APPENDIX F

Infrastructure Consequences of Lost Forest Production from Forest Land Conversion

How Does the Potential Conversion of Forestlands to Other Uses Threaten the Economic Viability of Current Milling Infrastructure?

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Abstract

In this study, we analyzed the economic viability of forest products facilities in light of a large potential conversion of forestlands. The study produced projections of forest acres under baseline and risk of conversion assumptions for five timbersheds in western Washington. A timber supply model that is sensitive to changes in forest area was used to determine potential harvest levels under baseline and risk of conversion assumptions. The results suggest significant potential harvest reductions by 2080 and a continued decline in the potential harvest level throughout the study period under a risk of conversion area projection. A reduction in harvest levels translates into less supply for forest products mills. As supply begins to decline, prices for timber will rise and the cost of producing products will increase. However, higher costs will not lead to higher product prices since many of Washington's forest products are commodities. As a result Washington mills will become less competitive. Sectors that consume smaller proportions of logs such as exporting and veneer and plywood establishments will find themselves competing for logs with lumber mills. The reduction in timber consumed by lumber and plywood mills will significantly impact the raw material supply to pulp mills as well.

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Introduction: The goal of this study was to provide policy and decision makers with a scenario that relates the effect of potential reductions in the timberland base to the state's future timber supply and the timber industry. Potential reductions in the state's timberland base have been identified as major obstacles to the long-term viability of forest-based industries. A number of factors contribute to the permanent conversion of timberlands to non-forest uses, but there is a general consensus that the combined impacts of population growth and resulting urbanization, and improved economic conditions over the past decade within Washington state significantly influence the value of forestland (College of Forest Resources 2007). Other factors influencing conversion are conflicting values at the urban/rural interface, an uncertain regulatory future, and changing timber market conditions.

This study utilized information on where the risk of conversion from forestland to other uses may occur and translated it into a permanent removal of harvestable timber. We then projected the volume of wood represented by the acreage and addressed what happens when this wood is no longer available over time. We provide an assessment of how the retention of the identified forestlands contributes to the current infrastructure and assess if the conversion and loss of productivity of these lands threatens the economic viability of currently existing facilities.

We determined a projected risk of conversion for productive, privately- or Tribally-owned timberlands located in western Washington using the *Washington State Forestland Database* developed by the University of Washington (Rogers and Cooke 2009). In the *Washington State Forestland Database*, conversion risk represents an estimate of the likelihood of parcels converting from forest to non-forest use. The risk to convert was determined by calculating the difference between per acre market value and per acre forest value for each parcel. Market value is a best estimate of the per acre value of each parcel, and if possible, as assessed by each county assessor. Since county assessor data was not available for each parcel, in some cases, market values represent the combined values of improved, unimproved lands and timberlands. Forest value represents the net present value of a parcel-specific, modeled forest management scenario that combines the soil expectation value with a five percent discount rate. In this study, we included forested lands with a differential between per acre market value and per acre forest value greater than zero; we considered these acres as having a positive conversion risk. Designated Forest Lands (DFL) are treated as if the risk of conversion were zero since the risk was not currently calculable or it was left undefined, and we assumed that DFL would behave as if conversion from forestlands were not allowed due to their land use designation.

An existing model for westside forests was used, with some modifications to allow for a changing land base. Modeling eastside forests is much more complex and no model similar to the westside model seems to exist. The budget did not allow development of eastside scenarios. While qualitative statements can be made based on the risk of eastside conversion, measures of their potential effects are needed, and there is no tool on the shelf to make the assessment within the time and budget allocated to this project.

In order to determine the conversion risk for forested lands that are representative of commercial timberlands, or potentially commercial timberlands, we applied the conversion risk attribute to three ownership classes: small forest landowners, industrial landowners, and tribal landowners. Small forest landowners represent those landowners that harvest no more than an average of two million board feet of timber per year and own 2500 acres or less. Industrial landowners represent landowners who own a minimum of 2500 acres and may harvest more than an average of two million board feet per year. Ownership types for these two classes must be either corporate or non-government. Tribal landowners represent tribal, non-corporate and non-government landowners and may own any amount of acreage, as well as harvest any range of average annual board feet.

