Discussion Paper 7 (DP7): Westside Regulatory Impacts and Responses

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Introduction

Regulatory constraints have become important factors affecting timber harvest volumes and economic returns for forest landowners. In Western Washington, regulatory constraints have increased significantly in recent years due to a major update to the forest practices regulations known as the Forests and Fish Rules (FFR). The FFR increased harvest restrictions around streams and other sensitive areas in an effort to help restore salmon populations and comply with the Endangered Species Act (ESA). The FFR are the result of 1999 legislation (WAC 222-30-021) that called for the implementation of the recommendations in the Forests and Fish Report, which represented a negotiated agreement between state and federal agencies and key stakeholder groups. Emergency rules went into effect in 1999 and were finalized in 2001. In 2006, the FFR were approved by federal agencies as a statewide Habitat Conservation Plan that satisfies the requirements of the ESA.

Forest and Fish Rules

In Western Washington, the FFR require a three-zone riparian harvest buffer along either side of a fish-bearing stream (Figure DP7.1). The total combined buffer width is one site potential tree height (SPTH), which is 90-200 feet depending on site quality. The zone adjacent to the stream is a 50-foot no-harvest core zone. This is followed by the inner zone, in which two partial harvest options are allowed subject to minimum tree count and basal area requirements. Option 1 allows thinning from below throughout the inner zone to a minimum of 57 conifers per acre. Option 2 divides the inner zone into two portions, allowing the trees furthest from the stream to be removed (up to a minimum distance of 80’ from the stream) while the trees in the portion closest to the stream are retained. The final zone is the outer zone, in which partial harvest is allowed with a minimum retention of 20 conifers per acre that are at least 12” in diameter. A 50-foot no-harvest buffer is also required around portions of non fish-bearing streams and around sensitive features such as seeps and springs.

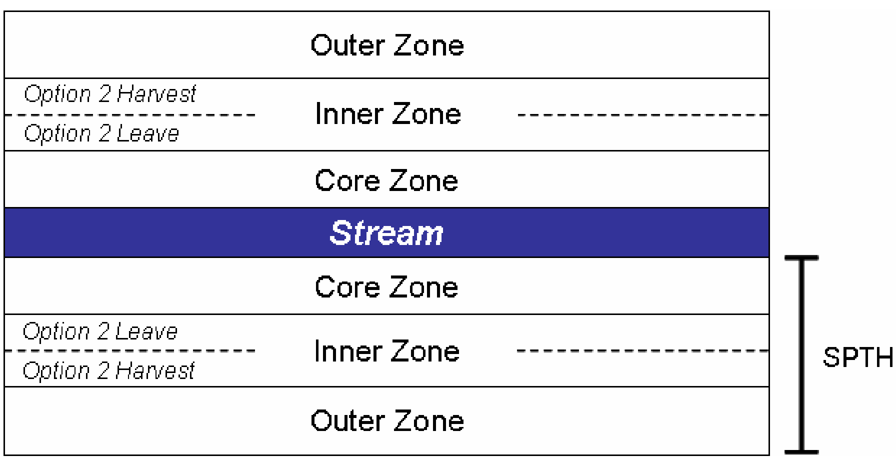


Figure DP7.1: FFR buffers for Western WA.

Regulatory Goals and Concerns

The goal of the Westside buffer rules is to put the development of riparian stands on a trajectory toward a desired future condition (DFC) of mature forest structure intended to provide high quality riparian habitat. This DFC is defined as “the stand conditions of a mature riparian forest at 140 years of age” (WAC 222-16-010). In addition to this ecological goal, the FFR also have the concurrent economic goal of “maintaining commercial forest management as an economically viable land use" (RCW 77.85.180). There have been concerns about the economic impacts of the riparian harvest restrictions, especially for small, private forest ownerships. These concerns were expressed in the Forests and Fish legislation, which found that the riparian harvest restrictions would "further erode small landowners' economic viability and willingness or ability to keep the lands in forestry use and, therefore, reduce the amount of habitat available for salmon recovery" (RCW 76.13.100) as an unintended impact.

The economic impacts on small forest ownerships are of particular concern, as small ownerships in western Washington tend to be located in lowland areas in close proximity to streams (Rogers 2004). This suggests that small ownerships are of particular importance for salmon recovery and are also likely to have disproportionate economic impacts compared to other ownership classes. In addition, with small ownerships, averaging the harvest impact over broader areas, as generally occurs with larger landowners, does not adequately represent the impact on a small owner and does not provide useful information with respect to how he or she will make decisions. The impacts are concentrated on those ownerships where streams are present (Figure DP7.2).

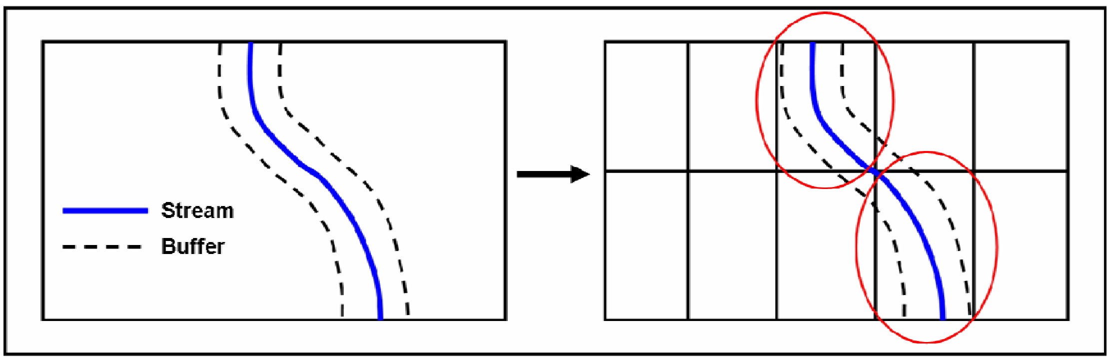


Figure DP7.2: Unlike large landowners (left) where buffer impacts are averaged over large areas, with small ownerships (right) the impacts are concentrated on individual properties where streams are present.

An examination and comparison of the overall economic impacts of riparian harvest restrictions on large and small landowners was completed as part of a Small Business Economic Impact Statement (SBEIS) of the FFR. The SBEIS found that in western Washington, the riparian harvest restrictions cost large landowners 11.1% of their total timber asset value compared to 19.1% for small landowners (Perez-Garcia et al. 2000). These results suggest that the restrictions indeed have disproportionate impacts on small ownerships. However, these results reflect the average impact for small landowners as a whole; they do not demonstrate the high variability across small ownerships that can be expected (i.e. Figure DP7.2). Owner decisions will be based on individual impacts, not averages.

Small Ownership Case Studies

To provide point estimates of the magnitude and variability of impacts for individual landowners, ten case studies were analyzed for small forest ownerships in western Washington that included riparian areas (Zobrist 2003). The case studies were located in Lewis County and Grays Harbor County, covering a range of coastal and inland sites. The case studies ranged in size from 33 to 310 acres, and each case study had different proportions of riparian and upland areas and had a mix of stream types, stream sizes, timber types, and timber age classes.

Most of the case study stands were medium to high site (class I or II). For Lewis County, the base management regime was assumed to be planting Douglas-fir (*Pseudotsuga mensiesii*)at 435 trees per acre (10 by 10 spacing) on a 50-year rotation with an early commercial thin from below to 180 trees per acre at age 20. For the stands that had lower site quality (class III), the rotation length was extended to 55 years. The Grays Harbor County case studies assumed a different thinning regime because of the prolific natural regeneration of western hemlock (*Tsuga heterophylla*) that occurs in the coastal region. For these cases, it was assumed that a pre-commercial thin from below would be done at age 15 to 270 trees per acre (200 Douglas-fir and 70 western hemlock) followed by a commercial thin from below at age 35 to remove half of the remaining stems.

