail, and completed many other recreation-focused projects near Lakeview

<table>
<tr><th>FY</th><th>Contracts</th><th>Partner agreements</th></tr>
<tr><td>2018</td><td>

Commercial harvest of 10 mmbf
Non-commercial thinning with hand piling on 1,024 acres
5,540 acres of prescribed fire and 5,500 acres of pile burning
5 miles of National Forest System roads that had been determined as no longer needed for resource management or fire suppression were decommissioned.
Contracted vegetation plots were completed to validate lidar data that was acquired during this FY to cover 434,000 acreas with the CFLR project area.
A cadastral surveying contract with a private land surveying firm was conducted in support of future timber sales

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Site monitoring:

The Chewaucan Biological Monitoring Team, via an agreement with Lake County Resource Initiative, established 38 new sites and revisited 95 sites. Revisited sites included harvest, aspen, steep slope logging impact, 10-year post-burn, and untouched old growth sites.

Invasive weed treatments:

The Lake County Cooperative Weed Management Area (LCCWMA) performed manual and herbicide invasive weed treatments on 636 acres with CFLR funds
An additional 455 acres were treated by LCCWMA through USFS matching funds and partner cash match.
Another 130 acres (178 sites) were treated with herbicide with funding for sage-grouse habitat improvement
The Youth Conservation Corp crew assisted with manual treatments in various locations throughout the project area
100s of other sites were revisited and treatment was deemed unnecessary.

Youth Crews

4 leaders and 18 youth crew members maintained 7 miles of the Fremont National Recreation Trail through clearing brush, removing downed trees, restoring tread, and performing general trail maintenance.
Two Youth Conservation Corps crews (1 crew lead and 4 crew members each) spent 8 weeks performing: surveys for wildlife, geology, archeology, botany, and weeds; weed abatement; trail maintenance; and recreation site maintenance.
A participating agreement between the Fremont-Winema National Forest and Lake County School District 7 was set up to employ a crew lead and 6 crew members for the Step Up Youth Crew. This youth crew will complete various trail and recreation maintenance projects on national forest lands for 4 weeks of each summer through FY 2023 including: trail tread repair and maintenance, trail clearing and brushing, trail sign and reassurance marker installation, micro trash cleanup, recreation facility painting, and recreation site ground maintenance.

Agreements with ODF and the BLM were put in place to ensure assistance with future pile burning and prescribed fire; the agreements enable the hiring of contractors through ODF and BLM to complete this work
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<tr><td>2019</td><td>

Commercial harvest of 12 mmbf
Non-commercial thinning with hand piling on 1,711 acres were conducted with the fourth contract for small tree thinning within the North Warner area within the last four years.
4,127 acres of prescribed fire and 5,410 acres of pile burning
A cadastral surveying contract with a private land surveying firm accomplished 7.75 miles of NFS boundary maintenance and the maintenance of 19 corner monuments that define the boundary lines, along with associated paperwork. This work will support future timber sales in the area.

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Site monitoring:

The Chewaucan Biological Monitoring Team, via an agreement with Lake County Resource Initiative, established 38 new sites and revisited 95 sites. Revisited sites included harvest, aspen, steep slope logging impact, 10-year post-burn, and untouched old growth sites.

Invasive weed treatments: Overall, 1,823.6 acres were treated and an additional 117.7 acres (782 sites) were accounted for within the CFLR Project Area.

The Lake County Cooperative Weed Management Area (LCCWMA) performed manual and herbicide invasive weed treatments on 643 acres with CFLR funds
An additional 702 acres were treated by LCCWMA through USFS matching funds and partner cash match.
Through a personnel agreement with the BLM, USFS provided funds for one BLM employee to work on national forest lands for invasive weed management.
The Youth Conservation Corp crew assisted with manual treatments in various locations throughout the project area
100s of other sites were revisited and treatment was deemed unnecessary.

Youth Crews

Northwest Youth Corps (NYC) completed approximately 24 of the 893 acres in the Mud Creek area using an adult (19-26 years old) saw crew of approximately 3-5 members with a crew leader.
4 leaders and 18 youth crew members maintained 19 miles of trails through clearing brush, removing downed trees, restoring tread, and performing general trail maintenance.
Two Youth Conservation Corps crews (1 crew lead and 4 crew members each) spent 8 weeks performing: surveys for wildlife, geology, archeology, botany, and weeds; weed abatement; ecosystem restoration; trail maintenance; and recreation site maintenance.
A participating agreement between the Fremont-Winema National Forest and Lake County School District 7 employed a crew lead and 4 crew members for 8 weeks on the Step Up Youth Crew. This youth crew completed various trail and recreation maintenance projects on national forest lands including: trail tread repair and maintenance, trail clearing and brushing, trail sign and reassurance marker installation, micro trash cleanup, recreation facility painting, and recreation site ground maintenance.

CFLN funding was provided to the High Desert Rangeland Association to complete a community-based wildfire pre-plan for the Summer Lake community. The plan will include locations and assessment of all structures, waterholes, existing or potential wildfire control lines, ingress/egress, and potential opportunities for defensible space, thinning, and/or prescribed fire treatments on public or private lands. This data will be provided to all agencies and partners to pursue implementation or to use during the next wildfire event.
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in the decade before the project began (2002–12). This data has been important for showing the impacts of treatments on the landscape—much of the monitoring data presented in the nine biophysical monitoring questions in this 8-year report were collected by the CBMT. Between FYs 2012–2019, the CBMT hired 26 different local students on the monitoring team. Many of these members returned season after season during the summer between years of high school and college, and some have continued even beyond that, returning as crew leaders on the team during the summers while working other jobs like school teachers during the rest of the year. During FY 2018 and FY 2019, the CBMT consisted of 14 members, all but one of which were returning members, including some returning for their seventh or eighth year on the team.

In addition, several youth crews comprised of youth crewmembers and adult crew leaders have also been supported with Lakeview CFLR funds during each year of the project. Northwest Youth Corps (NYC) crews have partnered with the Fremont-Winema National Forest for many years and have been integral to building and maintaining recreation trails. Agreements funded through the CFLR project have allowed the Forest Service to continue to partner with NYC to accomplish labor-intensive trail maintenance work across the Lakeview Stewardship CFLR landscape, while providing youth with job skills and training. Similarly, youth crews with adult leadership from the Central Oregon Intergovernmental Council and Youth Conservation Corps were also supported by Lakeview CFLR funds throughout the project, these crews also helped accomplish a wide variety of resource enhancement projects at recreation sites and trails across the CFLR landscape. Starting in FY 2018, the Fremont-Winema National Forest entered into a participating agreement with Lake County School District 7 to set up and employ another youth crew. This youth crew, called the Step Up Youth Crew, hires students only from the Lake County school district to complete various trail and recreation maintenance projects under the supervision of an adult crew leader, providing both summer jobs for local youth and additional capacity for this work on the CFLR landscape.

