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Preliminary Assessment of Riparian Conservation Strategies within the

Northwest Oregon State Forests Management Area

Introduction

Aquatic resources include surface waters such as rivers, streams, lakes, springs, seeps and wetlands as well as subsurface waters such as aquafers and groundwater. The legal directive for managing aquatic resources on State Forests is that it should "result(s) in a high probability of maintaining and restoring properly functioning aquatic habitats for salmonids, and other native fish and aquatic life" (OAR 629-035-0010 6(b), OAR 629-035-0020 1(b) and 2(a)).

Riparian forests can have a profound influence on the physical, chemical, and biological attributes of aquatic resources. For example, riparian shade influences water temperature, and the recruitment of large wood and other organic material can lead to the formation of habitats important to the aquatic community. The influence of riparian forests on the aquatic resource is highly variable and depends in part on the aquatic feature and its position within the landscape.

The main measure used for the protection of surface waters is a riparian buffer, which is the retention of vegetation around an aquatic feature. Riparian buffers can be classified as "no-cut," where active management is limited, and partial harvest, where some portion of the buffer trees can be removed beyond minimum stocking targets.

The challenge of selecting a riparian buffer scheme that "results in a high probability of maintaining and restoring properly functioning aquatic habitats" (OAR 629-035-0010 6(b)) is the diversity of aquatic resource features. A "one size fits all" approach may under-protect some aquatic features and over-protect others. The cost of under-protecting an aquatic feature is the compromise of functioning aquatic habitats, which is unacceptable. The cost of over-protection, where a buffer width exceeds what is needed to influence aquatic function, conflicts with the other stated GPV goal to "…provide sustainable timber harvest and revenues to the state, counties, and local taxing districts." (OAR 629-035-0020 2).

In Oregon, a stream classification scheme has been developed that serves as the basis for the riparian management strategy, which reflects the terrestrial / aquatic interactions within the stream network. Streams are classified under the Forest Practices Act by the presence of fish (Type F as fish-bearing, else Type N as non fish-bearing), by stream size (small, medium, and large based on annual flow), and by flow duration (perennial flow after July 15, otherwise, seasonal flow). Under the current Northwest Forest Management Plan (FMP), seasonal streams are further classified as those that have a high debris flow potential (DFP), and those that do not (seasonal other).

The BOF has received documentation from the Private Forests Division (hereafter referred to Private Forest Documentation) that explores the influence of buffer width on stream temperature and wood recruitment to the streams. The Private Forest Documentation characterizes findings from a Department riparian and stream temperature study referenced as "RipStream". The following draws on and supplements that document with issues that are specific to State Forests.

State Forests' riparian strategies in the current FMP (revised 2010) are described in Appendix J. Maximum protection is given to streams that have a direct impact on fish habitat (Type F) targeting key functional components such as providing shade and large wood. In addition, large and medium Type N streams are given equal protection as Type F streams because of their influence on water quality (e.g., stream temperature and fine sediment), which could directly influence Type F streams. Results from the RipStream study concluded that Type F buffers in the current FMP, meet Oregon Department of Water Quality standards for protecting cold water (Private Forest documentation). In addition, there is strong evidence that these Type F buffers will provide similar levels of wood to streams through time as compared to unmanaged riparian forests (Private Forest documentation). The most direct assessment on the adequacy of State Forests Type F buffers in providing the long-term recruitment of wood to streams was conducted on one of the RipStream sites using simulation modeling (Meleason et al, 2013[1]). The main conclusion was that the FMP Type F buffer was indeed sufficient as compared to unmanaged forest. In addition, this assessment characterized the range of uncertainty associated with long-term projections. Although this analysis was limited to one site, it is consistent with previous research on buffer width and wood recruitment (Private Forest documentation).

