State Trust Lands Implementation Monitoring Report: Implementation of the Riparian Forest Restoration Strategy (RFRS)

This document is meant to fulfill Washington Department of Natural Resources' (DNR's) ongoing commitment to report on the implementation of the State Trust Lands Habitat Conservation Plan (HCP). The intended audience includes the Services (including the U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries)), the public, and DNR staff.

Executive Summary

DNR adopted the Riparian Forest Restoration Strategy (RFRS) in 2006 to provide guidance on conducting riparian restoration treatments. DNR also committed to conducting field surveys and database integrity assessments in Chapter V of the Habitat Conservation Plan. The objectives of this project were to: 1) assess DNR's Land Resource Manager (LRM) database for accuracy in tracking the number of acres receiving riparian restoration treatments, 2) determine if silvicultural prescriptions for riparian treatments include required information, and 3) investigate whether restoration treatments are following RFRS guidance when implemented in the field. Key findings include:

- Discrepancies were found in the tracking of treated riparian acers in fiscal years 2018 and 2019. Errors were associated with the transition of database systems in 2018. No errors were found in fiscal years 2020-2022.

- 68% of reviewed silvicultural prescriptions (n=37) were complete, 8% were partially complete, and 24% were incomplete.

- There was 100% compliance with spatial delineation standards and buffer length requirements for the 37 assessed riparian treatments completed in fiscal year 2022.

- 70% of riparian thinnings were in compliance with requirements for down woody debris (DWD) creation, 15% were partially compliant, and 15% were not in compliance.

- Contracts for all riparian thinnings included DWD creation requirements.

Introduction

Timber harvest activities can have profound impacts on streams influencing water temperature, stream bank stability, sediment loads, nutrient loads, and the input of large woody debris. Historic logging practices often included the removal of overstory riparian trees from large areas which has been shown to negatively impact these important components of riparian ecosystem function. The combined effects of anthropogenic and natural disturbances have resulted in 60% of riparian areas managed by the Washington Department of Natural Resources (DNR) being in a developmental stage that impairs one or several important riparian functions (Bigley and Deisenhofer, 2006). When silvicultural prescriptions are designed for the restoration of such areas, active management can have a positive effect on accelerating the riparian forest towards the desired future condition (DFC).

The importance of protecting forest riparian areas was recognized in the Habitat Conservation Plan (HCP) which was adopted in 1997 and included a Riparian Conservation Strategy for the five west-side HCP planning units and a separate strategy for the Olympic Experimental State Forest (OESF). The conservation strategy of the OESF differed from the west-side planning units due to the forest's emphasis on research and unique climatic, geological, and physiographic characteristics (DNR, 1997). In 2006, DNR adopted implementation procedures for the Riparian Forest Restoration Strategy (RFRS) to expand upon the west-side Riparian Conservation Strategy by providing detailed guidance on the objectives, methods, and implementation of forest restoration activities within riparian management zones (RMZs). The RFRS applies to the west-side HCP planning units, except for the OESF, and outlines different scenarios where active management of RMZs can enhance the development of the riparian forest towards the DFC. Riparian areas in the OESF are managed under guidance in the HCP's OESF Riparian Conservation Strategy and are described in detail in the OESF Forest Land Plan (DNR, 2016).

This implementation monitoring project was conducted during the fall and winter of 2022 to assess if DNR's riparian management activities are in compliance with the RFRS and OESF Forest Land Plan (FLP). DNR committed to conducting field surveys and database integrity assessments in Chapter V of the HCP and this project was designed to address both aspects of monitoring (DNR, 1997). The project consisted of two parts: 1) assessment of DNR's Land Resource Manager database (LRM), and 2) field inspection of riparian harvest activities completed during fiscal year 2022. These monitoring activities are critical to ensuring the reliability of information stored in databases and successful implementation of the RFRS in the field.

Objectives

The objectives of this project were to:

1) assess the accuracy of the LRM database for tracking the number of riparian acres that receive restoration treatments

2) investigate if the prescriptions recorded in LRM for silvicultural activities in RMZs contain the required information

3) determine if DNR's riparian management activities are in compliance with guidance in the RFRS and OESF Forest Land Plan

Methods

Assessment of the LRM Database

A subset of Forest Management Activities (FMAs) was produced on August 15th, 2022, to investigate the documentation of riparian harvest activities in LRM. This subset of FMAs was produced by applying the following filters to the database:

1) FMAs with the "RIPARIAN" or "RIPARIAN_WETLAND" land class, and

2) completed FMAs with the "TIM_HARV" type, and

3) FMAs that occurred during or after fiscal year 2018

The 2018 fiscal year cut off was selected as this represents the first full fiscal year after LRM replaced the Planning and Tracking (P&T) system that was previously used to document DNR management activities. The land class field is included in LRM but was not explicitly included in the P&T system. The "WETLAND" land class value was excluded from this project. The resulting dataset included 414 FMAs documented as timber harvest activities within RMZs in the LRM system. This dataset was then used for the analysis of objective one.

