Future Prospects for Private Timber Harvest in Eastern Oregon

Darius M. Adams and Gregory S. Latta

ABSTRACT

Projections of eastern Oregon private sawtimber harvest are developed using a market model linked to a subplot level projection of growth and inventory. The “base” projection envisions nearly a 50% drop in forest industry harvest relative to recent historical levels, while nonindustrial private forestland harvest remains roughly stable. In this scenario the region would lose nearly one-third of its remaining lumber mills and processing capacity within the first 30 years of the projection. Log prices would show little long-term trend. Simulations of two hypothetical public policies show the impacts of changes in public harvest and the private land base. In a case of expanded riparian protection, which reduces the harvestable private land base by about 11%, private harvest falls by roughly 18% between 2003 and 2033. Large harvest reductions are projected on industrial lands because of limited merchantable inventories. A restoration thinning program on public lands that raises public harvest by 40 million board feet per year over 20 years, sustains recent mill numbers for the next 25 years (although total harvest continues to decline). Substitution of public harvest for private harvest would enable continuation of a higher private cut for several years after the thinning program has ended.

Keywords: timber markets, timber supply, market model

D uring the 1980s, eastern Oregon was one of the major timber-producing regions in the western United States. In this period it provided 9–10% of the softwood lumber produced west of the Great Plains and was home to more than 40 lumber mills, 6 plywood mills, and 7 reconstituted panel mills. Less than 35% of harvest came from private lands. During the past 20 years, the region has experienced an array of resource and policy changes that have had dramatic impacts on its industry and resources. A major insect outbreak beset all forest ownerships, raising mortality and reducing growth. The effects of long-term fire exclusion have been realized as increasing stand density, declining growth, growing fuel accumulations, and increased risk of catastrophic fire losses, and management policy shifts on public lands have reduced public harvest to less than 10% of its typical level in the 1980s. As a result, eastern Oregon today provides only about 4% of western US lumber output and only 14 sawmills and 1 plywood mill remain in operation. Regional harvest (2000–2004) has dropped to about 35% of its average level in 1980, and private lands are now the dominant source of timber supply.

This article develops projections of the long-term (50-year) timber harvest prospects of eastern Oregon’s private forests. Unlike past studies, our estimates are based on an economic model of the market for sawlogs in eastern Oregon. The projections include the customary views of timber harvest and inventory trends and also allow characterization of the future time pattern of prices in the region and the number of milling facilities in operation. We present a “base” case, consistent with the base scenario in the USDA Forest Service’s 2005 Resource Planning Act (RPA) Timber Assessment Update (USDA Forest Service 2006a), then examine the potential impacts of two major ongoing policy issues: (i) expanded protection of riparian zones and (ii) a program of restoration thinning on public lands that would raise public harvest.

Recent Area, Inventory, and Harvest Changes

Changes in the timberland base are one of the fundamental concerns in assessing future harvest potential. Data from several past inventories suggest that both industrial and nonindustrial private forestland (NIPF) areas in eastern Oregon have declined since the late 1970s (see Adams and Latta [2003]), with a 12% loss for NIPF and a 2% decline for industry (1978–1999). In absolute terms the NIPF loss amounted to some 155,000 ac, or about 7,800 ac/year. This rate has slowed somewhat between the two most recent surveys (1988 and 1999). In the more recent period, NIPF ownerships showed a net loss of 40,000 ac (from a 1988 base of 1,177,000 ac) while industrial ownerships gained 59,000 ac (on a 1988 base of 1,535,000 ac) primarily through purchases from NIPF (Azuma et al. 2002).

Private softwood timber inventories have also declined over the past 20 years. Industry inventory in eastern Oregon has declined more than 25% since 1978, while NIPF stock has dropped by nearly 18%. Part of this decline is due to loss of timberland area and associated volume to other owners and uses (particularly for NIPF) and increased mortality due to insect and disease attacks. The largest factor in the reductions, however, is the high rate of removals. On industry lands, Azuma et al. (2002) estimated that sawtimber removals were 43% greater than gross sawtimber growth from 1988 to 1999. NIPF sawtimber removals were more than 82% of gross growth for the same period.

