

## **Carbon Calculator Default Historical Harvest Regime Parameterization**

**Last Modified 10/25/2012**

### **Introduction**

In order to simulate past, present, and future carbon dynamics; the Forest Sector Carbon Calculator (FSCC) requires characterization of historical timber harvest regimes. This is needed because past, current, and future forest management can have long lasting effects on carbon dynamics. In the FSCC, the harvest scheduler determines the type of harvest (whole stems, whole trees, etc.), harvest interval, percentage of stand/landscape harvested, and utilization levels of harvested biomass. Simulated harvests generated by the harvest scheduler are then used by the harvest module of LANDCARB 3.0 in the FSCC to determine how grid cells are harvested and how live and dead plant biomass are removed and/or redistributed within a stand or landscape.

There are multiple factors limiting the realism of simulated harvests regimes characteristics for any given region or landscape over time. Heterogeneous harvest regimes across ownerships or regions, sparse historical documentation, and spatiotemporal limitations of retrospective analyses limit quantification of historical harvest types, intervals, extent, and spatial patterns. Additionally, harvest interval is something of a misnomer in the context of early timber harvesting across much of North America, where timber was harvested without a long-term plan for its replacement. This is in contrast to the “normal forest” concept developed in Europe, in which harvest rotations were designed to maintain constant increment and volume growth, and/or to provide for a continuous wood supply. Because of these limitations, the goal of historical harvest parameterization in the FSCC is to represent general patterns of past landscape-level harvest based on harvest interval and percent of area disturbed, while also capturing any major shifts in harvest type such as transitions from clear-cuts to partial harvests. We accomplish this by adjusting the type of harvest (stems, whole trees, etc.), harvest interval, percent of a stand/landscape harvested, and utilization levels to approximate general forest management trends over time. We also include historical prescribed fire and fire suppression within simulated harvest regimes, because they are a key component of overall management activities, and they can strongly influence carbon dynamics over time.

It is important to note that while other components of FSCC parameterization (such as historical fire regimes) are grouped by ecoregion and elevation band, harvest regimes are based on ecoregion and forest ownership (federal, state, private industrial, and private non-industrial forestlands). We parameterize harvest histories only at the ecoregion/ownership level because: harvest rates and spatial patterns of harvests in the region are strongly influence by ownership type (Cohen et al. 2002), quantitative data are lacking to parameterize long-term within-ecoregion harvest regimes across elevation gradients, and additional grouping by elevation band would result in ecoregion-ownership-elevation band combinations unlikely to exist in significant areal extents (for example private industrial forestlands at high elevations in the West Cascades Ecoregion). The following pages describe historical harvest regimes as characterized in the FSCC for the four main ownership categories listed above for the West and East Cascade ecoregions of Oregon.

### **Parameterizing complex multi-objective and multi-owner landscapes**

It is important to note that the default historical harvest histories described above are quite generalized. To approximate the historical regime we have programmed the FSCC with basic default harvest histories, but the user can change easily create their own history to generate other management scenarios as needed. Additionally, there are often multiple objectives and harvest histories within a given ownership type (wilderness, matrix, and O&C allocations on federal forestlands), while large landscapes with often contain forests from multiple ownerships. These multi-objective and multi-ownership landscapes are difficult to incorporate into a single default regime. Instead, the FSCC user can simulate a multi-objective, multi-ownership landscape by running separate simulations for each management scenario in the simulated landscape, and then averaging the results of these simulations, weighting by the proportion representation of each scenario in the simulated landscape. For example, if a simulated landscape is 40% federal and 60% private industrial forestland, each ownership would be modeling separately, and the model results averaged by weighting 0.4 to federal and 0.6 to private industrial.