For each case study, management was simulated under several scenarios, including no riparian harvest restrictions, maximum allowable riparian harvest under the FFR (usually Option 2 when permitted), and no harvest at all within the riparian zone (full width buffer). Two measures of economic performance were used to assess the economic impacts of riparian harvest restrictions: forest value and soil expectation value (SEV). Forest value is the net present value (NPV) of the expected costs and revenues from any existing timber combined with the economic value of the land for future rotations. NPV can be used to measure the total economic cost of riparian harvest restrictions, including both land and timber.

SEV is the economic value of the land by itself (separate from any existing timber) for the purpose of perpetual forestry use given the expected costs and revenues of managing timber starting with bare ground. Unlike forest value which largely reflects the value of existing timber for which prior establishment costs are sunk, SEV reflects the net economic return from sustainable forestry (successive rotations) starting with bare ground i.e. before planting. This is an important measure of the long-term economic sustainability of forestry as it represents the economic motivation to pursue future forest rotations rather than convert to an alternative land use once the existing timber is harvested. All economic calculations were done before taxes using a 5% real rate of return (Zobrist 2005).

The range and distribution of the impacts of riparian harvest restrictions on forest value (i.e. total economic cost) for the ten case studies are presented in Figure DP7.3. While there is a wide range of impacts, the larger impacts are associated with larger portions of ownership within a riparian area. There were also differences depending on how the riparian zone was managed. Assuming the maximum allowable riparian harvest, the economic costs ranged from 17.5% to 41.5% of the total economic asset value. However, many small landowners choose not to pursue the maximum allowable harvest. This may be due to several factors, including the complexity and additional layout costs associated with the partial harvest options for the inner and outer zones. When no harvesting in the riparian zone is assumed, the losses range from 25.1% to 57.4% of the total economic asset value.

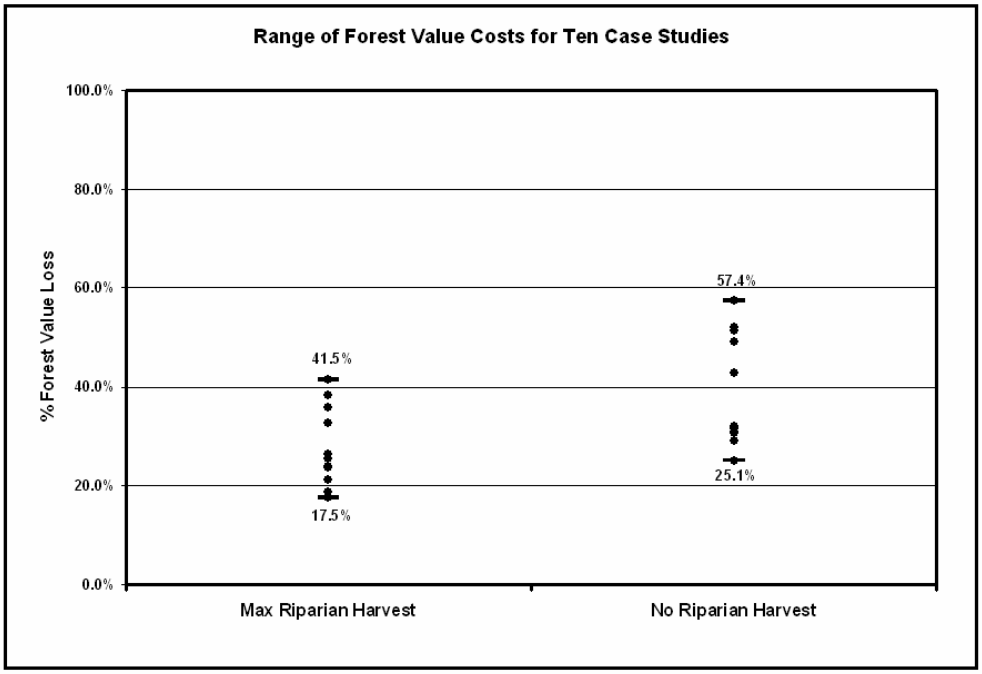


Figure DP7.3: Riparian harvest restrictions cause a significant reduction in economic asset value.

For future rotations in which all the costs of production are considered, the economic impacts of riparian harvest restrictions are more pronounced. This is illustrated in Figure DP7.4, which plots the range and distribution of the impacts on SEV for the ten case studies. The range and magnitude of impacts are wider, ranging from 22.9% to 144.8% of SEV assuming the maximum allowable harvest and ranging from 33.6% to 163.8% of SEV assuming no riparian harvest. Losses greater than 100% suggest that with the current riparian harvest restrictions, forestry is not economically viable (present value of expected costs exceeds present value of expected revenues) given the assumptions.

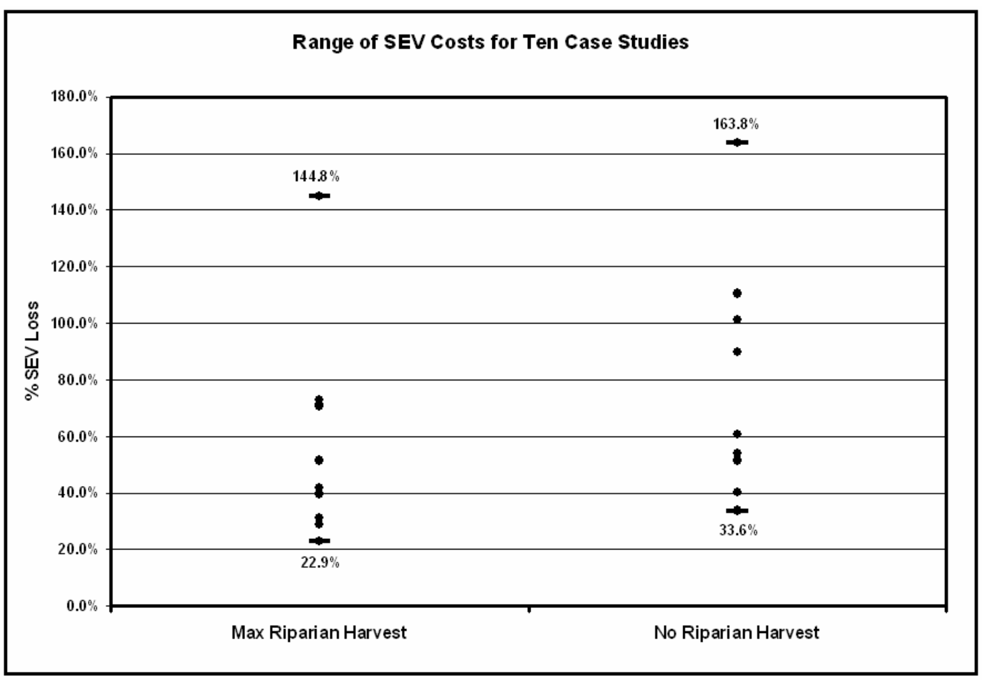


Figure DP7.4: The impact of riparian harvest restrictions on SEV is much more pronounced, which has important implications for the long-term economic viability of forestry.

Riparian Implications for Washington's Future Timber Supply

Harvest restrictions such as the FFR have both direct and indirect impacts on Washington's future timber supply. The direct impact results from timber volume that is off-limits for harvest due to regulatory changes. For the ten case studies, the reduced volume over the next 50 years ranged from 3.4 to 5 million board feet (depending on max vs. no riparian harvest) on a total of 406 riparian acres of designated riparian management zones. This amounts to a range of 8 to 12 thousand board feet (MBF) per riparian acre over the next 50 years.

