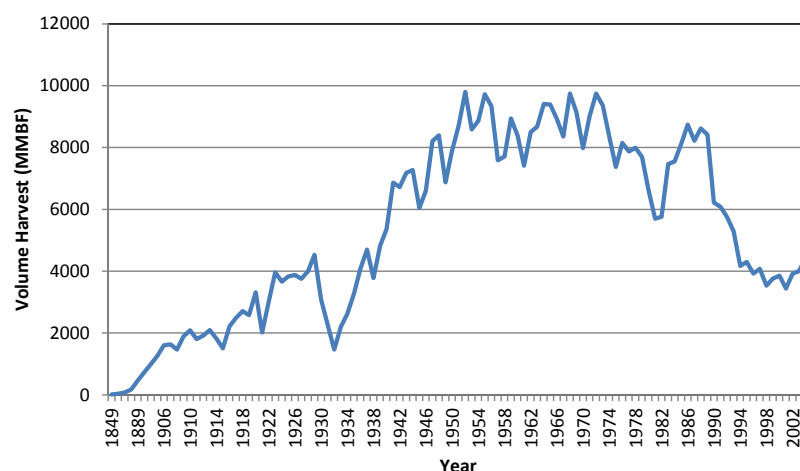


## Carbon Calculator Default Historical Harvest Regime Parameterization

### Introduction

In order to project carbon dynamics in the future, the Forest Sector Carbon Calculator (FSCC) requires a characterization of the historical timber harvest regime. This is needed because legacies of past management in the form of live and dead biomass in the forest can have long lasting effects that can take centuries to play out. In the FSCC, the harvest scheduler determines the interval and severity of harvests over time. Simulated harvests generated by the harvest scheduler are then used by the harvest module of LANDCARB 3.0 to determine how grid cells are harvested and how live and dead plant parts are removed and/or redistributed within a stand or landscape.

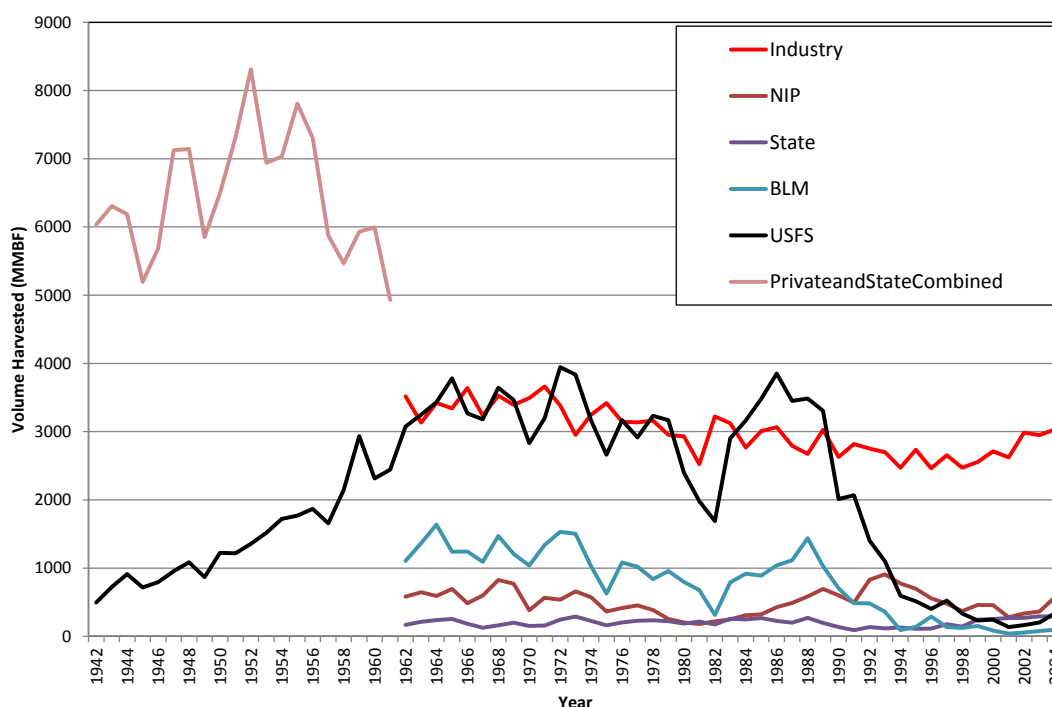
There are multiple confounding factors limiting the realism of simulated harvests characteristic of any given region or landscape. Heterogeneous harvest regimes across ownerships or areas, sparse historical documentation, and spatiotemporal limitations of retrospective analyses limit quantification of historical harvest interval, harvest type, and spatial patterns of harvests. Additionally, harvest interval is something of a misnomer in the context of early timber harvesting across much of North America, where timber was removed without a long-term plan for its replacement. This is in contrast to the “normal forest” concept from European forestry, in which harvest rotations were in part designed to maintain constant increment and volume growth, while providing for a continuous wood supply. Because of these limitations, the goal of historical harvest parameterization in the FSCC is to represent the general patterns of past landscape-level harvest based on harvest interval and intensity, while also capturing any major shifts in harvest type (such as transitions from clearcut to partial harvest). We accomplish this by adjusting the harvest interval and intensity to approximate general forest management trends. As an example, below we describe the historical harvest regime for U.S. Forest Service forest land in the west Cascades ecoregion of Oregon. Large scale logging did not begin in Oregon until the late 1800's (Figure 1).



