Riparian Rule Analysis: Analysis of riparian prescriptions and expected changes in restrictions

This document describes the results of the analyses of prescriptions that we have completed to date. Additional analyses will be provided in subsequent papers. This information on proposed prescriptions for meeting the Board of Forestry's (Board) rule objective includes the following elements:

- Descriptions of Prescriptions
- Predicted Temperature Change
- Change in Restrictions on Forest Practices
- Change in Wood Production Values (Economic Information)
- Ecological Information
    - Large Wood Recruitment
    - Change in Shade

Some preliminary information regarding Northwest and Southwest Regional Forest Practices Committees (RFPC) and stakeholder positions on geographic extent, stream reach extent and voluntary vs. regulatory approach is provided. These positions continue to evolve and will be provided in a final form for the July 2015 Board meeting.

PRESCRIPTIONS

We obtained a suite of riparian prescriptions from stakeholders and the Northwest and Southwest Regional Forest Practices Committees (RFPC), and the Department generated several potential prescriptions to ensure a full range of outcomes for the Board's examination. These prescriptions fell into three categories: no-cut buffers, variable retention buffers, and alternate prescription buffers. A prescription quick-reference table is provided in Table 1 followed by more detailed prescription narratives.

Table 1. Quick reference table of riparian prescriptions.

Prescription	RMA Width, Sm/Med (ft.)	Total BA, Sm/Med. (ft^2/1000')		Notes
No-Cut				
Department examined a range of no-cut prescriptions of 50, 70, 80, 90, and 100 feet in width.				
Variable Retention				
ODF-FPA	50 / 70	40 / 110-140		BA in conifer only.
OFIC-E	50 / 70	40 / 140		BA above FPA target in hardwood or conifer
AOL-B	50 / 70	60 / 140		BA above FPA target in hardwood or conifer
RFPC-A	50 / 70	80 / 160		BA above FPA target in hardwood or conifer
ODF-70/200	70 / 70	200 / 200		BA in conifer or hardwood
ODF-80/250	80 / 80	250 / 250		BA in conifer or hardwood
ODF-170/275	170 / 170	275 / 275		BA in conifer or hardwood
ODF-FMP	170 / 170	Depends on stand conditions		Three RMA zones: 25' no-cut, 25-100' managed for mature forest condition, 100' to 170' retain 15-70 conifers/1000'
Alternate Prescriptions				
Staggered-harvest		**1st entry**	**2nd entry**	
RFPC-B	50/70	Side 1: 50'/70' NC Side 2: Current FPA	Current FPA both sides	4-year riparian vegetation greenup
OFIC-C & AOL-A	50/70	40 / 120 ft2/1000'	FPA both sides	4-5 year greenup
South-sided buffer	**RMA Width, Sm/Med (ft.)**	**S-side, Sm/Med (ft^2/1000)**	**N-side, Sm/Med (ft^2/1000)**	
AOL-C	50/70	70 / 210	10 / 30	FPA or this if <45 deg from E/W
OFIC-F	50/70	52 / 182	28 / 98	OFIC-E or this if <45 deg from E/W
RFPC-C	50/70	100 / 180	40 / 120	FPA or this if <30 deg from E/W, BA above FPA target in hardwood or conifer

No-cut Buffers

For these scenarios, the Department generated a range of prescriptions where no trees are harvested from within the specified no-cut buffer distance (50, 70, 80, 90, and 100 feet), although trees may be felled for road construction, yarding corridors or other exceptions.

Variable-Retention Buffers

We analyzed several different variable retention buffer prescriptions generated by the RFPCs, other stakeholders and the Department. These prescriptions varied from one another in their no-cut distances, basal area targets, and riparian management area (RMA) width extents. Basal area was further differentiated in some cases by setting different conifer and/or hardwood targets. Per Board direction, the bookends of prescription retention values varied between the current Forest Practices Act (FPA) and State Forest Northwest Forest Management Plan (FMP) simulations.

Prescription: FPA

The FPA prescription demarcates one bookend under consideration. It has a 20 foot no-cut area, and RMA widths of 50 and 70 feet for small and medium streams, respectively. The standard targets are 40 and 110-140 $ft.^2$ of conifer basal area per 1,000 feet of stream per side of stream for small and medium streams, respectively. The range in basal area ($ft.^2$) for medium streams reflects the different standard target values across the different georegions[1] (geographic regions) west of the crest of the Cascade mountains.

Prescription: OFIC-E

Oregon Forest Industries Council (OFIC) proposed a prescription "E" which adds 20 $ft.^2$/1,000 ft. of alder basal area to all medium streams and increases the no-cut buffer width to 30 feet, while retaining the same RMA distances (50 ft. small, 70 ft. medium). The alder basal area would be obtained beyond the 30 foot no-cut distance. They proposed no changes for small streams other than specifying that retained trees would be evenly distributed throughout the RMA. All OFIC prescriptions are intended for application only to the Coast Range georegion; therefore, it would increase overall basal area targets for medium streams to match those of conifer standard targets for Interior streams (140 $ft.^2$/1,000 ft.). If insufficient alder is present on a medium stream to achieve the increase in the standard target then conifer (including those within 30 feet of the stream) are used to meet the standard target. If conifer basal area does not achieve the Coast Range conifer standard target of 120 $ft.^2$/1,000 ft., then the FPA is adhered to (629-640-400(6)(b) and (c)) with the exception that the no-cut buffer for medium streams remains at 30 feet.

Prescription: AOL-B

Associated Oregon Loggers (AOL) proposed a regulatory variable-retention prescription that they referred to as "B", similar to OFIC-E. A geographic extent for this prescription has not been specified at this time. Their RMA distances remain the same as current FPA standards. Basal area for small and medium streams would each increase by 20 feet, which would preferentially consist of hardwood. If insufficient basal area was available to meet the conifer basal area target

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[1] See the January 2014 Forest Practice Administrative Rules and Forest Practices Act, OAR 629-635-0220 and Figure 1 (page 50) (http://www.oregon.gov/odf/privateforests/docs/fparulebk.pdf).