Riparian buffers are also afforded to small perennial Type N streams and seasonal PDF. For small perennial Type N streams, a primary buffer function is to provide adequate shade to protect water temperatures. Preliminary results from the Trask Paired Watershed study suggest that no difference in stream temperature was observed within the first five years post-harvest on small Type N streams buffered according to current State Forests' standards. Fluvial transport of large wood out of these small streams is minimal since they are incapable of moving all but the smallest size classes. Thus, the buffer width needed for long-term wood recruitment is less than for Type F and medium and large Type N streams. The function of the buffer on seasonal PDF streams is to "load the channel" with wood and bedload so that when they fail, they deliver wood and gravel to a Type F stream.

The analysis reported here is a contribution towards the development of a revised FMP, looking at the possibility of a Land Allocation approach, which will achieve financial viability and improve conservation outcomes. The planning area includes Astoria, Forest Grove, Tillamook, North Cascades, Western Oregon and Western Lane State Forests Districts for a total of 610,621 acres. This document summarizes a preliminary assessment of selected riparian conservation scenarios as applied to streams in the planning area. A riparian conservation scenario is the collection of riparian buffer widths by stream type and is summarized by estimates of total acreage and monetary value. The general approach used for this analysis was to first estimate length of stream by stream type and then apply selected riparian conservation strategies to estimate riparian zone acreage within the planning area. Finally, the overall monetary value of excluding the riparian area from the production zone is estimated for each of the riparian conservation scenarios.

Methods

Estimating stream length by stream type. In the current FMP, streams are classified by presence of fish, persistence of flow, and stream size using the following criteria:

- Fish presence – "Type F" are inhabited by native or game fish such as trout and salmon for at least some portion of the year and "Type N" streams are uninhabitable by these fish species.
- Persistence of flow –

[1] Meleason, M. A., J. Groom, and L. Dent. 2013. A simulation framework for evaluating the effect of riparian management strategies on wood in streams: An example using Oregon's State Forest riparian management regulations. Pages 136 – 147 in P. D. Anderson and K. Ronnenberg, editors. Density Management in the 21st Century: West Side Story. PNW-GTR-880, Corvallis OR

- Perennial streams have surface flow after July 15 on an average water year and seasonal streams do not.
- Seasonal streams are further classified as (1) potential debris flow channels (PDF), which have a high potential to deliver bedload material (including wood and gravel) to a Type F stream, and (2) all other seasonal streams that do not have a high potential to deliver material to a Type F stream.

- Stream size – Three size classes as defined in the FPA, which is based on average annual daily flow: small (≤ 2 cfs), medium (> 2 cfs, and < 10 cfs) and large (≥10 cfs).

The estimate of stream length by stream type was conducted using modeled stream data. ODF maintains an official GIS layer for upper extent of fish use (UEFU) for the state of Oregon and the upper extent of perenniality (UEP) for State Forests; however, this stream layer has many unverified or unknown stream designations, especially for small Type N streams. For State Forests, both parameters require field surveys to determine their location along a stream.

For the purpose of this analysis, streams were modeled using digital elevation models (DEM) with a cell size of 5 meters. The official stream layer attributes for UEFU were conflated to the modeled streams. For streams without a UEP classification, a minimum basin area of 3.5 acres was used as the cutoff between perennial and seasonal flow.

Riparian Conservation Scenarios. For this analysis, nine riparian conservation scenarios were defined (Table 1). One of the key comparisons is between FPA and selected FMP buffer strategies. Since the FPA width and leave requirements vary by riparian stand characteristics (e.g., basal area), a minimum and maximum scenario was used to characterize the result of implementing the current FPA regulations within the planning area (Table 1). Although FPA buffer widths are defined as slope distances, they were applied in this analysis as horizontal distances to make them consistent with the FMP scenarios, which are based on horizontal distance. This simplifying assumption slightly inflates the results for the two FPA scenarios.

The remaining seven scenarios represent variants of the current FMP riparian protection measures. As currently defined, the riparian management area (RMA) is composed of three sub-zones (distance from stream in feet): stream bank (0 – 25), inner RMA (25 – 100), and outer RMA (100 – 170). The FMP goal for riparian conditions is to achieve “mature forest conditions” within 100 feet of all Type F and large and medium Type N streams. If the RMA is already in mature condition, the inner zone is left “unmanaged.” Active management within 100 feet of a Type F and medium and large Type N is rare, and only occurs if such actions can accelerate the development of mature forest conditions, such as thinning of young dense stands. The full extent of the RMA depends on the width of the outer RMA, which varies by stand conditions. Although the maximum width is 170 feet, 125 feet is assumed to be the maximum width given the current FMP criteria. Similarly, the RMA for small perennial Type N and seasonal PDF ranges from 25 to 50 feet.