While these case studies do not represent a statistical sample of forest conditions on small ownerships, they do include a mix of Westside conditions that can be scaled up to provide preliminary, ball-park estimates of Westside impacts. Using acreage estimates of non-FFR exempt small forest ownerships and estimated proportions of riparian zone, there are approximately 238,896 acres of designated riparian zones on small ownerships in western Washington subject to the FFR. Using the case study estimate of 8-12 MBF per riparian acre, this yields an approximate total restricted volume of 2.0 to 2.9 billion board feet over the next 50 years (39 to 59 million board feet per year) depending on how intensively riparian zones are managed.

These estimates only include the direct impacts of buffer restrictions on small forest ownerships in Western Washington. They ignore the impact of more difficult access to the timber caused by the buffers breaking the land into many smaller areas that may no longer be economically operational or any road or stream crossing upgrade requirements. Industrial lands are also subject to the FFR, and while they may not have as high riparian impact as a proportion of total acreage, they do have more total riparian acreage. As with the NIPF ownerships, the volume impact per riparian acre can be expected to be substantial. Industrial owners are more likely to pursue the maximum allowable harvest in the riparian zone, however, which should keep their costs at the lower end of the range.

The volume impacted by riparian buffers may be disproportionate by species. Of particular concern is red alder (*Alnus rubra*), which is often found in riparian areas. The commercial importance of red alder has increased in recent years. Demand for this species is strong, and alder log prices have exceeded Douglas-fir (Mason 2006). A reliable supply of this species will be needed to maintain the market infrastructure. For the ten case studies, the riparian harvest restrictions under the FFR reduced the harvestable red alder volume by 53% to 64%, compared to a 16% to 25% reduction for Douglas-fir and 17% to 26% overall (Table DP7.1)

Table DP7.1: Reduction in harvest volume by species over 50 years due to riparian harvest restrictions.

Species	Max riparian harvest	Full buffer
Douglas-fir	16%	25%
Red alder	53%	64%
Total	17%	26%

In addition to direct reductions in available harvest volume, the economic impacts can have long-term, indirect effects by reducing the economic competitiveness of forestry as a land use. The case studies above demonstrate that the economic costs of regulatory constraints can be high for individual landowners, especially the costs to the land value (SEV). The SEV costs are of particular concern, as they suggest a greater impact on future rotations. In some cases the loss in SEV was over 100%, indicating that, at a 5% cost of money, future timber rotations would not be economically viable. In these cases, when the existing trees are harvested at the end of the current rotation, there would be a high economic motivation for the landowner to pursue an alternative land use rather than begin a new forest rotation for which the revenues are not expected to cover the production and interest costs.

The over 100% loss cases not withstanding, any reduction in SEV is of concern because it diminishes the economic competitiveness of forestry relative to other land uses. Significant conversion of forestland to other uses has already been occurring in Western Washington (Bolsinger et al 1997) and land values for real estate development are often an order of magnitude higher than for forestry use. These pressures will be present even without regulatory constraints. However, further reductions in the economic viability of commercial forestry can be expected to exacerbate this trend, especially for landowners who are on the economic margin of conversion. Existing ownership patterns show that the forest land along streams has already been partitioned from larger upland tracts. The high cost of management within the riparian zone provides additional motivation to subdivide the land further in order to remove more of the riparian zones from timber use.

Additional forestland conversion would further diminish available timber supply, but perhaps of greater importance is the reduction in ecological services and other benefits provided by these lands remaining in forestry. The lands for which riparian harvest constraints provide the strongest economic motivation to pursue an alternative land use are the lands with the closest proximity to streams. At the same time, these are the lands that are most important for the conservation of aquatic resources. Differentially, lands being developed for non-forestry uses are not subject to the same stream buffering requirements as forestry. Depending on county-specific rules, timber can be cleared much closer to the stream for the purpose of development than for forest management purposes (Figure DP7.5). By converting to development uses, a landowner may be able to capture additional value from the existing timber while also realizing a much higher land value. The proximity to water may even increase the property's value for development purposes.

Figure DP7.5: A new (2006) housing development in Snohomish County, WA.

Only 15 feet of forested buffer is maintained around the stream, and houses are built within 30 feet of the stream edge. Had this parcel been used for forestry, a minimum of a 50-foot no harvest buffer would have been required, with additional buffering out to a total of 90-200 feet depending on stream type and site class.

Mitigation Efforts

There have been several efforts to mitigate the economic impacts of the FFR. The Forest Excise Tax was reduced from 5% to 4.2% of the stumpage value of harvested timber for landowners (large and small) impacted by the FFR. However, the value of the timber restricted from harvest is usually many times greater than the value of the tax credit, especially for small landowners, as the value of the credit is proportional to the volume of unrestricted, harvestable timber (Reeves 2004). For the case study examples above, the economic impacts were calculated before taxes. These results suggest that even if taxes were eliminated completely, some ownerships would not be economically viable given harvest restrictions. Ultimately, while tax policies are an important factor in the economic competitiveness of forestry in Washington, tax credits alone may not carry enough leverage to offset other regulatory constraints. The regulatory impacts are several times larger than taxes and hence of greater concern for maintaining land in forestry.

Another mitigation effort is the Forestry Riparian Easement Program (FREP). The FREP is a program exclusively for small landowners which provides direct compensation for the value of timber that is restricted from harvest under the FFR. The FREP pays participating landowners 50% of the stumpage value of the restricted timber in return for a 50-year easement on that timber. In cases where the value of the restricted timber exceeds a high impact threshold of 19.1% of the total timber sale value, the value in excess of this threshold is compensated at 100%. This means that the timber value that a landowner can lose due to riparian harvest restrictions is limited to 9.55% (50% of 19.1%).

Applying projected FREP payments significantly reduced forest value costs for the case study examples (Figure DP7.6). FREP payments coupled with maximum riparian harvest limited the costs to a range to 6.5% to 22.6% of forest value. Only the minimum trees required to be left pursuant to the FFR (i.e. the leave trees under the max riparian harvest scenario) qualify for the FREP, but even if no harvest was done in the riparian zone, the costs were reduced substantially to a range of 12.5% to 35% of forest value.

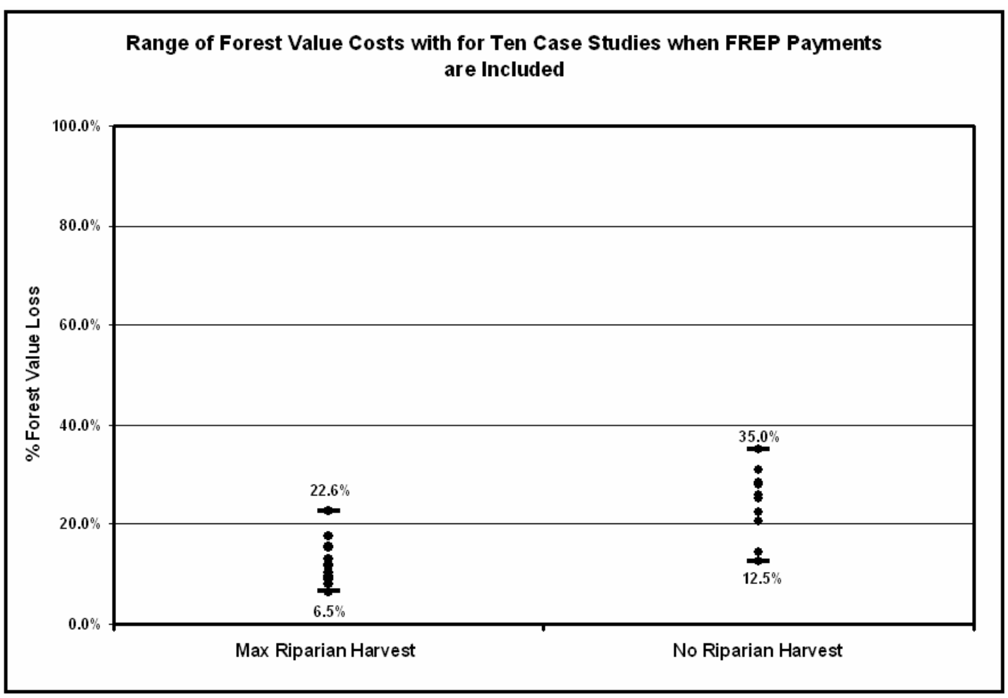


Figure DP7.6: Forest value losses are substantially reduced by FREP payments.