Table 1 presents the percent of forested lands falling within one of the three ownership classes that met the conversion risk assessment. The forested acres column represents total acreage within each county that fall into one of the three ownership classes described above. The counties included in this table represent five timbersheds located within western Washington. These include the North Puget Sound (Island, King, San Juan, Skagit, Snohomish and Whatcom), South Puget Sound (Kitsap, Mason, Pierce, and Thurston), Southcoast (Grays Harbor and Pacific), Northcoast (Clallam and Jefferson), and Southwest (Clark, Cowlitz, Lewis, Skamania and Wahkiakum).

Table 1: Percent of small forest landowner (SFLO), Industrial or Tribal forested acres by western Washington counties with positive conversion risk, and total forested acres.

County	Forest Acres	Forest Acres with a Positive Conversion Risk Value	Percent with a Positive Conversion Risk Value
Clallam	330,411	30,711	9.3%
Jefferson	192,051	22,083	11.5%
Island	56,600	47,027	83.1%
King	350,138	97,292	27.8%
San Juan	56,938	40,677	71.4%
Skagit	278,104	56,430	20.3%
Snohomish	247,327	114,344	46.2%
Whatcom	173,933	52,101	30.0%
Grays Harbor	697,079	32,385	4.6%
Pacific	434,474	9,470	2.2%
Kitsap	124,462	73,918	59.4%
Mason	314,769	44,734	14.2%
Pierce	354,860	97,304	27.4%
Thurston	196,948	62,424	31.7%
Clark	118,450	61,262	51.7%
Cowlitz	514,403	39,977	7.8%
Lewis	761,252	70,315	9.2%
Skamania	88,116	12,450	14.1%
Wahkiakum	114,642	7,129	6.2%

Table 2. Percent of forested acres and annual loss rate by timbershed.

Timbershed	Forest Acres circa 2008[1]	Forest Acres circa 1990[2]	Annual loss rate in percent[3]	Acres with positive conversion risk value	Percent with positive conversion risk value
Northcoast	522,462	533,000	0.1%	52,794	10.1%
North Puget Sound	1,163,040	1,342,000	0.7%	407,871	35.1%
Southcoast	1,131,553	1,256,000	0.5%	41,855	3.7%
South Puget Sound	991,039	1,062,000	0.4%	278,380	28.1%
Southwest	1,596,862	1,607,000	0.0%	191,133	12.0%

[1]From UW Forest Land Parcel Data Base
[2]From Adams et al., 1992 (excludes DNR and other public lands)
[3]Based on 19 years difference (1990 to 2008)

Table 2 presents estimates of the annual loss in forest acres and summarizes the data from Table 1 at the timbershed level. The loss rates were determined using estimates of non-industrial forest acres developed by Adams et al. (1992) and current estimates of forest acres developed by the *Washington State Forestland Database*. The North Puget Sound (Island, King, San Juan, Skagit, Snohomish and Whatcom counties) and Southcoast (Clark, Cowlitz, Lewis, Skamania and Wahkiakum counties) have the highest percent loss rate. The North Puget Sound timbershed has lost an estimated 180,000 acres, and the Southcoast timbershed has lost an estimated 125,000 acres. We estimated the loss in the western Washington timbersheds to be 395,000 acres in the nearly two decades since 1990.

Table 2 also indicates large numbers of acres that have positive conversion risk values on private ownerships in four timbersheds. The potential risk of conversion is highest in the North and South Puget Sound timbersheds. This is an area where we estimate about 250,000 private forest acres have been converted to date, but nearly 1 out of 3 acres have a positive conversion risk associated with them. Approximately 972,000 acres in western Washington have a higher market than forest per acre value.

Study Methods: We used the potential conversion risk characterized by positive risk values to create scenarios of future forest acres for each timbershed. We utilized published regional projections of timber supply to assess the conversion risk and possible loss of productivity of these lands and consider the threats to the economic viability of currently existing facilities (Perez-Garcia and Barr 2007). The timber supply projections utilized a model that was originally developed to enable the application of harvest projections along with growth and inventory data to make inferences about a timbershed's capability to meet a predetermined harvest requirement. We expanded the capabilities of the model to consider alternative scenarios of land conversion rates for this study.