Adhering to the current FMP’s riparian management strategy, the riparian conservation scenario can be described by two buffer widths. The first represents the width of small Type N and seasonal PDF stream and the second represents the buffer with of all Type F streams (regardless of stream size) and medium and large Type N (Table 1).

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Financial Cost. The net annual average value approximates the net annual value if the riparian forests were managed as part of the production area for each scenario. The value was calculated from the average production per acre per year from a 150-yr Patchworks simulation across all six districts. This value estimates the net average revenue that would have been generated if the riparian area was managed as the adjacent production zone. The “Riparian Buffer Value” for each scenario was estimated as the product of the sum of riparian buffer area (acres) across all districts and the weighted average by district area for the average production ($216.6 per acre).

Results

Based on this GIS assessment, the planning area has approximately 8,366 miles of streams, with approximately half the streams classified as perennial (Figure 1, Table 2). Approximately 17% of the streams by length are Type F and large and medium Type N, which represents the proportion of streams, afforded a riparian buffer under FPA and the larger of the two buffers for the FMP scenarios (Figure 1, Table 2). An additional 50% of the streams by length are afforded some level of riparian protection in the FMP scenarios that are not in the FPA scenarios (Figure 1, Table 2). The majority of the streams are small (88%), although by definition, seasonal streams are classified as small. When only perennial streams are considered, 67% of the streams are classified as small Type N.

The proportion of the planning area within riparian buffers ranged from <1% for the FPA minimum to nearly 8% for the FMP. This comparison assumes 50’ RMA on small Type N and 125’ on Type F and large and medium Type N (Figure 2). As compared to the FPA maximum, all FMP scenarios had at least twice the riparian buffer area.

The seven FMP scenarios fell into two general groups: the two scenarios with 50’ buffers for small Type N / seasonal PDF and the remaining five scenarios that had Type N/seasonal buffers ≤ 35 ft. A one foot increase in horizontal distance for the Type F and small and medium Type N buffers resulted in an increase of 173 acres. Similarly, a one foot increase in horizontal buffer width for small Type N and seasonal PDF resulted in an increase of 511 acres.

As with the proportion of the planning area within riparian buffers, the net annual riparian buffer values of the nine scenarios fell into three general categories. The FPA scenarios were by far the least expensive (maximum of $2.7 million/year) and the two FMP scenarios with the 50’ small Type N /seasonal PDF buffer were the most expensive ($10 million/year or more). A one foot increase in horizontal distance for the Type F and large and medium Type N buffers result in an increase in net annual average value of $37,470. Similarly, a one foot increase in horizontal buffer width for small Type N and seasonal PDF results in an increase in net annual average value of $110,750.

Discussion

This assessment explores the balance between financial cost and ecological benefits across the planning area. The relationship between ecological processes such as wood recruitment and riparian shade with buffer width are not linear but asymptotic (Private Forest documentation). In other words, there is a diminishing return in ecological benefit with an increase in buffer width. In contrast, the financial cost of riparian buffers is assumed to vary linearly in this assessment.

The overall cost (revenue generated if managed as part of the production zone) of a riparian buffer management strategy is driven by the relative proportion and level of protection given to stream types over the planning area. In this assessment, the FMP buffer scenarios were defined by two buffer widths – the first was applied to small Type N and seasonal PDF streams and the second was applied to Type F and large and medium Type N streams. Financial cost was more sensitive to changes in small Type N buffer widths and seasonal PDF streams than changes on Type F streams. This reflects that total stream length for small Type N and PDF streams differ by a factor of three.

