Discussion Paper 5 (DP5): Carbon as an Emerging Ecosystem Service with a Market Value

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Introduction

Forests produce many services benefiting many groups but for which the values are not internalized into market prices. The value of products, the value of real estate and the cost of meeting regulations including the risk of lawsuits are all internalized into market prices. The value of clean air and water and habitat are not, and in fact each may be a cost required to meet regulations rather than compensation for the value produced. Markets are developing for the carbon stored in forests, but not yet in products. As such carbon may be one of the more promising ecosystem services to return value to forest management. The link between forest management and carbon will be developed in this section recognizing that the markets and policies affecting carbon exchanges are embryonic but could explode if the demand for carbon trading moves from voluntary to mandatory.

Carbon Tracking and Life Cycle Studies

Several years ago a consortium of 15 research institutions across the US (mostly universities) launched a research project to characterize the environmental performance of wood as a renewable resource by developing a life cycle inventory (LCI) data base of all forest products inputs and outputs from forest regeneration, harvest, processing, construction, building use and final disposal. The Consortium for Research on Renewable Industrial Materials (CORRIM), published their findings in several journals (Lippke et al 2004, Perez-Garcia et al 2005) and on the web www.CORRRIM.org. Carbon tracking is one of the more important performance measures identified in the CORRIM studies. These reports provide the source for this analysis of the potential for carbon to provide value as an ecosystem service.

Carbon in Forest Pools

A simple example often cited is that carbon storage is maximized in the forest by lengthening rotations and/or foregoing harvests. It is true that extending the rotation age from 50 to 100 years in the Pacific Northwest (PNW) will more than double the volumes of wood biomass and carbon stored in the forest. Depending upon forest type and conditions, deferring forest harvest longer than 100 years may continue to increase the stored carbon but eventually, mortality due to natural causes such as windstorms, fire, disease, and senescence accompanied by combustion and decay will result in carbon release.

However, the carbon stored in forest biomass is only part of forest carbon storage accounting. Many different types of forest products can continue to store carbon long after trees have been harvested. While short-lived products such as paper may enter the waste stream quickly and decompose, long-lived products such as panels and lumber used in housing construction will store carbon for decades, even centuries. As housing stocks increase, the cumulative carbon storage of forest and products increases as well. The carbon stored in forest pools (stem, root, crown, litter, and dead or dying carbon pools) for rotation intervals of 45, 80 (with two thinnings), and 120 (with three thinnings) years, as well as no harvest or disturbance are shown in Figure DP5.1. While the growth model simulation shows carbon storage continuing to increase with time, empirical plot data shows no increase in average carbon for stands over 120 years of age for PNW forests, presumably reflecting the cumulative impact of disturbances over time.