**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)

However, 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.

Until the 1950's, timber harvested in Oregon and the west Cascades ecoregion came largely from private industrial forestland (Figure 2). After peaking in the early 1950's, harvest volume began to decline on private lands, at which point harvest on federal lands began to rise.



**Figure 2.** Volume of timber harvested in Oregon in millions of board feet (MMBF) by ownership. The volume of timber harvested on U.S. Forest Service (USFS) land declined sharply beginning in 1990. Note that until the 1960's, private and state harvests were not separated in historical data. Modified from Oregon Department of Forestry (2005)

Based on these historical records, we have parameterized the default FSC harvest regime for U.S. Forest Service lands in the west Cascade ecoregion to not begin until 1950. During this time period, clear-cuts (100% disturbed) were the standard harvest treatment on both Forest Service and private industrial forestlands of the region. Clear-cuts on Forest Service land generally were designed with an 80 to 120 year rotation interval, and we have set the default rotation interval to start at 120 years in 1950, shift to 100 years in 1955, 90 years in 1960, and 80 years from 1965 to 1990. This pattern of declining harvest interval is used to approximate the steady increase in timber harvested from 1950 to 1965, which largely plateaued by 1965. Early clear-cuts were also likely to have moderate utilization levels (i.e.

moderate amounts of carbon removed from the forest in relation to the amount of live carbon felled) compared to more recent harvests. More recent high utilization levels are the result of multiple factors, including: increased production of wood products from previously undesirable wood, general trends of increased efficiency, higher levels of sanitation and site preparation, etc. Finally, a standard practice after clear-cuts on all ownership types in the region was to broadcast burn the site prior to replanting. In the FSCC, the default harvest history for U.S. Forest Service lands in the west Cascades Ecoregion from 1950 to 1990 is therefore as follows:

**1950 to 1990:**

- **120 year interval from 1950 to 1955 on general forest land (land not taken out of production to meet other goals)**
- **100 year interval from 1955 to 1960 on general forest land (land not taken out of production to meet other goals)**
- **90 year interval from 1960 to 1965 on general forest land (land not taken out of production to meet other goals)**
- **80 year interval from 1965 to 1990 on general forest land (land not taken out of production to meet other goals)**
- **100% of stand disturbed (i.e. clear-cut) at a moderate utilization level**
- **Followed by a high intensity prescribed fire to burn slash, soil organic matter, and competing vegetation, preparing the site for replanting.**

By 1990, harvest levels on Federal lands in the Pacific Northwest region declined precipitously in response to lawsuits regarding the Northern Spotted Owl and concerns over logging of old growth forests. Under the Northwest Forest Plan, which was implemented to conserve and restore old growth species and habitats, harvest levels on U.S. Forest Service lands in region have remained low, somewhere between 15 – 25 % of pre-1990 levels. In addition to reduced harvest levels, the rotation length and harvest type have changed dramatically. Rotation intervals on Federal forests no longer exist within the conceptual framework of a “normal forest”. Typically current harvests on U.S. Forest Service land are partial cuts (thinning) in plantations that are 20--60 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. A common practice after thinning is the burning of slash piles. In contrast to broadcast burning of the entire area after a clear-cut as was common practice before 1990, slash pile burning comprises a small area (~5%) of given stand, and a much smaller percentage of a landscape in any given year. Slash pile burning is also conducted in a manner designed to minimize burning of living vegetation. Due to the small area impacted and lack of live biomass burnt, In the FSCC we have not included prescribed burning in the 1990 to 2010 default harvest regime.