The financial burden by buffer type is in contrast to the overall ecological benefit to the different stream types. Central to the directives in GPV is the protection of Type F streams especially maintaining and enhancing salmonid habitat. The elevated ecological importance and relative abundance affords a more precautionary approach in selecting buffer widths for Type F streams. Both wood recruitment and adequate stream temperature could be met on most Type F streams with buffer widths of between 80 and 100 feet slope distance (Private Forest documentation).

In contrast, buffer widths of 25 to 30 feet appear to be sufficient to maintain water temperature (preliminary Trask Paired Watershed Study results) in small Type N streams and load the channel with wood in seasonal PDF channels. A small Type N stream is defined by a perennial initiation point located in the upper portions of the watershed. Almost all of these streams are initially very narrow (0.1 to 1 foot in active channel width) and fully shaded by a combination of hillslope and shrubs such as salmonberry. Downstream of these initiation points, Type N streams can flow into or become Type F streams or increase in size as they combine with other Type N streams and become medium or large Type N streams. Overall, only 4% of Type N streams are classified as large or medium. Given that the vast majority of small Type N streams are initially very small and medium/large Type N streams are relatively rare, the effects of Type N streams on downstream fish-bearing streams is heavily skewed towards the smaller size classes, which need very little addition protection. There are "wider" small streams (e.g., >5 feet bankfull width) that may benefit from additional shade and these are assumed to be slightly greater in abundance than medium Type N streams.

FPA Buffer Scenarios. The two FPA buffer scenarios represent a baseline for comparison with the FMP buffer scenarios. The FPA buffer acres are overestimated because for this analysis, horizontal distance was used and not slope distance as prescribed in the FPA. Regardless, the difference between the FPA and FMP buffer scenarios do reflect the additional protection afforded to State Forests as directed by GPV. In fact, the difference between the FPA and FMP buffer scenarios represent the additional cost/protection afforded by State Forests. These contrasts between the two management approaches do not imply that the private forests are not meeting their intended objectives simply that they cannot be used to meet the objectives of State Forests.

No-cut Buffers. Although targets are used in both FPA (basal area) and the current FMP (conifer density) to determine the buffer width, all buffers in this analysis were assumed to be "no-cut" buffers. For State Forests, the objective of strategies to manage aquatic resources is to "result in a high probability of maintaining and restoring properly functioning aquatic habitats for salmonids, and other native fish and aquatic life (OAR 629-035-0010 6(b)". This implies that a fundamental goal of riparian buffers is to grow riparian forests to a desired future condition that would naturally grow at that site. The current condition of a riparian forest (e.g., basal area, tree density) may not reflect the protective measures needed to promote "properly functioning" riparian stand into the future.

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Limitations and Future Refinements. This effort has limitations that have the potential to severely bias the results and could be addressed if another iteration of this analysis was warranted. There are three areas that could be addressed.

1. Stream classification. The majority of streams are classified as small Type F, small Type N and seasonal PDF. A high proportion of small streams are actually classified as "unknown" in the official GIS data base, necessitating the use of modeled streams. The modeled stream assumptions could be refined this by applying these rules to small streams with this classification and comparing them to the known (field verified) values. Since our question is the sum of stream length by type by geographic region (versus currently summed for entire planning area) we could actually adjust our estimates as follows: stream length by stream type by geographic region = verified length + rule-based length * V / M, where V = sum of verified lengths and M = sum of modeled estimates for unclassified streams. This would adjust our model-based estimate for a given spatial extent (e.g., by district, or by district by HUC 12). This effort would take some GIS work and then some post-analysis.

2. Buffer overlap. The method used here to calculate buffer acreage was simply the product of the buffer width by stream length by type. This method is an overestimate because it does not account for overlap between buffers at confluences (e.g., a small perennial Type N's buffer within a Type F buffer). Sets of riparian buffer scenarios could be developed to assess overlap (e.g., for Type F 115, Type N and PDF as 25', 35', 50' so we get an estimate of overlap as compared to the linear approach.). This would require a modest investment in both GIS work and post-GIS analysis.