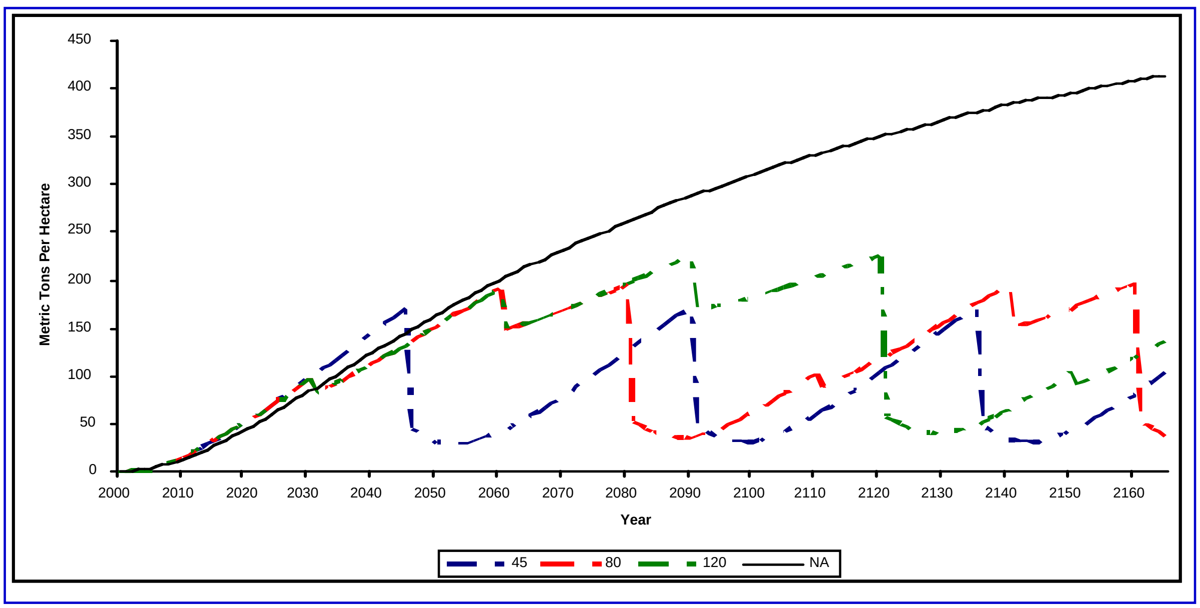

Figure DP5.1: Carbon in forest pools for different rotations

Carbon in Product Pools

Short-lived forest products decompose rapidly resulting in carbon emissions while long-lived products decompose slowly resulting in an accumulation of carbon from rotation to rotation. The carbon stored in products is illustrated in Figure DP5.2. for an 80-year rotation showing successively more product carbon storage in the first two thinnings followed by a larger increase at the harvest rotation. Figure DP5.2. also displays the emissions from the logging and manufacturing as negative pools, the rapid decomposition for short-lived products such as chips, and the accumulation of carbon storage in long-lived lumber products. Lumber products are assumed to last 80 years, the expected life of a house (Winistorfer et al 2005).

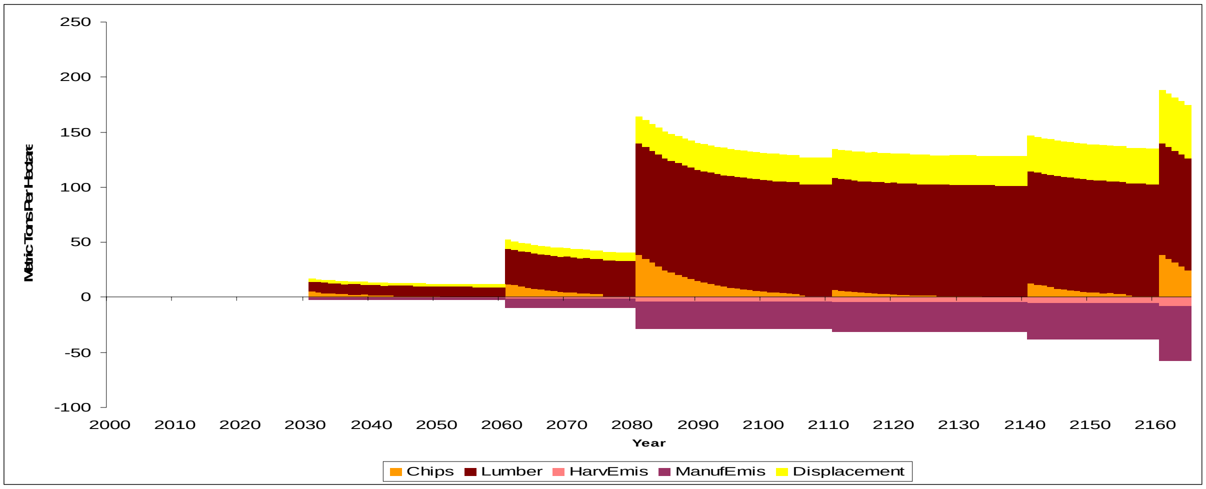

Figure DP5.2: Carbon in products, energy displacement and processing emissions

When short-lived products such as wood chips are used as a biomass source for energy production, energy otherwise generated from fossil fuels is displaced with a consequent offset to the carbon emissions from the energy used in wood product processing. While energy generation is currently a low-valued use of wood, when biomass substitutes for fossil fuels, carbon storage is effectively increased over time without the decomposition associated with short-lived products. Figure DP5.2. illustrates the displacement of fossil fuels as carbon stored, a partial offset to the carbon emissions shown for harvesting and processing.