After compiling the RMZ FMA dataset, an analysis on the frequency and size of RMZ FMAs over time and across regions and HCP planning units was conducted to investigate trends, and potential errors within LRM. Analysis of variance was used to test the effect of fiscal year on RMZ FMA size by region and was designed to test if this tool is effective for identifying errors in LRM (PROC MIXED; SAS Institute Inc., Cary, NC, USA). This analysis was conducted at the region level as not all HCP planning units had riparian treatments within each fiscal year. Figures were produced to visualize the data using SigmaPlot version 13 (Systat Software Inc., San Jose, CA) and were used to help identify trends and potential errors within the LRM database.

An investigation into the spatial accuracy of individual RMZ FMAs was conducted after the initial dataset analysis. Every RMZ FMA across all planning units with an area of five acres or greater was examined for accuracy using ArcMap version 10.8.2 (ESRI Inc., Redlands, CA), ariel imagery, and timber sale documentation. There were 95 such FMAs which accounted for 23% of the FMAs in the dataset but represented 67% of the total treated acres due to their larger size. There were an additional 26 FMAs included in the investigation that were smaller than 5 acres, but were part of timber sales with RMZ FMAs over 5 acres that were examined. This resulted in 121 FMAs being investigated. An independent dataset was utilized to identify and correct any detected errors, but no changes were made to the LRM database during the project.

Field Assessment of Riparian Harvest Activities and Review of Silvicultural Prescriptions

The RMZ FMA dataset created for objective one was further filtered to select the sites for the field assessment and silvicultural prescription review portions of the project. The dataset was first filtered to only include FMAs with a completion date of fiscal year 2022. There were 59 such FMAs, which were then further filtered to only include FMAs with a treatment area larger than 2 acres and less than 10 acres in order to increase sampling efficiency. An exception to this filter was the inclusion of any FMA with the variable retention harvest (VRH) technique as these units were thought to have the highest probability of impacting streams or accelerating the area towards the DFC. The resulting list contained 37 FMAs. One of these was excluded from the project due to winter conditions preventing access to the area and one additional FMA with an area over 10 acres was included when it was discovered that this FMA consisted of many smaller polygons which were then subsampled. The final list consisted of 37 FMAs.

The silvicultural prescription of all 37 FMAs were reviewed and determined to be complete, partially complete, or incomplete following guidance in the RFRS or guidance for silvicultural rotational prescriptions (PR 14-005-060). The RFRS outlines that silvicultural prescriptions within RMZs in west-side HCP planning units outside the OESF should include: 1) the current situation, 2) long-term stand objectives, 3) threshold targets, 4) activity objectives, and 5) chronology of entries. For the OESF, DNR silvicultural rotational prescription guidance requires prescriptions to include: 1) the current situation, 2) social, economic, and/or

environmental rotational objectives and threshold targets, and 3) the chronology of entries, costs/revenues, and financial analysis. To be complete, prescriptions were required to include all the required sections. A partially complete prescription included at least one of the required sections while an incomplete prescription did not contain any of the required sections.

Field assessments for the 37 selected FMAs were conducted between September 2022 and January 2023. FMAs outside of the OESF were assessed for compliance with several RFRS requirements including:

- Inclusion of a 25-foot unmanaged inner zone buffer

- Exclusion of ground equipment from operating within 25-feet of the inner zone outer edge

- Inclusion of a stream-type appropriate outer zone buffer

- Accurate FMA spatial delineation

- Creation of required down woody debris or snags (thinnings only)

- Retention of conifers and required number of big leaf maple (hardwood conversions only)

- Appropriate FMA size and distribution (hardwood conversions only)

The RFRS provides specific guidance on the size of buffers for the inner and outer zones and requires ground equipment to not operate within 25-feet of an inner zone edge. The buffer sizes of the inner, outer, and equipment exclusion zones of each of the FMAs was assessed visually while on site. A laser range finder was used when necessary to ensure restoration activities followed required buffers. More detailed and sophisticated assessments of RMZ buffers on DNR lands have been conducted in the past and found DNR implements this action with a high degree of compliance (Munzing, 2007; Munzing, 2008; Buffo and Hanell, 2013). Such detailed assessments were not a primary objective of this project.

Thinning treatments within RMZs are required to designate 5 trees from the largest diameter class per thinned RMZ acre for the creation of down woody debris (DWD) or standing snags. Trees selected for DWD creation should be selected within 25 feet of the forest management unit boundary adjacent to the inner zone and felled towards the stream when possible. A count of the number of trees dropped towards the stream for DWD creation or used for snag creation was taken by walking along the edge of the entire inner zone for each selected thinning treatment outside the OESF.