Historical timber harvests in eastern Oregon are shown in the left portion of Figure 1. Both private owner groups have shown marked variation over time, with a modest long-term downward trend on
industry lands and a decline on NIPF after the early 1990s. Neither private group appears to have responded in a sustained fashion to the decline in national forest harvest after 1990, despite the large price increases accompanying that change.

**Harvest Projection Model**

Future private timber harvests were projected using a market model that simulates the behavior of timber producers and timber buyers in the eastern Oregon softwood sawlog market. The approach uses a detailed representation of the private timber inventory that projects the growth and inventory of stands through time. Inventory data were derived from the Forest Service’s 1999 remeasurement of permanent inventory plots on private lands in eastern Oregon (Azuma et al. 2002). In this inventory, plots were subdivided into “condition classes,” areas with common forest type, stand size, tree stocking, and harvest history since the previous inventory. We use the condition classes as the basic resource units in our analysis. Each condition class in the survey sample represents a specific area in the inventory (determined by the condition class’s area expansion factor from the sample). In a model projection, the area represented by each condition class can be broken down into a number of even- and uneven-aged treatments that may vary over time.

**Inventory and Growth**

Possible management practices in existing stands and stands created in the future are grouped into six “management intensity” classes (MICs) as shown in Table 1. These regimes were adapted from an analysis of harvest potential in comparable forest types in eastern Washington (Bare et al. 1995). Both even- and uneven-aged forms use volume thresholds to establish the earliest times for harvest. Assignment of areas to each MIC in both the initial period and over the projections is determined within the model. In the market model, landowners choose the sequence of management regimes over time that will yield the maximum present net worth.

Growth and yield volumes for each condition class under the several possible MICs were estimated from the appropriate variant of the Forest Vegetation Simulator (FVS) calibrated for regions within eastern Oregon (USDA Forest Service 2006b). FVS is an individual tree, distance-independent model; hence, the detailed thresholds in some of the MICs (such as diameter and height limits) are readily projected.
Inventory is projected using a formulation that is a combination of Johnson and Scheurman’s (1977) models “I and II.” Areas assigned to uneven-aged MICs are tracked using the model I format, with separate activities for each combination of harvest timing and management. Areas managed under even-aged schemes are tracked using the model II form (specifying time of origin and time of harvest) with yield tables that meet the management restrictions in Table 1.

Market Model
Harvest is determined to maximize the sum of producers’ and consumers’ surpluses in the market for logs over the projection period, i.e., the model equilibrates log demand and supply over time. Demand derives from the need for log input at conversion facilities (lumber and plywood mills). We estimated log demand using a profit function approach separately for lumber and plywood. The resulting log demand relationships depend on lumber and plywood selling prices, prices of logs, prices of other inputs (labor and other materials), trends in technology, and processing capacity (as a measure of capital input). Details of this approach are described by Adams and Latta (2003).

Given the dispersed nature of the eastern Oregon private resource and the small number of remaining processing facilities, it is important to recognize the specific location and other operating characteristics of individual mills. Using only a single “average” demand location or demand center for the aggregate of all mills in eastern Oregon would mask the potentially critical effects of log transportation cost differences. Explicit treatment of individual mills also allows recognition of differences in processing capacity over time and, to the extent that data permit, other operating characteristics. To implement this approach in the present context with limited publicly available data on individual mills, we estimate mill level log demand by scaling the regional log demand equation using recent actual output by mill. We then add a system of conditions to control capacity behavior at the mill level. Output capacities, initially set at actual levels, can be maintained or expanded over time at given costs if future profitability warrants. If not maintained, capacity contracts at the depreciation rate. To further insure reasonable mill level behavior, we limit mills’ lowest operating rates (the ratio of output to capacity) to be no less than observed historical minimums and require that if a mill wishes to contract below some minimum size it must leave the industry (shutdown). These latter levels, or minimum mill sizes, vary by mill based on estimates of current technology and number of primary log breakdown facilities.