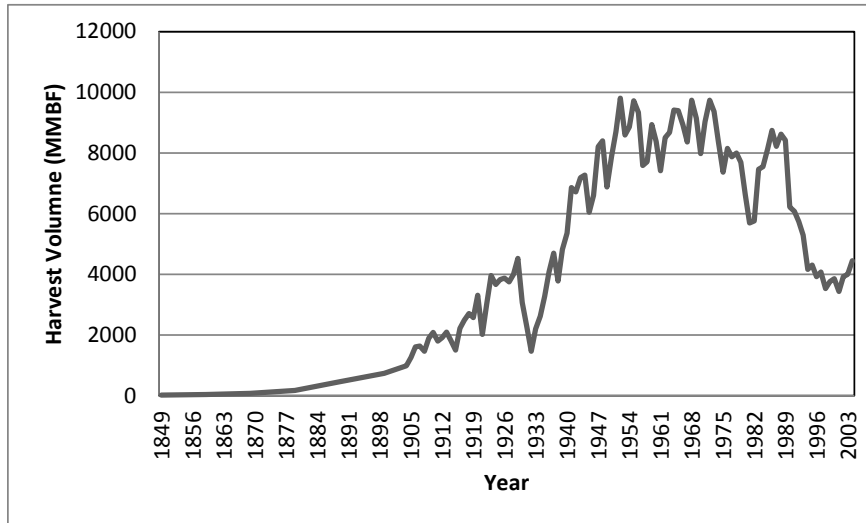
### **Future harvest regimes**

The user has the option to set future management to be that same as the most recent component of the default historical regime. This should not be viewed as a prediction of future regimes on the part of the FSCC creators. Changing policy, economic, and ecological conditions are extremely difficult to predict. However, if we assumed future timber harvests will be consistent with 1990 to 2010 implementation of the Northwest Forest Plan, harvest volume on federal forestlands of the West Cascades would continue to decline as old plantations reach ages at which point development of old growth forest attributes dominants management objectives. This would be represented in the Forest Sector Carbon Calculator by increasing rotation length gradually over time to an undetermined length representing a low level of thinning across the landscape.

## Historical Harvest Regimes, West Cascades Ecoregion

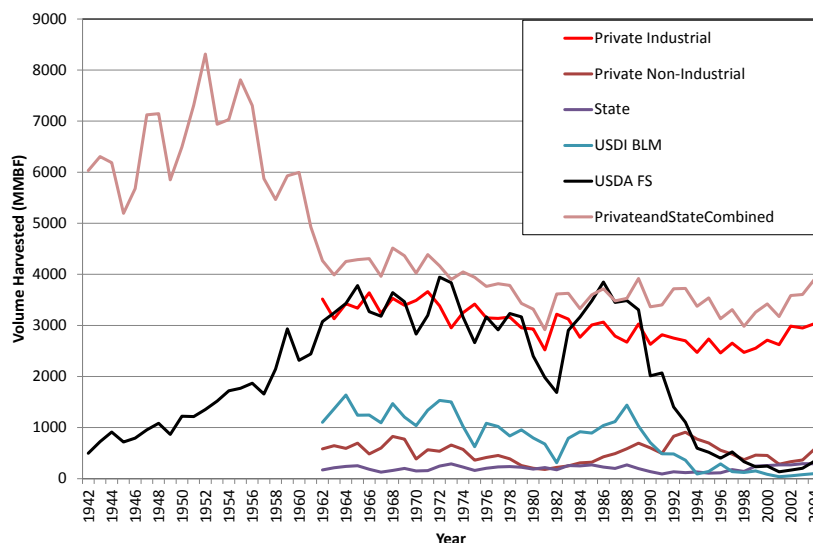
### Harvest rates over time

Large scale logging began in Oregon in the late 1800's (Figure 1), and was largely confined to private land. Large scale logging was initially dependent on large rivers and coastal proximity for transportation. As such, industrial logging probably started in coastal areas and in close proximity to major rivers and streams, with slightly delayed logging activity in parts of the west Cascades ecoregion at higher elevations and at greater distances from the major rivers such as the Columbia and Willamette.



**Figure 1.** Total volume of timber harvested in Oregon in millions of board feet (MMBF) from 1849 to 2009. Modified from Oregon Department of Forestry (2005).

Until the 1950's, timber harvested in Oregon came largely from private industrial forestland (Figure 2). After peaking in the early 1950's, harvest volume began to decline on industrial and state lands, while increasing on federal lands. By the 1960's harvest rates on all ownership types generally leveled off (but with significant year to year variability) until 1990. By 1990, harvest levels on federal lands in the region declined precipitously in response to lawsuits regarding the Northern Spotted Owl and logging of old growth forests. Culminating in the Northwest Forest Plan, forest management on federal lands shifted from primarily timber production to conservation objectives, and harvest levels on federal lands declined to 15 – 25 % of pre-1990 levels.



**Figure 2.** Volume harvested in Oregon in millions of board feet (MMBF) by ownership. Note that until the 1960's, private and state harvests were not separated in historical data. Modified from Oregon Department of Forestry (2005)

### *Harvest methods and harvest intervals over time*

Until the past few decades, clear-cuts designed with 80 to 120 year harvest intervals were the standard harvest method on federal, state, and private industrial forests in the region. These clear-cuts removed whole stems (rather than whole trees or all aboveground biomass), and had low to moderate utilization levels. Clear-cuts were commonly (and still are on private industrial land) broadcast burned within a year of harvest to prepare the seedbed for regeneration and remove competing vegetation.