Hardwood conversions in areas managed under the RFRS have a maximum allowable size of 2.5 acres and must be separated by an uncut segment with a minimum length of 150 feet. This requirement was assessed using aerial imagery and ArcMap version 10.8.2 (ESRI Inc., Redlands, CA). These treatments are also required to retain all live conifer and 1-3 big leaf maple (*Acer macrophyllum*) if present. This requirement was assessed by examining cut stumps and standing trees within the treatment area.

Riparian treatments within the OESF are managed under its Riparian Conservation Strategy and OESF Forest Land Plan. The OESF FLP includes a multi-scale and multi-disciplined approach to landscape level forest planning which is supported by a forest estate model referred to as the "tactical model". The tactical model produces an optimal solution for timber harvest planning and can recommend a number of acres for regeneration harvest within the interior-core

buffer of riparian areas (DNR, 2016) per Type 3 watershed. These acres are referred to as "allotted acres" and are typically small. Field inspection of FMAs within the OESF included an assessment of:

- Inclusion of a 25-foot unmanaged inner zone buffer
- Inclusion of a stream-type appropriate outer zone buffer
- Accurate FMA spatial delimitation
- Proper documentation of any allotted acres used during regeneration harvests

Results

Assessment of LRM

A visual representation of the frequency and average size of RMZ FMAs over time and across HCP planning units is provided in Figure 1. Between Fiscal Years 2018 and 2022 the Columbia, North Puget, OESF, South Coast, South Puget, and Straits planning units had 89, 237, 36, 20, 22, and 10 harvest FMAs in the RMZ FMA dataset, respectively. There were no harvest activities with the riparian land class in the Chelan, Klickitat, or Yakima planning units. These east-side planning units are not covered by the HCP, they follow Forest Practices Rules and the Forest Practices Habitat Conservation Plan. The distribution of these activities varied over time, but generally North Puget had the most riparian FMAs, and Straits had the least (Figure 1a). Across all planning units and years, the average FMA treatment area was 4.5 acres. Although this varied with time and region, the average FMA treatment area tended to be under 6 acres for any given planning unit in a given year (Figure 1b). An exception to this was the Pacific Cascade region having an average FMA treatment area of 19.2 acres in fiscal year 2019.
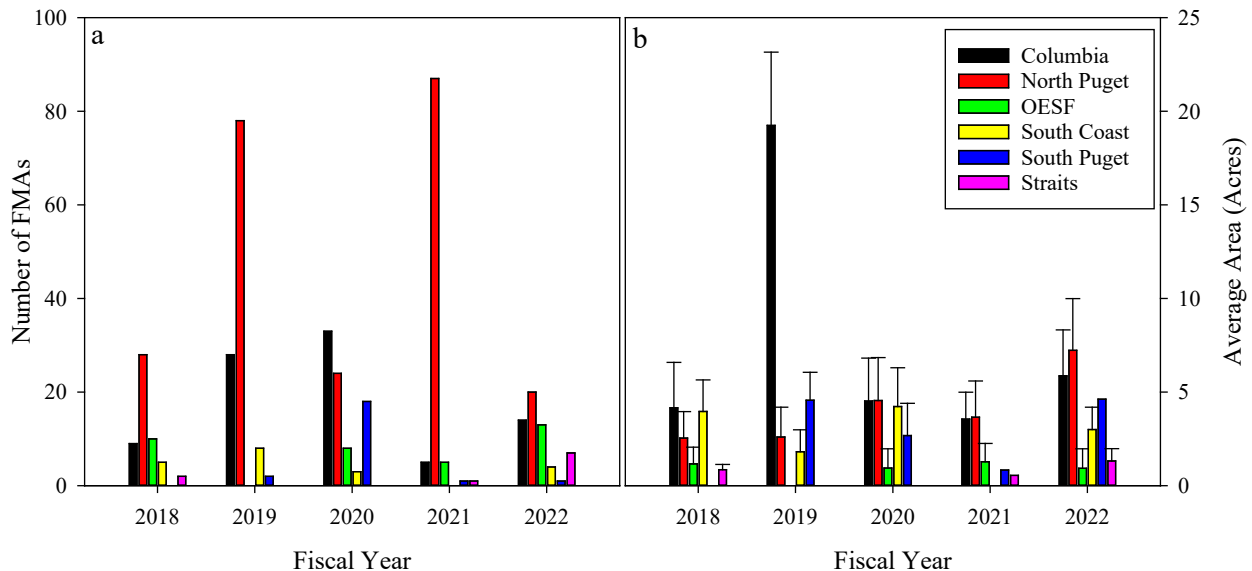

Figure 1. Summary of: a) total number of completed FMAs with the Riparian land class by HCP planning unit over time, and b) average FMA treatment area by HCP planning unit over time. Error bars represent standard error.