(still 40 or 120 ft^2/1,000 ft for small or medium streams) then all conifers remain unharvested within the RMA and hardwood may be removed down to the new target (60 or 140 ft^2/1,000 ft). If the total basal area did not meet the new target, no harvest would occur in the RMA.

Prescription: RFPC-A
The Northwest and Southwest Regional Forest Practices Committees (RFPCs) refer to their voluntary variable retention prescription as Option A. This prescription is intended for the Coast Range georegion and for two-sided harvests only. It is structured very similarly to the current FPA except that it increases basal area retention for small and medium F streams by 40 ft^2. The additional basal area may be met by including hardwood basal area if available. Insufficient basal area to meet the new target would result in no harvest within the Riparian Management Area (50 feet wide for small F streams, 70 feet wide for medium F streams).

Prescription: VR-70/200
For this Department-generated prescription, the RMA width for all streams, small and medium, was set to 70 feet. Target basal area was set to 200 ft^2/1,000 ft. If the sites had more than the target basal area (live conifer and hardwoods > 6" Diameter at Breast Height (DBH)) then harvest could reduce basal area down to the 200 ft^2 target. If they did not initially achieve the target basal area, then no trees were harvested from within the RMA. A geographic extent for this prescription has not been specified at this time.

Prescription: VR-80/250
For this Department-generated prescription, the RMA width for all streams, small and medium, was set to 80 feet. Target basal area was set to 250 ft^2/1,000 ft. If the sites had more than the target basal area (live conifer and hardwoods > 6" DBH) then harvest could reduce basal area down to the 250 ft^2 /1,000 feet target. If they did not initially achieve the target basal area, then no trees were harvested from within the RMA. A geographic extent for this prescription has not been specified at this time.

Prescription: VR-170/275
For this Department-generated prescription, the RMA width for all streams, small and medium, was set to 170 ft. horizontal distance, which is equivalent to the outer extent of RipStream[2] vegetation plots. Target basal area was set to 275 ft^2/1,000 ft. All sites achieved the target basal area within the RMA outer boundary distance. A geographic extent for this prescription has not been specified at this time.

Prescription: FMP
The FMP prescription is described in Appendix J of the current Northwest State Forest Management Plan. This prescription represents the other bookend in the range of prescriptions being considered, considering RMA width and retained stocking densities. In Appendix J medium and small type-F streams have a 170 foot wide RMA, measured as a horizontal distance. The RMA is divided into three zones, the stream bank zone, the inner RMA zone, and the outer RMA zone. No harvest is allowed within the stream bank zone, which extends from 0 to 25 feet from the stream. The inner RMA zone, encompassing the area 25 to 100 feet from the stream,

[2] RipStream - Oregon Department of Forestry Riparian Function and Stream Temperature Study.

targets achieving or maintaining the stand at a mature forest condition. Mature forest condition of a stand is determined by examining its stand density index (SDI) and the number of conifers per acre. Hardwood dominated inner zones or inner zones with a sufficient number of large conifers meet the mature forest condition and receive no harvest. Harvest may occur in inner zones with many small-diameter conifer trees such that the stand reaches its target SDI and number of retained conifers. The third zone, the outer RMA, extends from 100 to 170 feet. A specified number of conifer trees per acre are retained, with the number retained depending on the number of conifers in the inner zone.

Alternate Prescriptions

The following prescriptions were developed as alternate prescription harvests. They either prescribe harvesting on alternating sides of a stream with a gap between entries of several years (staggered harvest) or prescribe the retention of riparian trees on the south side of streams while promoting varying levels of retention on the north side (south-sided or sun-sided buffers).

Several variable-retention staggered harvest prescriptions were proposed that involved harvesting a single side of the stream to the FPA or similar standard, and then harvesting the alternate side four or five years later.

<u>Staggered-harvest prescriptions</u>

Prescription: RFPC-B

The RFPCs produced a prescription option that relied on entry timing. This prescription is meant to be voluntary only within the Coast Range georegion and only for two-sided harvests. One side of the stream would be harvested to current FPA standards while leaving the second side unharvested for the full RMA width protected (50 and 70 feet for small and medium F streams, respectively). A green-up period of four years would pass to allow riparian vegetation to respond, and then the second side could be harvested according to the current FPA rule language.

Prescription: OFIC-C and AOL-A

The Oregon Forest Industries Council proposed a one-sided FPA harvest (their option “C”) to be followed five years later by an FPA harvest on the opposite bank. The Association of Oregon Loggers proposed a similar prescription (their option “A”) that differed only in that it allowed a four-year green-up period. Since we modeled the first entry only, we treated these as the same prescription.

<u>South-sided buffer prescriptions</u>

Prescription: AOL-C

The third AOL prescription involved shifting up to 75% of the north-side RMA basal area of the current FPA standard target to the south side of the stream if the average valley azimuth exceeds 45 degrees from due north or due south. This prescription would maintain the same no-cut widths as required under the FPA.

Prescription: OFIC-F

This OFIC option modifies OFIC-E. For situations in which small F streams would meet the standard target of 40 $feet^2$/1000 feet of conifer basal area and medium F streams meet the standard target of 120 feet^2/1000 feet of conifer basal area plus 20 feet^2/1000 feet of alder and/or conifer basal area, 65% of total required basal area for both sides of the stream could be retained on the south side of the stream, for streams within 45 degrees of East/West. All streams would retain a 20 foot no-cut buffer.