Forest Carbon, Products Carbon and Substitution

Figure DP5.3. shows the carbon stored in the forest and both short- and long-lived product pools along with the displacement of fossil fuels as a positive pool and the energy for processing as a negative pool for a 45-year forest rotation. Note the positive trend increase in the carbon pool that develops when the long-lived products are available as substitutes for other product alternatives that are energy intensive in manufacture, such as steel or concrete. Note that the carbon in the forest is stable across rotations and, when the carbon in products is added, there is a modest increase in carbon stored. When the estimated reduction of carbon emissions associated with the use of wood as a product substitute for more energy intensive products, such as wood instead of concrete frame in this example, is added there is a substantial increasing trend in stored carbon.

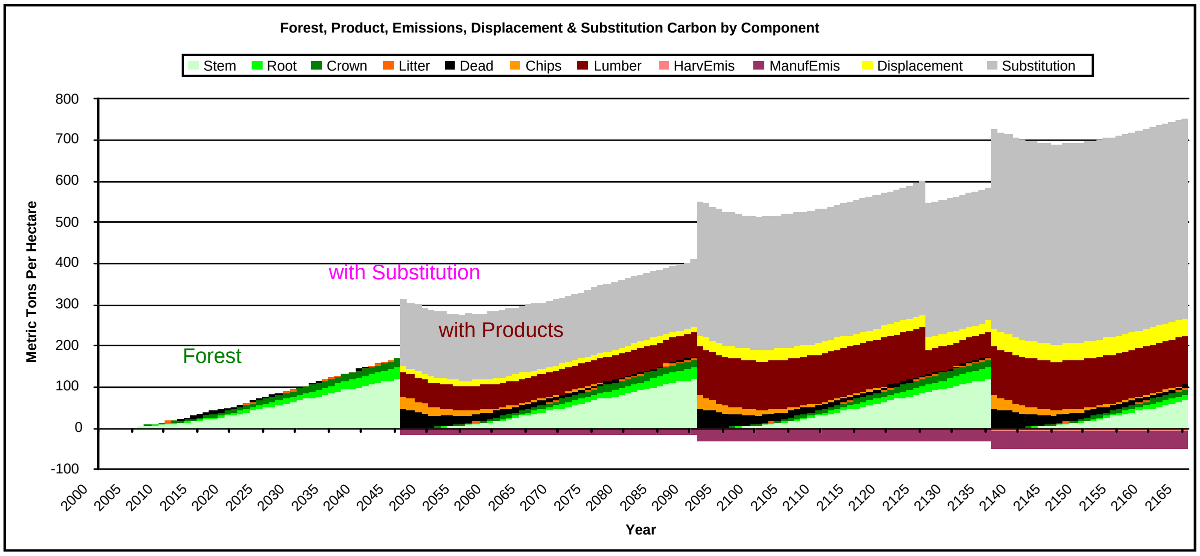

Figure DP5.3: Carbon in the forest and product pools with concrete substitution for the 45 year rotation

Impact of Forest Management

Figure DP5.4. summarizes the carbon account averages for intervals of 0-45, 0-80, 0-120 and 0-165 for each example rotation scenario and for the no action (no harvest or disturbance) scenario. In the first 45 years, since there is no harvest, there is little difference between the alternative scenarios. For the 0-80 year interval the 45-year rotation harvest produces product substitution that results in more carbon stored and offset than the other scenarios. For the 120-year interval, a harvest has also occurred on the 80-year rotation and a heavy thin on the 120-year rotation. Finally by 165 years all scenarios have included a harvest except for no action. The cumulative carbon storage and offset comparisons illustrate that shorter rotations followed by products manufacture and regeneration are likely to result in greater reductions to atmospheric carbon than longer rotations and no harvest scenarios. Note that no action for this simulation does not include carbon releases for forest fires or other disturbances that might logically occur within 165 year of forest growth.