An ANOVA analysis on the effect of fiscal year on the size (acres) of RMZ FMAs by region was conducted to help identify potential errors within LRM. This analysis showed no effect of time on the average size of RMZ FMAs for the South Puget Sound and Olympic regions (P>0.2753) but showed a strong effect of time of the size of RMZ FMAs for Northwest and Pacific Cascade Regions (P<0.0001). For the Pacific Cascade Region, this analysis demonstrated significantly larger RMZ FMAs in fiscal year 2019 than all other years, an effect easily observed in Figure 1b. The FMAs for this region and fiscal year were examined and some errors were found in LRM that prompted the detailed investigation of individual FMAs described in the methods.

The investigation into the spatial accuracy of individual RMZ FMAs found errors in fiscal years 2018 and 2019, but no errors during fiscal years 2020 through 2022 (Figure 2). There were two categories of errors found during the investigation:

I. FMAs for VRHs that were not in riparian areas, but had the riparian land class in LRM

II. FMAs for riparian treatments that had a spatial delineation larger than the actual treatment area.

Category I errors consisted of six VRH FMAs all of which were from the same timber sale in the Columbia planning unit and all of which had an FMA name that included "RMZ". FMAs associated with this timber sale were marked complete during fiscal year 2019, but the timber sale date was May of 2017. This timeframe represents the period during which LRM was replacing the P&T system and additional features, such as the land class category, were being added to the database. It is likely that during this process, FMAs that included descriptors such as "RMZ" in the FMA name were tagged with the riparian land class resulting in these six VRH units with "RMZ" in the FMA name being inaccurately tagged with the riparian land class.
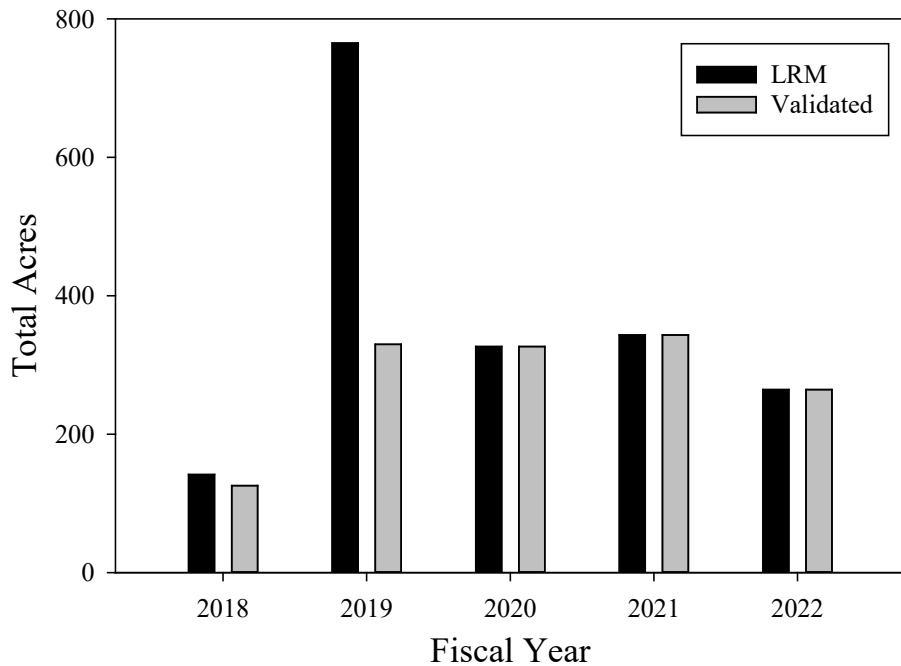

Figure 2. Comparison of treated acres in riparian areas documented in the Land Resource Manager database (LRM) vs the validated dataset produced in this project from fiscal year 2018 to 2022.

Although category I errors only affected six FMAs, these errors produced a large increase in the number of treated riparian acres in LRM due to the larger size of these VRH units when compared to typical RMZ activities. For example, the Columbia planning unit had 28 RMZ FMAs in fiscal year 2019 and the six FMAs with this error had a total area of 155 acres while the other 22 RMZ FMAs had a total area of 103 acres (after accounting for the category II errors described below).

There were 23 of the 121 FMAs assessed for accuracy that were found to have inaccurate spatial delineations (category II errors). These FMAs often consisted of large (>10 acre) polygons, a small portion of which was treated on the ground. An example of this is presented in Figure 3, which consists of a 14.8-acre FMA polygon outlined in blue within which, a one-acre hardwood conversion was conducted (outlined in yellow). This FMA was visited in the field, and it was confirmed that the restoration activity consisted of a 1-acre hardwood conversion only.