Private log supply is an implicit function of the costs of growing timber over time and of harvest and delivery to mills. Private timber suppliers are seen in this model as wealth or present net worth maximizers in a market where their supply actions (harvest and investment decisions) influence current and future log prices. Public harvest also contributes to log market supply, but because harvests from public lands are determined by policy and not market considerations, we take public cut as exogenous. Projected public harvest for the base case is shown in Figure 1. Log flows into and out of the region mostly involve western Oregon and have been relatively stable over the past 20 years. We have taken them as fixed at recent average levels in our analysis. Additional details of the market model can be found in the Model Appendix and in Latta and Adams (2005) and Adams and Latta (2005). We used a 6% real discount rate in all market simulations reported here.

Other Assumptions
To show the effects of policy changes, we compare the results from a “base” run to those from simulations under changed policy conditions. In the base run, projections of the determinants of demand in the market model that are not computed within the model were derived from the Forest Service’s 2005 RPA Timber Assessment Update (USDA Forest Service 2006a). These factors included national trends in lumber and plywood prices and labor costs. On the supply side, real costs of management, harvest, and transport are assumed to be constant over time.

In this article we examine changes in forest practice rules in riparian zones and the advent of a forest health thinning program on national forests. Because the distance of each private condition class from the nearest stream course (permanent or ephemeral) can be estimated from the survey data, it is possible to restrict or modify management options for plots within critical distance zones to reflect new policies. The public lands thinning program was implemented by combining the permanent plots for the national forests with the private plot database. Location and resource information for the national forest plots enabled computation of thinning volumes and the harvest, hauling, and other treatment costs.

Base and scenario projections also assume that the steady trends in land area loss from NIPF ownerships continue over the period to 2028. This leads to a loss of some 199,300 ac, a decline of just over 15% relative to the 1998 inventory sample. All of the loss goes to nonforest uses. The industrial land base is assumed to be constant.

Base Case Projections
The base case projection envisions a future for the US forest products sector with continued strong growth in product demand but limited product price growth due to competition from other US regions and import suppliers. In eastern Oregon, the base projection also assumes continuation of public policies regulating private management practices in their current form and no change in timber harvest policies on public lands.

Forest Industry
Inventories on industrial lands in eastern Oregon have declined steadily over the past 25 years and growing stock has been increasingly concentrated in the smaller size classes. Largely as a result of these trends, the average long-term base harvest projection for industrial owners falls to less than one-half of recent historical levels (roughly 175 million board feet/year versus 376 mmbf/year for 1999–2003). Earlier studies have foreseen similar limitations in harvest potential, with the projection by Sessions (1991) falling by nearly one-half relative to Beuter et al. (1976). Our projection falls by nearly one-half again (Figures 1 and 2A).

Reduced future harvest allows sawtimber inventories to stabilize and rebuild, but the recovery is slow given the low sites and slow growth of eastern Oregon forests (Figure 3). Only after the 50th year of the projection does industrial inventory rise above the 1998 level (inventory here includes land with less than 20 ft³/ac per year growth). Growth rates are also governed in part by the management regimes adopted on industrial lands. In the base case, nearly 86% of the industrial base is concentrated in uneven-aged or selection management, with one-half in the least-intensive regimes. In the smaller portion, using even-aged systems, roughly one-half is allocated to the most-intensive forms.
NIPF Owners

Nonindustrial sawtimber inventories also have been falling over the past 30 years, because of relatively high harvests and mortality and significant losses of timberland, but these lands have retained substantially higher portions of their growing stock in larger tree size classes than industrial ownerships. Consequently, the base case harvest projection for this ownership averages roughly 137 mmbf/year over the 2008–2058 period compared with the 1999–2003 historical average average of 129 mmbf (Figure 1). Earlier studies showed a downward adjustment in NIPF harvests as in the industrial case (see Figure 2B). The average harvest for the current base is about 80% of Sessions (1991) projection.

NIPF sawtimber inventories continue to fall rapidly in the first 10 years of the projection, then stabilize and rise (Figure 3). Roughly, 70% of the managed NIPF land base is allocated to selection regimes. Within the selection regimes, the least-intensive forms account for more that 60% of the area. In the areas using even-aged systems, the higher intensity regimes rise from roughly 30% at the start of the projection to nearly 60% by 2058.

