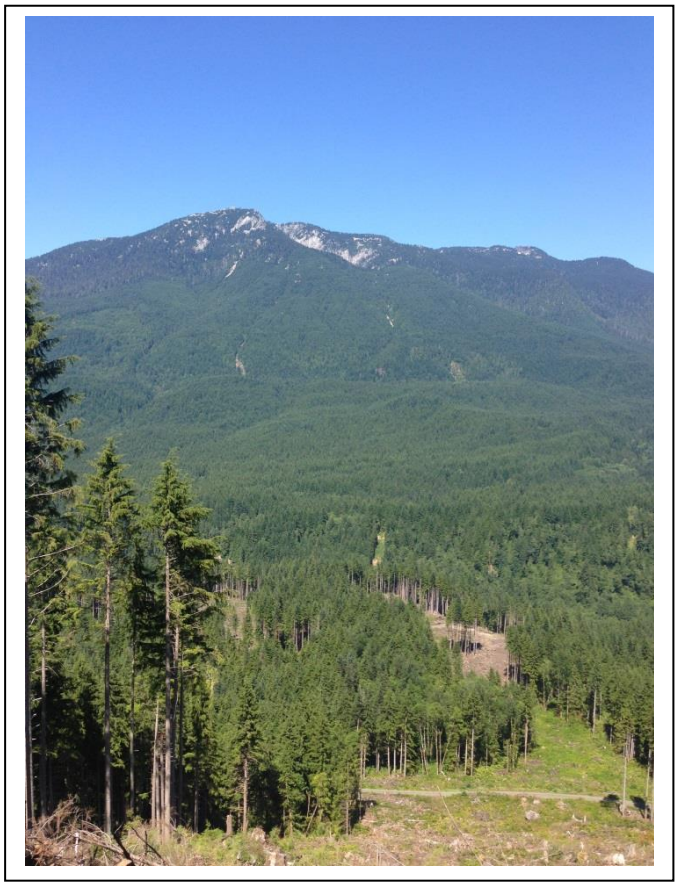
NATURAL RESOURCES

State Trust Lands Habitat Conservation Plan Implementation Monitoring:

Implementation of management activities in wetland management zones and hardwood-dominated riparian management zones



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Forest Resources Division,
Washington State Department
of Natural Resources

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Summary of 2013 Implementation Monitoring

This report is prepared by the Implementation Monitoring Program as part of DNR's quality control measures and commitments outlined in the Habitat Conservation Plan (HCP). The intended audience includes DNR staff and the Services (including the U.S. Fish and Wildlife Service and the National Marine Fisheries Service).

During 2013, the Implementation Monitoring Program conducted field reviews within the westside HCP planning units, excluding the Olympic Experimental State Forest Planning Unit, to assess implementation of:

- Management activities in wetlands and wetland management zones (WMZs) that were completed during fiscal year 2013 (14 timber sales); and,
- All hardwood conversion and individual conifer release riparian restoration treatments completed prior to August 2013 (15 timber sales).

For both topics, DNR successfully implemented, with a high rate of compliance, management activities in riparian areas that meet or exceed the protections described in applicable guidance documents. When confronted with unclear or conflicting guidance, DNR staff consistently took an approach that assured the protection of public resources.

Concerning DNR-protected wetland resources, the department conducted activities in WMZs only; no management activities occurred within forested wetlands, even though this is allowed by the wetland component of the Riparian Conservation Strategy. DNR mitigated for post-harvest windthrow on all timber sales by retaining live basal area in excess of the minimum allowable level. On average, WMZ widths were 122% of the minimum allowable width and, when applying 100-foot-wide WMZs to wetlands between 0.25 and 1 acre in size, monitoring found that DNR staff met width requirements at 98% of measurement stations. Monitoring found no instances of excessive rutting. Further detail on the wetland component of monitoring can be found in the section titled "Management of wetlands at least 0.25 acre in size and associated wetland management zones."

Hardwood conversion and individual conifer release activities were implemented as guided by the Riparian Forest Restoration Strategy (RFRS). As intended by the RFRS, these activities are relatively rare on state trust lands (approximately 7 harvest acres per year). Protection requirements for the inner and equipment exclusion zones were met on 14 out of 15 timber sales. We identified several aspects of the guidance for riparian hardwood harvests that could be improved with further clarification, which may result in better understanding of the activities by field staff. Further detail regarding this topic can be found in the section titled "Implementation of hardwood conversion and individual conifer release riparian restoration treatments."

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List of Acronyms

BMP	Best Management Practice
DBH	Diameter at breast height (4.5 feet)
DNR	Washington State Department of Natural Resources
EEZ	Equipment exclusion zone
FMU	Forest management unit
FRIS	Forest Resource Inventory System
HCP	1997 Habitat Conservation Plan for state trust lands
HWC	Hardwood conversion
ICR	Individual conifer release
IMF	Intensive Management Forester
RDFC	Riparian desired future condition
RFRS	Riparian Forest Restoration Strategy
RMZ	Riparian management zone
SMU	Special management unit
TPA	Trees per acre
TSDC	Timber Sale Document Center
VDT	Variable density thin
VRH	Variable retention harvest
WDFW	Washington Department of Fish and Wildlife
WMZ	Wetland management zone

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Implementation Monitoring Report: Management of wetlands at least 0.25 acre in size and associated wetland management zones

Executive Summary

The Riparian Conservation Strategy for the Five Westside Planning Units describes measures to protect wetlands. The strategy states the primary conservation objective as maintaining wetland hydrologic functions by maintaining a plant canopy, maintaining natural water flow, and ensuring stand regeneration.

We identified the implementation of management activities in wetlands and wetland management zones (WMZs) as a priority for monitoring because:

- Harvest activities in WMZs are identified as a high priority for implementation monitoring in Riparian Ecosystem Conservation Strategy Effectiveness Monitoring Introduction (Washington State Department of Natural Resources 2001), and
- The wetland component of the riparian strategy had not been systematically monitored previously.

The goals and objectives of this project were to:

- Determine the objective criteria for monitoring the implementation of management activities in wetland management zones, and use these criteria to develop methods to assess operational compliance through field reviews,
- Identify aspects of the guidance for wetland management, if any, that are unclear, conflicting, or difficult to implement consistently, and discuss how this has affected implementation on the ground, and
- Determine if HCP guidance was implemented as written.

We reviewed timber sales that implemented management activities in WMZs in western Washington HCP planning units, excluding the Olympic Experimental State Forest. Specifically, we reviewed all timber harvest and road construction activities to occur within WMZs on timber sales with a fiscal year 2013 closure date in NaturE, a revenue tracking database. In all, we reviewed 16 forest management units (FMUs) around 15 wetlands/wetland complexes on 14 timber sales.

Parameters measured in the field, where applicable and appropriate, included WMZ width, retained live basal area, wetland area, area of road construction mitigation, and rutting area and depth (if it exceeded contract stipulations). Rutting was monitored as a proxy for monitoring

changes to surface and subsurface flow. Additionally, we reviewed two WMZs where management was guided by consultation letters. At these WMZs, we determined whether the planned actions were implemented as written.

We found that only WMZs were managed; management of forested wetlands never occurred. Our results showed that all reviewed management activities within WMZs were implemented in ways that met or exceeded the HCP requirements, with the exception of two cases. In the first case, the WMZ adjacent to a wetland ≥ 0.25 and ≤1 acres in size was less than 100 feet wide at one measurement station out of a total of 20. The minimum WMZ width required by the HCP for this size of wetland is 100 feet[1]. This WMZ had an average width of 132 feet and an average live basal area 15 percent greater than the minimum that must be maintained. In the second case, an FMU applied a Riparian Forest Restoration Strategy (RFRS) prescription for hardwood conversion instead of wetland guidance. Application of the RFRS in this case was inappropriate because the harvest did not maintain a sufficient WMZ width and resulted in the aggregation of nearly all the retained trees near the wetland with no trees retained in a majority of the WMZ. Rutting did not exceed contract stipulations.

Guidance concerning the conservation objective of maintaining hydrologic function was limited. While no excessive rutting was observed in the course of monitoring, there remains a risk of failing to maintain natural water flow around wetlands when managing WMZs. Improved training of staff about forest soils and additional guidance about compaction, displacement, puddling, and other measurable forms of disturbance may reduce risk when harvesting WMZs and wetlands.

Introduction

Wetland protection afforded by the State Trust Lands Habitat Conservation Plan (Washington State Department of Natural Resources. 1997) is designed to maintain wetland hydrologic functions. These functions include the ability of wetlands to augment stream flow during low-flow periods, enhance water quality, attenuate peak storm water flows, and act as a pathway for groundwater recharge. These functions are supported by maintaining a live-plant canopy over and around the wetland, and by maintaining natural hydrologic patterns. The HCP stipulates required wetland management zone (WMZ) widths around wetlands of at least 0.25 acres in size, as well as sets a level of basal area that must be maintained and perpetuated through time in WMZs. The HCP also includes guidance concerning salvage operations and road construction in wetlands and WMZs. Additional guidance concerning wetland management comes from

[1] WMZs may be narrower is some cases due to road building or salvage harvesting, but these did not occur in this WMZ.

Managing Wetlands (Washington State Department of Natural Resources 2000). This manual includes what it calls a "first approximation" of practices to guide implementation of the HCP. Our review of wetland management zones concerned implementation of guidance in these two documents plus implementation of the rutting clause from harvest contracts, if any.

Monitoring Methods[2]

Guidance review

We reviewed available guidance for implementing management activities in wetlands and WMZs. We reviewed the guidance in order to 1) identify the criteria for assessing the implementation of wetland guidance (Table 1), 2) use this criteria to develop methods for monitoring the implementation of management activities in WMZs, and 3) identify areas of the guidance, if any, that are unclear, conflicting, or difficult to implement consistently.

Activity screening

We used DNR databases to identify wetlands ≥ 0.25 acres and WMZs associated with wetlands ≥ 0.25 acres and where harvest and/or road construction had occurred. We refined our query to identify only those units that were recorded as "closed" in fiscal year 2013 (July 1, 2012 – June 30, 2013) in NaturE, the DNR revenue tracking database. Our query found 14 forest management units (FMUs) around 13 wetlands and wetland complexes on 14 timber sales. Monitoring conducted field reviews of all these units. In addition, we found two FMUs adjacent to two wetlands where hardwood harvests following the Riparian Forest Restoration Strategy (RFRS; Washington State Department of Natural Resources 2006) were implemented. One of these harvests was a hardwood conversion while the other was an individual conifer release[3]. We included these in this assessment. In total, we reviewed 16 FMUs around 15 wetlands/wetland complexes on 14 timber sales.

Field data collection

We collected data, where applicable and appropriate, to assess basal area, WMZ width, ground disturbance, and/or mitigation for road construction in 14 WMZs. We measured basal area with variable radius plots taken at 100- or 200-foot intervals, depending on the length of the wetland edge. Given that there were no instances of harvest occurring within a forested wetland, all of our basal measurements were taken in WMZs. When a thinned WMZ was adjacent to a variable

[2] See supplemental materials for further detail regarding our methods

[3] A hardwood conversion is a harvest activity in which most hardwood trees are removed from a stand to allow a conifer-dominated stand to develop toward the riparian desired future condition defined in the RFRS. An individual conifer release is a harvest activity in which hardwood trees competing with conifer trees are selectively removed to accelerate the establishment of a structurally diverse, conifer-dominated stand. See the RFRS for more information about these harvest activities. The HCP does not provide for hardwood conversion of WMZs at this time.

retention harvest (VRH), we measured WMZ widths at 50-foot intervals (WMZ width is defined as the shortest line distance between the wetland edge and the first harvested tree in the upland unit). We visually estimated the area of ground-based equipment tracks within 50 feet of non-forested wetlands. We also looked for rutting in excess of the level allowed in the contract for each sale. Rutting contract stipulations were reviewed as proxy for the HCP requirement to maintain natural water flow. Where roads were constructed in WMZs, we verified that mitigation occurred as stated in the timber sale documentation. We also noted what types of harvest prescription methods were used to implement harvest activities.