Through interviews with agency staff, collaborative members, and partners, we consistently heard about the benefits of agreements, both in terms of work that they were able to accomplish on the ground as well as the benefits that they provided to local community members. Many agency staff and partners also emphasized the importance of CFLR funding to applying for and securing funding through shared agreements with other entitites. For example, they described how CFLR funds have frequently been used to meet required match requirements when applying for wildlife habitat enhancement funds through NGOs like the Mule Deer Foundation or the Rocky Mountain Elk Foundation. Because CFLR funds have met match requirements for these funding sources, successful proposals have led to additional work on and around the CFLR landscape through funds from partners with mutual management objectives. Finally, interviews with crewmembers of the CBMT emphasized the key personal benefits that members perceived through this work:

"Its helped me understand good recording practices, for a lot of stuff. Because we focus on recording high quality data, its kind of led into other aspects of my life, where like I know how to set stuff up to how it makes sense and is easy for other people to come in and look at it."

"Its hands down above anything else you could do [as a summer job in high school], we are doing real world science and real world data collection as well as working on real aspects of problem solving, whether its simple getting things done, or problem solving when it comes to logistics, problem solving when it comes to protocols even–having debates or discussions about what's the most logical thing to do, its just a really engaging way to teach and learn for young adults. And I think more than anything else it gives them a sense of pride and a sense of community and a lot of knowledge about the place that they live that they wouldn't get otherwise, at least that's what it did for me."

"I would say it prepared me for any job that I wanted. It created in me a mindset and a work ethic of 'hey, if you're doing this you need to do it right, because other people are depending on it.' That's huge and that's what people need in the workforce—dependable people who will do a good job even if you're not watching and who will take that responsibility seriously."

"It's really such a great unique experience, it changed my life... It gave me a sense of purpose and really, before that, I don't think I had it. Like, I was doing something and what I was doing was worthwhile to other people, and that's really powerful."

Considerations

Work has been accomplished on the Lakeview CFLR landscape through a variety of mechanisms. Restoration service contracts have been useful for acquiring the needed capacity for large scale and technical-intensive work across the landscape, and agreements have provided additional capacity to achieving objectives while often offering benefits to local entities and community members. Agreements with NGOs, local government, and other state and federal agencies have increased both in number and in scope since the beginning of the project, achieving a wide range of accomplishments, from validating lidar data to prescribed burning, road decommissioning, and aspen restoration.

In the future, the information from this monitoring question can inform considerations about what mechanisms can be used to accomplish different activities. Beyond that, the group might consider other ways to more specifically capture the wide ranging and important work of these agreements, including what entities were engaged and how, to more flly understand the impacts of agreements.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in four biennial socioeconomic monitoring reports. In particular: Eric M. White, Emily Jane Davis, and Cassandra Moseley contributed to monitoring question development and conducted the baseline assessment and first couple years of monitoring (FY 2012–13), Stacey Rosenberg contributed to FY 2014–15 monitoring efforts, and Autumn Ellison and Heidi Huber-Stearns have contributed to the past 6 years of monitoring (FY 2014–19).

Many thanks to the interviewees who offered their insights and perspectives on key project dynamics, implementation mechanisms, and the benefits to both the landscape and the local community. The Lakeview CFLR Project annual reports provide an account of project accomplishments. Annual reports for all CFLR projects are available at: https://www.fs.fed.us/restoration/CFLRP/results.shtml.

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Question 14

What are the total and matching funds used?

Goals:

To understand if CFLR is increasing the Forest Service and partners' abilities to raise and leverage funds.

Indicators:

Measured as both annual amounts and change over time:

- 14.1. Total direct CFLR funds, total matching funds, and total leveraged funds

Context

Funds to accomplish CFLR activities come from multiple sources. Direct funds are allocated as CFLR/CFLN dollars from the Forest Service Washington Office to use on CFLR projects, and matching funds are used to increase the amount of work accomplished. CFLR legislation requires a 50 percent match of CFLR/CFLN funds, which can come from Forest Service spending at various levels (Washington Office, regional, or forest-level) as well as from non-Forest Service sources (Omnibus Public Land Management Act, 2008). Capacity to accomplish CFLR tasks also comes from partners through both agreements that provide dollars for mutual work and in-kind contributions that increase the scale of work accomplished on the CFLR landscape through labor and other resources.

Approach

We reviewed Lakeview Stewardship CFLR annual reports to identify the amount of direct CFLR/CFLN funds and non-CFLR/CFLN funds, including Forest Service matching funds, funds contributed via agreements, and in-kind contributions, used in CFLR activities during each year.

Results

From FYs 2012–19, the Lakeview Stewardship CFLR project funded more than $54 milllion of on-the-ground restoration work and monitoring in the project area. Total funds varied between $4.7 million and $9.1 million per year (Table 14.1).

Direct CFLR/CFLN funds for the Lakeview CFLR project ranged from $1.4 to $2.7 million during each year. Matching funds met the 50 percent match requirement during every year, ranging from 51 percent of total funding accounted for in FY 2012 to 81 percent in FY 2017 (Figure 14.1).