While the FREP can substantially reduce economic impacts for small forest landowners, it does not fully address the impacts of riparian harvest constraints. The FREP is only applicable to small forest landowners and so it does not address the impacts of the harvest restrictions on industrial lands. The FREP also will not replace the directly restricted harvest volume. However, it does provide funds to help landowners with the additional expenses of managing within the riparian zone and thus may encourage more landowners to pursue the maximum riparian harvest which would keep harvest reductions at the lower end of the range. Furthermore, the FREP only compensates for existing timber—not for the lost economic productivity of the land that is tied up by that timber. In other words, while the FREP significantly reduces the total forest value costs, it does not change the SEV impacts and thus does not mitigate for any diminished motivation to pursue future rotations once the existing timber has been harvested and easement payments have been made.

Ultimately, the biggest limitation of the FREP may be funding. The FREP does not eliminate the costs of riparian harvest restrictions; rather it shifts those costs to the state. For the ten case studies, the present value of the total projected FREP payments was $1,914 per riparian acre. Using the same scale-up factor as before, the present value of the cost to cover all qualifying landowners would be in excess of $457 million, just for the Westside. This is equivalent to a cost of over $25 million per year, which far exceeds current funding for the entire state.

Opportunities for Management Alternatives to Achieve Desired Future Conditions

The significant economic costs of riparian harvest restrictions and the challenges of long-term mitigation of those costs suggest that lower cost management alternatives are needed. This is especially true for circumstances in which the prescribed harvest restrictions may not effectively achieve the DFC. Private ownerships in Western Washington are often characterized by young, dense Douglas-fir plantations. These stands would typically be thinned to maintain growth and vigor. However, commercial thinning is generally not permitted in the no-harvest portions of riparian buffers, and pre-commercial thinning is not economically attractive since the costs would not be recovered by subsequent commercial harvests in these areas. The absence of thinning would leave these areas closest to the stream that are particularly important for riparian function in a dense, overstocked condition that may inhibit the development of the DFC (Carey et al. 1996, Carey et al. 1999, Chan et al. 2004).

In anticipation of these issues, the FFR allow landowners to deviate from the default buffer prescriptions using approved alternate plans. The rules recognize alternate plans as a means of reducing compliance costs for landowners, stating that alternate plans can be used to “meet riparian functions while requiring less costly regulatory prescriptions”(RCW 76.13.110). The rules further suggest that templates be used to facilitate alternate plan preparation and approval for common situations such as young, overstocked stands (WAC 222-12-0403). Templates would outline specific strategies to serve as management models for achieving ecological and economic goals in riparian areas.

Alternate plan templates are a potential riparian management solution for achieving the DFC sooner in managed stands and for providing for greater economic sustainability, especially for small landowners. In the common case of young, overstocked stands, alternate plans can utilize thinnings throughout the riparian zone, which can accelerate the development of mature forest structure (Garman et al. 2003; Tappeiner et al. 1997). In particular, “biodiversity pathways” that utilize repeated, heavy thinnings over long rotations show promise as a management approach for quickly developing the DFC while reducing economic costs (Carey et al. 1996, Carey et al. 1999, Lippke et al. 1996).

Two example alternate plan templates for young, overstocked stands were developed based on the biodiversity pathway approach (Zobrist et al. 2004, 2005a). Both example templates utilize repeated thinnings throughout the riparian zone. Each template includes a 25-foot bank stability zone in which the overstory is not thinned below 60 trees per acre (TPA) in order to provide for continuous shade and bank stability. Beyond the bank stability zone, one template (Alt A) calls for additional buffering out to 80 feet that will receive additional thinning treatments and a regeneration harvest at age 100. The other template (Alt B) calls for additional buffering out to 50 feet but does not allow thinning below 25 TPA.

To measure the performance of template options relative to the DFC, a targeting and assessment procedure was developed (Gehringer, 2006). This procedure uses a reference dataset of actual stands that are representative of the DFC. The key stand attributes are then identified that best describe the structure represented by the reference dataset. The distributions of these attributes, when considered simultaneously, provide a quantitative management target. A stand whose attributes overlap with this target is statistically similar to the DFC as quantified by the reference dataset. In this case the reference dataset was comprised of Forest Inventory and Analysis (FIA) data that had been selected based on age, management history, and proximity to a stream. Stand density, quadratic mean diameter, and average height were identified as attributes that described the structure of the reference stands well and provided good discrimination between stands that were or were not representative of the DFC.

To compare the performance of the two example template options with the two FFR scenarios (max harvest and full buffer), each scenario was projected over time with the Landscape Management System (LMS) for a 20-year-old Douglas-fir plantation that was representative of a typical young, overstocked stand in Western Washington. This test stand was site class II, and a small stream was assumed for the regulatory scenarios. The DFC targeting and assessment procedure was used to assess what percentage of time each option achieved the DFC management target over a 140-year projection. The forest value and SEV cost per acre were computed for each scenario to compare economic performance. Unlike the earlier case study results that looked at costs across the combined riparian and upland areas for each ownership, for this comparison the economic costs were computed exclusively within the riparian zone (defined as the area within 170 feet from the stream, which is the full width of the buffer for site class II) to provide cost measures that are independent of upland ownership.

The results of the template and regulatory scenario comparisons are summarized in Table DP7.2. The two FFR scenarios had the lowest percentage of time in the DFC target because of the wide no-harvest areas which resulted in the longest delays for achieving the DFC. These scenarios also had the highest economic costs. Accordingly, the DFC/cost ratios, measures of efficient production of the DFC, were very low. The two template options achieved the DFC target a significantly greater percentage of the time, as the template options were able to achieve the DFC quickly and remain within the target over a long rotation. The economic costs of the template options were also lower. Furthermore, the SEV costs for the template options were less than 100% such that the templates did not reduce the economic return below the 5% target rate of return within the riparian buffer, which is an important criterion for maintaining a long-term incentive to keep the land invested in forestry. The combination of a high percentage of time in the DFC target and relatively low costs for the template options resulted in DFC/cost ratios that were among the highest. The template options thus appear to work well for achieving environmental goals in riparian areas while also maintaining sustainable economic returns.

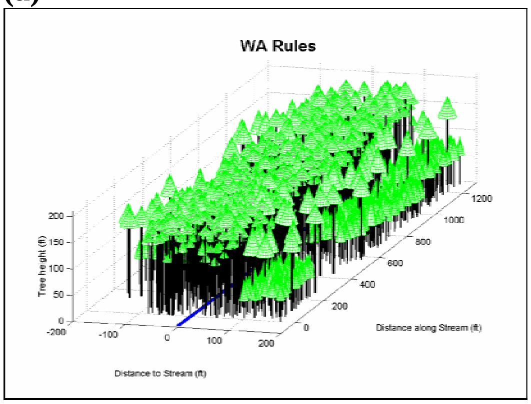
Table DP7.2: A comparison of the percent time the DFC target is achieved over a 140-year projection and the economic costs for the two FFR scenarios and two alternate plan template examples.