We reviewed the implementation of site-specific management plans that guided salvage operations in two WMZs. We monitored these plans in order to evaluate implementation of specific management commitments.

Data analysis

We used t-tests to determine the probability that the average WMZ width for each wetland equaled or exceeded the HCP requirements. Since multiple independent t-tests were used, we controlled for false discovery rate (see the supplemental materials for t-test hypotheses and an explanation of the false discovery rate). We pooled data across multiple FMUs when these units were associated with a single wetland.

Statistical analysis of the rate of implementation success was not necessary for this project because we reviewed all the WMZs in the population for fiscal year 2013.

Considerations

We identified three timber sales that exemplify some of the considerations that go into identifying areas to apply WMZ management and developing prescriptions. Two of these cases require resolving the difference between a WMZ and a riparian management zone (RMZ; management zones surrounding Type 1, 2, 3, and 4 streams). The other case involves prescription targets.

Table 1. Summary of HCP requirements for management in WMZs and variables assessed during field reviews.

Activity	Wetland size	Variable	HCP requirement
Upland variable retention harvest	≥ 0.25 and ≤1 acre	WMZ width	Minimum 100 feet wide
	> 1 acre	WMZ width	Average width is approximately equal to the 100-year site index of mature conifers in the adjoining stand or 100 feet, whichever is greater.
WMZ harvest	≥ 0.25	Live basal area	Maintain and perpetuate at least 120 square feet per acre
Road construction in WMZ	≥ 0.25	Mitigation acreage	On-site and in-kind equal acreage
Salvage	≥ 0.25	Location of operations	Allowed in areas that are not periodically flooded; harvest of live trees must be minimized to those necessary for access

Results

Guidance

We found there to be generally sufficient objective criteria available in the guidance to conduct implementation monitoring. However, guidance surrounding the conservation objective of maintaining hydrologic function could be improved. We successfully used the criteria in the HCP to develop methods for monitoring the implementation of management activities in wetlands (this report is the result; see methods section and supplemental for more information). We found that, in general, guidance is being implemented as written (see the following sections for further detail).

Field assessments

Field results show that all HCP requirements were met or exceeded on nearly every reviewed wetland (Table 2).

The average measured WMZ of the six wetlands > 1 acre in size and adjacent to upland variable retention harvests ranged from 95 to 138 percent of the minimum required width. No documentation was found for any WMZ that stated that a width other than the minimum required was applied. Variability in the width of two WMZs that averages less than 100 percent of the required width was such that the result was not statistically significant.

Two of three WMZs between wetlands ≥ 0.25 and ≤ 1 acre in size and adjacent to upland variable retention harvests met or exceed the minimum required width of 100 feet at all measurement stations. Adjacent to one wetland, the WMZ was shorter than the required 100 feet at one measurement station out of 20 total stations. This WMZ had an average width of 132 feet and an average live basal area of 138 square feet per acre. No documentation was found for any WMZ that stated that a width other than the minimum required was applied.

At one of the two wetlands managed under a consultation letter, we found all work was completed. At the other, we found that all projects had been completed except planting, which is planned to occur after a biomass sale in which slash piles will be removed.

Rutting

We found no instances where rutting exceeded the stipulations outlined in the contract, where available (Table 2). No documentation of operations suspended due to excessive rutting was found.

Table 2. Summary of rutting stipulations in the timber sale contracts for the units reviewed.

Summary of rutting stipulation	Number of contracts
No rutting limit	5
Rutting > 4 inches deep may not cover >10 % of a side skid trails	4
When rutting is > 4 inches deep the contract administrator may suspend operations and require mitigation	3
Rutting > 6 inches deep may not cover >10 % of a side skid trails	1

Prescriptions

Table 3 describes the different types of prescriptions DNR used while implementing management activities in WMZs.

Table 3. Summary of WMZ harvest prescriptions in the timber sale contracts for the units reviewed.

Type of prescription	Number of contracts
Mark to take	6
Salvage	2
Diameter range limits – with species preferences	2
Mark to leave	1
Diameter range limit – harvest all trees	1
Basal area target with characteristics of desired retained trees	1

Table 4. Results of field reviews of WMZs not including a WMZ salvage operation implemented following a site-specific management plan.

#	Planning unit	Wetland size	Wetland type	Upland harvest	# of WMZ width meas. /# of BA plots*	WMZ widths					BA plots		% area of machine use w/in 50 ft.
						Avg.	Min. required width (ft.)**	% of min width	# of meas. less than 100 ft.	Range (coefficient of variation)	Avg. BA	% of allowable minimum	
1	Columbia	≥ 0.25 and ≤ 1.0 acre	Forested	VRH	3/3	134	100	134%	0	110 - 149 (16%)	167	139%	NA
2	North Puget	≥ 0.25 and ≤ 1.0 acre	Forested	VRH	19/9	132	100	132%	1	76 - 165 (17%)	138	115%	NA
3	North Puget	≥ 0.25 and ≤ 1.0 acre	Non-forested	VDT	-/5	-	-	N/A	0	-	160	133%	5 - 10%
4	North Puget	≥ 0.25 and ≤ 1.0 acre	Forested	VRH	6/ measured all trees	116	100	116%	0	100 - 163 (20%)	125 (actual, not average)		NA
5	North Puget	≥ 0.25 and ≤ 1.0 acre	Forested and non-forested	VRH	8/4	110	100	110%	0	101 - 122 (7%)	195	163%	0%
6	South Coast	≥ 0.25 and ≤ 1.0 acre	Forested	VRH	4/3	139	100	139%	0	138 - 141 (1%)	147	122%	NA
7	South Coast	≥ 0.25 and ≤ 1.0 acre	Forested and non-forested complex	VRH	17/16	138	100	138%	0	112 - 169 (12%)	151	126%	0%
8	Columbia	> 1 acre	Forested and non-forested	VDT	-/16	-	-	N/A	N/A	-	233	194%	< 5%
9	Columbia	> 1 acre	Riparian/upland managed under wetland procedure by biologist's direction	VRH	-/5	-	-	N/A	N/A	-	200	167%	NA
10	North Puget	> 1 acre	Forested	VRH	9/5	128	135	95%	N/A	111 - 146 (9%)	156	130%	NA
11	North Puget	> 1 acre	Forested	VRH	8/4	134	135	99%	N/A	115 - 175 (16%)	205	171%	NA
12	South Coast	> 1 acre	Forested	VRH	23/13	240	189	127%	N/A	176 - 313 (13%)	142	118%	NA
13	South Puget	> 1 acre	Forested	VRH	33/12	220	160	138%	N/A	117 - 347 (20%)	133	111%	
14	Straits	> 1 acre	Forested and non-forested	VRH	9/5	186	156	119%	N/A	127 - 259 (22%)	252	210%	NA

* measurement /number of basal area plots
** horizontal distance

Considerations

Resolving RMZ and WMZs

The HCP distinguishes between wetland and riparian areas. The RFRS provides guidance for the management of RMZs and "riparian associated wetlands (periodically inundated areas of Type 1, 2, and 3 Waters)" while other wetlands are "managed according to existing HCP strategies" (Washington State Department of Natural Resources 2006, pg. 36). The term "riparian associated wetlands" lacks clarity, which can result in confusion as to when the RFRS applies. We assumed that the RFRS was not applicable to wetlands we reviewed.

Nonetheless, conifer thinning prescriptions from the RFRS are applied to WMZs at times. While this is acceptable, land managers are usually aware that by applying the RFRS they are applying the more restrictive guidance in terms of required retention of pre-existing forest structure and creation of new structures (downed wood and snags). This is the case when applying the RFRS prescriptions for conifer-dominated stands; the relative density target in RFRS prescriptions meets the wetland basal area target for nearly all stands where commercial harvest activities may take place (it is possible for a commercial thinning in a stand with a low quadratic mean diameter to not meet the RFRS specifications). The RFRS prescriptions for management activities that can occur in hardwood-dominated harvest units are not equally restrictive in terms of required basal area retention as compared to the wetland management guidance. Application of the individual conifer release prescription would require retaining a basal area of 120 square feet per acre in addition to meeting the RFRS requirements. Hardwood conversion, in most cases, cannot be effectively applied to WMZs due to the low residual basal area and poor distribution of retained trees associated with the prescription process[4].

We found two units where the distinction between wetland and riparian areas was ambiguous. In the first case, a DNR biologist mapped Type 3 and Type 5 channels in a meadow adjacent to the timber sale. The biologist also found ditches in the meadow, but was concerned that some ditches were not found due to thick herbaceous cover. The biologist consulted with the Washington Department of Fish and Wildlife (WDFW) regarding fish use in the ditches. WDFW noted that fish may use the ditches in high-water periods. The biologist recommended that a 100-year site index buffer, meaning WMZ, be applied to the meadow, and described the buffer as a "RMZ/WMZ buffer." However, as RMZs and WMZs have different management requirements,

[4] By defining a WMZ width, the HCP implies that retained trees should be present throughout the WMZ. While it is acceptable to have areas of low or zero retained basal area and other areas with basal areas well above 120 square feet per acre, intentionally aggregating nearly all the basal area near the wetland edge does not satisfy the requirement of a WMZ of a particular size.

the forester was left to determine the applicable prescriptions. Ultimately, a 2-acre area was identified as a WMZ and thinned down to 200 square feet per acre of basal area.

In the second case, the RFRS prescription for hardwood conversion was applied to an FMU in a WMZ protecting a forested wetland greater than 1 acre in size. As described in the timber sale's Aquatic Resources Addendum to the Forest Practices Application, the rationale for this was, "the agency's riparian forest restoration strategy is being applied to these WMZ buffers because they overlap with the Type 3 RMZs." As a result, most of the trees in the FMU were removed and the unit was subsequently planted with conifer (Figs. 1 and 2). Based on the map provided as part of the timber sale packet, at least part of the FMU was not in the Type 3 RMZ. Under the interpretation that this wetland is a "riparian associated wetland" this activity is acceptable. If the wetland is not a "riparian associated wetland" this activity is unacceptable. Without more clearly defining what constitutes a "riparian associated wetland," this harvest cannot be evaluated objectively.