Prescription: RFPC-C

This RFPC option uses option RFPC-A as its baseline. For streams with a general valley azimuth within 30˚ of east-west, half of the additional basal area proposed in RFPC-A would be moved from the north to the south side of the stream, while current FPA would be maintained on both banks. In other words, RFPC-A increases basal area retention on small streams from 40 to 80 ft^2/1000 ft for both banks, while RFPC-C increases basal area retention on the same streams to 100 ft^2/1000 ft on the south bank and maintains 40 ft^2/1000 ft on the north bank. This allows an additional 20 ft^2/1000 ft of harvest in total relative to RFPC-A as an incentive. Medium streams would have 180 ft^2/1000 ft on their southern banks.

PREDICTED TEMPERATURE CHANGE RESULTS

For each no-cut and variable retention buffer prescription we simulated harvest by removing, from pre-harvest stand data, each tree that fell outside of the prescription requirements. We then summarized the remaining tree data according to the needs of the predictive model. Next, we ran the predictive model with the simulated findings and produced predicted temperature outcomes (for more information on the model, see Attachment 3 from the April 2015 Board of Forestry meeting).

All alternative prescriptions fell outside the scope of our ability to model them fully. Some inferences from other prescription outcomes may be relevant, but the predictive model was otherwise not used to estimate their effectiveness.

We provide a summary of prescription responses below. Detailed results for prescription testing according to the three prescription categories are provided in Appendix 4.

Mean Prescription Responses

Figure 1 summarizes mean site responses of modeled prescriptions.

Modeled temperature outcomes for no-cut buffer prescriptions between 50-100 feet indicate that effectiveness generally increases with width but the marginal gain of temperature protection per foot of buffer declines beyond 50 - 60 feet. For example, for the increase between 80 and 90 feet we see less of a decline in stream temperature increase than we did between 30 and 40 feet. The Figure indicates that the wider the buffer, the less the risk of exceeding the Protecting Cold Water criterion. The average temperature increase for a 90 foot buffer lies below the Protecting Cold Water (PCW) criterion threshold of 0.3 ˚C increase (mean = 0.29 ˚C, 95% CI = 0.07 to 0.52 ˚C).

The variable retention buffers are demarcated by the bookends of the current Forest Practices Act (FPA) standard targets and the State Forests Northwest Forest Management Plan (FMP). On average the predicted mean temperature increase for the current FPA, if harvest is conducted exactly to the standard target, is 1.45 ˚C (95% CI = 1.1 to 1.8 ˚C). The predicted temperature increase was 0.20 ˚C for the FMP (95% CI = 0.04 – 0.37 ˚C). A summary of the behavior of variable retention buffers is complicated by the inseparable relationship between prescribed RMA width and stocking levels. Additionally, model results are combined for a given prescription theme for both small and medium streams to simplify consideration (see Attachment 3). Given these factors, Figure 1 again shows an asymptotic relationship between variable retention prescriptions and modeled temperature response. The certainty of achieving the PCW criterion improves as prescriptions increase variable retention standards and become more similar to FMP standards. The point of diminishing marginal returns is difficult to determine given the range of prescriptions. The 0.3˚C increase level intersects the mean predicted temperature change at approximately 280 square feet of basal area, with 95% credibility intervals including 0.3 ˚C between 240 and 370 square feet (approximated by the VR-170/275 prescription).

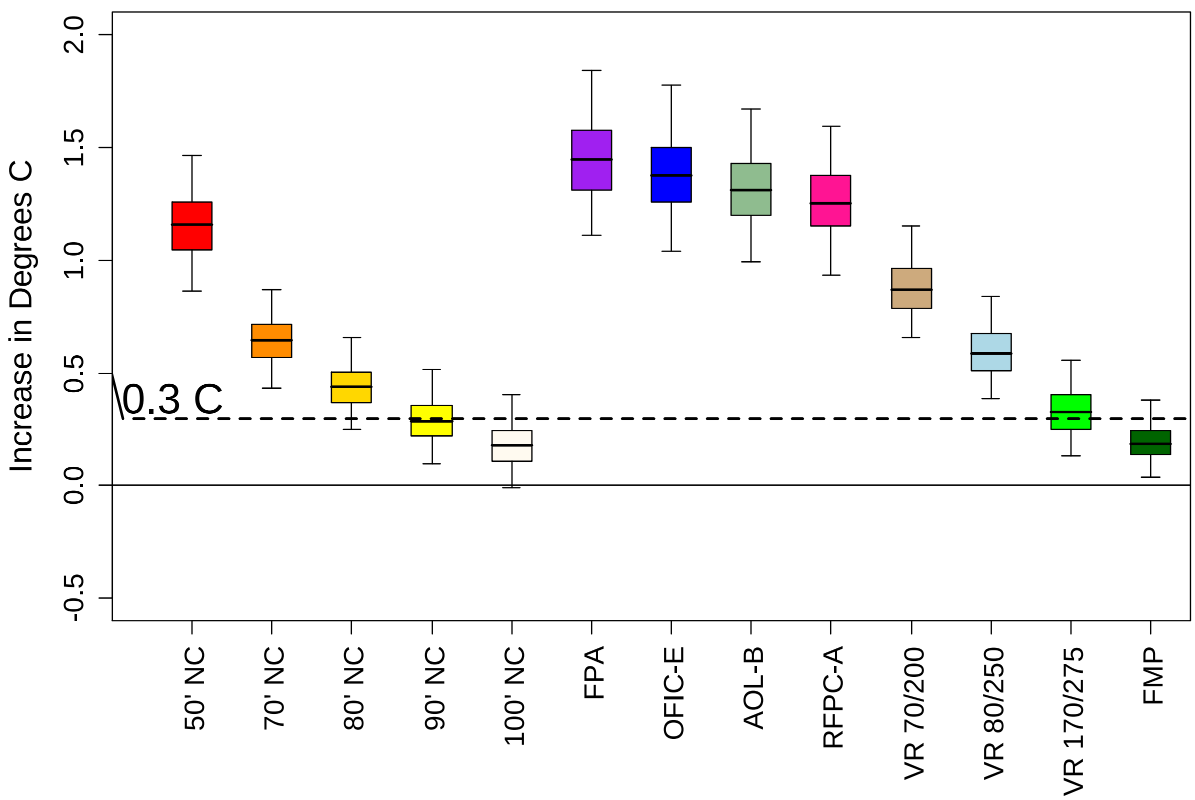

Figure 1. Mean temperature responses of 33 sites subject to different harvest prescriptions (see above for definitions). The 50, 70, 80, 90, and 100 foot NC prescriptions were subsets of the No-Cut prescription. The VR-170/275 values are specifically from the VR-170 prescription at a basal area retention value of 275 ft^2/1,000 feet of stream. The responses for two-entry prescriptions RFPC-B, OFIC-C, and AOL-A are not presented as predicted temperature increases could only be determined for a single side being harvest, not the effect of the entire harvest regime.