3. The cost value was calculated with a District-area weighted average to estimate the monetary value. The assumption here was that all districts have the same relative proportion of streams by type. This could be addressed by doing the calculation by district.

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Table 1. Riparian buffer management scenarios used in this analysis. All buffer widths are in feet with FPA buffers measured in slope distance and FMP buffers measured in horizontal distance. Multiple values within a cell designate the buffer width by stream size class: small, medium, and large. Cells with one value mean that the buffer width does not vary by stream size class for that stream type and riparian scenario. The four FMP scenarios are characterized by two buffer width with the first defining the horizontal buffer distance for small perennial Type N and seasonal PDF (potential debris flow) streams and the second for Type F (all size classes) and large and medium Type N.

Riparian Scenario	Buffer Width by Stream Type			
	Type F (small, medium, and large)	Type N (medium and large)	Type N (small)	Seasonal PDF (small)
FPA minimum	20, 20, 20	20, 20	0	0
FPA maximum	50, 70, 100	50, 70	0	0
FMP 25 / 100	100	100	25	25
FMP 25 / 115	115	115	25	25
FMP 25 / 125	125	125	25	25
FMP 30 / 115	115	115	30	30
FMP 35 / 115	115	115	35	35
FMP 50 / 115	115	115	50	50
FMP 50 / 125	125	125	50	50

Table 2. Stream length by type and size estimated for all streams within the planning area. All values are in miles with the percentage of all streams within parentheses.

Stream Type	Miles of Stream Length by Stream Size (percent of total)			
	Small	Medium	Large	total
Type F	423 (5)	386 (5)	504 (6)	1314 (16)
Type N	2871 (34)	103 (1)	10 (0)	2984 (36)
Seasonal PDF	1348 (16)	0 (0)	0 (0)	1348 (16)
Seasonal Other	2720 (33)	0 (0)	0 (0)	2720 (33)
total	7362 (88)	490 (6)	514 (6)	8366 (100)

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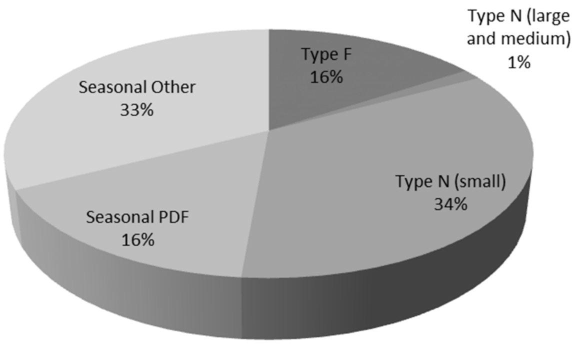

Figure 1. Proportion of stream miles by stream type estimated within the planning area. Stream types are defined as follows: Type F (fish-bearing), large and medium Type N (non-fish bearing), small Type N, seasonal PDF (seasonal streams with a high potential of debris flow into a Type F), and Seasonal Other (all other seasonal streams).