Clear-cuts on federal land were generally designed with an 80 to 120 year rotation interval, so we have set the default rotation interval to start at 120 years in 1950. We represent increasing harvest volumes on federal land from 1950 to 1965 by gradually decreasing harvest interval from 120 years in 1950 to 80 years by 1965. We then we hold the harvest interval constant at 80 years to represent the plateau in timber volume harvested on Federal lands from 1965- to 1990. Implementation of the Northwest Forest Plan in the 1990's dramatically changed harvest intervals and harvest type on federal lands. Harvest intervals on Federal forests no longer exist within the conceptual framework of a "normal forest". Typically, current harvests on USDA Forest Service land are partial cuts (thinning) in plantations that are 20-80 years old. Once stands are beyond 80 years old, harvests are unlikely to occur since the primary management objective for these stands becomes development of old-growth forest attributes. To represent this much lower harvest intensity, we have set current partial harvests to occur at a 200 year interval. In addition to the switch from clear-cutting to partial harvests, post-harvest burning on federal lands has switched from broadcast burning to burning of slash piles. Slash pile burning comprises a small area ( $\leq 5\%$ ) of a given stand, and a much smaller percentage ( $\leq 1\%$ ) of a landscape in any given year. Slash pile burning is also designed to minimize burning of living vegetation. Due to the small area impacted and the much smaller amount of live biomass burnt, we have not included prescribed burning in the 1990 to 2010 default harvest regime on federal lands.

In contrast to federal lands, private industrial lands have continued to use clear-cuts followed by broadcast burning as their primary harvest method, and harvest volume has not decreased since 1990. Harvest intervals on private industrial land have decreased from between 80-120 years in 1950, to about 50 years today (current harvest intervals on private industrial land can range from 30 to 80 years). As old-growth and mature forests have been harvested, the mean age and stand volume of private industrial forests has declined, so shorter rotation intervals since the 1950's have not resulted in a proportional increase in volume harvested. In addition to shorter harvest intervals, harvests on private industrial lands have seen increasing utilization levels over time (see Harvest Utilization Parameterization documentation), made possible by increased use of scrap and defective wood in the production of pulp and engineered wood products. This trend of increase utilization levels has occurred for all harvest types across all ownerships in the region.

State forestlands have been managed differently than private industrial or federal forestlands. Much of what is now state forestland was originally private forestland, on which logging was occurring by the 1880's. By the 1930's and 1940's this land was either logged over or burned by wildfire, and many of the landowners let their land return to the counties for delinquent taxes or sold it to the county for a minimal amount. The Forest Acquisition Act of 1939 encouraged counties to deed the foreclosed lands

to the Oregon Department of Forestry in exchange for a share of future timber harvest revenues, which created the bulk of the state forest system. From the 1950's until the 1990's, harvest practices on state lands largely mirrored those on federal lands. Since the 1990's, private industrial forestlands have focused on sustained timber production, while federal forestlands have focused more on conserving old-growth forests and promoting biological diversity (Spies et al. 2007). State forestlands have intermediate policy goals of both sustained timber production and maintenance of ecosystem functions (especially as relating to aquatic habitat and native species). State forests have a stated goal to have at least 50% of the landscape in layered forest and older forest structural types, but conservation of old-growth forests has not been a stated goal. We parameterize harvest trends on state forestlands since 1990 as intermediate between private industrial and federal trends, with a shift from clear-cutting to partial harvests (similar to federal lands) but with harvest intervals similar to those used prior to 1990 (100 year rotations).

The management goals on private non-industrial forestlands are the most difficult to characterize, because they represent many individual owners with differing objectives. There is almost no old-growth forest on private non-industrial forests, and it is likely much of this land was logged under private industrial ownership or homesteaded before the 1950's. While many private non-industrial land owners have timber production as the primary management goal, others place emphasis on a wide range of other objectives such as recreation, enhancing wildlife habitat, conserving biodiversity, and passive management (Lettman and Campbell 1997, Kline et al. 2000). Despite this diversity of management goals, private non-industrial land owners have shown a greater tendency towards partial cutting compared to industrial forestlands (Lettman and Campbell 1997). Given the wide range of management strategies found within this ownership type, we have characterized private non-industrial harvests as partial harvesting similar to those occurring on state lands since 1990, but we acknowledge this characterization does not represent a widely diverse group of management activities.