Parameters of the yield and inventory data provided in Anderson et al. (1994) were used in developing the projections of future timber supply. Four forest type classifications that included Douglas fir, Western Hemlock/Sitka Spruce, other softwoods, and hardwoods types were used in the inventory tables of Anderson et al. (1994) and they were maintained in this study. The modeling approach involved replicating historical harvest levels over four five-year periods, then evaluating constant, increasing or decreasing harvest level projections based on volume and area constraints. Projections were developed for the five timbersheds in western Washington. Each final projection defined the baseline used to assess the potential conversion risk associated with scenarios of the future forested acres.

We considered how land was removed from the forest land base to develop the land conversion scenario. Land was removed from the timberland base in one of three ways. First, we harvested acres that have reached their rotation age and subsequently removed these acres from the timberland base after harvesting without planting. Second, we removed acres and their associated volumes from the timberland base across all age classes irrespective of whether they have reached harvest age or not. Third, we removed acres prior to their use in projecting timber harvests.

The first approach assumed that the lands at risk of conversion would be used for a final rotation, and then they would be retired from the forest land base. That is, we assumed no further management, including planting or natural regeneration, would take place on these lands. The timber harvested contributed to the current timber supply and would not be available to meet future timber supply needs. The second approach represented a more intensive conversion assumption. We utilized this approach when the risk of conversion acreage exceeded the acres needed to meet timber supply requirements under the first approach. It suggested that land owners would not wait for the timber to reach their final harvest age before converting to alternative management objectives. It also assumed that timber volumes that exist on the land would not be used to supply logs to mills, (i.e. harvest activities do not take place when immature acres were removed from the land base.) The third approach was employed to calibrate the model to 1990 levels, given that the inventory and acreage data in Anderson et al. (1994) included DNR forestlands, and our analysis was limited to small forest, industrial, and tribal landowners.

Model Construction and Execution: The model is a spreadsheet application containing eight worksheets. The main worksheet performed calculations that estimated growth and harvest levels to 2100. Two worksheets contained input data on yield, existing acres and volumes, and historical harvest levels. The other worksheets were used to store results periodically and assist in analyzing results of the timber growth and harvest level calculations.

The model determined which age class provides the harvest volume required to meet a given total harvest requirement. The decision was to maximize a harvest value subject to three constraints. First, harvested volume in an age class could not exceed the actual volume present in that age class at any point in time during the forecasting horizon. Second, the total harvest volume summed over all age classes was constrained to equal the level stipulated for each individual time period. Finally, the acreage of timberland was first held constant to create a baseline and then allowed to change in a systematic fashion to infer the effect of changes in the baseline acreage on potential harvest levels.

Harvest levels for the five year periods starting in 1990, 1995, and 2000 were based on five year averages of available historical data (WA DNR Harvest Reports, several years). The projected harvest levels were determined through an iterative application of the model with two questions in mind: what is the sustainable harvest level so that harvest level in any period is not less than the harvest level in the previous period; and at what age does the harvest activity occur.

The process of making a harvest projection involved several steps. A first step was to choose a level of future harvest to constrain the total harvest in each time period. The acreage harvested over time is determined by imposing restrictions on the age classes in which the model could harvest timber volume to meet the harvest requirements. By using weights on age classes we restricted the harvest decision to acres within appropriate rotation ages. We assigned weights of 0 to 10 to all age classes and used a larger weight between 40 and 65 years of age to allow these ages classes to have larger values in the decision to harvest. A weight of 0 on other age classes precluded them from possible harvests by making them irrelevant in the maximization problem. The model was most heavily weighted to harvest in the 45 and 50 year age class in our projections.

The model was employed with different total harvest level constraints, until even flows of harvest levels were observed from age classes within credible rotation ages. Validity of the harvest projection was established using two metrics. Harvest volume per acre must be similar to historical harvest volume per acre. Rotation age must also be similar to historical data. Using these two metrics, we adjusted the harvest levels so that they produced harvest volume per acre and a rotation age that were justifiable. The data used to provide the projection's validity were taken from the Department of Revenue. Using their reported sales data and the associated timber cruise information we developed volume per acre averages for the timbersheds over time. The harvest projections were published in Perez-Garcia and Barr (2007).

