Two-Aged Stand Management in the Coast Range

A. Grotta

Douglas-fir forests in western Oregon are traditionally harvested and regenerated through clearcutting and replanting. But many landowners are interested in other harvest methods that retain some overstory trees. One such method is the two-aged or shelterwood system. In this system, a small percentage of overstory trees are left dispersed throughout the site, and the understory is planted or allowed to seed on its own.

Shelterwood harvests in western Oregon are rare. A two-aged system can be very challenging to implement because the younger understory trees' demand for light and growing space can be severely affected by competition from the overstory trees. There is always the chance of damage from wind throw, and if the residual overstory trees are harvested, some damage to the understory trees is hard to avoid.

On the other hand, this system increases the structural complexity of the stand and provides a seed source for natural tree regeneration.

This is one family's experience using a two-aged management method.

shelterwood harvest—Involves the cutting of most trees, leaving some to produce sufficient shade and seed to produce a new age class of trees beneath. The "shelter" trees can be removed after regeneration has been secured. If shelter trees are retained instead, the stand can be managed as a two-aged forest.

The Hayes Family

The Hayes family owns and manages 780 acres of forestland at several sites in Washington County, collectively known as Hyla Woods. The family's core management philosophy is to create forests that are both ecologically complex and economically viable. Managing multi-aged, multilayered, multispecies forests is a key part of their approach, with the assumption that these diverse forests will be more resilient to known and unknown stressors in the long term.

The family also considers forest productivity to be multifaceted. Through their management, they try to foster a richer, complex forest, including biological diversity and wildlife habitat, along with economic return from wood and other products. Central to this approach is the assumption that at some point in the future they will be able to realize economic returns from **ecosystem services** such as carbon sequestration, creation of wildlife habitat, or other functions.

The idea is that these will offset short-term reductions in harvest revenue that result from the shift from an even-aged to two-aged or uneven-aged management strategy. The family has also found premium markets for high-quality, tight-grained wood, which helps offset reduced harvest volumes.

ecosystem services—The goods and services that individuals and societies gain from our environment, including clean air and water, climate regulation, pollution control, flood regulation, recreation, food, and spiritual values.

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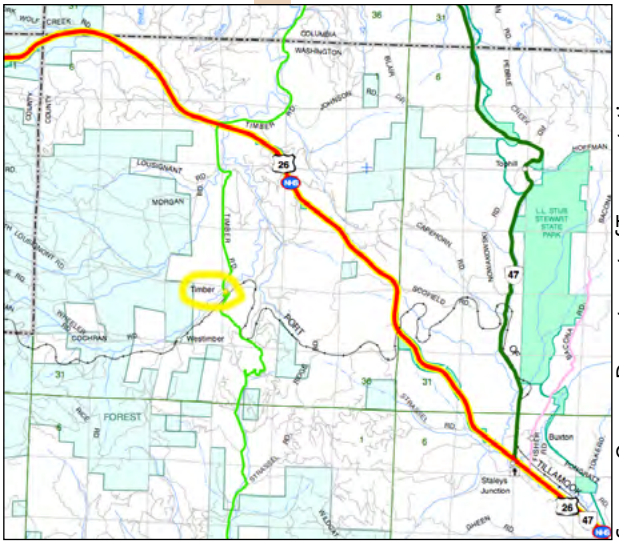
Stand and Forest Conditions

The 9-acre stand described in this case study is within a 160-acre parcel near the town of Timber, in the northern Oregon Coast Range at about 1,000 feet elevation. Ned Hayes bought the land in 1986. Peter Hayes (Ned's son) and Peter's wife Pam have been primarily responsible for its management since 2003.



Source: Oregon Department of Transportation

Timber, Oregon

The property was logged by railroad in the 1920s. Ensuing natural regeneration resulted in a forest dominated by Douglas-fir with a minor (approximately 2 percent) grand fir component. Soils are a Melby silt loam with a 50-year site index of 110–115 for Douglas-fir (see the Washington County Soil survey for soil descriptions). The property is bordered on the east and south by industrial forestland, with state forestland to the west and other small private owners to the north. Two perennial streams, headwaters of the Nehalem River, run through the property.