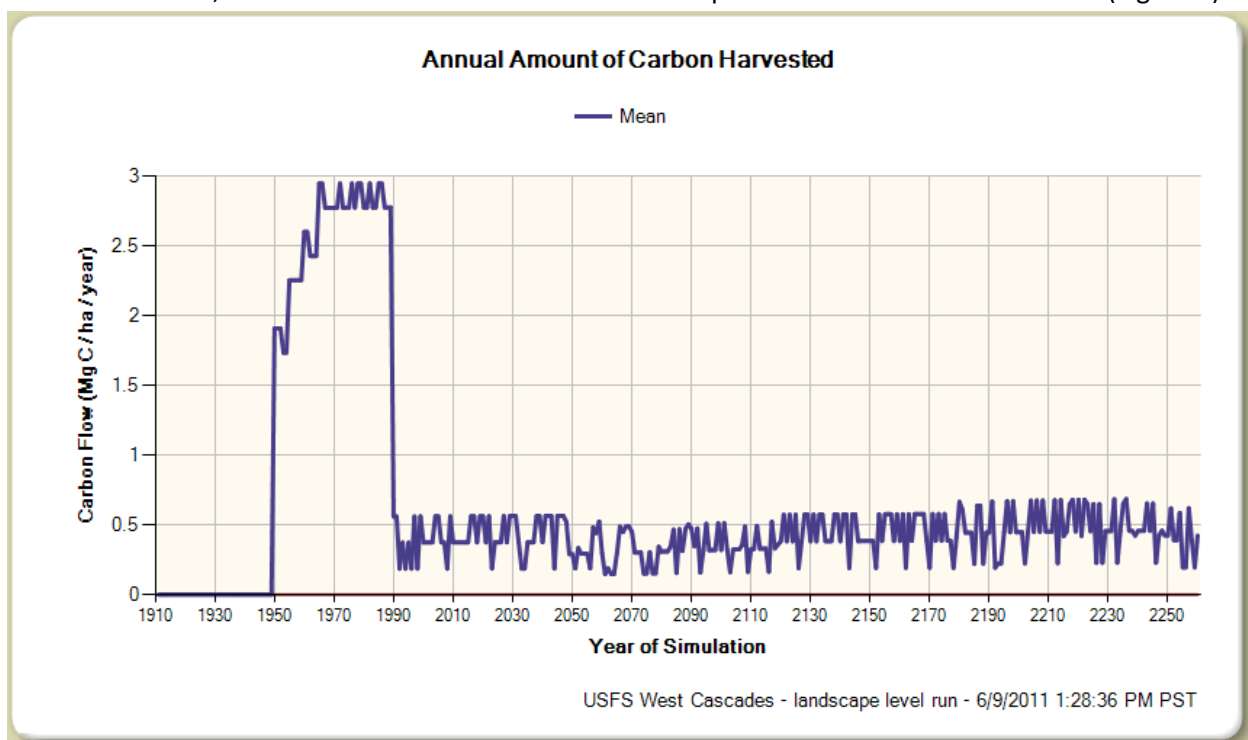
It is important to note these treatments are only applied to old plantations and forests within the managed forest allocation, comprising approximately 33% of Forest Service land in the west Cascade ecoregion. The remaining 67% of forest service land is allocated to reserves, wilderness or otherwise administratively withdrawn; where harvest is either prohibited or prohibitively difficult. These different aspects of the historical harvest regime are difficult to incorporate into a single default regime. To

approximate the recent regime we have programmed the FSCC with the following default harvest history, but the user can change this history to generate other management histories as needed.

**1991 to 2010:**

- **200 year harvest rotation interval**
- **35% of stand disturbed (i.e. partial harvest) at a moderate utilization level**
- **Harvest not followed by prescribed fire.**

Although the 200 year interval is not realistic at a stand level, it approximates the actual decline in timber harvested, with current volume at about 15-20% of pre-Northwest Forest Plan levels (Figure 3).



**Figure 3.** Simulated carbon harvested under the default harvest regime described above for the U.S. Forest Service forestlands of the west Cascades ecoregion.

The 200 year rotation may also be more realistic when a landscape has both old plantations that will be thinned and reserved areas that will not be harvested at all. Since harvestable area comprises only 33% of the landscape in this example, a 60 year thinning divided by the 0.33 proportion of the harvestable landscape would be a thinning interval of 181 years, which we have rounded to 200 years. Alternatively, different simulations in the FSCC could be run with different harvest histories representing a different ownerships or management allocations. Results of these different simulations can then be averaged, weighting the different simulations based on the proportion of the landscape area each ownership or land use allocation represents. However, this multiple simulation default is complicated for a first time user, so we have chosen the simple single default harvest history.

The default regime switches the harvest type from clearcuts to partial harvests, which is consistent with regional changes in Forest Service silvicultural prescriptions. Additionally, the switch from broadcast burning to slash pile burning of a very small proportion of the harvested area is parameterized in the FSCC simply as the elimination of post-harvest prescribed burning.

We have not set a default landscape harvest regime for the future, since changing policy, forest conditions, and objectives are 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 would continue to decline as old plantations reach ages at which point development of old growth forest attributes dominant 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.

#### **Literature Cited**

Oregon Department of Forestry. 2005. Oregon's Timber Harvests: 1824-2004. Compiled by A. Andrews and K. Kutara. Accessed online on May 31, 2011 at [http://www.oregon.gov/ODF/STATE\\_FORESTS/FRP/docs/OregonsTimberHarvests.pdf](http://www.oregon.gov/ODF/STATE_FORESTS/FRP/docs/OregonsTimberHarvests.pdf)