The published regional projections of timber supply were modified to reflect two changes since the 2007 study. The effect of public forest land (principally WA DNR) and inventory was removed from the projections based on the percentages of their contributions reported in Adams et al. (1992). Second, the change in the land base from 1990 to 2008 was incorporated using the rates listed in Table 2. After these changes were implemented, the acres with positive conversion risk value reported in Table 2 were removed over time from the timber land base for each timbershed. It was assumed that the conversion of these acres began in 2010 and was completed by 2030 or 2035, depending on the timbershed and its percent acres with positive conversion risk value.

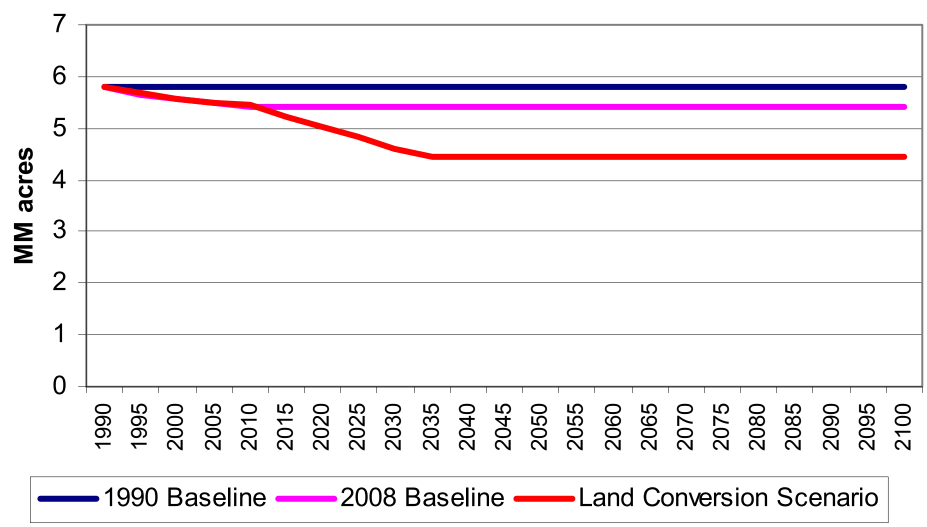

Figure 1. Forestland acres under three projections in millions (MM), (see text for explanation of each projection)

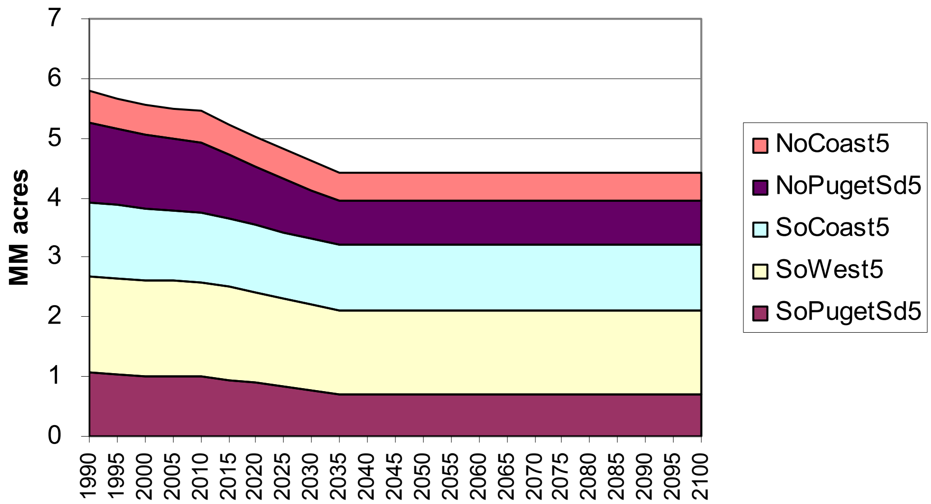

Figure 2. Forestland acre projections in millions (MM) under the Conversion projection by timbershed

Figure 1 depicts the land base projections. The 1990 baseline excludes public acres. The 2008 baseline reduces private acres by the estimated loss rate reported in Table 2. The land conversion scenario reduces the land base by the acres with positive conversion risk value reported in Table 2. Figure 2 provides the details for the land conversion scenario by timbershed. Since the acreage harvested to supply timber was smaller than the acres with positive conversion risk value in the North and South Puget Sound timbersheds, we utilized a combination of the first and second approaches to reduce the land base to reflect the large number of acres with positive conversion risk value in these two timbersheds. The first approach was utilized for the remaining timbersheds.