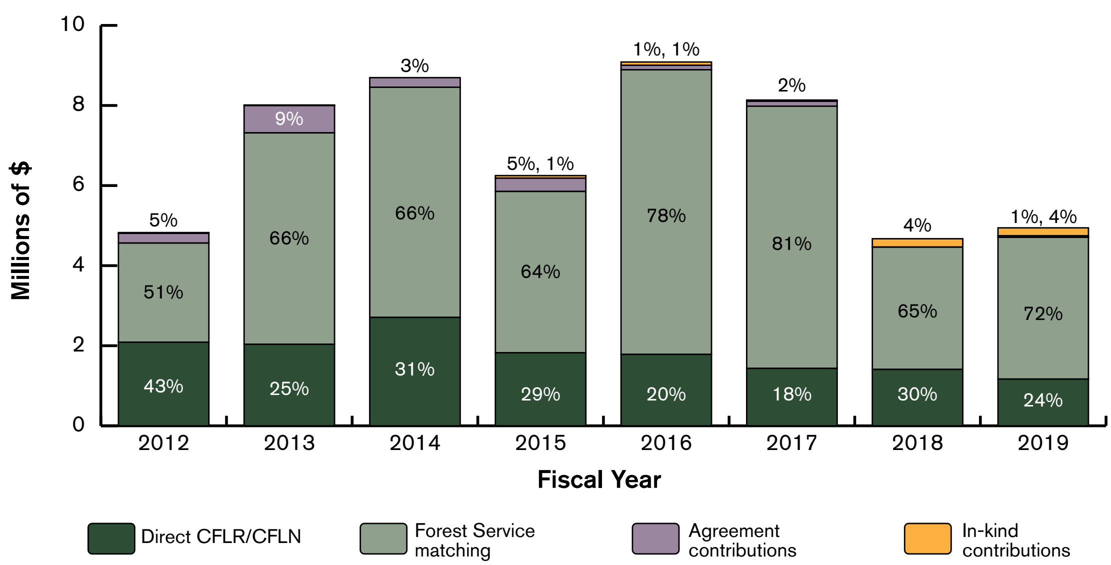
Funds contributed through agreements and in-kind came from a wide range of partners. These included many local NGOs (such as the Lake County Weed Board, Lake County Resource Initiative, Lake County Umbrella Watershed Council), regional and global NGOs (such as the Mule Deer Foundation, the Nature Conservancy, Northwest Youth Corps, Central Oregon Intergovernmental Council, the Rocky Mountain Elk Foundation), and state government (such as the Oregon Department of Forestry, the Oregon Department of Corrections). The methods for tracking how funds contributed through agreements changed during FY 2018 in an attempt to improve accuracy. This means that the dollars contributed through agreements cannot be compared across the years of the project. However the number of contributing partners illustrates that many partners were invested in the work happening on the project landscape. It also highlights the degree to which direct dollars allocated through the CFLR program were able to leverage other funds: during each year, direct dollars accounted for just 18–43 percent of the total funds expended on the project, with other sources making up the balance.

Table 14.1 Direct, matching, and contributed funding in support of CFLR activities, FY 2012–19

	2012	2013	2014	2015	2016	2017	2018	2019
Direct CFLR/ CFLN funds	$2,088,646	$2,037,204	$2,707,036	$1,824,530	$1,783,061	$1,433,272	$ 1,408,364	$ 1,166,809
Forest Service matching funds	$2,475,267	$5,278,075	$5,748,551	$4,028,358	$7,108,760	$6,549,424	$3,053,296	$3,540,163
Funds contributed via agreements	$243,246	$682,134	$239,178	$332,062	$111,794	$122,961	$1,461	$40,000
In-kind contributions	$18,909	$14,700	-	$64,182	$81,775	$30,000	$209,009	$196,869
Total	**$4,826,068**	**$8,012,113**	**$8,694,765**	**$6,249,132**	**$9,085,390**	**$8,135,657**	**$4,672,130**	**$4,943,841**

Data source: Lakeview Stewardship CFLR annual reports

Figure 14.1 Proporation of total funds coming from direct, matching, agreements, and in-kind contributions to support of CFLR activities during each year, FY 2012–19



Data source: Lakeview Stewardship CFLR annual reports

Considerations

The Lakeview CFLR Monitoring Plan notes that the amount of funds that the Forest Service, partners, and collaboratives are able to bring to restoration projects can serve as one indicator of collaboration and capacity.

During the first 8-years of the CFLR project, Forest Service match requirements were exceeded each year, and additional funds were contributed to projects on the landscape via agreements and in-kind contributions from a multitude of partners with mutual interests in accomplishing the restoration work. Altogether, Forest Service match with partner contributions accounted for well over half the funds during each year of the project, highlighting the impact and leveraging potential these funds have in accomplishing additional work on the landscape.

In the future, the collaborative can use this information to inform project planning , including exploring the potential for additional leveraging capacity within CFLR funds to achieve mutual goals on the landscape.

Acknowledgements

Many people have contributed to the socioeconomic monitoring for this project, and the results compiled for this report were originally published in four biennial socioeconomic monitoring reports. In particular: Eric White, Emily Jane Davis, and Cassandra Moseley contributed to monitoring question development and conducted the baseline assessment and first couple years of monitoring (FY 2012–13), Stacey Rosenberg contributed to FY 2014–15 monitoring efforts, and Autumn Ellison and Heidi Huber-Stearns have contributed to the past 6 years of monitoring (FY 2014–19).

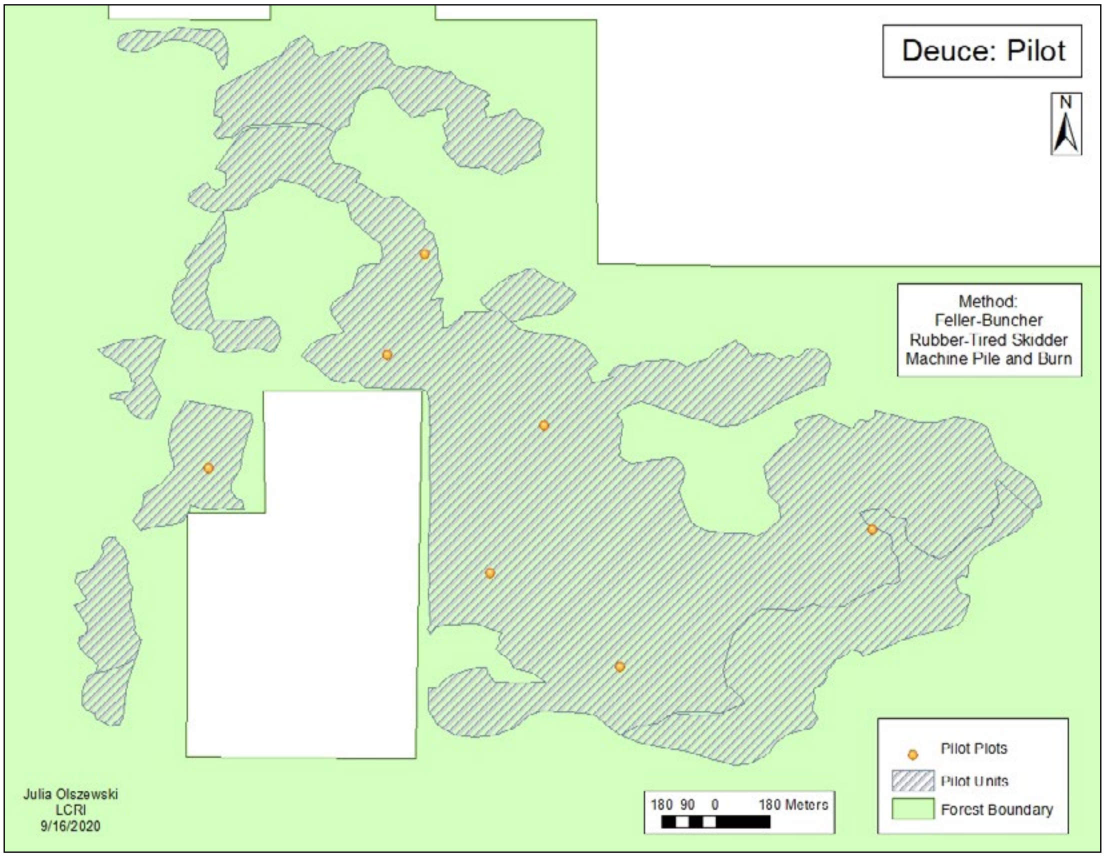
The Lakeview CFLR Project annual reports provided an account of expended funds to answer this monitoring question. Annual reports for all CFLR projects are available at: https://www.fs.fed.us/restoration/CFLRP/results.shtml.