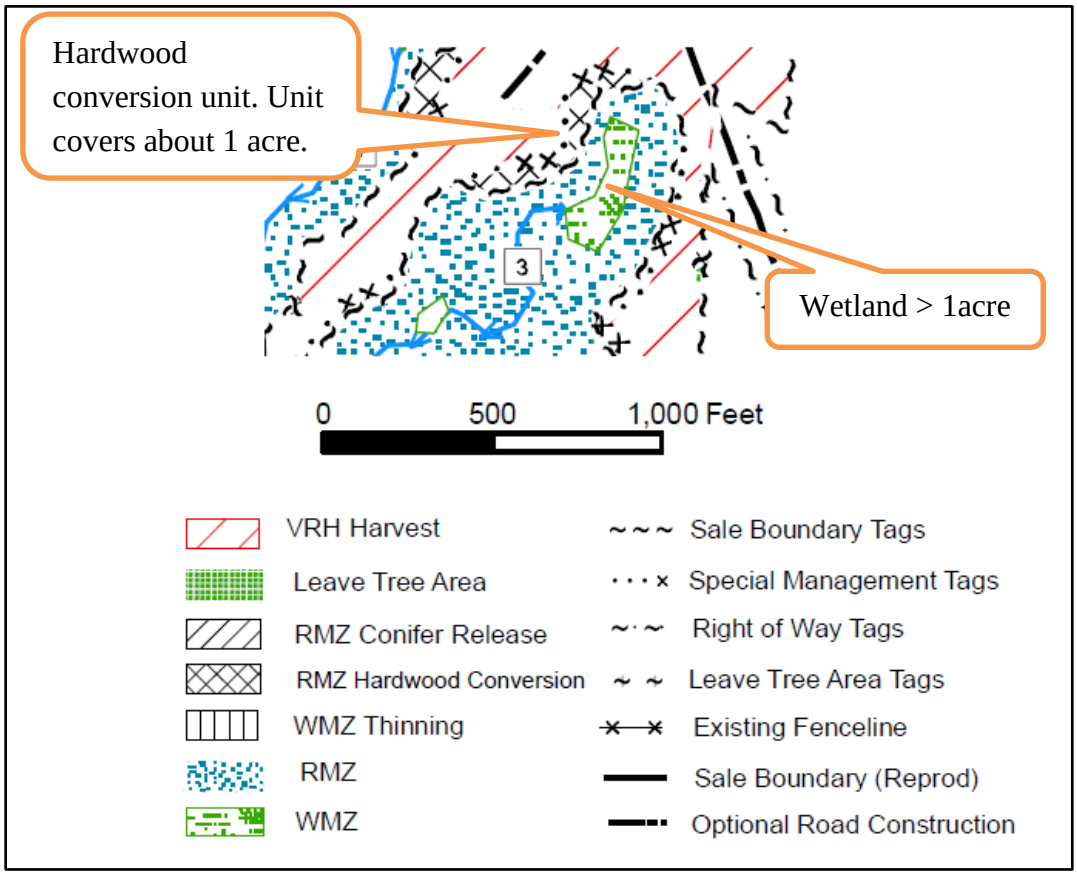

Figure 1. Portion of the timber sale map for the unit where a hardwood conversion activity was adjacent to a wetland.

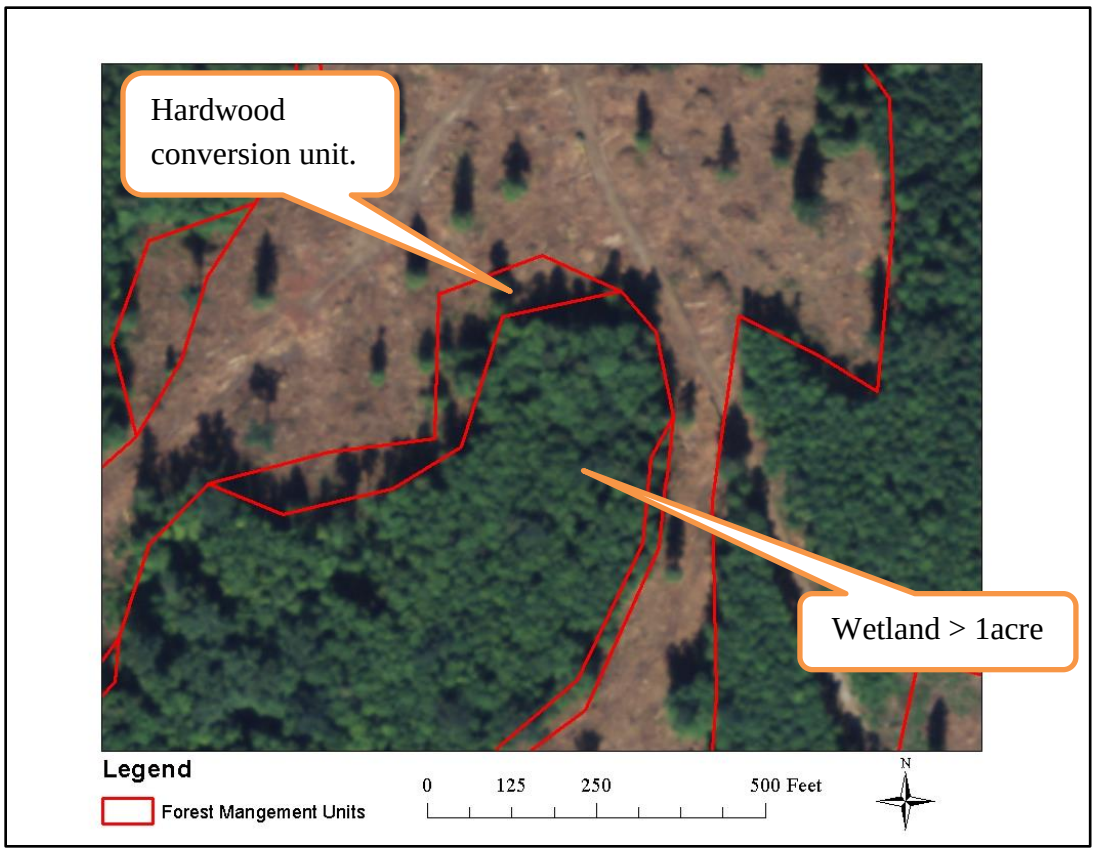

Figure 2. Post-harvest aerial image of the hardwood conversion unit adjacent to a wetland.

Windthrow in WMZs and the need to "perpetuate" 120 square feet of basal area per acre

The HCP requires that a minimum of 120 square feet per acre of live tree basal area be maintained indefinitely following management activities. One WMZ exemplified the need to factor in post-harvest windthrow when developing WMZ thinning prescriptions (Wetland 4 in Table 4). The residual basal area target for this FMU, as stated in DNR's computerized Planning & Tracking system, was 150 square feet per acre. Immediately after harvest the basal area was 147 square feet per acre. Post-harvest windthrow had since reduced the live basal area to 125 square feet per acre by July 2013 (there was approximately 14 months between the conclusion of harvest and the time we reviewed the site). By prescribing the retention of 150 square feet of basal area per acre, the forester was able to maintain 120 square feet of basal area per acre in the WMZ, even after windthrow occurred[5] (Table 5). The practice of developing prescriptions that result in a windfirm stand is necessary to meet the HCP requirement that a wind-firm stand be perpetuated through time.

[5] However, future windthrow may result in the basal area falling below the 120 square feet per acre threshold.

Table 5. Basal area of Wetland 4 immediately post-harvest and in July 2013.

	Immediate post-harvest BA/acre[1]	July 2013 standing BA/acre	% windthrow since harvest
Total BA	147	125	15%
western hemlock	123	104	15%
fir	19	16	18%
red cedar	0	0	0%
cottonwood	5	5	0%

[1] includes current standing live BA/acre plus BA from post-harvest windthrow

Recommendations

Foresters are provided little guidance as to how to implement the conservation objective of maintaining hydrologic function. This objective includes the requirement of "maintaining natural water flow (e.g., no channelization of surface or subsurface water flow)." We believe that foresters identify areas that are susceptible to water channelization and avoid harvest activities in them. Where harvest does take place, direction is written into contracts and provided by contract administrators. In the sales we reviewed, rutting was covered only in one contract clause (H-017). Other ground disturbances that could impact natural water flow were not included in the contracts we reviewed. We did not observe any instances of severe rutting during the 2013 field season. Nonetheless, there remains a risk of failing to maintain natural water flow around wetlands when managing WMZs.

Training foresters to better understand forest soils and providing guidance to better manage soils in WMZs would reduce this risk. Guidance could consider minimum standards for compaction, displacement, puddling and/or other measurable forms of disturbance. Standards could be variable depending on site conditions including topography and susceptibility of the soil to disturbance, among others.

Future wetland monitoring

We started a pre-sale review program of WMZ harvest activities in August 2013. As part of this effort, field visits will be made to one to three wetlands per region during the region browser review period, the pre-sale phase where timber sale documentation is reviewed by region staff. Data collection in these WMZs will follow the same methods as post-sale monitoring but with minor changes because a harvest has not occurred. Some of the WMZs will be re-visited

following harvest to evaluate the aspects of the wetlands guidance that cannot be evaluated pre-harvest, such as rutting and post-harvest basal area.

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Implementation Monitoring Report: Implementation of hardwood conversion and individual conifer release riparian restoration treatments

Executive Summary

The Riparian Forest Restoration Strategy (RFRS; Washington State Department of Natural Resources 2006) provides guidance for the management of riparian areas to improve watershed protection, instream aquatic habitat, and near stream habitat. Previous forest management along reaches of fish bearing streams has removed sources of large woody debris which are important for instream and riparian habitat structure. Because of their size and decay resistance, conifers are generally desirable as material for riparian down wood. Reestablishing and/or supporting already established sources of conifer large wood within riparian areas that are hardwood dominated because of management history is one of the management objectives of the RFRS.

The RFRS describes two management prescriptions that guide these hardwood harvest activities. Hardwood conversion typically removes the hardwood overstory and replants conifers, or releases advance regeneration. Individual conifer release typically reduces inter-specific competition by removing competing hardwood trees surrounding already established conifer trees.

We identified the implementation of hardwood conversion and individual conifer release treatments for monitoring because:

- The RFRS commits to monitoring and recognizes the importance of monitoring in evolving management practices through the adaptive management process,
- The RFRS describes significant risk and uncertainty associated with implementing these activities. Prior to this project, only one unit that included both hardwood conversion and individual conifer release activities has been monitored, and
- The 2001 risk assessment identified managed riparian buffers as a medium priority for implementation monitoring (there are plans to update the 2001 programmatic implementation monitoring priority plan in the future) (Washington State Department of Natural Resources 2001).

The goals and objectives of this project were to:

- Use objective criteria to monitor implementation of hardwood conversion and individual conifer release treatments and determine if guidance was implemented as written,

- Identify aspects of the guidance for hardwood conversion and individual conifer release, if any, that are unclear, conflicting, or difficult to implement consistently, and discuss how this has affected implementation on the ground, and
- Suggest areas of possible improvement to existing guidance, and
- Suggest possible indicators and site characteristics to consider when deciding whether to implement future riparian hardwood harvests.

Of the 73 timber sales that have utilized riparian management provisions of the RFRS since its inception in 2006, 15 have been hardwood conversion and/or individual conifer release treatments. We found that there were limited objective criteria in the RFRS procedures to use for assessing operational compliance. The only objective criteria that we could assess were the integrity of the inner zone and equipment exclusion zone. While the RFRS was intentionally written to allow site-specific professional judgment to be used, we identified several aspects of the implementation procedures for riparian hardwood harvests that could be improved with further clarification. While it is recognized that increased specificity in implementation criteria does not guarantee increased success of meeting the management objective, improving the implementation procedures has the potential to increase the consistency of treatment application across management units.

During field reviews, we found that hardwood conversions associated with a predominance of upland vegetation may be able to be converted to conifer with less cost and risk; conversely, conversion units that support an abundance of vegetation adapted to wetter environments typically required an herbicide treatment and may have poorer long-term success. In individual conifer release units, the availability and accessibility of harvest trees appears to play an important role in successful treatment implementation. As described in the RFRS, site-specific analysis is required to determine the appropriateness of hardwood stand management.

Introduction

The Riparian Forest Restoration Strategy describes a suite of silvicultural activities that may take place within riparian management zones (RMZs) for the purpose of "improving instream and riparian habitat conditions" (RFRS, Washington State Department of Natural Resources 2006). Silvicultural prescriptions are divided into categories for conifer and hardwood dominated RMZs[6]. Within hardwood dominated RMZs, restoration is accomplished through management activities that accelerate the development of structurally complex stand structures. Hardwoods are an important part of riparian stand structure; however, the management history of some areas

[6] RFRS applies to westside HCP planning units excluding the Olympic Experimental State Forest

may have resulted in riparian stands dominated by hardwoods that once supported long-lived conifers. In these areas, foresters have the option to remove hardwoods in order to support the development of a conifer dominated RMZ if site conditions allow.