Scenario	Time in DFC Target (%)	Forest Value Cost (%)	SEV Cost (%)	DFC/Forest Value Cost	DFC/SEV Cost
FFR Max Harvest	32	70	134	0.46	0.24
FFR Full Buffer	31	130	228	0.24	0.14
Alt A	70	29	67	2.44	1.05
Alt B	65	22	67	2.89	0.87

For further comparison between the regulatory and template scenarios, Figure DP7.7 shows the visual results of the FFR max harvest scenario and the two template examples after a 110-year landscape simulation. Different stand age classes were randomly assigned at 200-foot intervals along the stream. Stand units in reality would usually be much wider than 200 feet, but for demonstration purposes this simulates in a compressed space the staggered timing of treatments that would occur at the landscape level. Heavy cover is demonstrated for all scenarios both inside and outside the buffer, with the exception of the area outside the buffer between 200 and 400 feet along the stream that demonstrates a stand in an open condition for this particular time interval (110 years). In effect, at the landscape scale approximately 80% of the upland area (assuming a 50-year rotation) and 100% of the area closest to the stream is always covered.

As for the stand structure within the riparian buffer, the FFR max harvest simulation (Figure DP7.7a) shows a wide buffer with slender, uniform trees with short crowns. The alternate plan template simulations (Figures DP7.7b and DP7.7c) show medium-width buffers that have greater structural diversity including larger trees, deeper crowns, and height differentiation.

(a)



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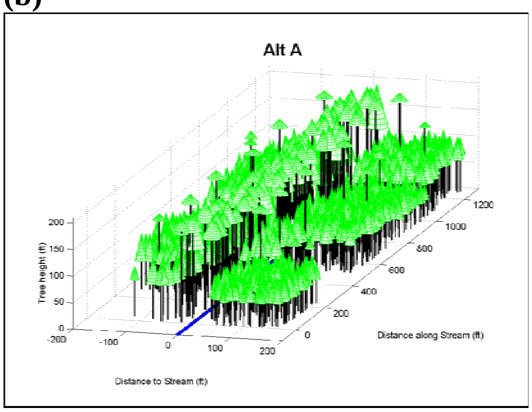

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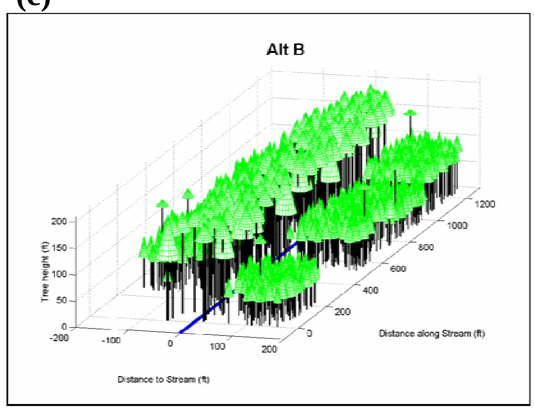


Figure DP7.7: Visual results after 110-year landscape simulations of the default regulatory buffers for FFR Max Harvest (a) and two example alternate plan templates (b and c).

The templates framework above appears to be a promising approach for balancing economic and environmental objectives and providing higher levels of both than might otherwise be achieved without this regulatory flexibility. The simple explanation for the effectiveness of these alternative plans for riparian protection relates directly to the fact that currently, the stands along streams are much more dense than unmanaged old forests and are not on a management trajectory to reach the desired condition. By thinning the stands the value of the removed thinnings greatly improves the economic returns and the thinned stands are placed on a trajectory that reaches the desired conditions much more rapidly, and both conditions are sustainable.

Estimating the Impact of Fish-Bearing and Headwater Stream Protection Across Large Areas

Introduction

While the case study analysis of riparian protection on small owners helps to reveal the disparity of impacts and even alternatives to reduce the impacts there are a number of somewhat complicating factors that make estimating the ecological and economic impacts of stream protection rules across a large landscape difficult.

For example, while the definitions of fish-bearing and non fish-bearing streams may be stable, the application of these definitions to stream miles is a moving target subject to changing interpretations, new stream assessment technology, and ground-truthing. Our knowledge about the stream network, as represented in the hydrography layer in Geographic Information Systems (GIS), is limited by error, resolution, and the dynamic nature of stream systems. Upgrades to the hydrography layer from ground-truthing are not tracked, thus providing uncertainty in the quality of existing stream data. Subsequently, any assessment based on these data should be viewed with caution. Of additional concern, since there are many more miles of headwater streams than fish-bearing streams, any uncertainty in the magnitude of management restrictions around these streams substantially alter the impact.

Given these complications we will extend the stand level and small owner case studies provided in the progress report with a spatial analysis of buffer impacts on private lands in Lewis County as a pilot project before extending the analysis to the seven timbersheds in the state. Lewis County provides an attractive sub-sample for previewing the issues for the westside timbersheds as it has a diverse range of ownerships and topography (Map 1: Lewis County location and Map 2: Ownership). The eastern portion of the county includes higher altitudes and mostly public ownership; the western portion contains more industry ownership with a diverse topography; and in the somewhat flatter middle area along the Interstate-5 corridor small private forest landowners are concentrated amidst growing urban areas where land conversion pressures are highest. More importantly perhaps is better data for Lewis county on ownership and buffer magnitudes.

Stream Typing: Old vs. New

Washington State's Forests and Fish Rules are based on an evolving system of stream typing that classifies streams into categorical types related to fish usage. Initially created in 1975, this system used six types (1, 2, 3, 4, 5 and 9), with types 1, 2 and 3 being fish-bearing, 4 non-fish-bearing perennial, 5 non fish-bearing seasonal, and 9 unknown or unclassified. With the adoption of the Forest and Fish Rules, stream typing changed to a system of S, F, N, and U (Shoreline, Fish-bearing, Non-fish-bearing, and Unknown), with type N sub-typed as Np for perennial and Ns for seasonal. These stream type changes initially had little impact, as under the Interim Rules there was a direct relationship between the old and new types with old type 1 classified as new type S, 2 and 3 as F, 4 as Np, 5 as Ns and 9 as U.

Stream typing impacts did result from the adoption of the Final Rules, as the new stream types were no longer linear transformations of the old types as they were under the Interim Rules (Table DP7.1). For private lands in western Washington, streams formerly typed as 1, 2 and 3 generally retained their fish-bearing status as new types S and F. Type changes for streams formerly classified as non-fish-bearing (4, 5 and 9) were substantial, with 44.3% of old type 4, 8.7% of old type 5 and 13.2% of old type 9 moving to new types S and F. This transition to fish-bearing status greatly increased the buffer area associated with the stream protection. In addition, 49.5% of the old type 9 streams were reclassified as new type N. These headwater streams may require buffers if they are perennial.

Table DP7.3: Distribution of old stream type length within new stream types for private lands in Western Washington from DNR's hydrographic layer

Old Type	New Steam Type % S	F	N	U	Total
1	77.54	20.48	1.97	0.01	100.00
2	13.83	86.17	0.00	0.00	100.00
3	0.58	95.93	3.49	0.00	100.00
4	0.21	44.11	55.66	0.01	100.00
5	0.08	8.58	91.33	0.01	100.00
9	2.28	10.87	49.51	37.34	100.00

In addition to stream typing changes, the new rules specify that the transition from seasonal to perennial non fish-bearing streams (Ns to Np) is at the Perennial Initiation Point (PIP), defined as the base of a catchment area, which is 5 ha (13 ac) in the Sitka Spruce Zone and 21 ha (52 ac) in the remainder of western Washington. PIPs have not been mapped by the Washington Department of Natural Resources (DNR), but they can be estimated using hydrological models in GIS. PIPs and 21 ha (52 ac) catchment areas were determined for Lewis County in southwest Washington. Type N stream segments falling within these catchment areas were typed as Np, with the remaining type N segments typed as Ns. On private lands, this results in a 134% increase in the total area impacted by headwater buffers compared to the old water typing rules. These increases in both fish-bearing and non fish-bearing stream mileage and associated riparian management zones can have a considerable impact on the economic viability of sustainable forest management on private lands.