Figure 3. Example of a forest management area (FMA) polygon with inaccurate spatial delineation (top). The boundary of the 14.8-acre FMA polygon is outlined in blue and the boundary of the 1-acre hardwood conversion within this FMA is outlined in yellow. The FMA was visited in the field, and it was confirmed that the activity consisted of a 1-acre hardwood conversion (bottom).

In total, category II errors produced a 16-acre overrepresentation of treated riparian acres in fiscal year 2018 and a 280-acre overrepresentation in fiscal year 2019. All the FMAs with category II errors had timber sale dates between June 2015 and March 2018 and FMA completion dates during fiscal years 2018 or 2019. This indicates that these polygons were created in the P&T system and then transferred to LRM. Additionally, the LRM FMA Spatial Delineation Standards

were not published until December 2018 (Johnson, 2018) which was after the timber sale dates for all the FMAs with category II errors. Therefore, these category II errors are almost certainly the result of a change in policy and database systems rather than errors by DNR operations staff.

The combined effect of the category I and II errors resulted in a 16-acre overrepresentation of treated riparian areas in fiscal year 2018 and a 435-acre overrepresentation in fiscal year 2019. This difference in 2018 was relatively minor at an 11% overestimation, but large for 2019 with a 57% overestimation (Figure 2). Additionally, this investigation highlighted the sensitivity of accurate tracking of treated riparian acres to category I or category II errors in large FMA polygons. For example, of the 20 largest RMZ FMAs within LRM, 16 had category I or II errors and the unvalidated acres of these FMAs accounted for 23% of the total RMZ acres in the database despite these FMAs representing only 4% of total RMZ FMAs.

After accounting for the errors found in LRM, there was no longer a significant effect of fiscal year on the size of RMZ FMAs for the Pacific Cascade Region (P=0.7349) demonstrating that this ANOVA analysis may be an effective tool for identifying potential errors within LRM. There was, however, still a significant effect of fiscal year on the size of RMZ FMAs for Northwest region (P<0.0001). During the assessment it was discovered that this region often combines several riparian treatment areas into a single FMA containing multiple polygons. While this practice was found to accurately track treated acres, it limits the ability of using the ANOVA analysis to identify potential errors as the size of any individual treatment area is masked within the aggregate total treatment area of the FMA.

Review of Silvicultural Prescriptions within LRM

The silvicultural prescription and field assessment portion of the project examined a subset of 37 RMZ FMAs that were marked as complete during fiscal year 2022. The criteria for compiling this subset of FMAs can be found in the methods section. There were 11 FMAs in the OESF and 8, 14, and 11 FMAs within the Columbia, North Puget, and South Coast HCP planning units, respectively. The selected FMAs included two hardwood conversions, 25 thinnings, and 10 VRHs (Table 1). All 10 of the VRHs were within the OESF, were not subject to the RFRS, and utilized allotted acres in the OESF Forest Land Plan (DNR, 2016). The silvicultural prescriptions of all 37 FMAs were reviewed and determined to be complete, partially complete, or incomplete. The results showed that 25 FMAs had complete silvicultural prescriptions, 3 were partially complete, and 9 were incomplete (Table 2). The nine incomplete prescriptions were found across four different timber sales. The most common missing elements for the partially complete prescriptions were the activity objectives and chronology of entries.

Field Assessment of Riparian Harvest Activities

The field assessment portion of the project examined the same subset of 37 RMZ FMAs that were used in the assessment of silvicultural prescriptions. The selected FMAs included two hardwood conversions, 25 thinnings, and 10 VRHs (Table 1). The inner, outer, and equipment exclusion buffers for all 37 of these FMAs were found to be in compliance with requirements. All the FMAs were also found to have accurate spatial delineation and tracking of treatment areas.

Table 1. Summary of reviewed riparian forest management activities (FMAs). Each FMA was assessed for: 1) compliance with down woody debris (DWD) requirements and 2) the inclusion of required sections in the silviculture prescription. FMA spatial delineation and buffer length of inner, outer, and equipment exclusion zones were also assessed, and all units were found to be in compliance with requirements.