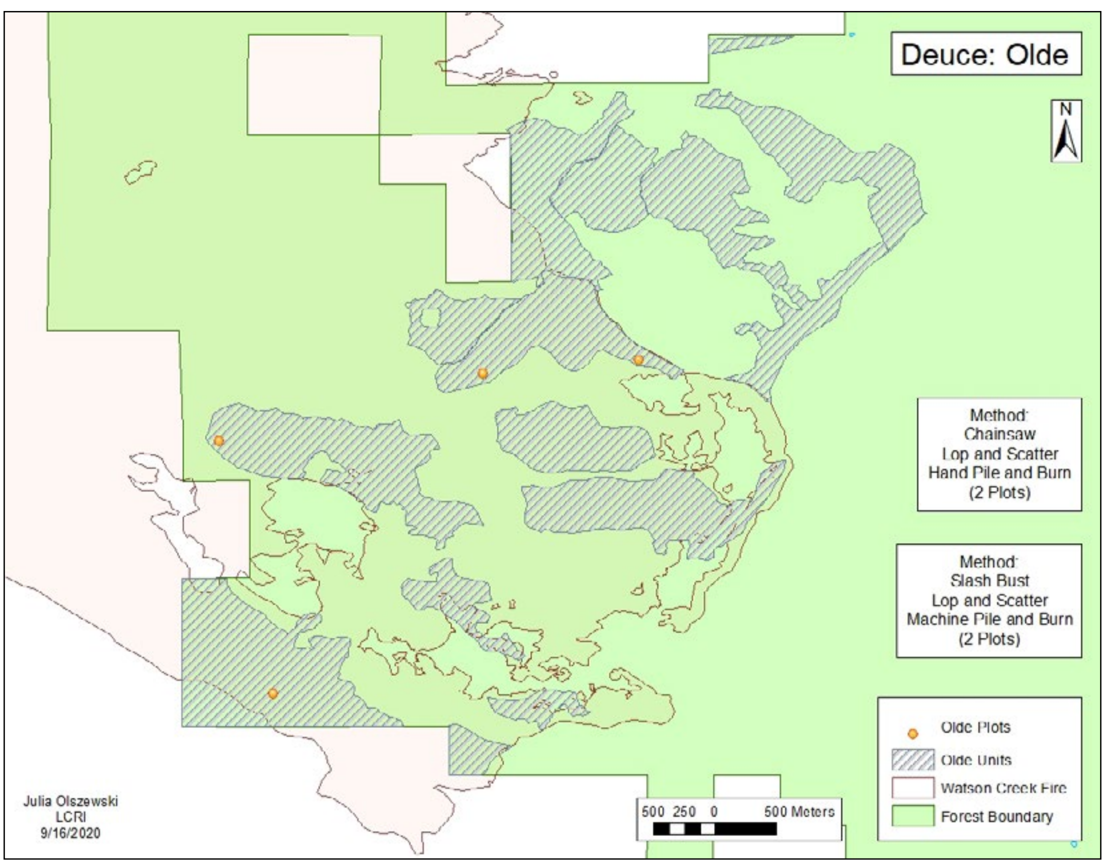
References

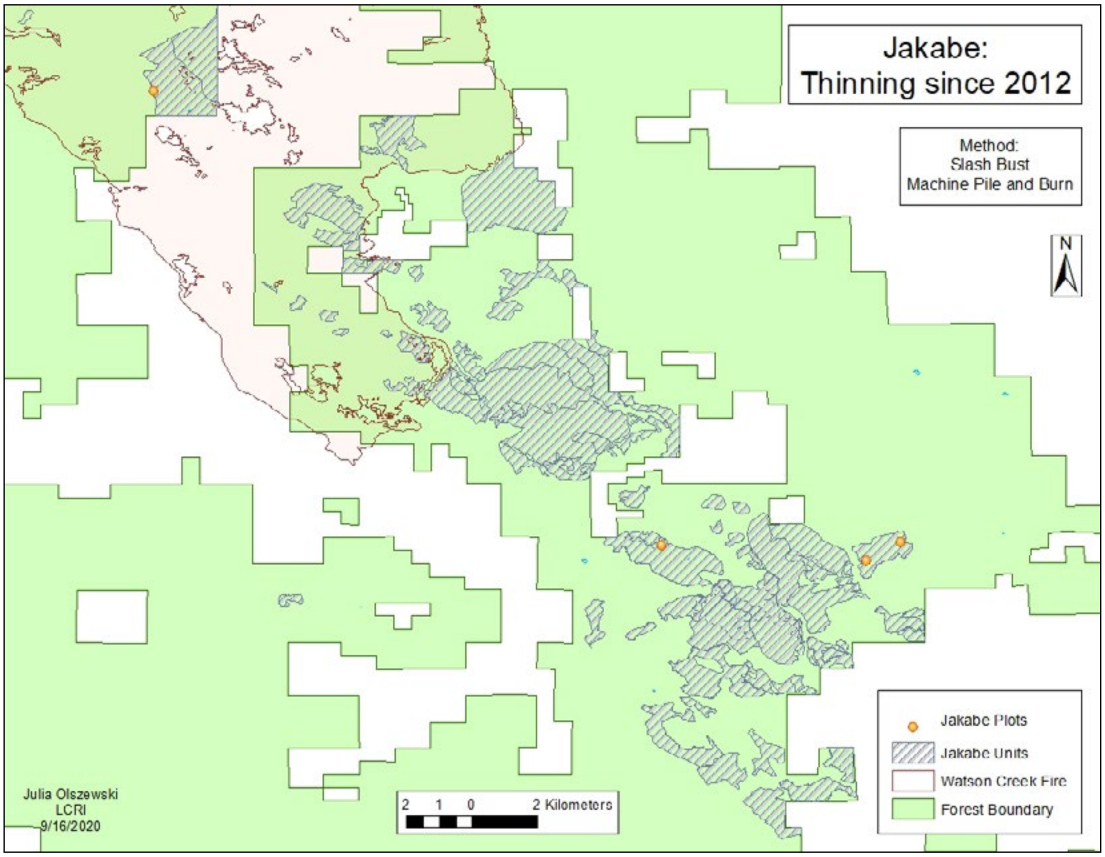
Omnibus Public Land Management Act of 2009 Title IV--Forest Landscape Restoration, Public Law No. 111-11, S.2593. 2008. Available at: https://www.congress.gov/bill/110th-congress/senate-bill/2593/text.