Economic Impact of Stream Typing Changes

Determining the area of required buffers and the resulting economic impacts is not trivial. For most areas of western Washington ground-truthed stream data are sparse or not available. Since the age class distribution is approximately uniform on private lands in Lewis County and site class is generally high, unrestricted management practices were simulated by a commercial thinning before age 30 with final harvest at age 50. In an earlier Lewis County study (Lippke et al 2000), private final harvest levels of 74 thousand board feet (mbf)/ha (30 mbf/ac) with a stumpage value of $396/mbf and a commercial thinning volume of 25 mbf/ha (10 mbf/ac) at $313/mbf were considered representative. Communication with local experts confirmed that, while markets have fluctuated in recent years, these values provide an adequate representation of current conditions (Stinson 2005).

Lost harvest revenue from riparian buffers on private land is estimated in Table DP7.4 under both new and old stream typing, excluding the cost of leaving 49 trees/ha (20/ac) outside of the more restrictive zones closer to the streambank. Buffer area was determined in ArcGIS using the DNR's hydrographic and site class layers with hydrological modeling using a 10-meter digital elevation model (DEM) to determine PIPs and classify streams as Np or Ns in accordance with the Forests and Fish Rules. The stream typing change increased total buffer area 56% on industry land and 77% for small forest landowners. The split between industry and smaller owners was derived using tax parcel identification (Rogers 2003).

Table DP7.4: Impact of new stream typing rules in Lewis Co.

	New	**Old**	**Change**
Small ownership (60,000 ha)			
Buffers (ha)	6,160	3,483	2,677
Buffers (% of total ha)	10.3	5.8	4.5
Rev/yr loss ($mils)	4.6	2.6	2.0
NPV loss ($mils)	92	52	40
Industry (230,000 ha)			
Buffers (ha)	20,052	12,885	7,167
Buffers (% of total ha)	8.7	5.6	3.1
Rev/yr loss ($mils)	14.9	9.6	5.3
NPV loss ($mils)	298	192	106
NPV total ($mils)	390	244	146

For industrial lands, the loss in the net present value (NPV) of future harvests (estimated using a 5% real discount rate) increased from $192 million under the earlier stream typing rules to $298 million under the new rules on 230,000 total ha (569,000 ac). The loss for small ownerships increased from $52 million to $92 million on 60,000 total ha (148,000 ac). The total combined NPV loss increased from $244 million to $390 million.

The percentage of total acreage in no-harvest buffers increased from 5.6% on industry lands to 8.7% under the new stream typing and from 5.8% to 10.3% for small owners. These percentages do not include the impact of leave tree requirements or the diminished economics associated with increased fragmentation and compromised operability for the remaining less restricted portion of the riparian zone. Many owners, especially small owners, may find it no longer economically feasible to harvest smaller slivers of land that are not restricted in buffers but have become difficult to access such that harvesting is cost-prohibitive.

Impact Disparity:

While it is noteworthy that the new stream typing rules increased the average impact on smaller owners substantially more than on industry lands, these averages understate the impact to individual owners as was demonstrated earlier. The increase in the average impact is largely related to the fact that small ownerships are concentrated in the lower flat lands that act as the interface between growing urban communities and more rural forests (Rogers 2004).

Impact of Newly Defined Headwater Streams

Acknowledging the uncertainty in the DNR hydrographic layer and stream typing methods, we compared the buffer area corresponding to fish-bearing (F) and non fish-bearing perennial streams (Np). Tables DP7.5 and DP7.6 show total and percentage buffer impacts respectively by these stream types. For Np streams the increase is larger for small owners, 143%, versus 133% for industry lands. However, the buffers for headwater streams are a lower percentage of the total buffer area for small ownerships, reflecting the greater proportion of industry lands and lower frequency of small ownerships at higher elevations where headwater streams are prevalent. Headwater buffers as a percent of total buffers increased from 13% to 17% for small owners compared to an increase from 21% to 32% for industry lands.

Table DP7.5: Buffer impacts by stream type in Lewis Co.

	F	Np
Small ownership		
Buffers (ha)	5,091	1,069
Buffers (% of total ha)	8.52	1.79
Rev/yr ($mils)	3.8	0.8
NPV ($mils)	75.7	15.9
Industry		
Buffers (ha)	13,705	6,347
Buffers (% of total ha)	5.95	2.76
Rev/yr loss($mils)	10.2	4.7
NPV loss ($mils)	203.7	94.3

Table DP7.6: Percentage increase in buffer impact under new stream typing rules by stream type and ownership class.

	% Increase		
	F	Np	Total
Small ownership	67	143	77
Industry	35	133	56
Total	42	134	60

The magnitudes of these impacts are very sensitive to potential errors in the hydrographic layers used to derive estimates of required buffers. While we may know with near certainty the location of large fish bearing streams, our knowledge of the Np streams is much more limited.

Potential Np Buffer Errors

Perhaps the biggest surprise in our analysis is the decline in our confidence in estimates of headwater streams based on concerns over the accuracy in the GIS hydrographic layer available from DNR. Recent studies on sample areas in southwest Washington using LIDAR (LIght Detection And Ranging) to create digital terrain models (DTM) have shown a substantial difference in stream mapping detail. Mouton (2005) provided a detailed comparison of stream networks derived from LIDAR data using hydrologic models in GIS and the DNR hydro layer. In his sample area he found 362 kilometers (km) of stream length using the LIDAR elevation model, which is a 432% increase over the 68 km in the DNR hydrographic layer. The corresponding area increase in buffers was somewhat less mainly because the size of the PIP catchment areas was reduced as a result of the improved site-specific PIP location determination and modeling. Mouton found 860 hectares in buffers using the LIDAR layer versus 240 hectares in the DNR layer, which is a 260% increase. These are substantial differences in buffer requirements with the difference related directly to the adequacy of the hydrographic layer. Since the variation in stream characteristics across the region is very large, it raises questions about the feasibility of estimating the economic impact of non-fish bearing perennial streams. Any scale factor to represent the increased streams identified in a LIDAR sample that might be developed from one or more sample areas will not likely be very representative for other parts of the county or state. However, LIDAR evidence indicates that estimates based on the current DNR hydrographic layer may be inadequate and likely understate the magnitude of the required buffer area.

This should not be interpreted to mean that owners are not protecting enough buffer area as the buffers are being managed in practice based upon walking the streams for a more reliable representation (ground-truth) than is available in the DNR hydrographic layer. A serious policy problem has surfaced, however, in that the impact of stream buffers is almost certainly much larger than early estimates with consequent increases to impacts on economic viability. Independent survey estimates of unmanaged acres on industry lands at the timbershed level do provide an alternative estimate of areas not being managed. These surveys do not suggest that the unmanaged acreage is larger than shown by the DNR hydrography layer, however this comparison is complicated by other factors such as unstable slopes and other non-riparian related set-asides. In effect, we lack sufficient data to determine the adequacy of currently available hydrography data and consequently to accurately determine the magnitude of buffer impacts. The magnitude of our estimated impacts over large landscapes must be viewed with caution.