Two different hardwood prescriptions are described in the RFRS: hardwood conversion (HWC), which typically removes a hardwood overstory and replants conifers, or releases advance regeneration, generally in stands with fewer than 25 conifer trees per acre (TPA), and individual conifer release (ICR), which typically reduces inter-specific competition by removing competing hardwood trees surrounding already established conifer trees in stands that initially have > 25 conifer TPA.

The prescriptions for HWC and ICR provide guidance regarding suitable areas for treatment implementation, and include criteria describing:

- Trees available for harvest
- Retention of conifers and bigleaf maple
- Maximum patch size and inter-patch spacing
- Protection of existing stand structures (snags, downed wood, etc.)
- Site consultation by natural resource specialist

Monitoring Methods

Guidance review

We reviewed the implementation procedures for ICR and HWC to determine what measurable criteria could be used to assess compliance with the RFRS through field reviews (refer to the RFRS for implementation procedures). During this process, we identified areas of guidance that are potentially unclear; a result of our guidance review was recommendations to modify implementation procedures to improve clarity and better achieve the long-term restoration goals of the RFRS.

Field data collection

We visited all timber sales where HWC and/or ICR were implemented since the inception of RFRS in 2006 and which were listed as completed in NaturE (a revenue tracking system) prior to August 12, 2013. These visits were intended to allow an assessment of operational compliance with the RFRS to occur. However, due to a lack of descriptive language in prescription processes for implementing ICR and HWC, collection of quantitative compliance data was limited to tallying instances of harvest activity within 25 feet of the 100-year floodplain (inner zone) and machine entries within 50 feet of the 100-year floodplain (equipment exclusion zone, EEZ), and

determining if patch sizes were no more than 2.5 acres. We collected additional data on the number and general location of uncut bigleaf maple, as well as documented instances when bigleaf maple or conifers were harvested. For one unit, harvest activity and machine entry data were collected in 2012 and reported in the 2013 Implementation Monitoring Report.

Qualitative assessment of site characteristics

During our field reviews, we noted what site characteristics tended to be associated with units that appeared most conducive to supporting conifer regeneration and/or a mixture of conifer and hardwood following harvest activities. We used this information to develop additional site criteria that may support, or deter, the decision to implement HWC and/or ICR.

Document review

We reviewed timber sale documents stored in the DNR Timber Sales Document Center (TSDC) electronic timber sales files and Planning and Tracking system. During this review, we noted whether there was documentation of a site consultation by a specialist. Additionally, we noted documentation regarding the harvest of conifers in a HWC or ICR unit.

Results

Field reviews

We found few instances of riparian hardwood management. Of the 73 timber sales to implement the RFRS since 2006, 15 applied HWC and/or ICR (Table 6).

Table 6. Number of timber sales that have implemented hardwood conversion and/or individual conifer release treatments from the inception of RFRS (April 2006) through August 2013, the approximate total acreage of HWC and ICR treatments, and the total number of timber sales to implement RFRS by Habitat Conservation Plan (HCP; Washington State Department of Natural Resources 1997) planning unit. Eastside planning units and the Olympic Experimental State Forest are not covered by RFRS.

HCP planning unit	Number of timber sales to implement HWC and/or ICR	Total number of timber sales where RFRS has been implemented	Approximate total acreage that has received HWC and/or ICR treatment
North Puget	9	30	26
Columbia	4	36	7
South Coast	2	8	12
South Puget	0	9	0
Straits	0	0	0

Assessment Criteria

Integrity of the inner zone (0 to 25 ft. from 100-year floodplain)

The integrity (defined as lack of ground, stream bank and/or vegetation disturbance) of the inner zone was maintained on all but one (14 out of 15) timber sales to implement riparian hardwood harvest guidance. The most common way this was implemented was by excluding the inner zone from harvest, accomplished by placing timber-sale boundary tags a minimum of 25 feet from the edge of the 100-year floodplain[7]. One management unit illustrated a common practice of placing the timber sale boundary tags on the upland side of the EEZ, recognizing that the low timber value in this area was not worth the risk of machine entry (this was documented in the timber sale packet). On one timber sale where the integrity of the inner zone was not maintained, three trees were harvested from within the inner zone of a hardwood conversion. This sale was reviewed in 2012 and the results reported in the 2013 Implementation Monitoring Report. These trees were harvested as result of placing timber sale boundary tags too close to the 100-year floodplain, which may have been hard to identify due to the shallow slope gradient adjacent to the stream.

Integrity of the equipment exclusion zone (0 to 50 ft. from 100-year floodplain)

The integrity of the EEZ was maintained on all harvest units but one where mechanical harvesting methods were used (the previously discussed sale [2012] that had harvesting in the inner zone also had a single machine entry within 50 feet of the 100-year flood plain). The different ways this was implemented on the ground was through flagging and/or marking the trees along the edge of the EEZ, stating in the contract that the EEZ is a set distance off the timber sale boundary tag line, or by aligning the EEZ and the timber sale boundary tag line. Some timber sales communicated harvest prescriptions to operators with cutting cards (Figure 3).

Maximum size of HWC unit and total treated acres

All reviewed HWC units were less than or equal to 2.5 acres in size. Under RFRS, approximately 45 acres of riparian restoration has occurred in hardwood dominated RMZs (Table 6); this constitutes less than 5% of the total acreage to receive restoration under RFRS.

[7] It is acceptable, and potentially beneficial, to place timber sale boundary tags closer to the stream as long as the first cut stump beyond the tags is greater than 25 feet from the 100-year floodplain (this method may increase the risk of harvesting trees from the inner zone and is best used in places where the 100-year floodplain is easily identifiable).

Cutting Card for
Riparian Forest Restoration Strategy:
Hardwood Conversion

Sale Name: _____
Agreement #_____

Units ____

- No equipment shall operate within 25 feet of the white Timber Sale Boundary tags.

-All hardwoods except for blue painted bigleaf maple will be removed (those being removed include hardwoods with Special Management Boundary Tags and orange butt marks).

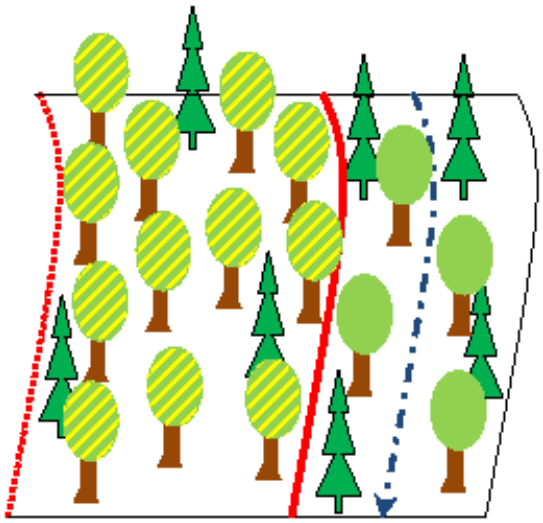
-All conifer and blue painted maple shall be retained.

-Conifer and blue painted bigleaf maple trees needing to be felled for operational or safety reasons shall be approved in writing by the Contract Administrator prior to felling.

Contract Administrator:_____

Phone Numbers: _____

Units ___: Riparian Hardwood Conversion



Type 3 or Type 4 Stream

White Timber Sale Boundary Tags

Blue Special Management Area Tags

All Red Alder and Big leaf maple, except trees marked with blue paint, shall be Felled and Harvested

Leave Trees – Conifer and Blue Painted Bigleaf Maple shall be Retained

Figure 3. Cutting card given to operators to clarify the harvest prescription in a hardwood conversion unit. This is an example of a sale that defined the EEZ as 25 feet from the tagged timber sale boundary.

Guidance review

Managing hardwood stands within riparian areas is ecologically complex and often silviculturally intensive. Hardwood stands are often a mosaic of site types and stand histories. Because of this, the RFRS was written to allow site-specific management plans to be designed and implemented by foresters and specialists; any approved plan would then be used as the basis for determining monitoring criteria. In the absence of a site-specific plan, the RFRS provides prescription processes that describe sideboards for management activities. As previously discussed, the RFRS provides limited objective criteria for assessing operational compliance in riparian hardwood harvest areas. For other aspects, the guidance is unclear and/or conflicting. In the following sections, we discuss some aspects of the guidance that may be causing confusion, and how the guidance has been implemented in harvest units (when available, orange boxes).

Distinguishing ICR from HWC

The long term goal of the RFRS is "to manage for structurally complex riparian forests," which are defined by a riparian desired future condition (RDFC). In riparian areas dominated by hardwoods (i.e., hardwood basal area > 50%) operations which remove hardwoods are appropriate when they result in a forest that is capable of reaching RDFC. In some areas these operations may require removal of all or most hardwoods, while in others only certain trees require removal. The RFRS provides two different prescriptions to differentiate these operations that appear to create two distinct types of hardwood treatments, HWC and ICR. Included in these prescriptions are different requirements that specify which hardwoods can be removed, which conifers can be removed, opening size, and need for specialist review.

We believe that the differentiation of HWC and ICR, as written in the RFRS, creates unnecessary confusion when attempting to implement restoration activities and may be a factor in why riparian hardwood harvests have been implemented on only 44 acres to date. Below are examples of confusion or operational difficulties that come from differentiating HWC and ICR.

Operations in areas with variable stand structure

The structural characteristic differentiating HWC and ICR prescriptions is the number of viable conifers per acre. HWC generally has fewer than 25 viable conifers per acre, while ICR has greater than 25 viable conifers. Few riparian reaches contain uniform stand conditions. Riparian management units may be largely homogeneous in structure and composition, however, more commonly RMZ reaches are a mosaic of pure conifer, areas of pure hardwood, and/or areas of intermixed conifer/hardwood (Box 1, Figure 4). The reality is most units likely contain characteristics of both a HWC and an ICR, and there is a resulting lack of clarity about which guidance to apply over what area. While these generalities in the guidance were designed to

allow for professional judgment to be employed by foresters, the lack of a clearly defined spatial context for distinguishing these treatments from one another at a scale lower than the stand level can confound objective implementation monitoring.

Box 1

Two timber sales illustrated variable stand structure. For both sales, hardwood harvest units were tagged out and FMUs were made in the Planning and Tracking system with the prescription of hardwood conversion and a timber harvest activity type of variable retention harvest or variable thinning. These units were characterized as having a heterogeneous hardwood-conifer overstory, and relatively low hardwood-to-conifer basal area ratio (this was a qualitative measure noted during field reviews, and informed by the Forest Resource Inventory System (FRIS). Harvesting in these units typically removed small groups of hardwoods (~0.1-acre or smaller) and left the rest of the harvest unit either unharvested or lightly thinned along with upland harvest edge (significant portions of the FMUs were not harvested). While the interpretation could be made that these small group removals classify as small hardwood conversions, at the unit scale these treatments would be better classified as conifer release because the overstory removal likely released residual trees and the small gaps are likely difficult to regenerate.

Figure 4. An example of a hardwood harvest unit with a high level of variability. In a single management unit, there is a group of pure hardwood (left), a group of intermixed hardwood-conifer (middle), and a group of pure conifer (right). A site plan for this RMZ may describe a scenario that implements aspects of both HWC and ICR. (Photo Credit: Zak Thomas)

Opening size

The RFRS uses the terms gaps and patches to differentiate two different classes of openings based on size. Openings are described, and the terms defined, in the introduction to the section titled “Specific Silvicultural Prescriptions” (p.24). The following summarizes this description:

- Gaps

    - Uneven-aged management method to create structural heterogeneity
    - In general, are 0.25 acres in size or less
    - Shall only be used outside the 100-foot zone from the 100-year flood plain
- Patches
    - Even-aged regeneration method
    - Will only be used in the hardwood conversion scenario
    - Will not exceed 2.5 acres
    - Will not be implemented within the inner zone

These definitions have an operational impact because they appear to indicate an expectation to regenerate patches, most likely though planting, to ensure conifer establishment. Gaps, however, are not subject to planting as they are a mechanism to influence stand development.