For alternate plan prescriptions proposing staggered harvests, we could only model the first entry in these cases, as the RipStream study design relied on simultaneous harvest of both riparian banks or leaving one side unharvested during the study. For this reason, these modeled values are not shown in Figure 1. The initial harvest entry for prescription RFPC-B is modeled to result in a temperature increase of 0.65 ˚C (95% CI = 0.44 to 0.89 ˚C). The first harvest entry for OFIC-C and AOL-A was considered similar enough to combine in modeling efforts and was anticipated to result in a mean predicted stream temperature response of 0.97 ˚C (95% CI = 0.50 to 1.45 ˚C).

We did not explicitly model south-sided buffer prescriptions, as the predictive model was not informed by stream orientation.

CHANGE IN RESTRICTIONS ON FOREST PRACTICES

The number of additional acres encumbered (i.e., beyond current rules) per mile of stream was calculated to provide an easy metric with which to compare the prescriptions. Additional encumbered acres per mile were greater for small than medium streams, and ranged from zero to 27.2 acres/mile (Attachment 2). For the No-cut prescriptions, the ranges of these acres were 0.9 to 11.7 and 5.4 to 16.2 acres/mile for medium and small streams, respectively. For Variable Retention prescriptions, the ranges of additional encumbered acres per mile were 0.4 to 23.3 and zero to 27.8 for medium and small streams, respectively. Three Variable Retention prescriptions (OFIC-E, AOL-B, RFPC-A) had less than two additional encumbered acres per mile for each of small and medium streams. Finally, there were no additional acres encumbered for three of the four alternate prescriptions. These prescriptions avoided additional encumbrances by either changing when portions of an RMA could be harvested (RFPC-B, AOL-A/OFIC-C) or moving retained basal area from one side of the stream to the other (AOL-C). RFPC-C moved a fraction of its additional basal area to the south side of the stream, and thus increases encumbered acres slightly above FPA. The exact values of these increases depends on the distribution of stream azimuths on the landscape. OFIC-F has the same total BA for both sides added together as OFIC-E, and thus would have a very similar amount of encumbered acres. For additional details of calculations for the numbers in the decision matrix (Attachment 2), see the Appendix of this Attachment.

CHANGE IN WOOD PRODUCTION VALUES (ECONOMIC INFORMATION)

The change in wood production values (i.e., value of additional acres encumbered beyond current rules) per mile of stream was calculated based on an average value per acre of $4,406/acre for industrial forestland and $6353/acre for non-industrial forestland. These values represent the average land and timber values (LTV) acres using a capitalized net income value approach. The average value is weighted by the distribution of site index and proportion of acres by geographic region. The differences between industrial and non-industrial values are due to assumed longer rotations and therefore older stands that have higher timber values for non-industrial owners.

The results mirror the results of the additional acres encumbered, as the values in the matrix are additional acres encumbered/mile times the $value/acre. Note the values are rounded to nearest $100. The change in wood production values per mile were greater for small than medium streams, and ranged from $0 to $122,400/mile for industrial forestland and $0 to $176,500/mile for non-industrial forestland (Attachment 2). For the No-cut prescriptions on industrial forestland, the values ranged from $4,000 to $51,700/mile and $23,700 to $71,500/mile for medium and small streams, respectively. For the No-cut prescriptions on non-industrial forestland, the values ranged from $5,700 to $74,500/mile and $34,200 to $103,000/mile for medium and small streams, respectively. For additional details of calculations of the land and timber values used in the decision matrix (Attachment 2), see the Appendix of this Attachment.

ECOLOGICAL INFORMATION

The Board also directed the department to develop ecological information related to each prescription, and in particular to look at impacts of proposed prescriptions on large wood (LW) recruitment. Stakeholders also expressed interest in seeing if the department could provide information on impacts to fish.

Large wood recruitment

Recruitment of large wood increases non-linearly with buffer distance (Figure 2). For the prescriptions analyzed, the range of recruitment of large wood from a mature conifer forest, expressed as a function of an unharvested scenario, ranges from 40% to 100% and 62% to 100% for small and medium streams, respectively (these bookends are the FPA and FMP, both of which are variable retention prescriptions; Attachment 2). Large wood recruitment ranged from 65% to 91% for No-Cut prescriptions. Finally, the south-sided alternate prescriptions cannot be rigorously evaluated for large wood recruitment since the simulation of vegetation plots cannot determine a mean buffer width. However, it is likely the prescriptions with short-term 1-sided harvests (RFPC-B, AOL-B/OFIC-C) would have large wood recruitment identical to that of FPA since these can be harvested down to FPA eventually. Similarly, it is likely the sun-sided buffer prescription AOL-C would have lower large wood recruitment than that of FPA since the same basal area is redistributed further from the stream, which reduces the probability of large wood reaching the stream (Meleason et al., 2002). RFPC-C and OFIC-F would offer some additional basal area relative to the FPA, although their effect on large wood recruitment cannot be analyzed since we do not know how the additional basal area affects buffer widths on north and south sides. These prescriptions can be bounded in that they cannot recruit more wood than their respective, associated variable retention prescriptions (i.e., OFIC-F must be less than OFIC-E, and RFPC-D must be less than RFPC-A since the same basal area is redistributed farther from the stream). For additional details of calculations for the numbers in the decision matrix (Attachment 2), see the Appendix of this Attachment.