The Impact on Sustainable Management

Despite these data limitations, the relative magnitude of the economic impacts raises questions about whether continued forest management is sustainable on private ownerships. The NPV loss of not being able to harvest timber in riparian buffers can be as high as $30,000/ha ($12,000/ac) depending on the age class (i.e. the time until the economic rotation age). Based on Table DP7.2, the average NPV loss for small ownerships is about $15,000/buffer ha ($6,000/ac). Even when this loss is allocated over all hectares (not just buffer zones), the average NPV loss for small ownerships is $1,532/ha ($620/ac), which includes $872/ha ($353/ac) under the old stream typing plus $512/ha ($207/ac) for new fish bearing and $158/ha ($64/ac) for net new Np. For industry owners, the average NPV loss is $1,295/ha ($524/ac), which includes $835/ha ($338/ac) under the old stream typing plus $230/ha ($93/ac) for new fish bearing and $235/ha ($95/ac) for net new Np. These results suggest that it is not economically attractive to manage or own forestland in riparian buffers. This further suggests a high motivation for conversion of these lands to non-forest uses, an unintended consequence that ultimately reduces available riparian habitat. Even for larger properties forest management may become economically inferior to other investment alternatives. As noted above, estimated losses may be underestimated because we expect the buffer area will be larger than our current estimates that have been derived from the DNR hydrographic layer (as noted by LIDAR comparisons) and the above loss estimates do not include the cost of leave trees, fragmentation impacts or unstable slope protection.

Impacts Scaled to Western Washington

Table DP7.7 scales up the Lewis County impact as a rough estimate for Western Washington, assuming for demonstration purposes that the ownership distribution of commercial forestland in other counties of Western Washington is proportional to Lewis County. Acknowledging that these estimates are potentially substantial understatements of the full impacts, we note that the NPV loss of private timber in buffers increased from about $2.0 billion under the prior stream typing rules to $3.2 billion under the new system for an additional loss of $1.2 billion.

Table DP7.7: Impact of new stream typing rules scaled to WWA

	New	Old	Change
Small ownership (0.97 mil. ha)			
Buffers (ha)	100,057	56,573	43,484
Rev/yr ($mils)	75	42	32
NPV ($mils)	1,494	845	650
Industry (1.34 mil. ha)			
Buffers (ha)	116,696	74,987	41,709
Rev/yr loss ($mils)	87	56	31
NPV loss ($mils)	1,734	1,115	619
NIPF+Ind. NPV ($mils)	3,229	1,960	1,269

The economic losses are not limited to lost timber revenue. The lost opportunity to process harvested logs means reduced economic activity with direct and indirect job and revenue losses to mills, workers, rural communities, as well as local and state taxing districts. The total economic impact is therefore several times larger than the revenue loss from reduced timber harvests. The harvest loss from the changed stream typing for Western Washington is estimated to be 86 million board feet per year. Using Conway's economic model (Conway 1994) as adapted for use with alternative management scenarios (Lippke et al. 1996), we can estimate the expected impact of the new stream typing rules based on the DNR hydrographic layer to be an additional loss of 3,170 direct and indirect jobs. Accordingly, gross state product would be reduced $139 million and state and local taxes by about $15 million. Labor productivity gains are being analyzed and probably have reduced the jobs impact in recent years.

We estimate these impacts for each timbershed and owner group in another section of this report, reducing the uncertainty associated with the degree that Lewis County is a representative sample. We can not expect to reduce the uncertainty related to accuracy of he hydrography layer until better data becomes available.

Management Alternatives

Using the targeting and assessment procedure developed by Gehringer (2005) and the management alternatives examined for small owner alternative plans (Zobrist et al. 2005) in our Second Progress Report (page 22-23) we can provide some insight on the impact of management alternatives for motivating sustainable forest management in riparian areas. The statistical assessment procedure provides an evaluation whether stream buffers managed under different treatments develop similar structure to that of mature, unmanaged forests, which is considered to be the desired future condition (DFC) along streams. We used the assessment procedure to evaluate the percentage of time over a period of interest that a management alternative results in forest structure that is statistically similar to that of mature, unmanaged forests. When using this ecological metric in conjunction with economic viability metrics (Zobrist 2005) we gain insight into both the benefits and costs associated with different management strategies.

Table DP7.8 compares the SEV/ha for a regulatory no-harvest buffer, no buffer at all (i.e. unrestricted commercial management), and a narrower buffer with thinning treatments designed to put riparian buffer areas on a pathway to reach the desired future condition (DFC) of natural mature stands more rapidly and more reliably. Note that while the SEV for the narrower buffer with thinning is lower than the no buffer alternative, it is still positive, indicating that a 5% minimum target rate of return is still achieved (in contrast to the negative SEV for the no touch buffer). It also reaches the statistical criteria for DFC more than twice as frequently as the more costly no-touch buffer. The removal of the excess density found in young commercial stands by thinning treatments improves both the economics of sustainable forestry and the desired ecological condition of the riparian areas.

Table DP7.8: Thinning Alternative

	Soil expectation value ($/ha)	Time in DFC (%)
No Touch Buffer	-531	32
Thin & Narrow Buffer	512	65-70
No Buffer	1,549	<32

Conclusions

In spite of great difficulty in estimating the economic impact of headwater stream management, it would appear that new stream typing rules being applied in Washington State have significant economic impacts that may have the unintended consequence of motivating a change in land use investment away from forestry. However, there are alternative buffer management treatments that appear to substantially lower the cost of stream protection and at least partially restore the motivation to pursue sustainable forest management.

Disproportionate impacts on small ownerships are large, both on average across the owner classes, and even more so for those owners with a higher percentage of acres along streams. Incentives may be required for many to keep their land in forestry. The estimated increase in buffer area related to new stream typing is large (+60%) and may become substantially larger as better hydrographic mapping becomes available through LIDAR and ground surveys. The quality of information available in the DNR hydrographic layer does not appear to be adequate to make good estimates of economic impacts. In addition, the sparce sampling of forest inventory plots in sensitive areas such as riparian zones precludes accurate assessment of riparian zone conditions. Investing in LIDAR data and analysis routines, ground-truthed for robust confidence, would improve buffer estimation accuracy and economic impact analysis. Understanding the comparisons of a wider array of management alternatives designed to minimize economic impacts while sustaining healthy riparian environments will be important to refine protection strategies to avoid unintended consequences such as deforestation associated with land-use conversions.

Literature Cited:

Bolsinger, C., N. McKay, D. Gedney, and C. Alerich. 1997. Washington's Public and Private Forests. Resource Bulletin. PNW-RB-218. Portland, OR: USDA Forest Service. Pacific Northwest Research Station. 144 p.

Carey, A.B., B.R. Lippke, and J. Sessions. 1999. Intentional systems management: Managing forests for biodiversity. *Journal of Sustainable Forestry* 9(3/4):83-125.

Carey, A.B., C. Elliott, B.R. Lippke, J. Sessions, C.J. Chambers, C.D. Oliver, J.F. Franklin, and M.G. Raphael. 1996. *Washington Forest Landscape Management Project: A pragmatic, ecological approach to small-landscape management*. Washington Forest Landscape Management Project Report No. 2. Washington State Department of Natural Resources, Olympia, WA. 99 p.

Chan, S., P. Anderson, J. Cissel, L. Larsen, and C. Thompson. 2004. Variable density management in riparian reserves: Lessons learned from an operational study in managed forests of western Oregon, USA. *Forest Snow and Landscape Research* 78(1/2):151-172.

Conway, Richard. 1994. The Forest Products Economic Impact Study Current Conditions and Issues. Prepared for WFPA, WADNR, and WADTED by Dick Conway and Associates, Seattle, Washington. 59p.

Garman, S.L., J.H. Cissel, and J.H. Mayo. 2003. *Accelerating development of late-successional conditions in young managed Douglas-fir stands: A simulation study*. General Technical Report PNW-GTR-557. USDA Forest Service, Pacific Northwest Research Station, Portland, OR. 57p.