Base Case Market Changes

Combining private supplies and public harvest assumptions, total base case harvest for eastern Oregon declines to about two-thirds of recent historical levels (1998–2002) by 2023 and then stabilizes for the remainder of the projection (see Figures 1 and 6). The decline in harvest volume precipitates mill closures. Mill numbers drop to 10 by the 2008 period and oscillate in the 10–12 range for the remainder of the projection (Figure 4). In the base case, closures are concentrated in the Blue Mountain region in the northeastern portion of eastern Oregon. Delivered log prices (Figure 5) follow the time pattern of mill numbers for the first 25 years of the projection, declining rapidly in the first 10 years, with another spike in 2023 as mill numbers rise and fall. In later years mill numbers rise once
ownerships, respectively. The hypothetical alternative would extend
limit harvest to partial cutting in another 0.7% and 1.8% on the two
lands and 1.5% of NIPF lands from harvest in the no-cut zone and
current riparian protection rules remove about 0.8% of industry
lands in the actual regulations. Using this approach we estimate that
general form and extent of excluding or limiting harvest access to
cut boundary out to 50-ft. This is a significant simplification of a
partial cut buffer on perennial streams extending from the 20-ft no
cut zone around all streams and a
nature), we approximate the impacts of current riparian protection
perennial or intermittent (nothing in respect to their fish-bearing
future mortality in the residual stands. Opponents are concerned
about an array of nonwood forest values and services that may be
improved in the future.


Projections Under Changed Policies

The base projection is restricted by an array of assumptions regard-
regarding background economic conditions (including national prod-
uct prices and regional production costs) and constant public poli-
cies. In this section we relax this latter limit, examining two changes:
one involving an extension of riparian protection zones on private
land and a second that envisions the establishment of a program of
restoration thinning on national forestlands. Riparian protection
rules have received much attention over the past 10 years because
their restrictions can remove significant areas from harvest entry.
Debate over restoration thinning on public lands is of somewhat
more recent origin, but passage of the federal Healthy Forests Rest-
oration Act of 2003 raises the prospect that such a program might
emerge in the future.

Expanded Riparian Protection

Because our inventory data only allow us to identify streams as
perennial or intermittent (nothing in respect to their fish-bearing
nature), we approximate the impacts of current riparian protection
regulations by means of a 20-ft no cut zone around all streams and a
partial cut buffer on perennial streams extending from the 20-ft no
cut boundary out to 50-ft. This is a significant simplification of a
much more complex set of rules, but we believe it captures the
general form and extent of excluding or limiting harvest access to
lands in the actual regulations. Using this approach we estimate that
current riparian protection rules remove about 0.8% of industry
lands and 1.5% of NIPF lands from harvest in the no-cut zone and
limit harvest to partial cutting in another 0.7% and 1.8% on the two
ownerships, respectively. The hypothetical alternative would extend
the no-cut buffer to 100 ft on all streams (and drop the partial cut buffer). This policy would remove an additional 9% of the indus-
trial land base and 14% of NIPF lands from harvest.

Projected aggregate harvest, ownership inventory, mill numbers,
and prices are shown in Figures 3– 6, together with the base case.
Total harvest falls by about 11% over the projection (average
2003–2058) in this case, 18% on industrial lands, and 14% on
NIPF. The industrial reduction is larger than the fraction of land
loss because of the limited volumes of merchantable inventory on
these lands in the near term. Indeed, harvest reductions in the first
20 years alone average nearly 30%. The NIPF impact is closer to the
proportion of area lost because of the higher volumes of larger ma-
terial on NIPF lands. Inventories for both owners rise steadily above
the base under this policy as the additional riparian no-cut reserves
continue to grow (Figure 3).

Mill numbers fall sharply at the outset as cut contracts (Figure 4)
and remain two to three mills below the base for the remainder of
the projection. Most of the additional loss occurs in the Blue Moun-
tains region. Prices (Figure 5) also fall below base levels after the
2003 period. Ordinarily, a supply contraction would be expected to
lead to a price increase. In our model, however, mills are discrete
units with minimum operating rates and capacities. As a result, log
consumption does not adjust smoothly when mills drop out of
production (the demand reduction is “lumpy” with a big drop when
a mill closes). Thus, in the present case, the drop in number of mills
and the associated reduction in log demand more than offset the log
supply reduction, pushing prices below the base case.