Study Results: The effect of a lower number of forested acres was to reduce harvest levels. To see this we report the potential harvest levels that could occur between the ages of 40 to 65 years under the 1990 baseline, 2008 baseline and Land Conversion projections (Figure 3). The distribution of potential harvest levels between the ages of 40 to 65 years under the three projections among timbersheds is portrayed in Figure 4. Finally Table 3 records the differences and their percents.

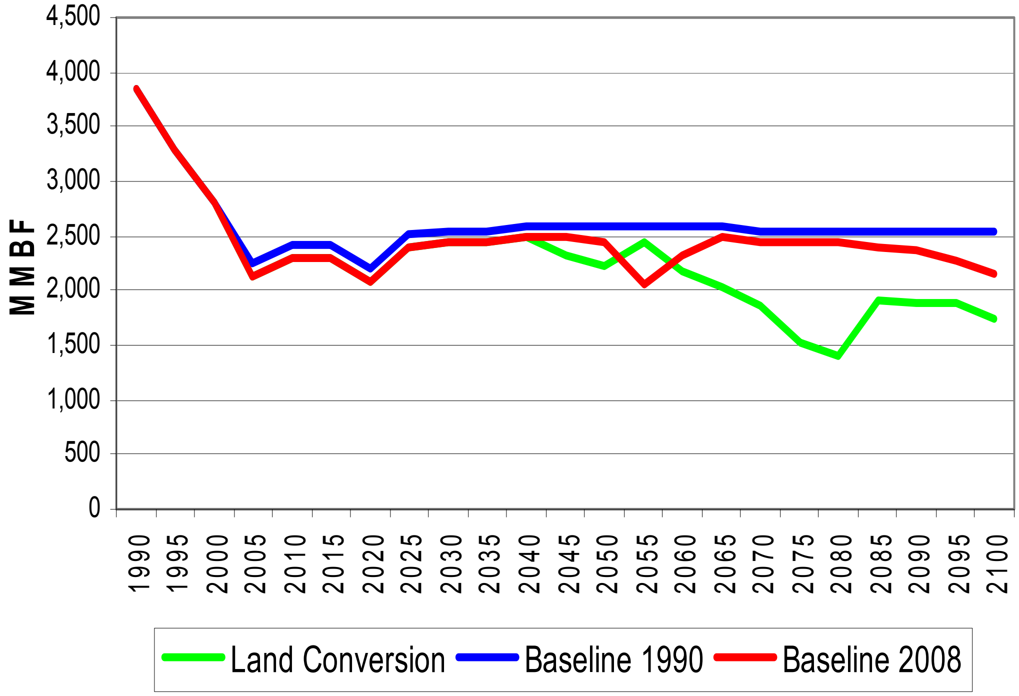

Figure 3. Harvest levels in billion board feet (BBF) under the three land area projections