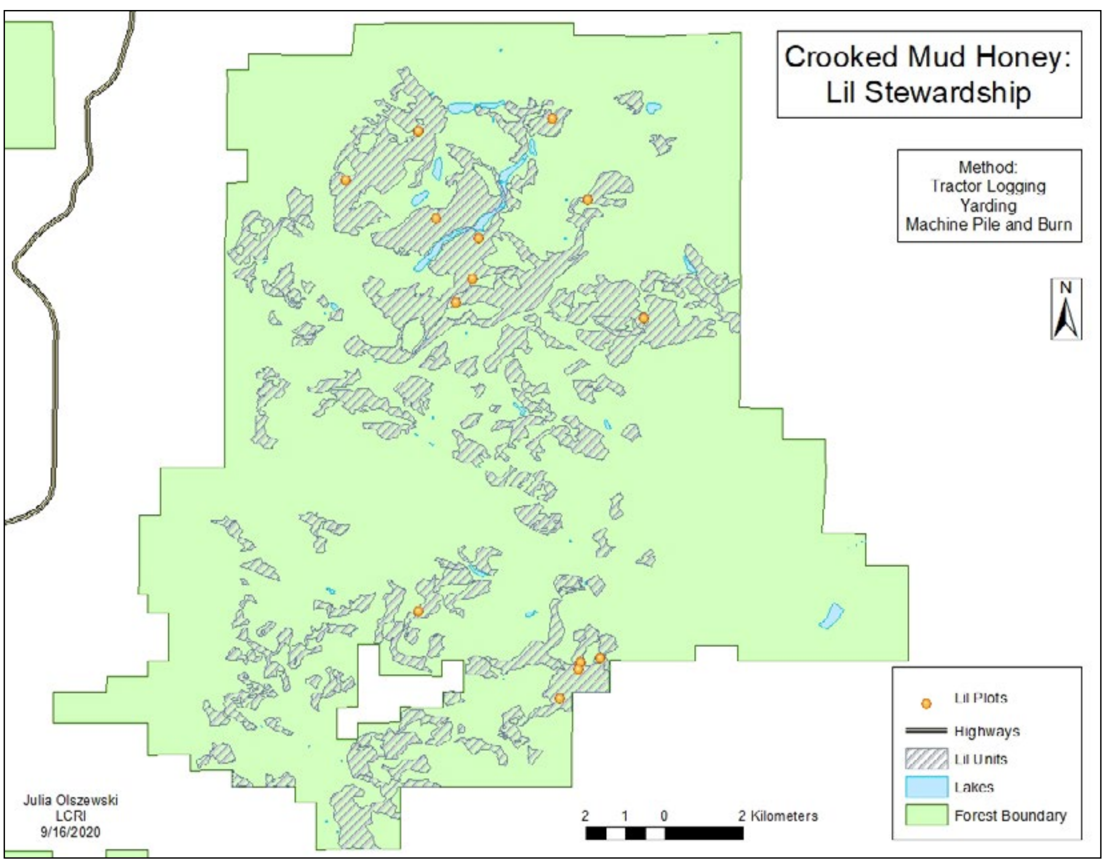
A CBMT crewmember marks a tree based on input by a breakout group of participants during a Lakeview Stewardship Group field tour exercise, 2018. Photo courtesy of Autumn Ellison, University of Oregon.

Appendix 1A Maps of Treatment Units and Plots






Jakabe:
Thinning since 2012
Method:
Slash Bust
Machine Pile and Burn
N
Jakabe Plots
Jakabe Units
Watson Creek Fire
Forest Boundary
2 1 0 2 Kilometers
Julia Olszewski
LCRI
9/16/2020


Crooked Mud Honey:
Lil Stewardship
Method:
Tractor Logging
Yarding
Machine Pile and Burn
N
Lil Plots
Highways
Lil Units
Lakes
Forest Boundary
2 1 0 2 Kilometers
Julia Olszewski
LCRI
9/16/2020

Appendix 8A Summary of yearly water temperature data collected at stations in the CFLR project area from 2012-2020

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Red highlight denotes OR 2012 Cat.5 303(d) list for water temperature.									
Red background denotes streams with DEQ standard: Season: year round non-spawning.									
Beneficial use: redband or Lahontan cutthroat trout: 20ºC 7-day average maximum.									
Green background denotes stream with DEQ standard: Season: summer. Beneficial use: salmonid fish rearing: 17.8ºC 7-day average maximum.									
White background denotes streams that are not listed on 303(d) list. These streams show yearly maximum using 20ºC for maximum.									
•In all cases value presented is maximum of the weekly average of the daily maximum temperature.									
•DEQ standard value is 7day average of the daily maximum.									
•Parenthesis is number of days temperature is above DEQ standard for that stream 17.8 or 20.									
•The number of days HOBO is deployed between June 1 and Sept 30 varies annually, maximum possible number of days is 122.									
Anna River-Summer Lake 1712000514									
Foster Creek FS4800									
Harvey Creek HV5140									
Harvey Creek HV5460									
Wooley Creek WO5360	22 (38)								
Lower Chewaucan River 1712000604									
Crooked Creek CK5200	17.1 (0)				17.4 (0)	16.2 (0)			x
Mill Flat Creek MI4760									
Willow Creek WL4680 17.8									
Willow Creek WL4840									
Middle Chewaucan River 1712000602									
Bear Creek BE4800 17.8	20.2 (46)	20.8 (41)	21.5 (38)	19.3 (13)	19.6 (20)	18.4 (16)			x
Bear Creek BE6600									
Chewaucan River CH4675 20									
Chewaucan River CH4790									