Thinning on Public Lands

The implementation, form, and extent of any restoration thin-
ing program on the national forests in eastern Oregon is com-
pletely conjectural at this point. Some advocates believe that such a
program could be effective in reducing standing hazard material
and, if removals were large enough, accelerate growth and reduce
future mortality in the residual stands. Opponents are concerned
about an array of nonwood forest values and services that may be
adversely affected and the potentially high costs of such programs.
Thus, the present example, developed from a case described in Ad-
ams and Latta (2005), is strictly hypothetical. It would expand na-
tional forest harvest on average by 40 mmbf/year over a 20-year
period beginning in the first 5-year period of the projection
The hypothetical 20-year thinning program on public lands acts to temporarily offset the projected decline in private harvest, sustaining recent mill numbers for another 25 years and reducing harvest pressure on private lands. The savings in private inventory support higher harvest levels for another 5 years beyond the end of the thinning program. Programs of longer duration would be expected to extend these effects, and although this example was couched in terms of a restoration thinning program, it serves to illustrate the potential effects of any expansion of public harvest in the region.

What would happen if both of these policies were adopted? Would the thinning program compensate for the private land lost to expanded riparian protection? We don’t show this simulation in the figures, but the results are easy to envision. While the thinning program is active, total regional harvest and prices follow the general patterns of the “thinning-alone” case, although harvest is not quite as high and prices do not shift as far from the base. Mill numbers also follow the thinning-alone case until the 2018 period. At the cessation of the program (2023 and beyond), however, harvest and mill numbers fall immediately to the base level and eventually well below the “riparian-alone” case. The savings of private inventory that provided an additional period of higher output in the thinning case has been counterbalanced by the riparian land loss. The thinning program more than offsets the harvest and capacity impacts of the riparian policy in the near term, but by maintaining a larger number of mills (and harvest) in the near term while reducing the harvestable private inventory, the longer-term contractions in the eastern Oregon forest sector are substantially larger than the riparian policy alone.

**Literature Cited**


**Model Appendix**

Following Latta and Adams (2005), the general structure of the model is outlined in the following list (the time subscript is suppressed, except where essential). The subscript CC refers to the basic private inventory condition classes (subplot units) or sources of log.

Discussion

The base case projection envisions a substantial near-term decline in eastern Oregon harvest and lumber processing capacity as private harvest falls. In this outlook, industrial lands are unable to sustain recent harvest levels and NIPF ownerships do not increase harvest enough to compensate for the loss. Harvest projections for both private owner groups are well below those of earlier studies by Beuter et al. (1976) and Sessions (1991). Mill numbers decline by roughly one-third, with the largest losses in the Blue Mountains region. Impacts of the harvest decline on log prices are limited because demand contraction (mill closure) closely parallels the shift in supply.

Expanding the no-harvest zone by fivefold in a hypothetical change in riparian protection policies has an impact on projected harvest that is somewhat larger than the proportional loss in timberland access. This is caused by, primarily, limitations in merchantable inventory on industrial ownerships. The policy leads to the loss of an additional two to three mills and a further contraction in processing capacity. Changes of this general sort, although of lesser magnitude, might also follow from private land base losses in riparian areas through shifts to nonforest uses such as resort or residential development.

(2003–2007). In our model, this additional sawtimber supply is simulated by augmenting the private timber inventory with a set of public land areas and their associated thinning volumes. These areas “compete” with private timber sources having their own harvest volumes and harvest and haul costs, entering the supply stream only as prospective market returns dictate. As a result, the actual flow of thinned sawtimber into the market is somewhat uneven, the largest harvests, more than 80% of the volume, coming in the first 10 years of the projection.