In practice, the need to regenerate openings is based on more than opening size within the RMZ. Other factors include location and shape of the opening, presence and density of advance regeneration, overstory tree composition, and site-specific objectives. It is possible that planting in gaps, in addition to patches, is appropriate to reach RDFC.

The RFRS uses the terms gap and patch as a means to distinguish the silvicultural prescriptions for ICR and HWC. In ICR treatments the objective is expected to be achieved by gap creation or thinning, while HWC treatments call for the creation of patches 2.5 acres in size or less. This distinction may lead to unnecessary uncertainty over planting requirements. Monitoring found that planting of gap size canopy openings, particularly those adjacent to upland harvests being planted, was common. If a forester wishes to preclude certain gaps from planting to achieve the activity objective, it is recommended that these areas be described in the site plan and/or marked on the ground to assure the desired stand structure is retained following planting.

Conifers available for harvest

The prescriptions for ICR and HWC provide slightly different guidance regarding which conifers may be harvested, if any. The prescription for ICR states that conifers may be harvested for the creation of yarding corridors and skid trails. For HWC, the guidance in the activity prescription states “All live conifers must be retained in the patch cuts and advance conifer regeneration shall be protected where operationally feasible” (p.32, the language of this sentence is not clear as to whether harvesting conifers for operational reasons is acceptable). In a section titled Summary of Riparian Forest Restoration Strategy Commitments, additional guidance is given that states: “No conifers will be cut during the restoration of hardwood-dominated stands except for operational

reasons" (p.70). It is not clear as to what types of activities may, or may not, warrant the harvest of conifers to facilitate operations.

A related issue is that the RFRS is unclear as to whether the harvest of non-viable conifers for non-operational purposes is an acceptable or prohibited action. At times, the presence of non-viable conifers has significantly limited the implementation of ICR treatments. In hardwood-dominated riparian harvest units with an intermixed conifer-hardwood overstory, it is not uncommon to have a non-viable conifer blocking the harvest of a group of hardwood trees that, if removed, would result in the release of viable conifers. In these types of stands, DNR has taken a conservative approach, removing only those hardwood trees in the outer most portion of the RMZ that was possible to harvest without cutting non-viable conifer trees.

Viable conifers have the following characteristics:

- DBH >6"
- Live crown >30 percent
- Height to diameter ratio <100
- Free of root rot

Our field reviews found that conifers were not harvested on most timber sales with the exception of two (Box 2). On other timber sales, operations either met the treatment prescription while avoiding conifers, avoided implementing the treatment in areas with higher conifer density, or had instances of both these situations within the same harvest unit. In some units, it was apparent that the requirement to avoid the harvest of any conifers hindered access to otherwise merchantable hardwoods. At times, this hindrance was significant and prevented achieving the activity objective at the unit scale. A discussion of the role of conifers that are likely "non-viable" for the long-term restoration goal of the RMZ would be helpful. Such conifer might be safer to leave as down wood at the time of hardwood removal.

Box 2

There were two instances of viable conifers being harvested within hardwood-dominated RMZs. In the first instance, approximately five viable conifers were harvested in a hardwood conversion implemented in the RMZ of a Type 3 stream. This was an error on the part of the operator, was identified by Forest Practices and a Notice to Comply was issued. Mitigation requirements stated in the Notice to Comply have been implemented. In the second instance, three undocumented conifers were harvested within an ICR unit on a Type 4 stream. There was no apparent documentation in reference to these trees being removed, and there was no indication that they were removed for the creation of a skid trail of cable corridor.

Hardwoods available for harvest

The considerations for removing hardwoods differ between HWC and ICR. In ICR, hardwood removal is limited to "selectively removing hardwood trees overtopping or otherwise competing with conifer trees for resources (i.e., space, light)." This is to be implemented by either: a) targeting individually marked trees for removal to release selected conifers (i.e., mark-to-take, the only method used by DNR to date), or b) prescribing a specified cutting radius around each conifer. As we understand this prescription as applied by DNR foresters, harvested hardwoods should be definably competing with conifer trees, but this is currently implemented using a subjective process. In the absence of definable criteria describing what constitutes a competing tree, objective implementation monitoring is difficult (Box 3).

Box 3

Since the RFRS provides no guidance as to what a competing tree is, our field reviews were not able to determine if harvested trees were competing with a residual conifer or not. In areas where hardwood harvest activities consisted of thinning or gap creation (see previous discussion), hardwoods were harvested up to ~30 feet from the nearest residual viable conifer.

In HWC units, the RFRS calls for the harvest of "all hardwoods except 1-3 big-leaf maple per acre (if present)"[8]. This requirement is not replicated for ICR units as the RFRS makes no mention as to whether retention is bigleaf maple is required.

As written, the RFRS lacks detail about the size and location requirements of these retained bigleaf maple. This lack of detail confounds implementation monitoring, and may result in misapplication of the guidance as it was intended (Box 4). In particular, the prescription is unclear as to whether bigleaf maple present on the edge of a patch, but bound out of the timber sale with timber sale boundary tags, count towards the retention quota, or whether these trees need to be within the patch. Also, the guidance does not provide a lower bound to the diameter of bigleaf maple counted towards the retention quota; currently, bigleaf maple saplings and advance regeneration could be considered available to fulfill the retention quota. More explicit guidance describing the size and location of bigleaf maple that must be retained in HWC units may lead to a more consistent implementation of this aspect of the RFRS.

[8] The RFRS also favors retention of bigleaf maple while harvesting conifer dominated RMZs.

Box 4

There were six timber sales that had bigleaf maple present within the RMZ as determined through field recon and/or documentation in the timber sale packet. Of these:

- Two timber sales retained the prescribed amount of bigleaf maple within the timber sale boundary.
- Two timber sales indicated that 1 to 3 bigleaf maple were to be marked to leave in the harvest area but, in at least one unit, were not retained (and there was no evidence of butt marking on harvested bigleaf maple). In these units, there were instances where bigleaf maple was present immediately adjacent to the treatment area but excluded from harvest with timber sale boundary tags.
- Two timber sales specifically targeted the removal of all bigleaf maple from within the harvest area as per contract schedule. Both of these sales had overstory bigleaf maple present immediately adjacent to the treatment area but excluded from harvest with timber sale boundary tags, or had unmerchantable 1" – 3" DBH bigleaf maple present within in the patch cut.

Documentation of specialist consultation

HWC and ICR have different requirements for specialist consultation. In order to help develop a site-specific management plan, consultation with a specialist is required for all HWCs but is only suggested for ICRs. When consultation does occur, the RFRS does not define what level of documentation is necessary, or whether this documentation needs to be included in the timber sale packet. Documentation need not be lengthy, but record of the consult in the timber sale packet or TSDC is recommended.

Additional clarification could also better define what positions can provide consultation. The RFRS states that appropriate specialists may include a biologist or silviculturist; however, it does not state whether other positions (for example, riparian designees or other riparian specialists) could also provide consultation. Additionally, DNR's Intensive Management Foresters (IMFs) have requested to be consulted for planning harvest activities in hardwood harvests units that will require planting.

We did not find documentation of consultations for HWC treatments within the timber sale packets of several sales (Box 5). We found no documentation of site consultations for any individual conifer release treatment.

Box 5

Of the twelve timber sales that implemented hardwood conversions (and therefore required consultation with a specialist):

- Five sales had clear documentation that a specialist had reviewed the site plan
  - Four of these were reviewed by a region silviculture staff member and documented in the Planning & Tracking system
  - One was reviewed by a region riparian designee and documented with an email on TSDC
- Two sales had site plans reviewed by a specialist, but these reviews were not documented in the timber sale jacket
- Five sales had no apparent documentation or evidence of consultation with a specialist

Other operational considerations

Herbicide application in HWC areas

The ability to utilize herbicide in hardwood conversion units, at times, increases the chance of success at meeting the activity objective; so, having an understanding of the rules and regulations pertaining to herbicide application, in particular to where spraying can and cannot occur, is generally a good practice. As previously discussed, IMFs have requested to be consulted for HWC treatments; these consultations are a good time to assess and discuss potential brush response and site preparation and regeneration plans.

Familiarizing DNR staff (foresters and silviculturists) with how the Forest Practices Rules for herbicide application apply to waters on state lands would be beneficial. For example, Forest Practice Rules for forest chemicals (WAC 222-38-020) prohibit hand spray from occurring within 50 feet of bankfull of a Type 3 stream, but there is no requirement to apply a buffer when hand spraying along a Type 4 stream or other surface water (including wetlands, Type 5 streams, seeps, and water holding topographic features) as long as herbicide is applied directly to target vegetation. A practice has been to maintain a no-spray buffer of at least 50 feet on Type 3 and 4 streams (as discussed in more detail in the following section, this is sometimes implemented by instructing herbicide applicators to stay 25 feet away from the timber sale boundary tag line), and a 25-foot buffer on other surface waters. While these conservative practices are appropriate in some situations, when implemented in hardwood conversion units, they can prevent the application of herbicide to harvested areas (which can be implemented up to 25 feet from the 100-year floodplain, as well as on seeps, Type 5s, etc.), which as previously discussed can inhibit treatment success. Two examples of how this has manifested on the landscape include 1) a strip of untreated brush along with streamside edge of the unit, and 2) unsprayed sections of hardwood conversion units around water holding/producing topographic features. These spray buffers can

represent a large portion of some of these units. Improved dissemination of spray rules and identifying these units as requiring more intensive contract administration may allow DNR to more effectively site-prep hardwood conversion units for planting. Conversely, DNR could avoid implementing hardwood conversions in troublesome areas with potentially aggressive brush response.

Timber sale boundary tag line as basis of operational instructions

Timber sale boundary tag lines can be used as a basis for instructing machine operators and chemical spray applicators about unmarked operational boundaries. For example, machine operators may be instructed to stay 25 feet from the tag line to ensure that they do not enter the EEZ (Figure 3). This is an acceptable practice; however, there are many occasions where the timber sale boundary tag line is more than 25 feet from the 100-year floodplain, in which case these directions are overly restrictive. For example, reasons why the tag line may be more than 25 feet from the 100-year floodplain include (but are not limited to) potentially unstable slopes, difficult topography, stand type break (maybe change to conifer dominance), poor timber quality, protection of bigleaf maple, or wet features that may prohibit spray (such as wetlands, Type 5 stream confluences, seeps, or poorly drained topography). In addition, the RFRS specifically states that the inner zone shall be expanded where necessary to minimize the short-term impacts to riparian functions, especially shade, on a site-specific basis; this may result in a tag line more than 25 feet from the 100-year floodplain[9].

The opposite problem can occur when tags are placed closer than 25 feet from the 100-year floodplain. Tags can be placed closer than 25 feet from the 100-year floodplain as long as the first harvested trees in more than 25 feet from the 100-year floodplain. In this case, there is a potential for machines to enter the EEZ or chemicals to be applied too close to the stream.

This problem can be resolved by noting areas where distance from the tags is appropriate for determining the EEZ or chemical use buffer, and areas where machine use and/or chemical application is appropriate to the tag line.

[9] In this case the width of the EEZ would also be greater than 50 feet as the RFRS states that "no ground equipment will be allowed within 25 feet of the inner zone." Future revision of the RFRS should consider if this stipulation is necessary since widening the inner zone to retain shade does not inherently require additional restrictions on machine use.