### *Fire Suppression over Time*

Fire suppression was a primary task of the USDA Forest Service upon its establishment in 1905. Wildfire suppression was initially not very effective, and varied broadly by ownership, geographic location, and access. It was not until the 1940's that wildfire suppression was broadly applied, due to improvements in vehicles, equipment, and road development. In the FSCC, we have set fire suppression to begin in both ecoregions and all ownership types in 1940. Although wildfire policies changed somewhat beginning in the 1960's to recognize the ecological benefits of fire, fire suppression continues to be broadly applied to large areas of forestlands in the region. As such we have set fire suppression to remain unchanged from the 1940's to the present. While fire suppression is often thought to have reduced the area of forestlands burned, many additional factors (such as climate, climate-fuel relationships, disturbance history, etc.) play important roles influencing the area of forestland burned (Agee 1993, Littell et al. 2009)

## Harvest Regimes as Parameterized in the Forest Sector Carbon Calculator, West Cascades Ecoregion

### Federal Ownership (USDA Forest Service, USDI Bureau of Land Management)

<b>1940</b>	Effective fire suppression begins								
<b>1950</b>	Large-scale harvesting begins								
<b>1950–1990</b>	<p>Dominant harvest type is clear-cutting (100% disturbed)</p> <p>Whole stem removal</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <p>Steady increase in timber harvested on federal land beginning in 1950, plateauing in 1965. Trends in timber harvest volume parameterized by shortening harvest intervals over time. Utilization levels also increased during this time period.</p> <table><tr><td><b>1950–1954</b></td><td>120 year rotation, low utilization level</td></tr><tr><td><b>1955–1959</b></td><td>100 year rotation, low utilization level</td></tr><tr><td><b>1960–1964</b></td><td>90 year rotation, low utilization level</td></tr><tr><td><b>1965–1989</b></td><td>80 year rotation, moderate utilization level</td></tr></table>	<b>1950–1954</b>	120 year rotation, low utilization level	<b>1955–1959</b>	100 year rotation, low utilization level	<b>1960–1964</b>	90 year rotation, low utilization level	<b>1965–1989</b>	80 year rotation, moderate utilization level
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<b>1990–2010</b>	<p>Dominant harvest type switches to partial harvesting (35% disturbed) with a much longer harvest interval (200 years)</p> <p>Whole stem removal</p> <p>High utilization levels</p> <p>Harvest not followed by prescribed fire</p>								

### Private Industrial Ownership

<b>1880</b>	Large-scale harvesting begins												
<b>1880-1925</b>	<p>Early harvesting occurred in relatively low amounts, which would translate into unrealistically long harvest intervals ranging from 300 to 1,500 years in a “normal forest”. Such long harvest intervals pose problems, because in the FSCC the minimum age of a forest at which it can be harvested is linked to the harvest interval (minimum age eligible for harvest <math>\geq</math> 90% of harvest interval). This would mean minimum harvest age <math>\geq</math> 1350 for a harvest interval of 1500 years, but forests will not reach this age by 1880 in the FSCC because simulation starts in the year 1412. In order to characterize the total amount of harvesting during the 1880-1925 time period, the harvest interval is set to 200 years and the percent of forest harvested is modified to result in harvest volumes similar to which would occur with 300 and 1500 year harvest intervals. While this characterized the total amount of harvest volume, it is represented as partial harvesting (rather than clear-cuts)</p> <p>Whole stem removal</p> <p>Low utilization levels</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <table><tr><td><b>1880-1900</b></td><td>200 year harvest interval, 15% disturbed</td></tr><tr><td><b>1900-1925</b></td><td>200 year harvest interval, 65% disturbed</td></tr></table>	<b>1880-1900</b>	200 year harvest interval, 15% disturbed	<b>1900-1925</b>	200 year harvest interval, 65% disturbed								
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<b>1940</b>	Effective fire suppression begins												
<b>1950-2010</b>	<p>Dominant harvest type continues to be clear-cutting (100% disturbance)</p> <p>Whole stem removal</p> <p>Trend from moderate to high utilization levels</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <p>Continued trend of shortening harvest intervals</p> <table><tr><td><b>1950-1959</b></td><td>100 year harvest interval, moderate utilization levels</td></tr><tr><td><b>1960-1969</b></td><td>90 year harvest interval, moderate utilization levels</td></tr><tr><td><b>1970-1979</b></td><td>80 year harvest interval, moderate utilization levels</td></tr><tr><td><b>1980-1989</b></td><td>70 year harvest interval, moderate utilization levels</td></tr><tr><td><b>1990-1999</b></td><td>60 year harvest interval, high utilization levels</td></tr><tr><td><b>2000-2010</b></td><td>50 year harvest interval, high utilization levels</td></tr></table>	<b>1950-1959</b>	100 year harvest interval, moderate utilization levels	<b>1960-1969</b>	90 year harvest interval, moderate utilization levels	<b>1970-1979</b>	80 year harvest interval, moderate utilization levels	<b>1980-1989</b>	70 year harvest interval, moderate utilization levels	<b>1990-1999</b>	60 year harvest interval, high utilization levels	<b>2000-2010</b>	50 year harvest interval, high utilization levels
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State Ownership (Based loosely on history of the Santiam State Forest)