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Chewaucan River CH4835	27.2 (77)	28.6 (85)	28.5 (98)	28.8 (90)	28.6 (72)	26.8 (73)			x
Chewaucan River CH4915									
Coffeepot Creek CO4920 20									
Coffeepot Creek CO5080		25.1 (48)	21.2 (11)	24.4 (54)	20.2 (4)	19.3 (0)			x
Coffeepot Creek CO6580									
Coffeepot Creek CO6800									
Little Coffeepot Creek LC5120 17.8									
Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Dog Creek DO5000	22.5 (34)		23.1 (31)	26.8 (85)	25.3 (65)	23.2 (45)			x
Upper Chewaucan River 1712000601									
Ben Young Creek BY5040 20		25.8 (49)							
Ben Young Creek BY5120	25.1 (57)		25.8 (54)	25.5 (81)	23.2 (45)	22.7 (35)			x
Ben Young Creek BY5400		24.1 (32)	24.1 (41)	25 (55)	22.8 (31)	21.5 (33)			
Ben Young Creek BY5560									
Chewaucan River CH 5120 20	25.7 (60)	26.8 (72)	26.9 (73)	27.4 (84)	26.6 (63)	24.3 (71)			x
Dairy Creek DY5200									
Dairy Creek DY5270	18.5 (0)	18.6 (0)	19.2 (0)	19.3 (0)	18.6 (0)	17.6 (0)			x
Dairy Creek DY5350									
Dairy Creek DY5800									
Deadhorse Creek 5360	14.3 (0)	15 (0)	14.5 (0)			14 (0)			x
Deadhorse Creek 5980									
Deer Creek DER5460	20.5 (4)	21.1 (20)	21.7 (18)		19.7 (0)	18.5 (0)			x

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Elder Creek EL5300	21.9 (35)		24.2 (36)	23.1 (48)	22.9 (33)	21.6 (30)			x
Elder Creek EL6220									
Elder Creek EL6535									
Elder Creek EL6800									
Morgan Creek MO5350 17.8		24.6 (74)	25.5 (74)	24.8 (88)	23.8 (68)	24.1 (73)			x
Morgan Creek MO5420									
Morgan Creek MO5450									
North Creek NO6680			22.2 (14)	21.7 (44)	22.7 (24)	21.4 (20)			x
Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Shoestring Creek SH5300 17.8	21.3 (48)	22.4 (34)	21.4 (24)	21.7 (55)	20.3 (27)	20.9 (42)			x
WF Shoestring Creek WSH5300 17.8									
WF Shoestring Creek WSH5800									
South Creek SO5155 20									
South Creek SO5220	25.9 (71)	27.3 (58)	26.2 (69)	20 (0)	24.5 (58)	24.6 (71)			x
South Creek SO5340									
South Creek SO5380									
South Creek SO5400									
South Creek north trib SO5420									
Spring Creek SPG5600									
Spring Creek trib SPG5450									
Swamp Creek SW5120 20	27.5 (77)	28 (32)			25.8 (56)	24.7 (70)			x
Swamp Creek SW5400			19 (0)						
Swamp Creek SW6000									

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tepee Creek TP5440	11.1 (0)	16.3 (0)							
Witham Creek WI6560	18.2 (0)	19.9 (0)	20.5 (2)	18 (0)	19.4 (0)	18.3 (0)			x
East Witham Creek WI6560	18.7 (0)	20.6 (6)	20.9 (4)	18.5 (0)	20.3 (3)	19.1 (0)			x
Honey Creek 1712000704									
Honey Creek HO6200 20		18.6 (0)			23.4 (41)	21.3 (17)	22.3 (22)		x
Little Honey Creek LHO5960 17.8		19.6 (15)			14.4 (0)	12.9 (0)	14.6 (0)		x
Deep Creek 1712000703									
Burnt Creek BN5640									
Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Burnt Creek BN6000	26.2 (55)	26.3 (50)	26.4 (67)	26.5 (78)	25.2 (64)	24.5 (55)		22.6 (25)	x
Burnt Creek BN6200									
Camas Creek CA5500 20	25.6 (76)				25.4 (68)	23.8 (52)			x
Deep Creek DP5700 20	21.2 (34)	23.7 (43)		23 (54)	21.8 (10)	20.1 (2)		19.8 (0)	x
Deep Creek DP5840									
NF Deep Creek NDP6000 20	19.7 (0)	20.3 (4)			20.6 (4)	19.5 (0)			x
MF Deep Creek MDP6060	17.5 (0)	18.4 (0)							x
SF Deep Creek SDP6040	19.4 (0)	20.2 (4)			20 (1)	19.2 (0)			x
Dismal Creek DS5720 20					18 (0)	17.3 (0)			
Dismal Creek DS6900	22.2 (42)	22.9 (25)	22 (36)	22.4 (53)				20.3 (10)	x
Horse Creek HR5960 17.8									
Mosquito Creek MQ6000					15.9 (0)	15.2 (0)			x

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mud Creek MD6460	22.1 (33)	23.2 (22)	19.8 (0)	22.5 (29)	21.7 (26)	21.4 (19)			x
Polander Creek PL5680 17.8					15 (0)	12.7 (0)			x
Porcupine Creek PP6500 20									
Porcupine Creek PP6660									
Porcupine Creek PP6700	14.8 (0)	16.3 (0)	15.1 (0)	15.4 (0)	15.3 (0)	14.1 (0)			x
Willow Creek WLO5580									
Willow Creek WLO6020	24.8 (57)	26.8 (69)		24.5 (55)	22.4 (35)	21.2 (37)			
Willow Creek WLO6080	21.6 (41)	23.5 (42)	24.2 (46)	24.2 (71)	22.5 (31)	21.4 (22)		20.6 (10)	x
Willow Creek WLO6100									
Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Twentymile Creek 1712000701									
NF Twelvemile Creek TW6620									
Willow Creek-Frontal Goose Lake 1802000103									
Crane Creek CR5200									
Kelley Creek KE5400									
Thomas Creek 1802000102									
Augur Creek AG5820									
Bauers Creek BS5120 17.8									
Bauers Creek BS5200				17 (0)	16.4 (0)	15.9 (0)			x
Camp Creek CM5400 17.8				23.8 (84)	19.6 (25)	21.1 (53)			x
EFCamp Creek ECM5320 17.8				23.9 (86)	21.5 (56)	19.4 (19)			x