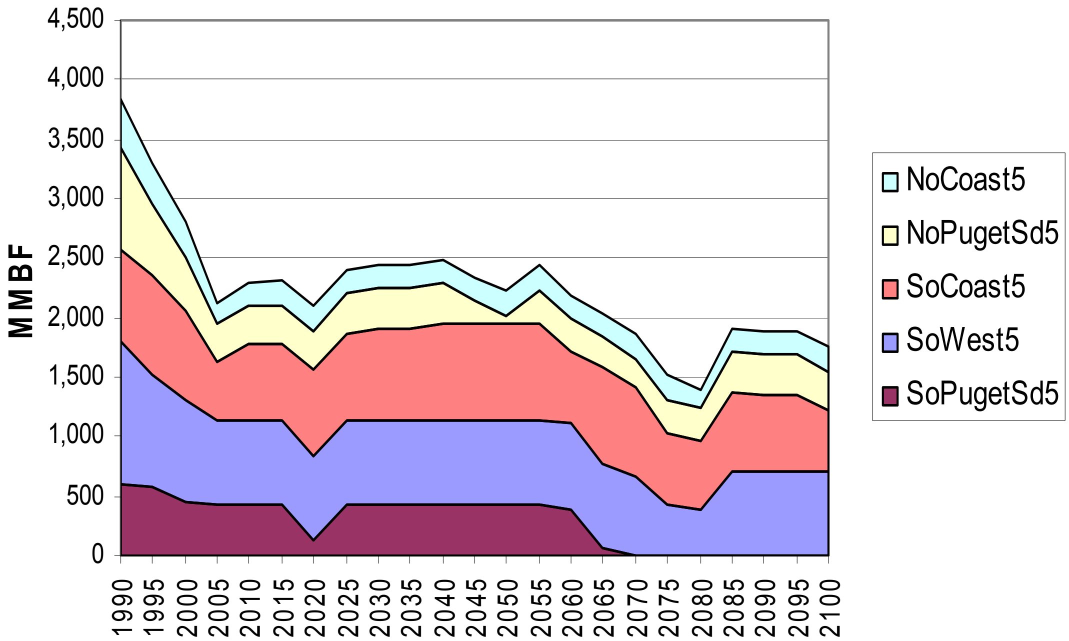

Figure 4. Harvest levels in billion board feet (BBF) under the Conversion projection by timbershed

Table 3. Potential harvest levels between the ages of 40 to 65 years in MMBF under three projections of forestland acres and their differences

Year	Baseline 1990	Baseline 2008	Land Conversion	Difference between Baselines and Land Conversion Scenario			
				Baseline1990		Baseline 2008	
				MMBF	%	MMBF	%
1990	3,837	3,837	3,837	0	0%	0	0%
1995	3,293	3,293	3,293	0	0%	0	0%
2000	2,803	2,803	2,803	0	0%	0	0%
2005	2,241	2,129	2,129	-113	-5%	0	0%
2010	2,412	2,300	2,300	-113	-5%	0	0%
2015	2,417	2,305	2,305	-113	-5%	0	0%
2020	2,204	2,091	2,091	-112	-5%	0	0%
2025	2,507	2,395	2,395	-113	-4%	0	0%
2030	2,552	2,440	2,440	-112	-4%	0	0%
2035	2,552	2,440	2,440	-113	-4%	0	0%
2040	2,597	2,485	2,485	-113	-4%	0	0%
2045	2,597	2,485	2,332	-265	-10%	-153	-6%
2050	2,597	2,443	2,222	-376	-14%	-221	-9%
2055	2,597	2,058	2,434	-164	-6%	376	18%
2060	2,597	2,331	2,183	-414	-16%	-148	-6%
2065	2,597	2,485	2,042	-556	-21%	-443	-18%
2070	2,552	2,440	1,858	-695	-27%	-582	-24%
2075	2,552	2,440	1,514	-1,038	-41%	-926	-38%
2080	2,552	2,440	1,402	-1,150	-45%	-1,038	-43%
2085	2,552	2,399	1,904	-648	-25%	-495	-21%
2090	2,552	2,371	1,890	-662	-26%	-480	-20%
2095	2,552	2,266	1,886	-666	-26%	-379	-17%
2100	2,552	2,143	1,749	-803	-31%	-394	-18%

Figure 3 and Table 3 suggest that by 2050 there will be a decline in potential harvest levels by 9% or 221 million board feet (MMBF) from age classes 40 to 65 years. Potential harvest levels could continue to drop from these age classes reaching minimum levels of 1,400 MMBF in 2080 for the Land Conversion projection, a decline of 1,038 MMBF (43%) from the 2008 baseline projection. There would be a declining trend in potential harvest level that averages 12 MMBF per year starting in 2045.

Figure 4 suggests that potential harvest level from age classes 40 to 65 years in the South Puget Sound timbershed will disappear by 2070 due to the removal of 278,380 forested acres (28% of the 2008 baseline acres) from the land base. An age class distribution problem (i.e. the lack of volume in age classes 40 to 65 years) appears in all timbersheds by 2080.

Threats to Existing Facilities: A reduction in harvest levels will translate into less supply for forest products mills. As supply begins to decline, prices for timber will rise and the cost of producing products will increase. Higher costs will not lead to higher product prices however since many of Washington's forest products are commodities. As a result Washington mills will become less competitive.