Unit	Area (Acres)	Harvest Technique	DWD Creation	Prescription
1	2.49	Hardwood Conversion[1]	Not Required	Complete
2	1.65	Hardwood Conversion[1]	Not Required	Complete
3	30.88	Thinning	Partial	Partial
4	8.2	Thinning	Compliant	Complete
5	8.06	Thinning	Partial	Partial
6	7.52	Thinning	Partial	Incomplete
7	6.87	Thinning	Compliant	Complete
8	6.67	Thinning	Compliant	Incomplete
9	6.24	Thinning	Not Required	Incomplete
10	5.68	Thinning	Compliant	Complete
11	5.2	Thinning	Compliant	Complete
12	4.98	Thinning	Not Required	Incomplete
13	4.97	Thinning	Compliant	Incomplete
14	4.73	Thinning	Not Required	Complete
15	4.08	Thinning	Compliant	Complete
16	4.07	Thinning	Partial	Complete
17	3.85	Thinning	Compliant	Complete
18	3.81	Thinning	Compliant	Complete
19	3.32	Thinning	Compliant	Incomplete
20	2.99	Thinning	No	Complete
21	2.89	Thinning	Compliant	Incomplete
22	2.81	Thinning	Compliant	Complete
23	2.75	Thinning	Compliant	Complete
24	2.3	Thinning	Compliant	Complete
25	2.3	Thinning	Not Required	Partial
26	2.29	Thinning	No	Incomplete
27	2.2	Thinning	No	Incomplete
28	3.95	VRH	Not Required	Complete
29	1.2	VRH	Not Required	Complete
30	1.05	VRH	Not Required	Complete
31	0.69	VRH	Not Required	Complete
32	0.66	VRH	Not Required	Complete
33	0.61	VRH	Not Required	Complete
34	0.53	VRH	Not Required	Complete
35	0.1	VRH	Not Required	Complete
36	0.08	VRH	Not Required	Complete
37	0.03	VRH	Not Required	Complete

[1] hardwood conversion assessments include additional criteria described in the text

Table 2. The number and proportion of reviewed silvicultural prescriptions that were found to be complete, partially complete, or incomplete. Category definitions can be found in the methods.

	Complete	Partially Complete	Incomplete
Number of Prescriptions	25	3	9
Proportion of Prescriptions	68%	8%	24%

Both hardwood conversions were less than the maximum allowable 2.5 acres defined in the RFRS. These units were also within the same timber sale, adjacent to one another, and separated by an uncut patch with a length of approximately 235 ft which is larger than the required 150 ft. Although the prescription for unit 1 prescribed all conifers to be retained and these trees were painted with a blue band, the contractor felled approximately five conifers within the conversion area before DNR staff were able to identify this error. Upon recognition of this issue, DNR worked with the contractor to retain the remaining conifers, leave the cut conifers on site for DWD creation, and retain additional big leaf maple trees to increase stocking of the remaining stand. After working with the contractors on this issue, the harvest of the adjacent unit 2 was executed within the prescription such that all conifers and two big leaf maple trees were retained. Following guidance in the RFRS, both unit 1 and unit 2 received a vegetation management treatment in the fall of 2022 to reduce shrub and hardwood competition and are scheduled to be planted in 2023 with a mix of Douglas-fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Sitka spruce (*Picea sitchensis*).

There was a wide range of conditions found across the 25 thinning FMAs that were assessed. Generally, 14 FMAs were in compliance with DWD and snag creation requirements, four were partially compliant, three were out of compliance, and four were found to not require this activity. Three of the four FMAs that were found to not require DWD creation were wetland thinnings that had received the riparian_wetland land class rather than the wetland land class in LRM (units 9, 12, and 14). For each of these, timber sale maps and other documentation clearly identified them as wetland thinnings, and these units were not included when calculating compliance percentages. The final thinning not requiring DWD creation was located in the OESF, was not subject to the RFRS, and not included in compliance percentage calculations. Finally, one of the partially compliant units had trees marked for DWD creation that were not felled due to safety concerns and this unit was also not included in the percent compliance calculations. As a result, 70% of the FMAs were compliant with the DWD and snag creation requirements, 15% were partially compliant, and 15% were not in compliance. Snag creation was not common with only two FMAs including a snag creation component.

All ten of the VRH RMZ FMAs (units 28-37) occurred in the OESF and were not subject to the RFRS. These were small harvests with nine of the ten FMAs having an area of 1.2 acres or less. All ten of the VRHs utilized acres allotted in the OESF Forest Land Plan (DNR, 2016) to have RMZ buffers that were smaller than would have otherwise been required. Field inspection of these harvests found them to be implemented as instructed in the guidance and to have accurate spatial delineation and documentation of allotted acres.

Riparian Thinning Case Studies

There was only one issue with the implementation of the prescribed restoration treatments for the FMAs that were in compliance with the DWD component of the RFRS. Unit 10 was

designed as Type III riparian thinning in conjunction with an uplands VRH. The prescription was well documented, a Schedule A was included in the timber sale contract, clearly outlining the scope of the work, the trees to be harvested were individually marked throughout the harvest area, and the contractor was provided with a cutting card clearly illustrating which trees to harvest and which to fall towards the inner zone for DWD creation. The notes from the contract administrator (CA) clearly indicate that the prescription and Schedule A for the unit was discussed with the contractor on at least four occasions over a three-month period and the contractor assured the CA that they would contact them before cutting the unit and if they had any questions. However, the contractor began work in the unit during a week where the CA was unable to visit the sale due to training and contract close-out work for another sale. Upon visiting the sale the following Monday, the CA found the unit had been harvested such that all the trees painted for harvest had been retained while all others designated for retention had been harvested. This lowered the residual stocking of the stand from the prescribed 104 trees per acre to 33 which is below the minimum of 75 required by the RFRS.