Watershed and Stream Name	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cottonwood Creek CO5200									
Cox Creek CX5040 17.8									
Cox Creek CX5280				23.2 (65)	22.3 (54)	19.9 (22)			x
Grizzly Creek GZ6180	17.9 (0)								
Shingle Mill Creek SHM5400 17.8	18.1 (1)								
Thomas Creek TH4894 20		25.7 (39)	24.3 (57)	26.8 (86)		25.1 (57)			
Thomas Creek TH5265					26.8 (72)			25.7 (32)	x
Thomas Creek TH5580		25.1 (23)	20.2 (2)	23.6 (67)	24.2 (31)	23.4 (53)			
Thomas Creek TH5760			25.6 (50)	25.8 (81)	23.9 (49)			21.3 (6)	x
Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Thomas Creek TH5980	20.9 (7)	23.4 (28)				20.4 (6)			
Thomas Creek trib UTH5650	19.5 (0)			16.7 (0)	21.8 (21)				
Tom Young Creek TY5200									
Drews Creek-Frontal Goose Lake 1802000101									
Antelope Creek AT5870									
Dent Creek DT4980 17.8									
Dent Creek trib DTT5180									
Dent Creek trib DTT5400									
Drews Creek DR4860					23.1 (74)	23.4 (61)			
Fish Creek FS5730									

Watershed and Stream Name	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Green Creek GN5360		23.1 (35)	23.1 (39)						
Hay Creek HA4980 17.8									
Dry Creek-Frontal Goose Lake 1802000104									
NO SITES									
North Fork Willow Creek-Willow Creek 1801020402									
NF Willow Creek NFW5200 17.8	25 (87)	27.5 (102)	26.4 (78)	27.5 (97)	27.7 (108)	20.8 (38)	25.3 (77)	24.7 (66)	x
Wildhorse Creek WH5275									

Appendix 12A Background on Lake County contractor capacity

Forest and watershed restoration

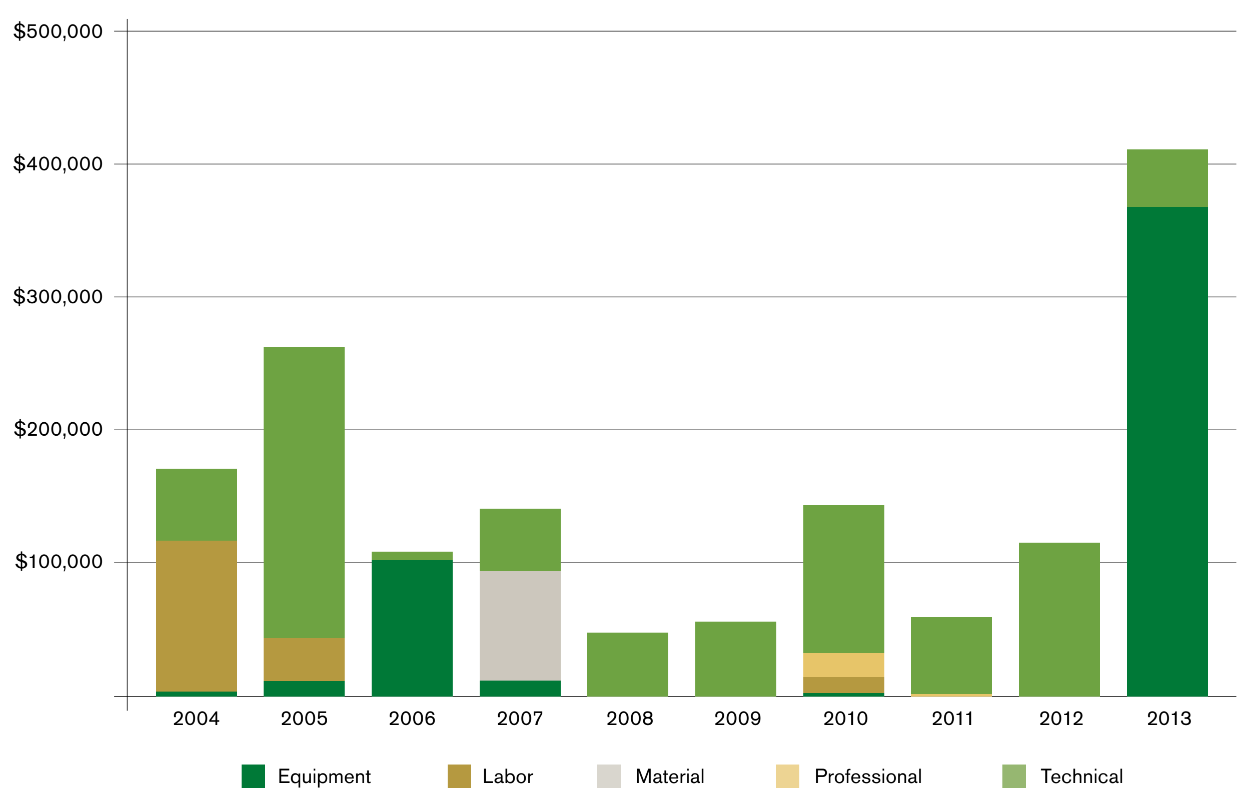
In the 10 years from 2004 to 2013, 13 businesses in Lake County and Bly, Oregon have had one or more contracts with the Forest Service to do forest and watershed restoration. In any given year, about 4 local businesses have an active contract with the Forest Service for restoration work. The average number of businesses each year with active contracts has remained fairly steady over time.

During the 2004 to 2013 period, local businesses had restoration service contracts with the Forest Service worth about $1.5 million. The value and worktype of contracts obtained by local businesses for Forest Service restoration work has remained fairly steady over time (Figure 12.A1). On average, in any given year, local businesses had contracts worth, in total, about $75,000. An increase in contract value in 2013 was caused by a single contract for equipment-intensive work within Lake County. Early in the last decade, local businesses did complete some labor intensive restoration work for the Forest Service. In recent years, however, local businesses have not captured labor-intensive restoration work for the Forest Service in Lake County or elsewhere.

Although a number of restoration contractors in Lake County have worked with the Forest Service, most of the value from restoration contract work has accrued to a handful of local businesses. Two local businesses doing technical and equipment-intensive work received 56% of the contracted value for restoration work during the 2004 to 2013 period. Just four businesses accounted for 79% of the restoration work value during the period.

Local businesses doing restoration work for the Forest Service work almost exclusively in Lake County. When traveling outside of Lake County, local businesses have worked in Klamath County (road work

Figure 12.A1 **Contract value and worktype for local businesses having contracts for Forest Service restoration in Lake County and elsewhere, 2004–13**



and weed spraying) and in Tillamook County (tree thinning). For the most part, local businesses have not been successful in securing restoration contract work outside Lake County.

Timber harvesting

Operators who are purchasing, or completing, timber harvests on Forest Service lands are also part of the local contractor base. Tom Harmon Logging and Collins Pine have purchased timber sales from the Forest Service in recent years. Tom Harmon Logging purchased Forest Service timber only from the Fremont-Winema NF during the period 2009 to 2011. Over the same period, Collins Pine purchased timber from both the Fremont-Winema NF and the Lassen NF in California.