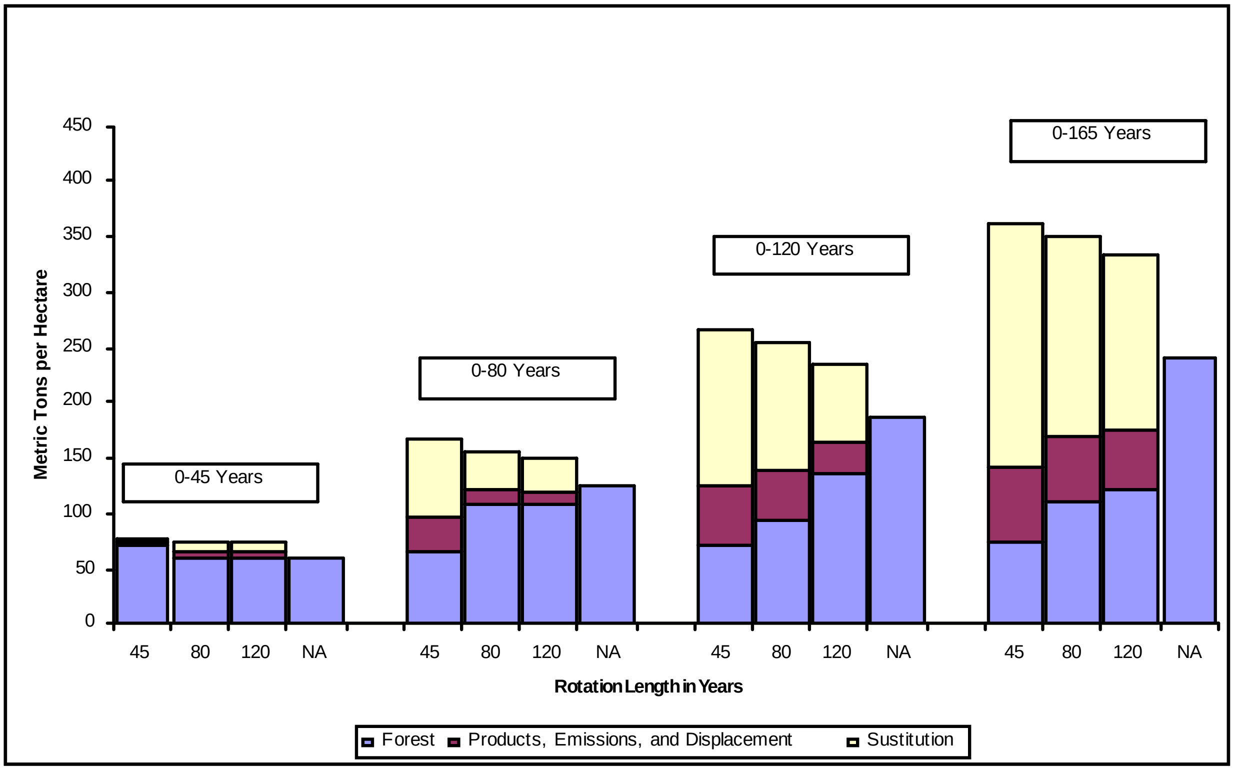

Figure DP5.4: Average annual carbon over time intervals in forest, product, and concrete substitution pools for different rotations

Figure DP5.5. shows the carbon stored in the base case with a 45-year rotation and a more intensive management example to illustrate the potential results of fertilization and a commercial thinning on the same rotation. As a second case, the rotation was extended by 10 years to see if the response time after the thinning would produce increased storage. There is a significant increase in carbon stored from the intensive management but very little gain from increasing the rotation age by ten years.

What these analyses highlight is that drawing the boundary conditions for carbon analysis around a forest is only correct if there is no harvest, in which case, over the long term, the forest stores an amount of carbon that is neither increasing nor decreasing when disturbance cycles are considered. When forest management occurs on working forests, it no longer makes sense to limit the carbon estimates to the forest alone. CORRIM LCI/LCA analyses have been conducted for the PNW, the Southeast, and the Inland West. In all areas, the results indicate that forest management approaches that maximize production of long-lived forest products have the greatest potential to contribute to reduction of atmospheric carbon.