The forest industry consumed nearly 2,484 MMBF (million board feet) of logs from private sources according to the 2006 Washington Mill Survey (Smith et al. 2008; Table 8a). About 62% of these logs went to lumber mills. The majority of remaining volume went to exporting, and veneer and plywood facilities. Table 3 suggests that by 2080 the supply of logs could potentially fall to 1,402 MMBF. This harvest volume represents 91% of the volume of logs consumed by the sawmilling sector alone in 2006. Diversion of nearly all logs to lumber production is not likely since forest lands produce a variety of timber, some of which is higher-valued and used by veneer and plywood mills as well as export facilities and other forest enterprises.

Nevertheless, lumber mills remain the major users of harvested timber. Lumber mills in western Washington numbered 52 in 2006 (Smith et al. 2008; Table 13). There are four to five large mills in western Washington with eight-hour shift capacities that can produce more than .5 MMBF lumber tally. Their total eight-hour shift capacity is about one quarter of the 10 MMBF lumber tally capacity in western Washington. Around 32 mills (62% of all lumber mills), including these large mills, have a capacity to produce .120 MMBF or more, for about 90% of the 10 MMBF capacity. These mills consumed 1,400 MMBF of logs from private sources in 2006 (Smith et al. 2008; Table 21b). The reduction of 1,038 MMBF by 2080 represents 75% of the raw material input by these mills.

Exports of Washington logs reached 286 MMBF in 2006 (Smith et al. 2008; Table 57). The volume represents 76% of the loss in potential timber harvest levels by 2055. Veneer and plywood mills consumed another 234 MMBF of logs (Smith et al. 2008; Table 35), although this number does not distinguish the log volumes that originated from Washington private lands.

While larger sawmills could compete with other sectors consuming logs, a third of mills in the state are smaller in size and could find it more difficult to compete. Undistinguished from the survey and modeling results are the effects of the supply reduction on hardwood lumber mills.

Sawmills, veneer and plywood mills supply chips and wood residuals for other industries, primarily pulp mills. In 2006, 3.3 million dry tons of chips and wood residuals were produced in western Washington (Smith et al. 2008; Table 26). The twelve pulp mills statewide consumed 4.2 million tons of mill residues in 2006 (Smith et al. 2008; Table 44). A 43% reduction in timber consumed by lumber and plywood mills by 2080 will significantly impact pulp mill raw material supply.

Sawmills in the South Puget Sound timbershed numbered eight in the 2006 (Smith et al. 2008). All but two have a capacity to produce .120 MMBF lumber tally or more. Two mills have eight-hour shift capacities that produce more than .5 MMBF lumber tally. The loss of potential timber harvest levels within this timbershed by 2060 will impact their competitiveness.

The effect of removing forest lands with a risk of conversion on western Washington infrastructure is measured conservatively in this study. The study allowed timber harvest to occur on the majority of the lands removed. This assumption pushes the effect into the future reaching its maximum impact when acres no longer contribute timber from a subsequent rotation. If harvest activities were not assumed to take place on lands with a risk of conversion, then the effect described above would occur earlier affecting harvestable timber volume in the current rotation.

Conclusions:

The percent of forested acres among private ownerships with positive risk of conversion values ranged from 35% in the North Puget Sound timbershed to 4% in the Southcoast timbershed. The other three timbersheds in western Washington had between 10% to 30% percent of their forest lands with a positive risk of conversion value. Nearly one million acres have positive risk of conversion values in western Washington.

The reduction in forested acres over the next three decades led to a projected 153 MMBF reduction in potential harvest levels in age classes 40 to 65 years by 2045; reaching a 1,038 MMBF reduction by 2080 a 43% loss in timber volume over the 2008 baseline projection. The declining trend in potential harvest levels in these age classes continued over time and averaged 12 MMBF per year.

A reduction in harvest levels translates into less supply for forest products mills. The reduction of 1,038 MMBF by 2080 represents 75% of the raw material input by sawmills. Use of logs by exporting facilities and veneer and plywood plants will be reduced by lower harvest levels and higher competition from sawmills. While larger sawmills could compete with other sectors consuming logs, a third of mills are smaller in size and could find it more difficult to compete. The reduction in timber consumed by lumber and plywood mills by 2050 will significantly impact chip and residual wood raw material supply to pulp mills.

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