Considerations for riparian hardwood harvest unit site selection

Hardwood conversion

Site selection is crucial for determining where to implement HWC due to the specific management commitment to regeneration that persists until the new stand is in free-to-grow status. The RFRS gives some general guidance in regards to where to apply hardwood conversions. This guidance is limited to the presence of conifer stumps and presumed history of forest practices. This guidance may result in the application of these prescriptions to inappropriate areas.

While there are many locations on state lands where hardwood conversion is possible, it is important to realize that treatment response can be highly variable, and once implemented, DNR is committed to the conversion effort. The primary management concern following the removal of the hardwood overstory is the regeneration of a new cohort of conifer trees, and the most significant factor effecting the regeneration of conifers is brush response (which can be aggressive within moist, nutrient-rich areas). As previously discussed, the ability to treat the brush within the harvest area with herbicide can be a significant factor to whether the treatment objective will be achieved. In consideration of these two criteria, it becomes apparent that some potential hardwood conversion locations are significantly more conducive to treatment than others, as well as significantly less costly.

The following criteria may be helpful when considering whether to implement hardwood conversion, and where. These criteria were developed through qualitative assessment during field reviews and discussions with region staff.

Stumps as indicators of historical forest conditions

While the simple presence or absence of old conifer stumps can indicate the historical forest structure and composition, it is important to consider both the density and species of the stumps present. A high density of conifer stumps may indicate with greater certainty that the site was historically conifer dominated; conversely, a low density of conifer stumps may indicate a historical condition dominated by hardwoods. Also, the presence of conifer stumps from species better conditioned to wetter environments, such as redcedar, may provide further insight into the past forest condition. Another important consideration is that it was common practice in the past to broadcast-burn harvest areas to remove slash; therefore, the absence of stumps should not preclude the implementation of hardwood conversion in an area. It may also be useful for foresters to consider how past management practices changed the site's growing conditions; it is

possible that the initial removal of conifers changed the growing conditions to make the site more conducive to supporting hardwood species.

Understory plant composition and potential for aggressive shrub response

While it can be difficult to predict how understory woody and herbaceous species will respond to the removal of the hardwood overstory, considering some general characteristics of the pre-harvest stand may inform a better management decision. An understory dominated by upland vegetation associated with drier sites (sword fern, salal, Oregon grape, etc.[10]) is the best indicator that the post-harvest silvicultural effort will be minimal (Figure 5). Conversely, a dominance of facultative brush species may indicate a need to aggressively treat vegetation prior to planting (and potentially re-treat to release seedlings), particularly when the vegetation has the potential for significant vertical growth (such as salmonberry, elderberry, vine maple, etc.). As previously discussed, considering the post-harvest silvicultural effort while planning where HWC will be implemented is recommended. As DNR gains more experience implementing hardwood conversions consistently and identifying sites conducive to treatment with minimal cost, it may be beneficial to develop guidance that associates a high likelihood of treatment success with particular plant associations.

Topographic indicators

Implementing the treatment in a "raised" RMZ associated with an incised or gorged stream can be beneficial because a) these sites may be drier than other areas nearer to streams, and b) laying out the units can be done more efficiently since the 100-year flood plain is more easily identifiable. Additionally, it may be advisable at times to avoid water channeling or holding topography (such as Type 5 streams, seeps, poorly drained soil, etc.) that may preclude management activities to facilitate conifer establishment.

[10] Species listed as facultative upland (FACU) in the National Wetland Plant List maintained by the US Army Corps of Engineers (available to DNR staff on the "Westside Wetlands" SharePoint page), or not listed in the National Wetland Plant List (and therefore considered upland obligates) are indicative of drier sites.

Figure 5. This hardwood conversion unit had a pre-harvest dominance of sword fern, a facultative upland species, and required little-to-no herbicide application in order to get the unit prepped for planting. This picture was taken from the upland edge of the RMZ facing towards the inner zone (line of standing trees). The primarily upland condition within the RMZ was supported by an incised stream channel that created separation between riparian and upland vegetation. (Photo Credit: Zak Thomas)

Individual conifer release

Achieving the activity objective for ICR at the unit scale is largely a function of the structure and composition of the riparian unit before harvest. Specifically, the relative dominance of hardwoods compared to conifers and the spatial distribution of these trees are important factors to consider when determining whether a unit is conducive to treatment from an operational perspective. The RFRS allows the ICR prescription to be applied to a wide range of stand conditions, including harvest units with 25 viable conifers per acre to harvest units where hardwoods barely possess more basal area than conifers. These largely intermixed hardwood-conifer harvest units are less conducive to ICR than areas with a more pronounced dominance of hardwood trees. Additionally, stands where hardwoods are grouped together and accessible from the upland side of the unit are potentially more conducive to treatment. Additionally, as utilizing

mark-to-take prescriptions in common, being knowledgeable of what an operator or cutter can or cannot harvest is useful for maximizing harvest efficiency and volume removal.

Best Management Practices (BMPs)

- Slash accumulation in hardwood-dominated harvest areas can be significant. To assure an adequate number of planting locations, consider piling slash or include a contract stipulation to create a sufficient number of planting locations per acre in the RMZ. If machine piling, consider precluding slash removal from the EEZ to limit the risk of machine entry.

- Determining the upland edge of a riparian special management unit (SMU) can be difficult post-harvest, particularly in hardwood conversions where many, if not all, of the tagged trees may be removed. Being able to identify this line post-harvest has operational significance in that the managed RMZs may have different planting prescriptions, stipulations for herbicide application, or specific management commitments (e.g., a concurrence letter). Assuming that silviculture staff are able to consistently and accurately re-establish SMU tag lines places unnecessary risk on DNR. An effective method to reduce the risk of misidentifying SMU lines post-harvest is to double-tag some of the boundary trees that may be harvested (Figure 6). This method is especially useful when large sections of the boundary are available for harvest. Flagging the SMU line can also be effective, but be aware that flagging can be incidentally shifted, damaged, or removed during operations.

- Biotic and abiotic factors can act as barriers to treatment success in hardwood harvest units. The removal of competing trees in ICR treatments increases the likelihood of windthrow of the residual overstory, particularly in wet riparian areas. If the harvest unit is in a wind prone area, consider the orientation of the upland edge of the harvest unit in relation to prevailing winds, or use a wind buffer. Ungulate browse pressure can be significant, particularly where redcedar is planted (planting redcedar is a common practice in HWC units). If browse pressure is likely, consider using barrier protection (vexar tubes, fencing, etc.) or regenerate species, such as spruce, which are less susceptible to browse.

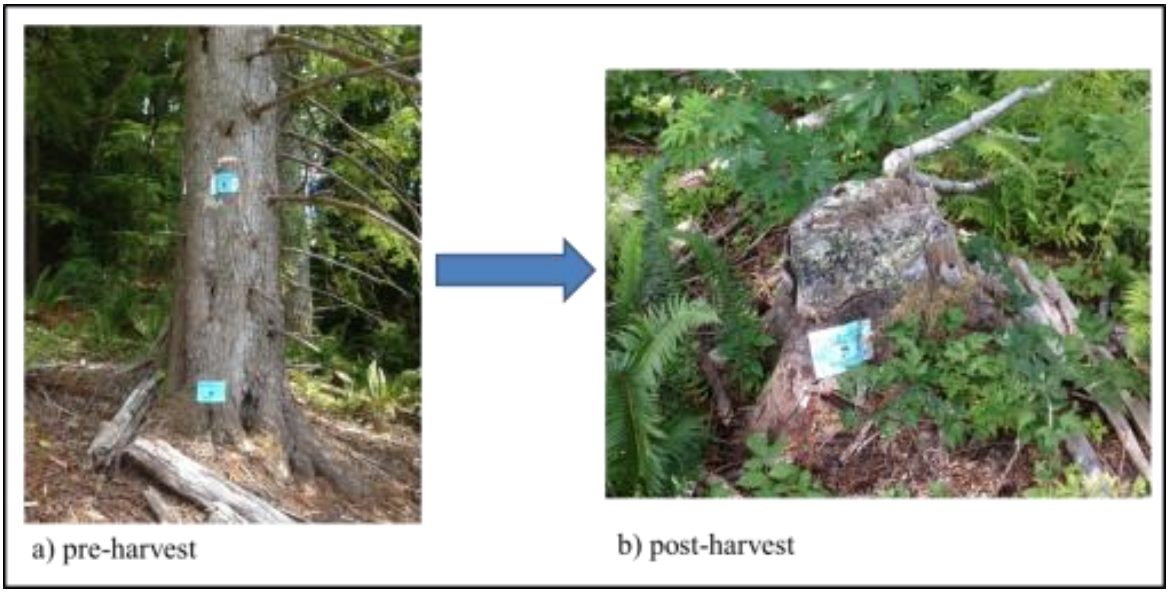


Figure 6. Double tagging potentially harvestable trees along a SMU tagline can be beneficial because it permits identification of the SMU following after a harvest, which allows a more effective application of post-harvest management activities. (Photo Credit: Zak Thomas)

Conclusions

The guidance, which monitoring was able to assess objectively during field reviews, is being implemented with a high degree of operational compliance. When confronted with unclear guidance, DNR has taken an approach that assures the protection of resources. While being the most conservative and involving the least amount of disturbance, this approach, at times, has hindered the achievement of the activity objective at the unit scale as well as potentially reduced the volume of timber removal. It is apparent that when implemented under the right conditions these treatments are a valuable tool that can be used to attain multiple management objectives, including ecological restoration and revenue production. Hardwood harvests are relatively rare activities within riparian areas on state lands in western Washington (~5% or less of RFRS acres); consistent with the ecological risks identified within the RFRS and potential management costs, this appears to be as intended in the conservation strategy.

References

Washington State Department of Natural Resources. 1997. *Final habitat conservation plan*. Olympia, WA: Author.

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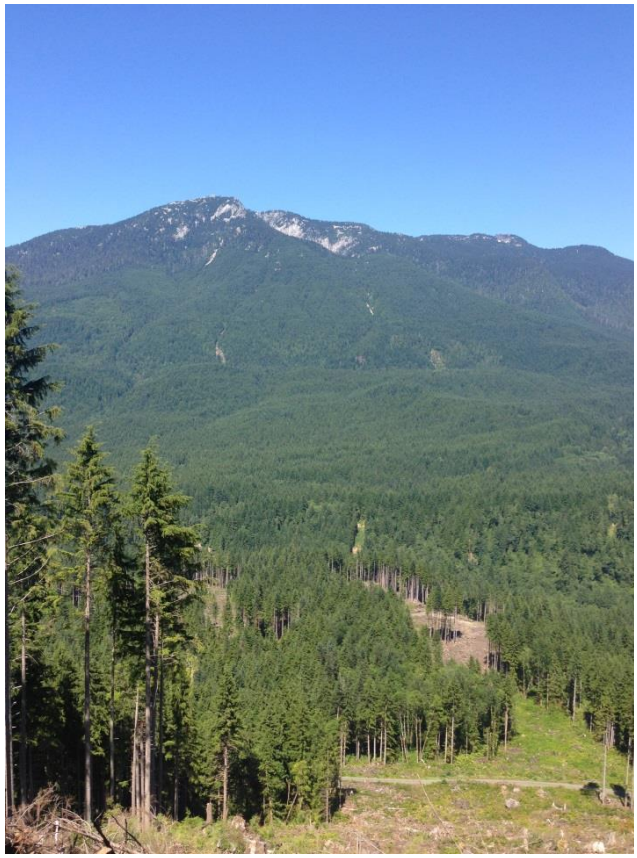
RESOURCES

NATURAL

SUPPLEMENTAL INFORMATION:

State Trust Lands Habitat Conservation Plan Implementation Monitoring:

Implementation of management activities in wetland management zones and hardwood-dominated riparian management zones



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Forest Resources Division,
Washington State Department of
Natural Resources

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Peter Goldmark - Commissioner of Public Lands

Wetland and WMZ monitoring

Methods

Activity screening

We found wetlands ≥ 0.25 acres where harvest and/or road construction had occurred by finding FMUs encompassing these activities. We found these by first querying DNR's Forest Management Planning and Tracking database (P&T) to find FMUs with "wetland" as an objective category. We then queried a Geographic Information System (GIS) layer, which is compiled from P&T data, for FMUs with names that included "WMZ," or "WET." Once we identified these units, we reviewed the prescriptions in P&T to verify that activities were planned in each unit. We retained all FMUs that were part of timber sales listed as "closed" in NaturE, DNR's revenue tracking database, during fiscal year 2013 (July 1, 2012 – June 30, 2013). We dropped any FMU located in eastern Washington or the Olympic Experimental State Forest since we were interested only in activities that implemented the wetland component of the Riparian Conservation Strategy for the Five Westside Planning Units[1]. Two additional units were found while conducting field reviews. These units had been identified in P&T as riparian management zones, but we considered them to be WMZs because they were adjacent to wetlands > 1 acre in size, and outside the 100-year floodplain of a Type 3 stream. In total, we reviewed 16 forest management units (FMUs) around 15 wetlands/wetland complexes on 14 timber sales.