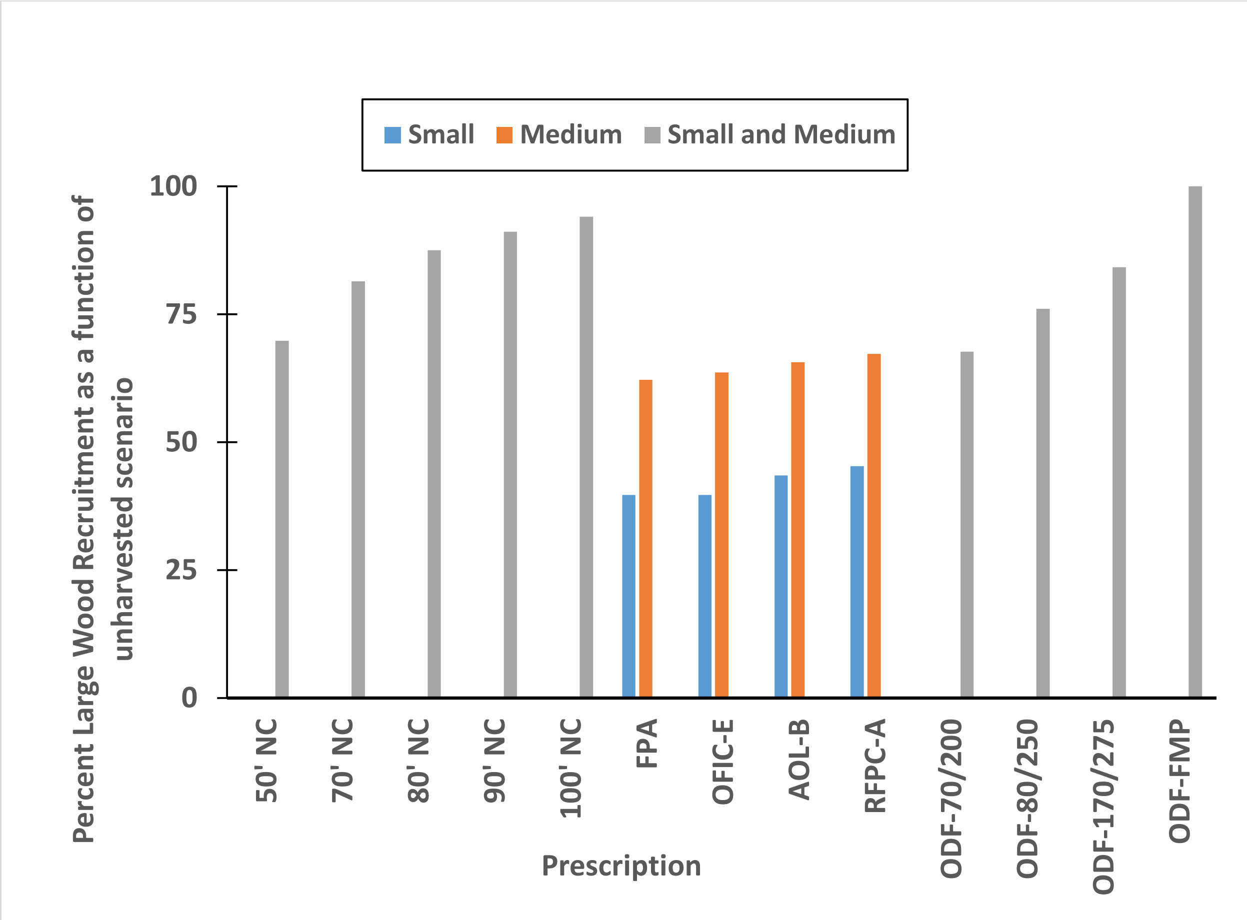

Figure 2. Cumulative recruitment of large wood (% of that from an unharvested reach) for each prescription

<u>Shade</u>

The relative decrease in percent shade gets smaller with increasing buffer width (Figure 3). This magnitude ranged from 0% to 26% and 0% to 18% for small and medium streams, respectively, for the FPA and FMP prescriptions (Attachment 2). Decrease in percent shade for No-Cut prescriptions ranged from 4% to 17%. Finally, the alternate prescriptions cannot be rigorously evaluated for decrease in percent shade since the predictive analysis is unsuitable for examining either a staggered harvest of stream sides or harvest prescriptions based on valley azimuth. However, it is possible the prescriptions with short-term 1-sided harvests (RFPC-B, AOL-B/OFIC-C) would retain somewhat more shade than that of FPA since these allow some time for riparian shrubs and trees on the harvested side to respond to the increase in sunlight resulting from the first entry. Similarly, it is likely that the south-sided buffer prescriptions (AOL-C, OFIC-F, RFPC-C) would retain more shade than that of FPA since more trees, and hence effective shade, are retained on the side of the stream which affects stream shade the most. For additional details of calculations for the numbers in the decision matrix (Attachment 2), see the Appendix of this Attachment.