<b>1880</b>	Large-scale harvesting begins on what is originally private forestland								
<b>1880-1925</b>	<p>Early harvesting occurred in relatively low amounts, which would translate into unrealistically long harvest intervals ranging from 300 to 1,500 years in a “normal forest”. Such long harvest intervals pose problems, because in the FSCC the minimum age of a forest at which it can be harvested is linked to the harvest interval (minimum age eligible for harvest <math>\geq 90\%</math> of harvest interval). This would mean minimum harvest age <math>\geq 1350</math> for a harvest interval of 1500 years, but forests will not reach this age by 1880 in the FSCC because simulation starts in the year 1412. In order to characterize the total amount of harvesting during the 1880-1925 time period, the harvest interval is set to 200 years and the percent of forest harvested is modified to result in harvest volumes similar to which would occur with 300 and 1500 year harvest intervals. While this characterized the total amount of harvest volume, it is represented as partial harvesting (rather than clear-cuts).</p> <p>Whole stem removal</p> <p>Low utilization levels</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <table><tr><td><b>1880-1900</b></td><td>200 year harvest interval, 15% disturbed</td></tr><tr><td><b>1900-1925</b></td><td>200 year harvest interval, 65% disturbed</td></tr></table>	<b>1880-1900</b>	200 year harvest interval, 15% disturbed	<b>1900-1925</b>	200 year harvest interval, 65% disturbed				
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<b>1925-1940</b>	<p>During this time period the land was largely logged over or burned, represented by a pulse of clear-cuts with very short harvest intervals and 15 years with large high severity wildfires.</p> <p>50 year harvest intervals, clear-cuts (100% disturbed)</p> <p>Whole stem removal</p> <p>Low utilization levels</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <p>Wildfires with a 15 year interval, 75% disturbance, large fire sizes, and high fire severity</p> <p>Effective fire suppression begins</p>								
<b>1940</b>									
<b>1940-1990</b>	<p>In the 1940's, recently logged and burned private forestlands switched ownership to the counties, and then the state. State forests established. State forests managed similarly to federal forests.</p> <p>Dominant harvest type is clear-cutting (100% disturbed)</p> <p>Whole stem removal</p> <p>Harvest immediately followed by prescribed fire (100% disturbed, high severity)</p> <p>Steady increase in timber harvested on federal land beginning in 1950, plateauing in 1965. Trends in timber harvest volume parameterized by shortening harvest intervals over time. Utilization levels also increased during this time period.</p> <table><tr><td><b>1940-1954</b></td><td>120 year rotation, low utilization level</td></tr><tr><td><b>1955-1959</b></td><td>100 year rotation, low utilization level</td></tr><tr><td><b>1960-1964</b></td><td>90 year rotation, low utilization level</td></tr><tr><td><b>1965-1989</b></td><td>80 year rotation, moderate utilization level</td></tr></table>	<b>1940-1954</b>	120 year rotation, low utilization level	<b>1955-1959</b>	100 year rotation, low utilization level	<b>1960-1964</b>	90 year rotation, low utilization level	<b>1965-1989</b>	80 year rotation, moderate utilization level
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<b>1990-2010</b>	<p>Dominant harvest type switches to partial harvesting (35% disturbed) like federal forests, but with a shorter harvest interval (100 years) than federal forests</p> <p>Whole stem removal</p> <p>High utilization rates</p> <p>Harvest not followed by prescribed fire</p>								