Several actions were taken to address the contractor's deviation from the Schedule A. The situation and timeline of events leading to the issue were well documented and mitigation efforts were designed and implemented. The mitigation efforts included: 1) leaving all remaining standing conifer, 2) leaving all the cut trees within the unit for DWD creation, and 3) planting a mix of western hemlock, Sitka spruce, and western redcedar throughout the area to create a diverse new age class. During the field assessment, approximately 180 well distributed felled trees were located within the harvest area both as individuals and as groups. Seedlings of a diverse mix of the prescribed species had been planted throughout the area and appeared vigorous. In summary, the resulting unit contained an overstory dominated by Douglas-fir, a new diverse age class of conifer seedlings in the understory, and high levels of DWD well distributed throughout the area.

Four of the RMZ FMA thinnings assessed in the field were partially compliant with the DWD component of the RFRS. Two of these FMAs had the appropriate number of trees marked for DWD creation, however some were not felled during harvest. Unit 5 was an 8-acre FMA that was found to have 35 trees felled for DWD creation and six standing trees marked for DWD creation, but not felled. This unit had a dense brush layer and the stems of many of the trees were also covered in moss and lichen. The combined effect of these two conditions made the painted trees difficult to see in some areas and it is likely the contractor simply missed them during harvest (Figure 4). Unit 6 was a 7.5-acre FMA that was found to have 25 trees felled for DWD creation and 10 standing trees that had been marked for DWD creation but were not felled. The 10 standing trees were all located along a portion of the sale that neighbored a powerline corridor and it is likely that the operators did not feel they could safely drop these trees without a risk of impacting the power lines (Figure 4). In both cases, the standing trees represented less than a third of the total trees marked for DWD creation.

Unit 16 was a four-acre FMA with a dense understory of sword fern and other vegetation. During the assessment, twelve trees felled for DWD creation were observed which is lower than the required 20, however it is likely that some were missed during the assessment. A hiking trail ran along the entire length of the inner zone of the unit and sections of the felled trees were removed as to not interfere with the trail. It is possible that trees may have also been felled further away from the inner zone as to not interfere with the trail. This combined with the lush vegetation making

it difficult to locate the felled trees makes it likely that some felled trees were not located. It is also worth noting that the other FMA associated with this timber sale (Unit 24) was found to be in compliance with the DWD requirement.

Unit 3 was a 30-acre FMA that was found to be divided into multiple riparian thinnings scattered throughout a larger timber sale. Two of these thinnings were assessed in the field, one of which was found to be in compliance with DWD requirements while the other was missing this component. A Schedule B was included in the contract for the sale outlining the thinning prescription for the RMZ areas and specifying the number of trees required for DWD creation in each area. One potential issue with performing contract administration with this sale was that the purchaser hired one contractor to perform work in the first two units before halting operations and then restarting at a later date with a separate contractor. The unit that was missing DWD was harvested with this second contractor.

Figure 4. Example of trees marked for down woody debris creation but left standing at unit 5 (left) and unit 6 (right). The trees at unit 5 were difficult to locate while the trees at unit 6 were along a powerline corridor.

Three of the 25 assessed riparian thinning FMAs did not contain evidence of trees felled for DWD creation or snag creation. Two of these FMAs (units 26 and 27) were within the same timber sale which contained a Schedule A in the contract specifying the DWD and snag creation requirements. Timber sale documents show that trees designated for DWD creation were painted with a single red band and the letter "D" and that take trees within the thinning area were marked with a single pink band. No records could be found to explain why the Schedule A was not followed, but it is possible the contractor did not fully understand this component of the work and did not differentiate between the trees painted pink or red. It is worth noting that both of these units

were in older forests and contained several naturally occurring snags which were protected during the harvest (Figure 5). Similarly, unit 20 was a riparian thinning where DWD or snag creation was not observed despite containing a Schedule B in the contract specifying this requirement. No records could be found to explain this lack of artificially created DWD or snags, however, the unit had blowdown which resulted in natural DWD creation (Figure 5).

Figure 5. Example of standing dead wood in unit 27 and blowdown in unit 20.

Discussion

This implementation monitoring project was designed to assess if DNR's riparian management activities are being accurately tracked in LRM and properly implemented in the field. The review of the LRM database found two categories of errors in the tracking of treated riparian acres that produced an 11% and 57% overrepresentation of treated acres in fiscal years 2018 and 2019, respectively. Both error categories were found to have occurred during the transition from the P&T system to LRM and no errors were found after 2020 indicating that, once established, LRM has been highly accurate in tracking treated riparian acres.