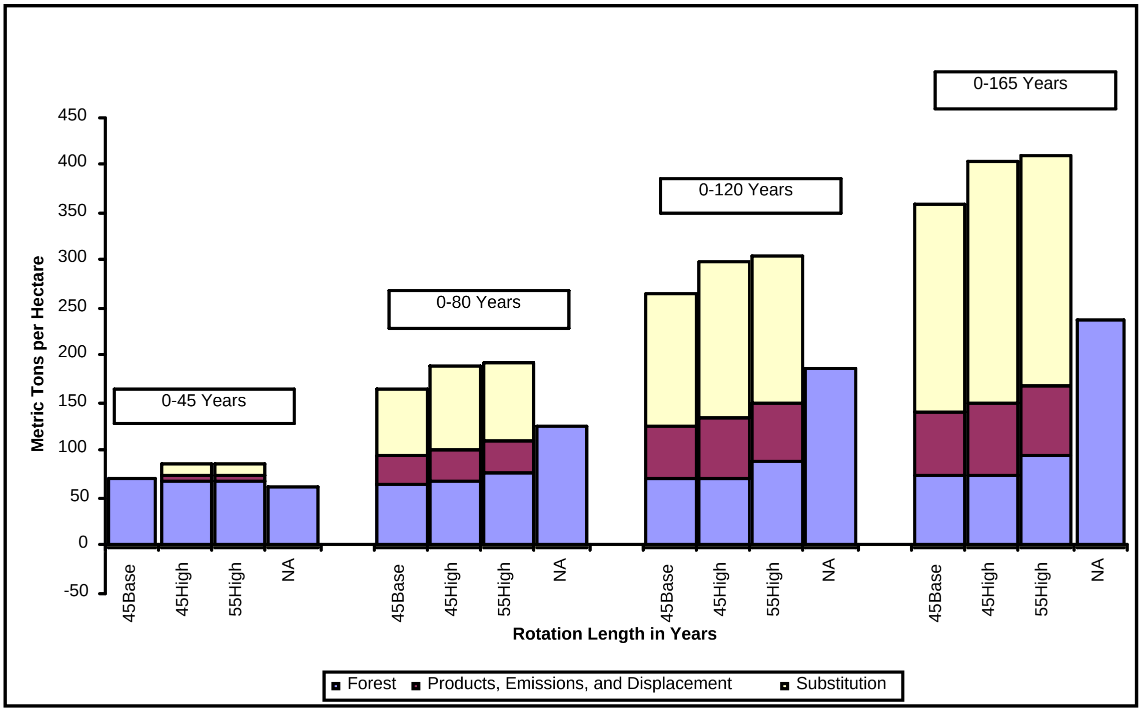

Figure DP5.5: Average carbon in forest, product and concrete substitution for different management intensities.

Valuing Carbon as an Ecosystem Service

Figure DP5.3 shows carbon increasing about 3.5 tons per hectare per year (1.4 tons per acre) in the first 45 years rising to 4.5 tons per hectare (1.8 tons per acre) in 165 years. This ecosystem service could add $500 to $700 of net present value (NPV) per acre if carbon is valued at $20 per ton. However, the value of carbon will be dependent upon supply and demand. Emerging voluntary markets have produced transaction prices that have ranged from less than $1 per ton to $20 per ton.

If carbon markets only recognize the carbon storage benefits in the forest pool there is at best only a first rotation payment with no further increase in carbon stored since carbon storage is stationary over the long term. In addition, if the principle of additionality is required whereby only new carbon is credited, there would be no new carbon in the forest except by demonstrating that the forest land is newly converted from other uses or being managed more intensively to produce additional carbon over a base level.

The question then becomes over what baseline can credits for additionality be obtained? The increase over natural regeneration may be as much as 100% more carbon. The increase in carbon for increased management, as shown in Figure DP5.5., is about 10% and if limited to forest carbon it is only a first rotation payment. But it could contribute $60 or more NPV which could be enough to motivate more intensive management since the rate of return to investments for the next increment of intensive production was shown to be almost unchanged under the commercial management options. A small incentive could therefore increase investments in more intensive management resulting in increased carbon storage.

The real problems with capturing value for carbon as an ecosystem service reside in the accounting rules relative to the policy. Using the California Climate Action Registry example (2005) credits are only accrued through three activities, (1) afforestation, (2) avoiding what would be near certain deforestation and (3) conservation. The first two don't really apply to a fixed commercial land base. The registry examples for conservation cite such activities as harvesting less basal area, longer rotations, or leaving increased volumes in buffers. As shown by Figures DP5.3. and DP5.4., these approaches would likely be counterproductive because the carbon flowing into products would be reduced which would increase the use of fossil fuel intensive substitutes such as steel and concrete. Reducing harvest in effect reduces substitution which provides the highest leverage for storing carbon and offsetting carbon releases. The increase in Washington Forest and Fish Rule streamside buffers would likely be interpreted as required in the baseline and therefore would not be eligible as a credit. However in neighboring states with voluntary action buffers, forest owners could receive credits for exactly the same buffering of streams. These outcomes suggest that new and more universal accounting metrics will need to be recognized in order to avoid unintended consequences and ensure parity among crediting regions.