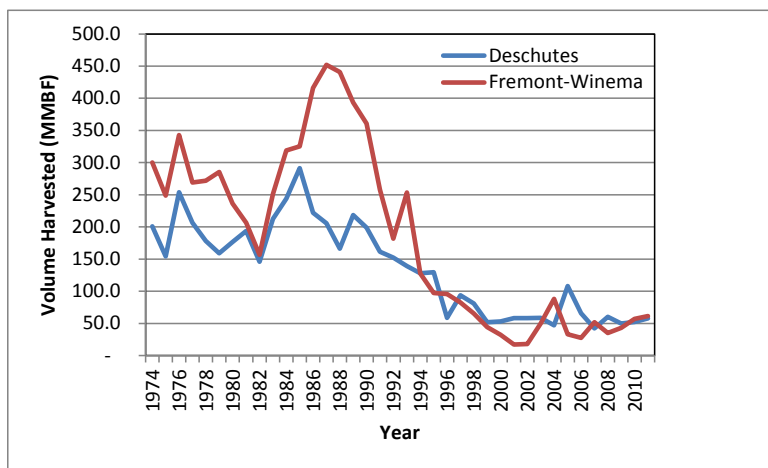
### Private Non-Industrial Ownership

- 1880-1925** Early harvesting occurred in relatively low amounts, which would translate into unrealistically long harvest intervals ranging from 300 to 1,500 years in a “normal forest”. Such long harvest intervals pose problems, because in the FSCC the minimum age of a forest at which it can be harvested is linked to the harvest interval (minimum age eligible for harvest  $\geq 90\%$  of harvest interval). This would mean minimum harvest age  $\geq 1350$  for a harvest interval of 1500 years, but forests will not reach this age by 1880 in the FSCC because simulation starts in the year 1412. In order to characterize the total amount of harvesting during the 1880-1925 time period, the harvest interval is set to 200 years and the percent of forest harvested is modified to result in harvest volumes similar to which would occur with 300 and 1500 year harvest intervals. While this characterized the total amount of harvest volume, it is represented as partial harvesting (rather than clear-cuts)  
Whole stem removal  
Low utilization levels  
Harvest immediately followed by prescribed fire (100% disturbed, high severity)  
**1880-1900** 200 year harvest interval, 15% disturbed  
**1900-1925** 200 year harvest interval, 65% disturbed
- 1925-1950** 120 year harvest interval, 100% disturbed  
Whole stem removal  
Low utilization levels  
Harvest immediately followed by prescribed fire (100% disturbed, high severity)
- 1940** Effective fire suppression begins
- 1950-2010** Harvests switch from clear-cutting to partial harvest as harvested lands switch from industrial to non-industrial ownership and clearing associated with homesteading ends  
Dominant harvest type switches to partial harvesting (35% disturbed) with 100 year harvest interval  
Whole stem removal  
Moderate utilization levels rising to high levels by 1990  
Harvest not followed by prescribed fire

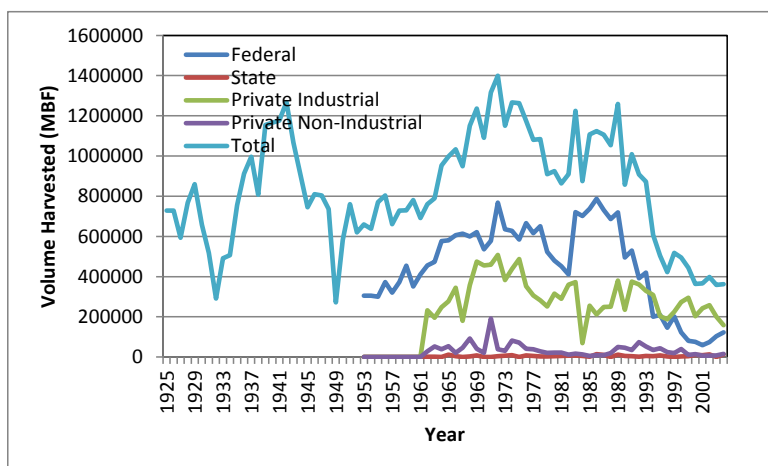
## Historical Harvest Regimes, East Cascades Ecoregion

### *Harvest rates over time*

Much less data is available for historical harvest regimes in the East Cascades, with respect to both length of records and ownership type. At the onset of East Cascades harvest records in 1925, private industrial harvests are well underway. Overall harvest volume increased in the late 1930's and early 1940's, dropped until 1960's, increased a second time until the mid 1970's, declined somewhat in the late 1970's and early 1980's, and increased a third time until 1990. From the early 1950's until 1990, trends in harvest volume were generally synchronous between ownership types. Since 1990, harvest volume has declined dramatically on federal forestlands, slightly declined on private industrial lands, have not declined on state forestlands, and initially increased on private non-industrial lands.