In the 1970s and '80s, the previous owner conducted selective harvests throughout the site. Little is known about the volume harvested during this time. By 1997, the site was supporting approximately 60 trees per acre, with the dominant trees measuring about 30 inches **DBH**. Total volume in 1997 was about 22,000 board feet (22 **MBF**) per acre. Over time, perhaps as a result of the selective harvests and natural disturbances, new trees regenerated in the understory, resulting in a forest that is largely even-aged but with a minor component of younger, smaller trees.

DBH—
Diameter at breast height (4.5 feet)

MBF—
Thousand board feet. A board foot is used to measure or express the amount of wood in a tree. The dimensions of a board foot are 12″ x 12″ x 1″.

The forest is generally free of insect and disease problems, aside from pockets of laminated root rot, which are found scattered across the site. These areas tend to be dominated by salal and bitter cherry. Other common understory species include vine maple, Oregon grape, and bracken and sword fern.

The landowners, along with a host of community partners, researchers, and volunteers, regularly monitor their forests to determine whether their efforts to increase the structural and species diversity are leading to their intended outcomes, which include enhanced biodiversity and other measures of land health. Bird, amphibian, and stream surveys are ongoing as a part of this effort.

Harvest Goals and Implementation

In 1997, Ned Hayes and consulting forester Mike Barnes implemented a shelterwood harvest on about 9 acres on a fairly flat hilltop. Before the harvest, the stand had patchy **stocking** with significant gaps filled with vine maple. Though most of the trees dated back to the 1920s, there were some smaller, younger trees that had grown in the intervening years.

stocking—
A description of the number of trees per acre, basal area, or wood volume per acre in a stand compared with a desirable level for best growth and management. Often stocking is used as a relative term, such as partially stocked, normally stocked, or overstocked.

The harvest was designed to achieve several goals. The first was to set the stage for growing a new age class of trees, so the canopy needed to be opened up and the site prepared for planting. Second, the family wanted to

develop a more complex stand structure in the long term, with a greater diversity of tree ages, species, and canopy layers.

This second objective drove many of the decisions about which trees to cut and which to leave. The largest dominant trees were retained. Other trees were retained to create a varied overstory pattern, with a mix of heights and individual and clumps of trees dispersed across the site (Figure 1). To increase the overall species diversity of the stand, grand fir and other minor species were left. As a result, the residual stand makeup shifted to about 6 percent grand fir (compared to 2 percent throughout the property as a whole).

Source: Oregon Explorer.

Figure 1. 2005 aerial photo showing the stand (outlined in blue) where the shelterwood harvest was implemented. Note the varied spatial distribution and size of the residual trees throughout the unit. The property line is directly to the south of the stand. Scale = 1:2,500.

This harvest yielded 116 MBF (roughly 13 MBF/acre). Around 75 percent of the trees were removed; but because the largest trees were retained, only about 60 percent of the stand volume was removed. After the harvest, about 35 trees per acre of varying sizes remained on the site. Logs were moved by crawler tractor and **shovel** to a designated skid trail that runs through the middle of the stand. Slash was piled in some areas and scattered in others, but neither burning nor chemical site preparation was used.

Regeneration

A mix of Douglas-fir (75 percent), grand fir (15 percent), and western redcedar (10 percent) was planted the year following the harvest, with some hemlock planted a few years later. Seedlings were **released** manually as needed in the years following planting, mainly to control Scotch broom (an invasive shrub). Redcedar survival was poor due to browse damage, although both big game repellent and mesh tubes were used to try to control the damage.

In addition to the planted seedlings, natural regeneration was abundant. As a result, by 2006, about 380 trees per acre had reached **"free to grow"** height and were surviving in the understory with many smaller seedlings (Figure 2, page 4). It is not known how many of the seedlings regenerated naturally compared to what was planted. This young **cohort** is approximately 75 percent Douglas-fir and 25 percent grand fir.