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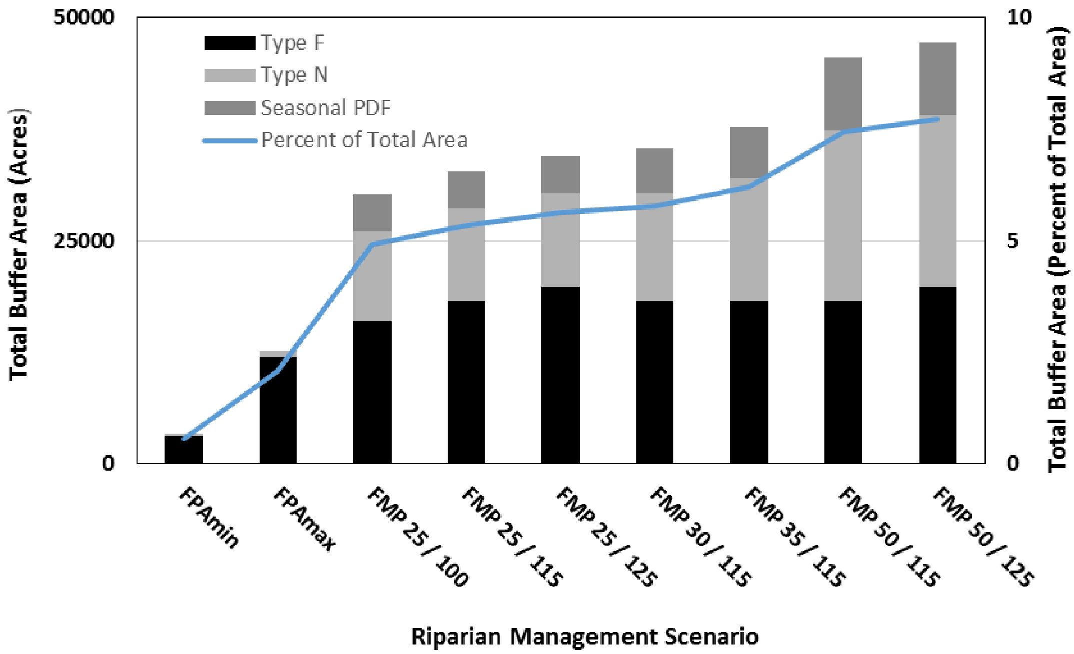

Figure 2. Total acres and the percent of total acres in riparian buffers estimated for the nine riparian conservation scenarios within the planning area. See Table 1 for riparian conservation scenario definitions.

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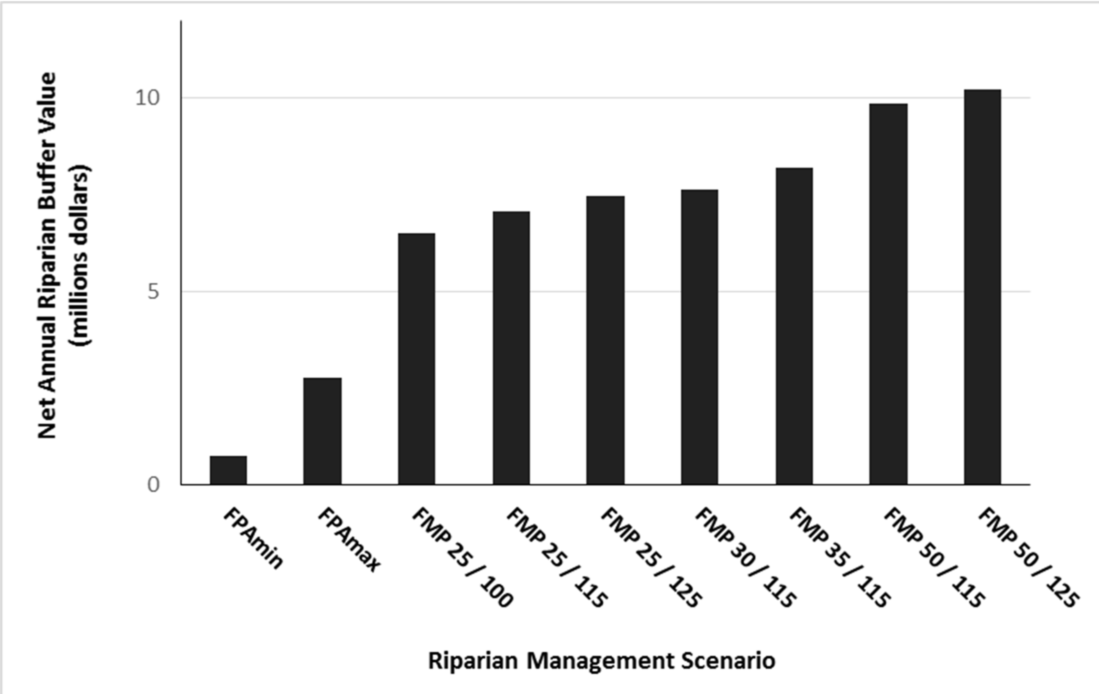

Figure 3. The net annual average value estimated for each riparian conservation scenario. This value approximates the net annual value if the riparian forests were managed as part of the production area for each scenario.