**Figure 3.** Volume harvested from two National Forests in the East Cascades Oregon in millions of board feet (MMBF). Note the prominent decline in harvest volume beginning in the 1990's. Modified from USDA Forest Service Region 6 data.



**Figure 4.** Volume harvested from two National Forests in the East Cascades Oregon in thousands of board feet (MBF). Note the prominent decline in harvest volume beginning in the 1990's. Modified from USDA Forest Service Region 6 data.

### *Harvest methods and harvest intervals over time*

Harvesting began around 1900 in the East Cascades, later than the Coast Range and West Cascades. Early harvesting in the East Cascades was localized and small scale, serving local building material and fuel needs. Early harvesting largely occurred on private lands, and was dominated by high grading and low utilization levels. By 1920, larger scale logging was more common, probably due to construction of railroads and resulting improvements in transportation. At the time, large scale logging largely occurred on private lands, and was still dominated by high grading. As with forests in the West Cascades, wildfire suppression became more effective around 1940 due to improvement in vehicles, equipment, and access. By 1950, logging increased on federal lands, and logging on both federal and private industrial lands was dominated by clear-cuts with 60-90 year harvest intervals, which as continued on private industrial forestlands to the present. By 1970, federal forestlands switched from clear-cuts to shelterwood and group selection harvest types (still 60-90 year harvest intervals). Improvements in utilization levels followed the same trends over time as in the West Cascades. By 1990, harvests on federal forestlands again switched harvest types, transitioning to fuel reduction treatments often characterizing by felling and leaving small diameter trees onsite, followed by prescribed burning. A small amount of felled timber in fuel reduction treatments is harvest and some partial harvesting still occurs, although in combination utilization levels are low.

Oregon's two State Forests in the East Cascades display two divergent harvest histories. The original parcels of Sun Pass State Forest were private industrial forestlands that were completely logged prior to being sold to the State of Oregon in the 1940's. Sun Pass State Forest is largely managed as uneven aged mixed-conifer, for which we generalize partial harvests on a 60-90 year harvest rotation. We have set state forestland in the FSCC to represent the historical harvest history of Sun Pass State Forest. Gilchrist State Forest is the other major state forest in the region, and was created in 2010. Before being created from private industrial forestland, Gilchrist was largely harvested via clear-cuts in the 1990's. Given its young age, timber harvests are unlikely to occur on Gilchrist State Forest over the next couple decades.

As in the West Cascades, private non-industrial forestlands have extremely diverse harvest histories. . There is almost no old-growth forest on private non-industrial forests, and it is likely much of this land was logged under private industrial ownership or homesteaded before the 1950's. While many private non-industrial land owners have timber production as the primary management goal, others place emphasis on a wide range of other objectives such as recreation, enhancing wildlife habitat, conserving biodiversity, and passive management (Lettman and Campbell 1997, Kline et al. 2000). Despite this diversity of management goals, private non-industrial land owners have shown a greater tendency towards partial cutting compared to industrial forestlands (Lettmen and Campbell 1997). Given the wide range of management strategies found within this ownership type, we have characterized private non-industrial harvests as partial harvesting similar to those occurring on federal lands between 1970-1990, but we acknowledge this characterization does not represent a widely diverse group of management activities.

## Harvest Regimes as Parameterized in the Forest Sector Carbon Calculator, East Cascades Ecoregion

### Federal Ownership (USDA Forest Service, USDI Bureau of Land Management)

<b>1940</b>	Effective fire suppression begins
<b>1950</b>	Large-scale harvesting begins
<b>1950–1970</b>	Dominant harvest type is clear-cutting (100% disturbed) Whole stem removal Increase in timber harvested on federal land from 1950-1970. Trends in timber harvest volume parameterized by shortening harvest intervals over time. Utilization levels also increased during this time period. <b>1950–1959</b> 90 year rotation, low utilization level <b>1960–1969</b> 70 year rotation, moderate utilization level
<b>1970–1990</b>	Dominant harvest type switches to shelterwood and group selection (75% disturbed). Harvest interval stays at 70 years. Whole stem removal Utilization levels improve
<b>1999-2010</b>	Dominant harvest type switches to fuel reduction (35% disturbed) Harvest interval stays at 70 years. Trees are felled but not harvested in many (but not all) areas, low utilization level Prescribed burn following felling (100% disturbance, moderate severity)