Carbon cap and trade systems have received the most attention and these systems attempt to define a baseline so that only carbon stored above the baseline can be traded to offset any need for new carbon emissions such as a new utility that would exceed the cap. The problem is that it is nearly impossible to isolate new carbon from old especially in multiple carbon pools relating to forests. Since forests are essentially carbon neutral for any given rotation, taking in and giving off equal amounts of carbon over the long term, the carbon stored in the forest should not be eligible for carbon trading unless it can be proven to be a new forest. That is, that the forest that is eligible for the trade is not just offsetting the deforestation of an existing forest somewhere else. However the carbon exported from the forest that is used to offset fossil fuel intensive products such as steel, concrete, plastics, or even coal, oil and natural gas if it is used for biofuel, should be eligible to offset new carbon emissions above the cap elsewhere. Ironically it the use of wood to displace fossil fuel intensive products that can produce offsets, yet the carbon accounting methods have yet to acknowledge this.

Resolving the difficulty in measuring carbon above a baseline is a futile exercise because reducing carbon emissions sufficient to offset the increases in emissions elsewhere, requires that carbon trading schemes must penetrate all markets that use carbon from fossil fuel derived energy. The logical mechanism is a carbon tax on the use of fossil fuels. Such a tax would drive down the use of fossil fuels and drive up the demand for products that displace fossil fuel intensive products. The cost of carbon would be bid back into all carbon storage pools including the existing carbon stored in the forest and products not just some defined increase in pools. The tax would be inflationary but could easily be offset by tax cuts. Defining trading rules that produce the same kind of market impact is the challenge. Crediting all non-fossil energy sources and uses of carbon from solar sources is the challenge and of much greater complexity than a tax on sources of fossil fuel emissions.

Impact on forestry from correct carbon accounting

If the market values carbon stored in all pools, (forest, products, displaced fossil emissions) whether through credit schemes or market responses, the derived values from forest management will change depending upon the price of carbon. Market economic models have been simulated showing that carbon prices will ultimately rise substantially to price out the use of fossil fuels for energy (Nordhous 2007). While the debate goes on as to the relevance of market models to get the price response right (Weitzman 2007), there is no disagreement that the price of carbon emissions must rise substantially for effective reduction to occur. Upwards of $50/ton C stored ($14 CO2 released) will most likely be exceeded before any serious attempt to reduce emissions succeeds. If this price is valued at a 5% cost of money, it will contribute $1150 NPV/acre in 50 years which is comparable to the SEV from current timber markets. If the value of substitution for fossil fuel intensive products is included, the value exceeds $3000/acre. In effect we have the extreme and potentially perverse perspective that if the return only goes to the carbon in the forest, the motive would likely be to cease harvesting. However, if the value goes to wood being used to displace fossil fuel intensive products, the returns are almost three times larger which is enough to motivate intensive management with growth increases on short rotations.

Previewing Eastside Carbon Issues

The above Westside examples assume no disturbances such as fire. The higher frequency of fires in the inland region will have two additional impacts on carbon storage. First, with the high risk of fire there is the associated risk of carbon emissions from fire followed by the decomposition of dead wood after a fire. Fire risk reduction treatments can avoid releases of the carbon that is emitted by fire and post-fire decomposition of dead material when removals are converted to long-lived products or biofuels, which provides substitutes for fossil fuel intensive products and fuels. While the removal of small diameter material may be costly, the avoided cost analysis (Discussion Paper 10-E) would suggest it is a good public investment. If incentives are used to remove the excess fuel, some of the material may be best used as a biofuel, displacing fossil energy sources as another way to extend the carbon benefits long after the carbon leaves the forest. In addition, the destructive fires associated with excess density can cause substantial problems for regeneration and hence forest productivity, lowering post-fire growth productivity for an extended period of time. This more complex interaction between fire, management treatments, timing of entries and carbon is discussed in Discussion Paper DP11-E: Impacts of Thinning and Implementation Schedules on Fire Hazard Reduction Effectiveness, Carbon Storage, and Economics. The interaction of management intensity, silvicultural systems, ownership, harvest volumes, and piece size with climate change generate a wide range of likely carbon outcomes. A summary of the potential carbon impacts by owner group and across all owners in eastern Washington is provided in Discussion Paper 8-E: Eastside Climate Change, Forest Health, Fire and Carbon Accounting. .

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