Collins Pine has purchased the bulk of the timber sales offered on the Lakeview and Paisley ranger districts and all of timber sales within the Lakeview Sustained Yield Unit—consistent with the terms of the Unit—between 2009 and 2011 (Table 12.A1). Collins Pine relies mostly on Lake County and Bly, OR contractors to complete their Forest Service timber harvesting. A timber sale associated with the Ruby Pipeline installation in 2010 accounted for about half of the timber value on the Paisley and Lakeview ranger districts during the 2009 to 2011 period. Local companies completed harvesting activities for the Ruby Pipeline sale and the processing of harvested timber.

Fire suppression

In addition to those businesses doing restoration work on Forest Service lands, an additional group of local businesses complete fire suppression and support services for the Forest Service. Between 2004 and 2013, 43 businesses in Lake County and Bly, Oregon had one or more contracts with the Forest Service for fire suppression or support. Many contracts are established in preparation for fire season and some of those are never obligated funding because of lack of fire suppression need. Although 43 local businesses had contracts for fire suppression or fire support, just 13 local businesses actually received funds under those contracts. There was little to no overlap between companies that had contracts for restoration work and those with contracts for fire suppression and fire support.

Table 12.A1 Timber sales on the Paisley and Lakeview ranger districts purchased by Lake County buyers, 2009–11

Year	Name	Purchaser	Purchaser location	Sale value
2009	Launch SYRS task order	Collins Pine	Lakeview	$17,083
2009	Dent North SYRS	Collins Pine	Lakeview	$21,277
2010	Stack SYRS task order	Collins Pine	Lakeview	$40,945
2010	Dent South SYRS	Collins Pine	Lakeview	$14,994
2010	High Salvage	Tom Harmon Logging	Lakeview	$1,085
2010	Rip Salvage	Tom Harmon Logging	Lakeview	$48,056
2010	Ruby Pipeline	Ruby Pipeline	Colorado	$571,567
2011	LA Stewardship	Collins Pine	Lakeview	$195,972
2011	LA SYRS task order	Collins Pine	Lakeview	$90,317

Source: USDA FS Timber Information Management System

Appendix 12B Local businesses contracting with Forest Service for restoration and fire suppression contracts and timber purchase, 2004-15

Businesses in Lake County and Bly, Oregon work with the Forest Service on restoration projects, timber harvesting, and fire suppression and support services. These businesses perform work in Lake County and in other areas. Table 12.B1 includes a list of all local businesses that have engaged in contract activity with the Forest Service between 2004 and 2015. The list is separated by restoration work, timber sales, and fire suppression and support activities. Although many of these contractors, especially those related to fire suppression and support, are not supported by CFLR funding, this list highlights local contractor capacity in Lake County and Bly, Oregon. Data for the list was obtained from USDA Forest Service databases of primary contractors and timber purchasers. Collins Pine and other vendors may subcontract work out to additional local contractors who are not on this list. These subcontractors also provide valuable services and are a vital element of the local contractor base.

Figure 12.B1 Local businesses that have contracted with the Forest Service, 2004-2015

			Years with contract(s)											
	Business	**Activity**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Restoration	Anderson Engineering & Surveying, Inc	Professional							x	x				
	Carlon's Gravel Pit, LLC	Material											x	
	Dame Joseph	Labor							x					
	Dog Lake Construction LLC	Equipment		x	x	x								
	Ecosystems Management Inc	Technical			x	x	x	x	x	x	x	x	x	x
	High Grade Contracting	Equipment										x		
	Jacobs Kenneth Wayne	Equipment					x							
	Jefco Enterprises	Material											x	
	Lockett Trucking Incorporated	Equipment			x				x					
	Lytle Simms	Labor	x											
	Natural Resource Innovations LLC	Technical							x					
	Perry Watson	Labor	x	x										
	Perry Watson	Technical	x	x										
	Richmond John F Contracting	Material				x								
	Shari Reed	Technical				x	x	x	x	x	x			
	Tall Town Equipment	Technical										x	x	
	Terrence R Murray	Equipment	x		x									
	Zamudio, Karen A	Technical									x			
Timber	Collins Pine	Timber purchase	No data					x	x	x	x	x	x	
	Tom Harmon Logging	Timber purchase							x	x	x			
Fire suppression*	Bradley Forest	Fire		x										
	Blackhawk Enterprises	Fire							x	x				x
	Cobian Gabe Trucking	Fire				x								
	Danny Lee	Fire		x										
	David L. Holgate	Fire		x										
	Davidson Floyd	Fire		x	x									
	Desert Springs Trucking Limited Liability Company	Fire		x					x	x				
	Dog Lake Construction Limited Liability Company	Fire								x				x
	Donald T. Oconnor	Fire		x										
	Gearhart Events	Fire		x										
	Elliot, Rick D	Fire					x			x		x		x
	Gary Mccleese And Son Equipment	Fire		x										
	Gloria Babb	Fire		x										
	Harlan Ray Logging Incorporated	Fire								x				x
	Hartman Willmetta	Fire		x										
	Jacobs Kenneth Wayne	Fire		x						x				x
	James M. Nottier	Fire		x	x	x								
	Lee Wayne	Fire		x	x									
	Lindsey, John E.	Fire		x	x	x								
	Lytle Simms	Fire											x	
	Lockett Trucking Incorporated	Fire			x				x					x
	Montgomery Montie Incorporated	Fire		x										
	Northwest Forest Industries LLP	Fire		x										
	Oleary Equipment	Fire		x										
	Ortega Pamela	Fire		x										
	Partridge Warren Contracting	Fire							x					x
	Robison Jimmy D.	Fire		x										
	Sheridan And Messner Joint Venture	Fire		x										
	Stewarts Firefighters Food Catering	Fire	x	x	x	x	x	x	x	x	x	x	x	x
	Fish And Fire LLC	Fire										x		x
	Ward John	Fire							x					x
	Wayne Eleehmann Contractor	Fire		x					x	x				
	Wessel, Jeff And Billi	Fire								x				x
	Withrotor Aviation Inc.	Fire		x			x		x	x	x	x		x

* Fire suppression indicates businesses that had preseason agreements with the US Forest Service prior to each year's fire season. Data were obtained from the Virtual Incident Procurement System (VIPR)

Source: Business names are those entered in the Federal Procurement Data System records. Data was obtained from FPDS, VIPR, and other Forest Service data sources.

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