Private Industrial Ownership

<b>1900-1920</b>	Localized, small-scale logging begins, largely partial harvesting and high grading (25% disturbed), long harvest intervals (200 years) used to represent small amount of landscape logged during this time period Whole stem removal Low utilization levels
<b>1920-1950</b>	Large-scale harvesting begins, dominated by partial harvest and high grading (35% disturbed). Trends in harvest volume simulated by changing harvest interval between 60-90 years. Whole stem removal Low utilization levels
	<b>1920-1929</b> 90 year harvest interval, low utilization level
	<b>1930-1939</b> 60 year harvest interval, low utilization level
	<b>1940-1949</b> 60 year harvest interval, low utilization level
<b>1940</b>	Effective fire suppression begins
<b>1950-1990</b>	Dominant harvest switches to clear-cutting (100% disturbance) 60 year harvest intervals Whole stem removal Moderate utilization levels
<b>1990-2010</b>	Dominant harvest switches to group selection and shelterwood cutting 90 year harvest interval, 65% disturbance; Whole stem removal High utilization level

State Ownership (Based loosely on history of the Sun Pass State Forest)

- 1900-1920** Land is privately held. Localized, small-scale logging begins, largely high grading (25% disturbed), long harvest intervals (300 years) used to represent small amount of landscape logged during this time  
Whole stem removal  
Low utilization levels
- 1920-1930** Large-scale harvesting begins, dominated by partial harvest and high grading (35% disturbed) 90 year harvest interval.  
Whole stem removal  
Low utilization levels
- 1930-1945** Dominant harvest switches to clear-cutting (100% disturbance) 60 year harvest intervals  
Whole stem removal  
Low utilization levels
- 1940** Effective fire suppression begins
- 1940's** Land transferred to state, Sun Pass State Forest created.
- 1950-1990** Dominant harvest type switches to shelterwood and group selection (50% disturbed).  
Harvest interval declines to 60 years.  
Whole stem removal  
Utilization levels improve from moderate (1950-1990) to high (1990-2010)

Private Non-Industrial Ownership

- 1900-1920** Land is privately held. Localized, small-scale logging begins, largely high grading (25% disturbed), long harvest intervals (250 years) used to represent small amount of landscape logged during this time.  
Whole stem removal  
Low utilization levels
- 1920-1950** Large-scale harvesting begins, dominated by partial harvest and high grading (35% disturbed) 100 year harvest interval.  
Whole stem removal  
Low utilization levels
- 1950-1990** Dominant harvest type is shelterwood and group selection (35% disturbed).  
Harvest interval stays at 100 years.  
Whole stem removal  
Utilization levels improve from moderate (1950-1990) to high (1990-2010)

## Literature Cited

- Agee, J. K. 1993. Fire Ecology of Pacific Northwest Forests. Island Press. Washington, DC.
- Cohen, W. B., T. A. Spies, R. J. Alig, D. R. Oetter, T. K. Maersperger and M. Fiorella. 2002. Characterizing 23 years (1972-1995) of stand replacement disturbance in western Oregon forests with Landsat imagery. *Ecosystems* 5: 122-137.
- Lettman, G., and D. Campbell. 1997. Timber harvesting practices on private forest land in western Oregon. Oregon Department of Forestry, Salem, Oregon, USA.
- Littell, J. S., D. McKenzie, D. L. Peterson, and A. L. Westerling. 2009. Climate and wildfire area burned in the western U.S. ecoprovinces, 1916-2003. *Ecological Applications* 19(4): 1003-1021.
- Kline, J. D., R. J. Alig, and R. L. Johnson. 2000. Fostering the production of nontimber services among forest owners with heterogeneous objectives. *Forest Science* 46(2): 302-311.
- Spies, T.A., K.N. Johnson, K.M. Burnett, J.L. Ohmann, B.C. McComb, G.H. Reeves, P. Bettinger, J.D. Kline, and B. Garber-Yonts. 2007. Cumulative Ecological and Socioeconomic Effects of Forest Policies in Coastal Oregon. *Ecological Applications*. 17(1): 5-17
- Oregon Department of Forestry. 2005. Oregon's Timber Harvests: 1824-2004. Compiled by A. Andrews and K. Kutara. Accessed online on October 19, 2012 at [http://www.oregon.gov/odf/state\\_forests/frp/docs/oregonstimberharvests.pdf](http://www.oregon.gov/odf/state_forests/frp/docs/oregonstimberharvests.pdf)