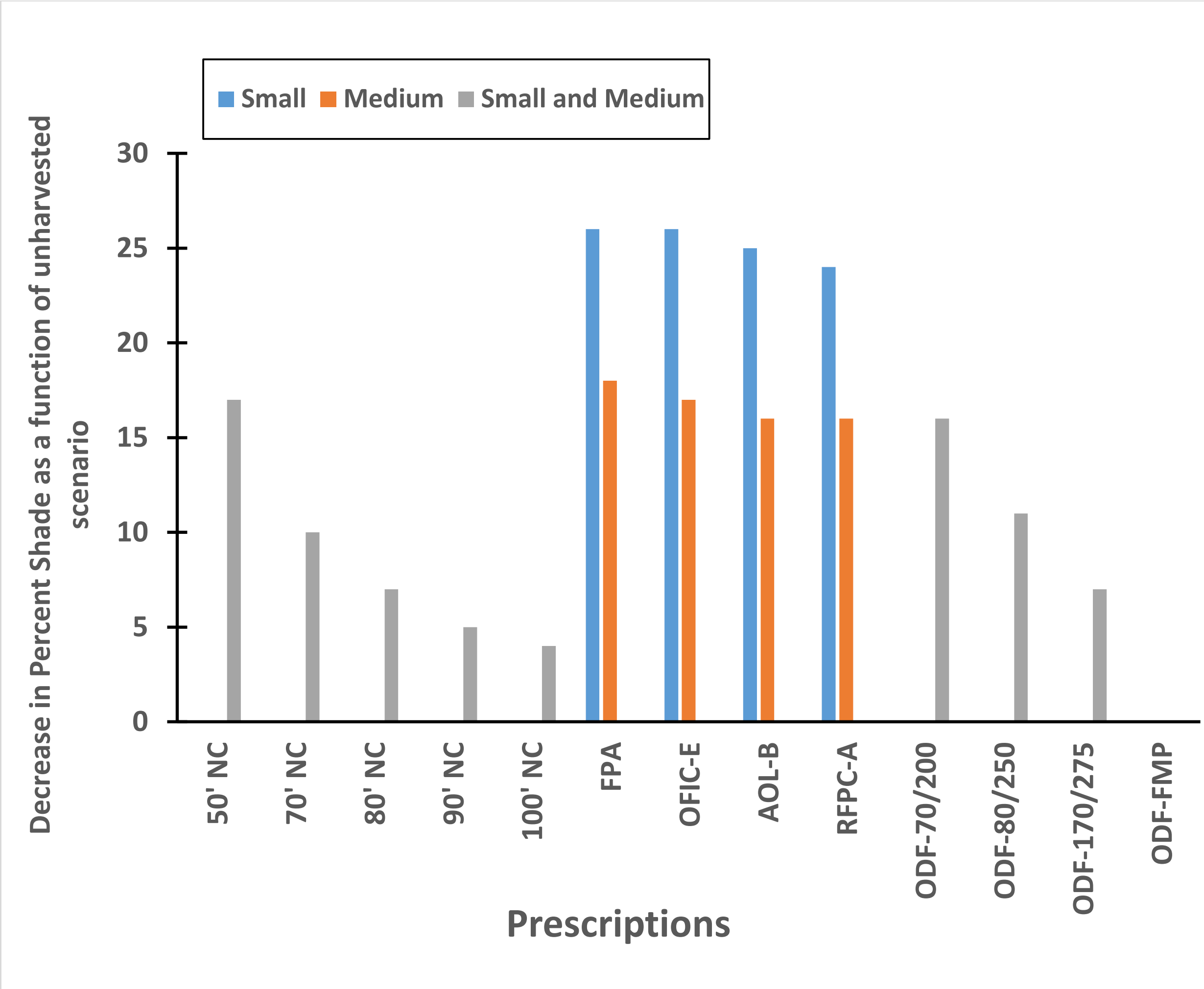

Figure 3. Decrease in percent shade, relative to unharvested scenario for each prescription.

<u>Fish</u>
We have not completed the analyses yet for fish and other ecological functions, and will provide this information at the July 2015 Board meeting.

<u>Additional Acres encumbered by Geographic Region, Ownership, and Stream Type</u>
We have not completed the analyses yet for additional encumbered acres per Geographic Regions, Ownership, and Stream Type, and will provide this information at the July 2015 Board meeting.

Appendix

Change in encumbered acres per mile

This metric assesses how many additional acres per mile of stream would be encumbered for each prescription analyzed. The formula for calculating this is:

ΔAcres/mile =[2*($W_{Rx,k}$ - $W_{FPA,k}$)*5,280 (feet/mile)]/[43,560 ft.^{2}/acre]

where 2 is because buffers are on both sides of the stream, $W_{Rx,k}$ is the mean buffer width (feet) of the prescription, and $W_{FPA,k}$ is the mean buffer width (feet) for sites where every tree harvestable under the FPA is removed. Both of these widths are determined by simulating harvest using data from RipStream vegetation plots. Subscript k indicates values that may be different for small and medium streams, depending on the prescription.

This calculation assumes no overlap of buffers due to e.g., tributaries. A cursory assessment of data in one georegion (the Coast Range) indicates these overlaps comprise less than 3% of the total encumbered acres, thereby suggesting this assumption does not introduce significant error.

Large Wood Recruitment

For each prescription, this metric is the percentage of large wood recruitment as a function of the non-harvested scenario. It is calculated from the average linear interpolation of large wood recruitment values from two publications as:

$$\boldsymbol{LW\%(W_{Rx}) = [\sum_{j=1}^{2} LW\%_{Pub,j}(W_{Rx})]/2}$$

where $LW\%_{Pub,j}(W_{Rx})$ is the large wood recruitment value from publication j evaluated at the mean buffer width for prescription Rx, W_{Rx} (in feet), and j=1, 2 are McDade and others (1990), and Meleason and others (2002), respectively. To determine this prescription-dependent recruitment of large wood:

$LW\%_{Pub,j}(W_{Rx})= LW\%_{Pub,j}(W_i) + [(W_{Rx}- W_i)/(W_{i+1} - W_i)]*[LW\%_{Pub,j}(W_{i+1})-LW\%_{Pub,j}(W_i)]$

where $LW\%_{Pub,j}(W_i)$ evaluated at W_i (the buffer width for the nearest data point from the publication to W_{Rx} that is also closer to the stream) and W_{i+1} is the next furthest-out data point in the publication.