Data collection

Wetland edge identification and area measurement

First, we identified the wetland edge since all other measurements were based off of this location. This was accomplished using the methods that DNR foresters are trained to use in the field and which are derived from guidance provided in the Forest Practices Board Manual from 1995 and the Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains Valleys and Coast Region (U.S. Army Corps of Engineers 2010). In training, foresters are instructed to identify and delineate wetlands by assessing three ecological parameters, including:

> a) hydrophytic vegetation – vegetation that requires, or is tolerant of, prolonged inundation or soil saturation during the growing season

[1] This strategy applies to all western Washington planning units expect the Olympic Experimental State Forest Planning Unit.

b) hydric soils – soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part

c) wetland hydrology – saturation within one foot of the soil surface for two weeks or more during the growing season in most years

As field indicators for one or more criteria may be seasonally difficult to discern, professional judgment (of foresters, specialists and monitors) is used when necessary.

These parameters were assessed with respect to the 1995 Forest Practices wetland definition, which is used by DNR on state lands. The definition states:

> 'Wetland' means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, such as swamps, bogs, fens, and similar areas. This includes wetlands cleared, restored, or enhanced as part of a mitigation procedure. This does not include constructed wetlands or the following surface waters of the state intentionally constructed from wetland sites: irrigation and drainage ditches, grass-lined swales, canals, agricultural detention facilities, farm ponds and landscape amenities.'

Upon reaching a wetland, we first determined the wetland edge by evaluating vegetation, hydrologic and soil indicators (See Appendix 1b: Wetland indicators). For the vegetation indicators, we did not establish formal plots but instead selected a circular area 11.78 feet or less in radius ($1/100^{th}$ acre or less) in which to estimate vegetation coverage. The size of the circular area depended on vegetation conditions. In order to determine wetland hydrology, we looked for primary and secondary indicators (See the Wetland Indicators section below). Wetland hydrology is indicated by one primary or two secondary indicators. Soil indicators were evaluated based on surface and underground soil conditions. We typically dug three soil pits at each wetland to assess the soil profile. We dug one pit in an area with pronounced wetland vegetation and hydrologic indicators and one pit in an upland area. We dug the third pit in an area where the vegetation and hydrologic indicators transitioned from wetland to upland. Once the edge was determined, we used this point to understand the 'signature' of the wetland edge which helped us determine the wetland edge at subsequent measurement points (henceforth, called stations). At each station, we recorded one or more of the indicators that we used to identify the wetland edge. These stations were also used as the base for measuring WMZ width and locating basal area plots.

We estimated the size of the wetland visually in the field and occasionally in GIS as well. If the wetland was close in size to the HCP thresholds where required protection changes (i.e. 0.25 and 1.0 acres), we collected GPS points along the wetland edge and measured the area in GIS. Each GPS point was compiled from the average of at least 20 location estimates. We used a Garmin 60CS or Garmin 62S GPS unit for all GPS data collection.

Basal area measurements

Since the basal area requirement applies to the entire WMZ, not just the managed area (the wetland side of which was delineated by timber sale boundary tags), we collected basal area data using plots placed systematically throughout the entire lateral extent of WMZs where management activities occurred. The measurement area was bounded on the wetland side by the wetland edge. The outside edge of the WMZ was defined as the requisite width, which depended on the size of the wetland. We defined the lateral extent of the measurement area as the area between the intersections of the managed area (defined by timber sale tags) and the WMZ. The lateral boundary of the measurement area was a line perpendicular to the tangent of the wetland edge extending to the edge of the WMZ.

For wetlands ≥ 0.25 and ≤ 1 acre, this meant that we took the first measurements where the timber sale boundary tag line surrounding an area where wetland thinning is prescribed first comes within 100 feet of the wetland edge. For wetlands > 1 acre in size, measurements began where the tags come within a distance equal to the 100-year site index of the upland stand. Unthinned skips and voids within the managed area counted toward the basal area. Trees between the managed area and the wetland also counted toward the basal area. However, trees outside the managed area laterally did not count toward the basal area.

We used a basal area factor (BAF) 20 prism to collect basal area data. Only live trees were counted[2]. We recoded the species of each tree counted.

We placed plots in the WMZ surrounding wetlands systematically with a randomized start location, if space allowed. We randomized the location of the first plot parallel to the edge of the wetland between 50 and 75 feet from the shortest line between the wetland edge and the edge of the WMZ that defines that lateral edge of the managed WMZ. Random numbers were generated by a smart phone application. In the 100-foot WMZ around wetlands ≥ 0.25 and ≤ 1 acre in area, all plots were located 50 feet from the edge of the wetland. In 100-year site index WMZs, the plot alternated between 50 feet from the wetland edge and the 100-year site index minus 50 feet from the wetland edge.

We spaced plots parallel to the wetland edge based on the length of the wetland edge (Table 1; Figs. 1 and 2). If a WMZ was managed with more than one FMU, we summed the lengths of the wetland edge adjacent to each unit to determine plot spacing.

In all managed wetland areas, a minimum of three plots were measured, if space allowed. If three plots could not be placed randomly in a management area, we systematically placed the plots to fit. In very small management units we found basal area by measuring diameter at breast height

[2] This basal area requirement of the Riparian Conservation Strategy for the Five Westside Planning is intended to retain a tree canopy that is sufficient to maintain the hydrologic characteristics of the wetland. As only live trees transpire, the basal area requirement only applies to live trees.

of all trees. We also did this in one WMZ as it was clear that the three randomly placed plots did not adequately capture the basal area of the WMZ. In addition, post-harvest windthrown trees were also measured to determine the basal area immediately following the harvest.

When management occurred in the entire WMZ completely encircling the wetland, we placed the first plot 50 to 75 feet parallel to the wetland edge from an arbitrary point where we happened to be standing. We determined the location of the plot clockwise or counter-clockwise from the arbitrary point based on the direction we had travelled to reach the point. If we reached the point following a generally clockwise path, the plot was located clockwise from the arbitrary point, and vice versa.

In areas where a harvested WMZ surrounded two or more wetlands, no plots were put between wetlands areas closer together than 100 feet so as to keep plots least 50 feet from any wetland. If wetlands were more than 100 feet apart, plots were placed around each wetland such that they did not overlap.

Some plots were dropped because of overlap with other plots. Plot overlap was due to sinuous wetland edges or multiple wetlands in a complex. In these cases, an alternate plot center was placed 50 feet in the direction of travel parallel to the wetland edge. If this location was unacceptable, the plot was dropped. Data collection resumed at the next scheduled plot.

Table 1. Distance between basal area plots.

Length of wetland edge	**Distance between plots**	**Expected number of plots**
0 to 2000 feet	100 feet	3* to 20
2000 to 4000 feet	200 feet	10 to 20

* A minimum of three plots were taken in each WMZ. Where three plots could not be placed without overlap all trees in the WMZ were measured.

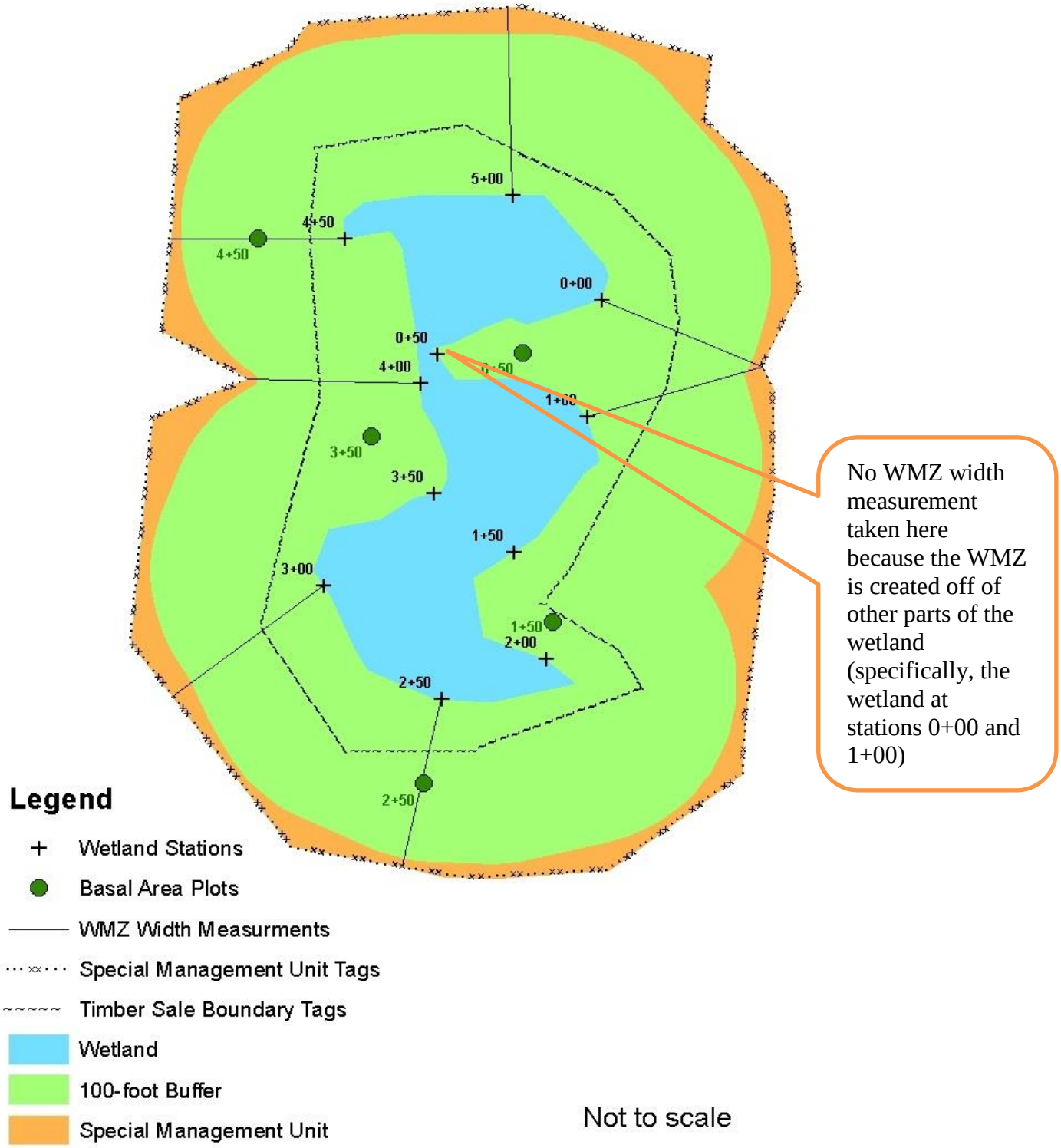

Figure 1. Diagram of WMZ width measurements and basal area plot locations when harvest occurs on all sides of a wetland. Note: width is measured along the shortest line between the wetland edge and the edge of the special management unit while basal area plots are located perpendicular to the wetland edge.