The thinning volumes augment regional supply just in the periods of most rapid decline in the base case (Figure 6). This has two effects on private timber owner behavior. In the short-term there is some substitution of public for private harvest. Private cut falls below base levels in the first 10 years and is replaced by thinning harvests from public lands. These harvest reductions allow private inventories to accumulate more rapidly (Figure 3) and provide the basis for private harvests rising above the base case in periods after the termination of public thinning. In effect, they create some private inventory “savings” that are used in later periods. Given a fixed-term thinning program, however, the savings are finite and the higher public harvests only act to postpone the decline in regional harvest back to base case levels.

Higher regional harvests sustain higher mill numbers until 2023, when they return to base case levels (Figure 4). Because the thinning program ends in the 2018 period, the higher mill numbers projected for 2023 are supported by higher than base level private harvest in that period. Operating capacity is also higher than base levels during and after the program period, so there are not only more mills but they are, on average, somewhat larger than in the base case. This has important impacts on log price behavior, as illustrated in Figure 5. In the first 10 years of thinning, prices fall below the base case as might be expected. More mills are operating and they are somewhat larger, but there are no “new” mills opened and supplies are ample for capacity. In later periods, even as mill numbers begin to fall, the remaining facilities have higher capacity, raising log demand and prices above base case levels.
supply; MILLS is the log processing locations or centers of log demand. The decision variables are the areas allocated to even- and uneven-aged management MICs on private lands, capacity change due to maintenance and expansion expenditures, and the mix of shipments from plots to mills.

\[
\text{MAX} \sum_{\text{TIME}} \left[ \sum_{\text{MILLS}} \text{willingness to pay} \left( \text{receipts}_{\text{MILLS}}, \text{capacity}_{\text{MILLS}} \right) \right.
\]
\[
- \ \text{capacity costs (maintenance, expansion)}
\]
\[
- \ \text{transport costs (CC \to MILLS)}
\]
\[
- \ \text{harvest costs}
\]
\[
\left( \text{final harvests, thinnings, partial cuts} \right)
\]
\[
- \ \text{planting and silvicultural costs} \left( 1 + r \right)^{-\text{TIME}}
\]
\[
+ \ \text{discounted terminal inventory contribution}
\]
\[
\left( \text{even flow after last projection period} \right), \quad (1)
\]

Subject to

2. all CCs must be allocated to some mix of MICs (as defined in Table 1) in each period;

3. area of even-aged planting \( \leq \) area harvested in new and existing even-aged stands this period;

4. \( \text{harvest}_{\text{CC}} = (\text{final harvests} + \text{thinnings})_{\text{EVEN-AGED AREAS}} + (\text{partial cuts})_{\text{UNEVEN-AGED AREAS}} \)

5. \( \text{harvest}_{\text{CC}} = \sum_{\text{MILLS}} \text{shipments}_{\text{CC,MILLS}} + \text{exports}_{\text{CC}} \)

6. \( \sum_{\text{CC}} \text{shipments}_{\text{CC,MILLS}} + \text{log imports}_{\text{MILLS}} + \text{public harvest} \geq \text{receipts}_{\text{MILLS}} \)

7. \( \text{receipts}_{\text{MILLS}} \leq \text{capacity}_{\text{MILLS}} \)

8. \( \text{receipts}_{\text{MILLS}} \text{ must either be } \geq \mu \text{ capacity}_{\text{MILLS}} \text{ or they must be zero;} \)

9. \( \text{capacity}_{\text{MILLS}} = \text{capacity}_{\text{MILLS,TIME,-1}} \left( 1 - \delta \right)^5 + \text{maintenance}_{\text{MILLS}} + \text{expansion}_{\text{MILLS}} \)

10. \( \text{capacity}_{\text{MILLS}} \geq \text{minimum capacity}_{\text{MILLS}} \)

11. convexity constraints (piecewise linearization of willingness to pay functions);

12. nonnegativity of decision variables.

where \( \text{exports}_{\text{CC}} \) and \( \text{log imports}_{\text{MILLS}} \) are exogenous log exports and imports, \( \text{maintenance}_{\text{MILLS}} \) and \( \text{expansion}_{\text{MILLS}} \) are capacity changes due to expenditures on maintaining the current capacity of a mill or expanding it, \( r \) is the discount rate, \( \delta \) is the capacity depreciation rate, and \( \mu \) is the minimum operating rate.