This calculation assumes that large wood recruitment increases linearly between successive data points, which is likely a close approximation since this distance is 6.6 feet for each publication.

Decrease in percent shade

A relationship of decrease in percent shade for no-cut buffer width compared with a reference, unharvested site, in 10 foot increments, was determined from RipStream data (note: at the April Board meeting we presented a method to determine shade based on FEMAT curves. However, we decided to use the data from RipStream since these were more rigorously determined). To determine decrease in percent shade for a particular prescription:

$\Delta S(W_{Rx})= \Delta S(W_i)-[(W_{Rx} - W_i)/(W_{i+1}- W_i)]*[\Delta S(W_i)- \Delta S(W_{i+1})]$

where $\Delta S(W_{Rx})$ is the decrease in percent shade evaluated at W_{Rx} (the mean buffer width for prescription Rx), $\Delta S(W_i)$ is the decrease in percent shade from RipStream data evaluated at W_i (the nearest point to W_{Rx} that is closer to the stream), $\Delta S(W_{i+1})$ is the decrease in percent shade from RipStream data evaluated at W_{i+1} (the nearest point W_{Rx} that is further from the stream).

This calculation assumes a linear relationship between decrease in percent shade and buffer width over 10 foot intervals.

References

McDade, M. H., F. J. Swanson, W. A. McKee, J. F. Franklin, J. Van Sickle. 1990. Source distance for coarse woody debris entering small streams in western Oregon and Washington. *Canadian Journal of Forest Research* 20:326–330.

Meleason, M.A., S. V. Gregory, J. P. Bolte. 2002. Simulation of Stream Wood Source Distance for Small Streams in the Western Cascades, Oregon. USDA Forest Service Gen. Tech. Rep. PSW-GTR-181.

Calculation of Land and Timber Values

The Department calculated the land and timber values (LTV) using a capitalized net income value approach. The value of an acre of forestland is calculated as the present value of the net cash flow that can be produced over time (in this case in perpetuity). The approach is a value-in-use appraisal method that can represent the value of mature and immature stands, and bare land. The application of LTV to bare land is equivalent to soil expectation value (SEV), the present value of a perpetual series of timber harvest starting at age zero.

The LTV calculation also requires an estimate of the distribution of restricted acres by site class and stand age or volume. The stand age and/or stand volume will be used to calculate the value of the standing timber portion. USFS Forest Inventory Analysis data did not have sufficient plots to provide an accurate estimate of the standing volume in riparian acres.

The department built standing timber values based of work completed to estimate the values of timberlands at rick from wildfire (Figure A1). The department added annual management costs to the calculation and did not use stand establishment costs. The department calculated LTV separately for industrial (Figure A2) and non-industrial forestland (Figure A3), due to differences in standing volume and rotation ages. For non-industrial forestlands, average rotations were extended to 70 and 80 years.

The Department used Oregon Department of Revenue (DOR) Specially Assessed Forestland Values as the estimate of SEVs and added those values to the standing timber values, discounted appropriately. The department assume an age distribution of a regulate forest to calculate the average value by site index. The overall western Oregon value was weighted by the distribution of site index and proportion of acres by geographic region.

5% Market Discount Rate (Real)							Net Present Value ($/acre, market value) at stand age indicated							
Location	Site Index Range	Discount Rate (Real)	Harvest Volume (MBF/acre)	Stumpage Value ($/MBF)	Stumpage Price Increase (Real)	Stand Establishment Cost $/ac.	5	10	20	30	40	50	60	70
Northwest OR														
Site Index Range	110-140	5.0%			0.5%									
NW High Site	140		38	$400		$800	$2,117	$2,636	$4,085	$6,330	$9,809	$15,200		
NW Average	120		35	$380		$750	$1,853	$2,306	$3,574	$5,538	$8,583	$13,300		
NW Low Site	105		32	$360		$700	$1,605	$1,998	$3,096	$4,797	$7,434	$11,520		
Southern OR														
Site Index Range	85-120	5.0%			0.5%									
Southern High Site	120		30	$330		$650	$890	$1,108	$1,717	$2,660	$4,123	$6,389	$9,900	
Southern Average	105		25	$300		$575	$674	$839	$1,301	$2,015	$3,123	$4,840	$7,500	
Southern Low Site	85		21	$280		$500	$529	$658	$1,020	$1,580	$2,449	$3,794	$5,880	
Eastern OR														
Site Index Range	60-85	5.0%			0.5%									
Eastern High Site	85		21	$200		$475	$244	$303	$470	$728	$1,129	$1,749	$2,710	$4,200
Eastern Average	75		15	$185		$430	$161	$200	$311	$481	$746	$1,156	$1,791	$2,775
Eastern Low Site	60		12	$170		$400	$118	$147	$228	$354	$548	$850	$1,316	$2,040

Assumptions

Discount Rates: Personal communications with MBG and ODF

Volumes: Estimated based on Avg W OR harvest of 30 MBF/acre (G. Lettman, ODF)

Stumpage Prices: Estimated from average 2012+2013 Western ($543/MBF) and Eastern ($362/MBF) Oregon Log Prices minus $175 Logging & Transportation Cost (B. Kaetzel, ODF)

Real Stumpage Price Increase: Personal communications, MBG and ODF

Stand Establishment Costs include; Site Prep, seedlings, planting labor and a release spray - More of a "free to grow" status value (from M. Dykzeul - Member survey)

Figure A1. Regeneration/Forestland Value Estimator for Private Oregon Forestlands at Risk from Wildfire, Accounting for Stand Age and Site Productivity