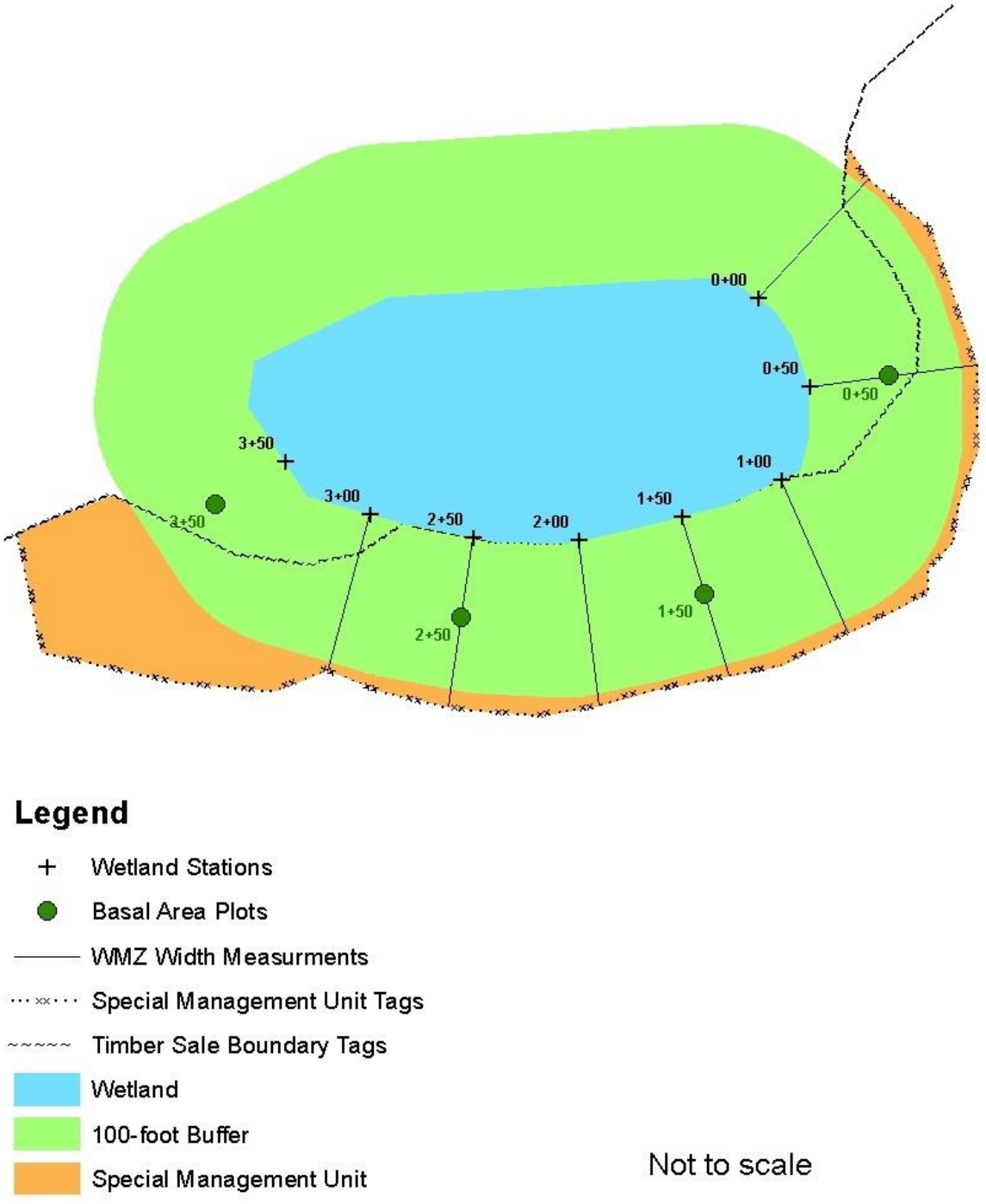

Figure 2. Diagram of WMZ width measurements and basal area plot locations when harvest occurs on one side of a wetland. Note: width is measured along the shortest line between the wetland edge and the edge of the special management unit while basal area plots are located perpendicular to the wetland edge.

WMZ width

Where management in WMZs was adjacent to upland regeneration harvests, we measured the distance from the outside edge of the wetland to the first stump beyond the Special Management Unit tags used to define the WMZ at 50-foot intervals. We made measurements along the shortest line between the wetland edge and the upland harvest edge. We did not take measurements in places where the edge of the WMZ was closer to other parts of the wetland than to the measurement point.

We measured horizontal distance to the nearest foot with a laser range finder and/or a metal tape. The rangefinders used were the Laser Technology TruPulse 360R (accuracy rating ± 1.0 foot) and Laser Technology Impulse 200 LR (accuracy rating ± 0.1 foot).

Exceptional situations

Wetland complexes and small harvest units around convex portions of wetlands were two exceptional cases that required different plotting schemes or additional plots. In wetland complexes it was necessary to put basal area plots between the wetland in areas where WMZ width measurements were not applicable. Basal area plots in these areas were spaced the same distance apart as the plots in the WMZ.

In small harvest units around convex wetland areas, the typical spacing of WMZ width measurements and basal area plots was too wide, resulting in under-sampling of the spatial extent of the WMZ or too few measurements. In these areas, WMZ width measurements were taken every 50 feet as measured from the upland side of the WMZ. Spacing of wetland plots was based the upland side of the WMZ as well.

Consultation letter monitoring

Two FMUs visited had consultation letters for salvage operations allowed under the HCP. We evaluated these FMUs based on the requirements in the concurrence letters.

Machine use near non-forested wetlands

We monitored rutting consistent with language in clauses H-017 of the timber sale contract that covered each harvest activity. This was done by visually estimating the area of ruts within skid trails within the WMZ. In addition, we visually estimated the area of ground-based equipment tracks within 50 feet of the edge of non-forested wetlands based on recommendations for management in Managing Wetlands (DNR 2000).

Road construction in WMZs

We looked for new road construction within WMZs. In sales where road construction took place, we verified the presence of mitigation features.

Data collection period

Data were collected between July 3, 2013, and July 31, 2013.

Analysis

We entered data from field datasheets into Excel. We calculated descriptive statistics using Excel. Data from separate managed areas adjacent to the same wetland or wetland complex (i.e., part of the same WMZ) were pooled for analysis.

For tests of WMZ width, the null hypothesis was that the width was equal to or wider than the reported 100-year site index for the adjacent upland stand. The alternate hypothesis was that the WMZ was narrower than this.

Because multiple t-tests were run, the false discovery rate was controlled. The false discovery rate is the proportion of results for which the null hypothesis is rejected when it should be accepted out of the total number of results for which the null hypothesis is rejected. This rate was controlled for by using the Benjamini-Hochberg procedure (McDonald 2009). In this procedure each result is ranked by p-value from lowest to highest. Then the p-values are compared to *(i/m)*Q*, where *i* is the p-value rank, *m* is the total number of tests, and *Q* is the desired false discovery rate. If p is less than *(i/m)*Q* the result is significant, meaning the null hypothesis is rejected. If p is greater than *(i/m)*Q* the null hypothesis is accepted. The lower the value of *Q* the less likely the null hypothesis will be rejected due to chance.

For this project, a range of *Q* values were used. The values used were 0.05, 0.1, and 0.2. We used a range of values because we were uncertain of the appropriate threshold to use. We also hope that by using a range of values trends can be identified over time.

Wetland indicators

The wetland indicators below come from "cheat sheets" on the Westside Wetlands SharePoint page. Also see Regional Supplement to US Army Corps of Engineers Wetland Delineation Manual for Western Mountains, Valleys and Coast Region for additional information.

Hydrology indicators

Primary (you need one primary indicator to satisfy criterion):

- Observation of surface water
- Observation of high water table (12" or less below surface)
- Saturation within 12"(with associated water table immediately below saturated zone OR restrictive layer within 12" of surface)
- Watermarks
- Sediment deposits
- Drift deposits
- Algal mat or crust
- Iron deposits
- Soil surface cracks
- Inundation visible on aerial photographs from growing season
- Sparsely vegetated concave surface
- Salt crusts
- Aquatic invertebrates
- Water-stained leaves (secondary along Coast)
- Hydrogen sulfide odor
- Oxidized rhizospheres along the channels of living roots, within 12" of soil surface
- Presence of reduced iron in upper 12" of surface (changes color when exposed to air)
- Recent iron reduction in tilled soils
- Stunted or stressed plants

Secondary (you need two secondary indicators to satisfy criterion):

- Drainage patterns (evidence of recent flow)
- Dry season water table (between 12" and 24" of the surface)
- Saturation visible on aerial imagery
- Geomorphic position (concave area, toe slope, floodplain, depression, swale, drainage-way, low fringe of water body, extensive flat, area where groundwater discharges)
- Shallow aquitard (within 24" of surface)
- FAC Neutral test (drop all FAC veg from assessment. More than 50% of the dominant vegetation is FACW or OBL)

- Raised ant mounds
- Frost heave hummocks

Wetland Plants (hydrophytes)

Indicator Status:
Obligate (OBL): Found in wetlands more than 99% of the time
Facultative wetland (FACW): Usually found in wetlands (67 to 99% of the time)
Facultative (FAC): Equally likely in wetlands and non-wetlands (34 to 66% of the time)
Facultative upland (FACU): Usually in uplands, but can be in wetlands (1 to 33% of the time)
Obligate upland (UPL): Found in uplands more than 99% of the time

Assess vegetation in each of the following strata:

1) TREES (all woody veg. 3"DBH and larger)
2) SAPLINGS/SHRUBS (all woody veg. <3" DBH)
3) HERBS (all non-woody plants)
4) WOODY VINES

Data needed to identify dominants:

1) List all species within each stratum, and identify coverage and indicator value.
2) Rank each species within strata by coverage.
3) Add coverage of each species within each stratum, beginning with highest coverage, until you immediately exceed 50%. These species (plus any species with 20% or more coverage) are dominants*.

Vegetation Indicators:

- Rapid test: All dominant species across all strata are OBL, FACW, or a combination of the two
- Dominance test: More than 50% of the dominants across all strata are OBL, FAW, or FAC ("50-20 rule")
- Prevalence index of 3 or less
- Morphological adaptations (buttressed roots, adventitious roots, tussocks, multiple stems) on FACU plants, that, if counted as hydrophytes, would raise the hydrophytic dominance to satisfy rapid test, 50-20 rule or prevalence index.
- Wetland non-vascular plants: More than 50% of the total cover of bryophytes consists of species that are known to be associated with wetlands. (NOTE: If the site has mineral soil, ask for help from a specialist!).

Hydric soils

Hydric soils may have some combination of the following characteristics:

- Organic muck (usually very dark in color, smooth, not gritty), throughout profile or on the surface of a mineral soil
- Peat (an organic soil in which the decomposing plant matter is still visible/identifiable, such as sphagnum peat or woody peat)
- A thick dark mineral surface layer, in which the colors of the soil minerals are masked by decomposed organic matter.
- Colors: grey, greenish, bluish, or pale brown to beige
- Reddish, yellowish or rusty-looking spots or mottles (redoximorphic features)
- Pale grey or beige areas or spots (depletions)
- Rusty-looking halos around the channels of live roots
- Hydrogen sulfide odor (smells like rotten eggs)
- Black nodules or concretions

If you are not sure if the soil is an upland soil or a hydric soil, get specialist help.