The FMAs that were found to have category I errors were all part of the same timber sale which had a timber sale date of May, 2017 and FMA completion date of fiscal year 2019. This indicates that these FMAs were created in the P&T system and then migrated to LRM. Additionally, all these FMAs had "RMZ" in the FMA name which likely caused confusion during the database transition process and resulted in these FMAs receiving the riparian land class by error. Similarly, all the FMAs with category II errors had timber sale dates prior to March, 2018 and FMA completion dates during fiscal years 2018 or 2019. Therefore, these FMAs were created

under the P&T system and then migrated to LRM prior to the release of the LRM FMA Spatial Delineation Standards (Johnson, 2018). This indicates that the errors found within LRM were due to issues during the transition from P&T to LRM rather than errors by DNR operations staff.

The review of silvicultural prescriptions found a wide range in the structure and detail of the information provided. None of the five required sections were found in 24% of the reviewed prescriptions which were either entirely missing or contained insufficient information describing the activity. The prescription of all other activities within the timber sales for these FMAs were also reviewed and did not contain information on the riparian treatments. The silvicultural prescriptions that included all five of the required elements varied in the level of detail provided. For example, the activity objectives ranged from a general description of a thinning from below to a detailed description of the treatment and specific selection priority for which trees to harvest.

The field assessment portion of the project found that all the reviewed FMAs had accurate spatial delineation and buffers that met or exceeded minimum requirements. A more detailed assessment of RMZ buffer widths on DNR lands managed under the RFRS was conducted in 2012 and also found that all of the assessed RMZ buffers were equal to or larger than required (Buffo and Hanell, 2013). Generally, the field assessments found the planning of riparian restoration treatments to be within the guidance provided in the RFRS, but also that errors can occur in the implementation of these treatments due to issues with contract administration. This was often despite significant efforts by DNR staff to communicate with the contractors such as in the example for unit 10 described in the results section. When deviations from the prescription were identified, mitigation efforts such as increasing DWD creation, increasing bigleaf maple retention, or underplanting with a diverse mix of conifer species were considered. DNR is working on how to ensure the information gathered from these site visits can be best used to achieve prescription implementation goals.

No evidence of DWD or snag creation were observed in three of the 25 thinnings assessed in the field, despite this requirement being included in the signed contract. For all three cases, this error had not been documented and it is unclear what occurred. Although these units did not contain DWD creation, all other aspects of the prescription did appear to follow RFRS requirements and existing snags were protected during the operations.

The implementation of riparian restoration treatments throughout the westside HCP planning units demonstrates the dedication of DNR staff to being good stewards of state trust lands. All of the hardwood conversion and thinning treatments that were assessed in this project appeared to be accelerating the development of the forest towards the DFC enhancing the ecological function of the state's riparian forests.

Recommendations

The results of this project generated information that may be used to improve the tracking and implementation of DNR's riparian restoration treatments. The review of LRM found that the accurate reporting of treated riparian acres is highly sensitive to large FMAs with category I or II errors and that ANOVA analysis on the impact of fiscal year on FMA size can help to identify years with potential errors. This type of review could be incorporated into the implementation monitoring program on a periodic basis to help ensure the integrity of riparian FMAs in LRM.

The development of detailed site-specific silvicultural prescriptions for riparian restoration treatments is important for documenting the rationale behind these important treatments. Many of the reviewed prescriptions were detailed and included all the required elements, but 24% were found to be incomplete. To address this, it is recommended that the regions be provided with a template to assist in silvicultural prescription development for riparian treatments. This template should include specific information to include in each of the five required sections. Division and regional staff are collaborating to update the prescriptions for FMAs that were found to be incomplete during this project and have also initiated a prescription review process for all planned timber sales to ensure silvicultural prescriptions are developed following internal guidance. It may also be necessary for the monitoring program to periodically review such prescriptions to ensure that guidance is being followed.

The issues that were identified with the implementation of the restoration treatments were all due to contract administration, not by a lack of information provided. It is difficult to provide recommendations on how this may be improved as DNR staff were often found to have taken significant efforts to communicate with contractors, painted individual trees for harvest and DWD or snag creation, and provided documentation to clearly illustrate the prescription to the contractor. In almost all cases, mistakes that were made by the contractors were identified and mitigation was conducted. In a few cases, however, the lack of DWD creation was not identified until this monitoring project was conducted. Therefore, it is recommended that a field review of riparian treatment areas is performed as part of the contract closeout process to ensure activities are compliant. Additional attention may also be required for timber sales that have a change of contractor during the operation to ensure the requirements of riparian treatments are clearly understood.

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