For Industrial Forestland

Location	SI Range	Discount Rate (real)	Harvest Volume (mbf/ac)	Stumpage Value ($/mbf)	Stumpage Price Increase (real)	Annual Mgmt. Cost ($/ac)	0	10	20	30	40	50	60	LEV using DOR
Variables							Present Value of Standing Timber at Age Indicated, assuming rotation age of 50 years for NW and 60 years for Southern.							
Site Index Range	110-140													
NW High	140	5%	38	400	0.5%	5.0		$ 2,032	$ 3,752	$ 6,164	$ 9,746	$ 15,200		$ 925
NW Average	120	5%	35	380	0.5%	5.0		$ 1,260	$ 2,527	$ 4,492	$ 7,536	$ 12,253		$ 713
NW Low	105	5%	32	360	0.5%	5.0		$ 2,098	$ 3,196	$ 4,897	$ 7,534	$ 11,620		$ 573
Site Index Range	85-120						0	10	20	30	40	50	60	
Southern High	120	5%	30	330	0.5%	5.5		$ (44)	$ 1,052	$ 2,295	$ 3,941	$ 6,319	$ 9,900	$ 713
Southern Average	105	5%	25	300	0.5%	5.5		$ (312)	$ 636	$ 1,650	$ 2,941	$ 4,771	$ 7,500	$ 573
Southern Low	85	5%	21	280	0.5%	5.5		$ (493)	$ 355	$ 1,215	$ 2,267	$ 3,725	$ 5,880	$ 303

Present Value of Land plus Standing Timber at Age Indicated, assuming rotation age of 50 years for NW and 60 years for Southern (Discounted SEV+timber Value).

0	10	20	30	40	50	60	Regulated Forest Average	Western OR Weighted Average
$ 925	$ 2,163	$ 3,966	$ 6,513	$ 10,314	$ 16,125		$ 6,296.38	$ 4,405.59
$ 713	$ 1,361	$ 2,692	$ 4,761	$ 7,974	$ 12,967		$ 4,725.49	
$ 573	$ 2,179	$ 3,328	$ 5,113	$ 7,886	$ 12,193		$ 4,977.84	
0	10	20	30	40	50	60		
$ 713	$ 19	$ 1,154	$ 2,460	$ 4,210	$ 6,757	$ 10,613	$ 3,377.07	
$ 573	$ (262)	$ 718	$ 1,783	$ 3,157	$ 5,122	$ 8,073	$ 2,473.44	
$ 303	$ (467)	$ 398	$ 1,285	$ 2,381	$ 3,911	$ 6,183	$ 1,791.76	

Figure A2. Calculation of average land and timber (LTV) value for industrial forestland.

For Non-Industrial Forestland (adjusted to 70, 80 year roatation)

Variables							Present Value of Standing Timber at Age Indicated, assuming rotation age of 70 years for NW and 80 years for Southern.									LEV using DOR
Location	SI Range	Discount Rate (real)	Harvest Volume (mbf/ac)	Stumpage Value ($/mbf)	Stumpage Price Increase (real)	Annual Mgmt. Cost ($/ac)	0	10	20	30	40	50	60	70	80	
Site Index Range	110-140															
NW High	140	4%	60	400	0.5%	5.0		$ 1,871	$ 3,547	$ 5,595	$ 8,268	$ 11,889	$ 16,892	$ 23,872		$ 925
NW Average	120	4%	58	380	0.5%	5.0		$ 1,652	$ 3,239	$ 5,161	$ 7,657	$ 11,029	$ 15,681	$ 22,167		$ 713
NW Low	105	4%	57	360	0.5%	5.0		$ 1,422	$ 2,915	$ 4,704	$ 7,014	$ 10,123	$ 14,405	$ 20,370		$ 573
Site Index Range	85-120						0	10	20	30	40	50	60	70	80	
Southern High	120	4%	43	330	0.5%	5.5		$ (716)	$ 504	$ 1,714	$ 3,074	$ 4,756	$ 6,968	$ 9,977	$ 14,143	$ 713
Southern Average	105	4%	37	300	0.5%	5.5		$ (1,003)	$ 100	$ 1,144	$ 2,271	$ 3,625	$ 5,375	$ 7,734	$ 10,985	$ 573
Southern Low	85	4%	32	280	0.5%	5.5		$ (1,177)	$ (145)	$ 799	$ 1,785	$ 2,941	$ 4,412	$ 6,378	$ 9,075	$ 303

Non-Industrial Forestland adjusted to 70, 80 year roatation calculation

Location	SI Range	Harvest Volume (mbf/ac)	60	70	80
Site Index Range	110-140				
NW High	140	38	50	60	
NW Average	120	35	47	58	
NW Low	105	32	45	57	
Site Index Range	85-120				
Southern High	120	30		37	43
Southern Average	105	25		32	37
Southern Low	85	21		28	32

Present Value of Land plus Standing Timber at Age Indicated, assuming rotation age of 70 years for NW and 80 years for Southern (Discounted SEV+timber Value).

0	10	20	30	40	50	60	70	80	Regulated Forest Average	Western OR Weighted Average
$ 925	$ 1,959	$ 3,677	$ 5,788	$ 8,553	$ 12,311	$ 17,517	$ 24,798		$ 8,952.46	$ 6,353.4
$ 713	$ 1,720	$ 3,340	$ 5,310	$ 7,877	$ 11,354	$ 16,163	$ 22,880		$ 8,222.90	
$ 573	$ 1,476	$ 2,995	$ 4,824	$ 7,190	$ 10,384	$ 14,792	$ 20,943		$ 7,488.49	

0	10	20	30	40	50	60	70	80	Regulated Forest Average
$ 713	$ (670)	$ 572	$ 1,814	$ 3,222	$ 4,976	$ 7,293	$ 10,459	$ 14,856	$ 4,431.49
$ 573	$ (967)	$ 154	$ 1,224	$ 2,390	$ 3,802	$ 5,637	$ 8,121	$ 11,558	$ 3,303.34
$ 303	$ (1,158)	$ (117)	$ 842	$ 1,848	$ 3,034	$ 4,550	$ 6,583	$ 9,377	$ 2,552.79

Figure A3. Calculation of average land and timber (LTV) values for non-industrial forestland.