Gehringer, K.R. 2006. Structure-based nonparametric target definition and assessment procedures with an application to riparian forest management. Forest Ecology and Management Vol 223, March 2005, pages 125-138.

Lippke, B., S. Marshall, M. Ludwig, J. Moffett, D. Fitzpatrick and B.B. Bare. 2000. Lewis County Economic Assessment, for the Lewis County Natural Resources Advisory Committee. CINTRAFOR Special Paper 35, College of Forest Resources, Univ. of Washington, Seattle, WA. 62 p.

Lippke, B.R., J. Sessions, and A.B. Carey. 1996. Economic Analysis of Forest Landscape Management Alternatives: Final report of the working group on the economic analysis of forest landscape management alternatives for the Washington Forest Landscape Management Project. Special Paper 21, CINTRAFOR, College of Forest Resources, Univ. of Washington, Seattle, WA. 157 p.

Mason, C. L. 2006. *Red alder market implications for management; reasons for optimism. In Proceedings:* Red alder-a state of knowledge. Deal, R.L. and C.A. Harrington, eds. Gen. Tech. Rpt. PNW-GTR-669. Portland, OR: USDA Dept. of Ag., pacific Northwest Research Station. 150 p.: 133-136.

Mouton, A. 2005. Generating stream maps using LiDAR Derived Digital Elevation Models and 10-m USGS DEM. M.Sc. Thesis, Univ. of Washington, Seattle, WA.

Perez-Garcia, J.M., J. Edelson, and K. Zobrist. 2000. *New proposed forest practices rules small business economic impact statement*. Washington State Department of Natural Resources, Olympia, WA.

Reeves, L.H. 2004. Comparing the value of leave tree buffers with a forest excise tax credit in Washington state. *Western Journal Applied Forestry* 19(3):165-170.

Rogers, L.W. 2003. Determination of the Current State of Geographic Information Systems Data in Washington State Counties. Report prepared for the Washington State Department of Natural Resources under contract. Rural Technology Initiative, College of Forest Resources, University of Washington, Seattle, WA.

Rogers, L. 2004. Map of Known Washington State Non-Industrial Private Forestland Parcels by Elevation Ranges. Rural Technology Initiative, College of Forest Resources, University of Washington, Seattle, WA. Available online at http://www.ruraltech.org/gis/sflowria/maps/ sflodb/NIPF_by_Elevation_Bands_Version_3.jpg

Stinson, S. 2005. Personal communication that captured the consensus of a group of Lewis County family foresters on timber prices.

Tappeiner, J.C., D. Huffman, D. Marshall, T.A. Spies, and J.D. Bailey. 1997. Density, ages, and growth rates in old-growth and young-growth forests in coastal Oregon. *Canadian Journal of Forest Research* 27:638-648.

Washington Department of Natural Resources (WADNR). 1999. Forests and Fish Report. Olympia, WA. 177 p.

Zobrist, K.W., K.R. Gehringer, and B.R. Lippke. 2005. A sustainable solution for riparian management. P. 54-62 in Understanding Key Issues of Sustainable Wood Production in the Pacific Northwest, Deal, R.L. and S.M. White, eds. USDA For. Serv. Gen. Tech. Rep. PNW-GTR-626..

Zobrist, K.W. 2005. Economically Sustainable Working Forests: Financial Analysis Principles and Applications. Northwest Environmental Forum Topic Paper 2. Northwest Environmental Forum, College of Forest Resources, University of Washington, Seattle, WA. 16 p.

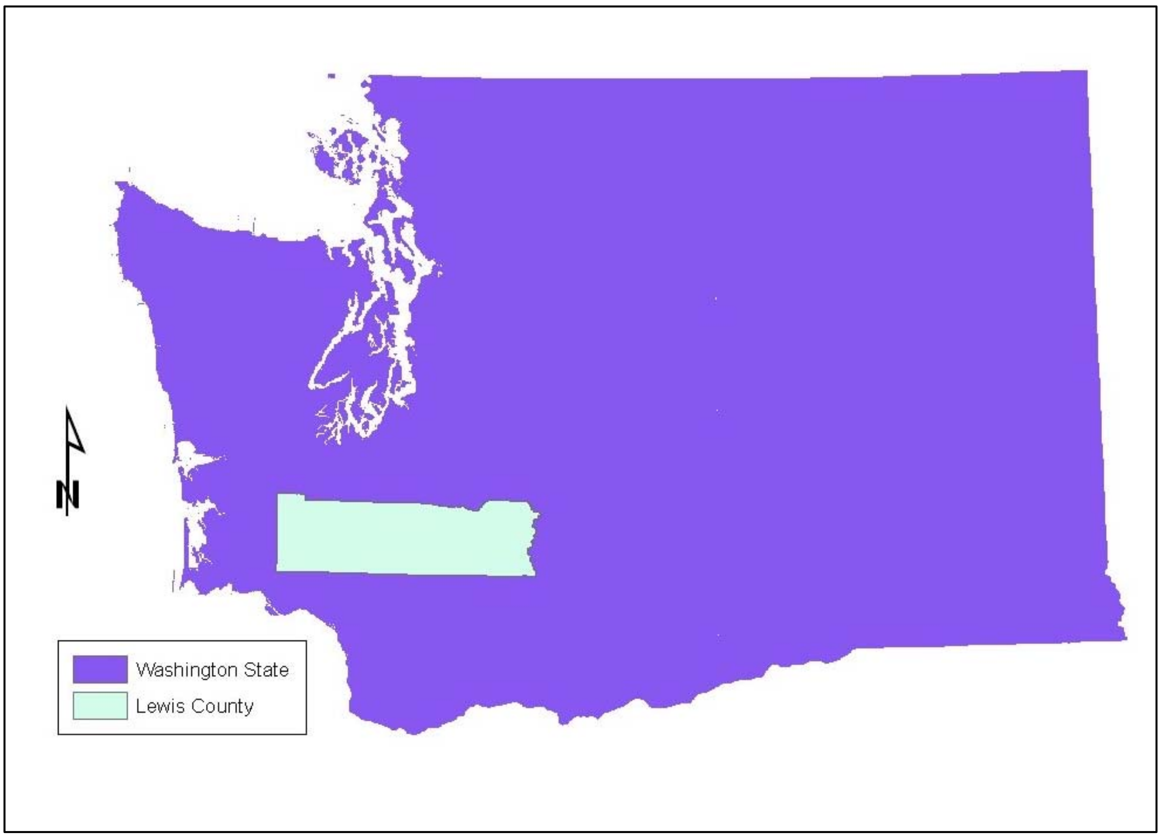
Zobrist, K. 2003. *Economic impacts of the Forests and Fish Rules on small, NIPF landowners: Ten Western Washington case studies*. RTI Working Paper 1, Revised Edition. Seattle, WA: Rural Technology Initiative, College of Forest Resources, University of Washington. 23 pp.

Zobrist, K.W., K.R. Gehringer, and B.R. Lippke. 2005a. A sustainable solution for riparian management. P. 54-62 in *Understanding Key Issues of Sustainable Wood Production in the Pacific Northwest*, Deal, R.L. and S.M. White, eds. USDA Forest Service General Technical Report PNW- GTR-626.

Zobrist, K.W., K.R. Gehringer, and B.R. Lippke. 2004. Templates for Sustainable Riparian Management on Family Forest Ownerships. *Journal of Forestry* 102(7):19-25.

[1] Washington Administrative Code (WAC) 222-30-021

Map 1: Headwater Stream Buffers, Lewis County example



Map 2: Lewis County Forest Land Ownership