Current Stand Structure

In 2006, researchers from Oregon State University College of Forestry installed a 1-acre permanent inventory plot and several smaller subplots in the stand, as part of a larger study of two-aged stand performance in western Oregon. All overstory trees were measured in the plot, and understory trees were measured in the 1/50-acre subplots. The plots were measured again in spring 2011.

The 2006 inventory, conducted when the young trees were 7 to 8 years old, indicated that most of the seedlings were growing less than 12 inches per year in

shovel—
An excavator equipped with a special arm that can pick up and move logs from one place to another.

release—
A treatment that reduces competing vegetation around seedlings to ensure their survival and continued growth. Methods include manual cutting or grubbing or the use of herbicides.

"free to grow"—
A seedling or small tree that is free from direct competition from other trees, shrubs, grasses, or herbaceous plants

cohort—
A group of trees of similar age that have developed after a disturbance such as fire or timber harvesting.

height. The 2011 measurements showed that height growth has improved as the trees have grown above the shrub layer; average annual height growth for the understory trees was over 2 feet from 2006–11.

However, height growth is highly variable: growth is best on the young trees that are in larger openings, while trees that are close to overstory trees are growing more slowly (Figure 3). Also, the grand fir understory trees are growing more consistently in height and diameter compared to the Douglas-fir, with few showing signs of suppression. Because grand fir trees are more shade tolerant than Douglas-fir, they appear to be less affected by shading from the overstory trees.

In 2011, the stand had 395 trees per acre. Around 70 percent of these trees were less than 4 inches DBH (Figure 4, page 5). The rate at which the young cohort will grow into the upper diameter classes will depend on management decisions going forward.

Photo by Stephen Fitzgerald, © Oregon State University

Figure 2. The stand in 2009, showing the residual overstory trees (background) and young cohort (foreground). Note the good height growth on the young trees.

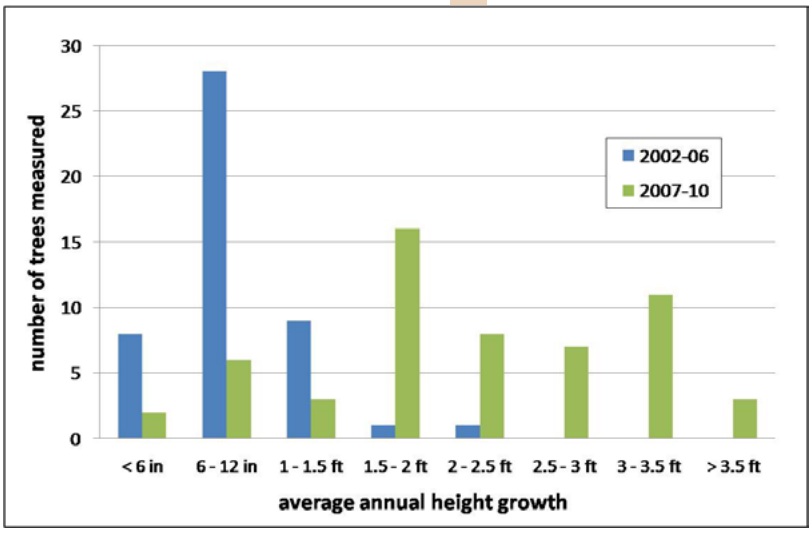


Figure 3. Average annual height growth of understory trees for two periods, 2002–06 growing seasons and 2007–10 growing seasons.

Future Stand Management

Currently, the residual overstory trees are controlling (suppressing) some understory tree growth and development, causing the younger trees to differentiate into various size classes. A growth model that simulates future stand development shows how this trend might continue if the stand is left untreated (Figure 5, page 6).

With no further harvesting, at age 40 (2037) many trees are likely to remain below merchantable size while growth is concentrated on the overstory trees and those understory trees that are less affected by competition (e.g., growing in openings). However, because the family's business strategy is to grow trees with high ring counts (slow annual diameter growth) for which they can currently realize a market premium, the slow understory growth may ultimately be desirable.

Peter and Pam Hayes' long-term goal is to create an **uneven-aged stand** structure on this site. Uneven-aged stands typically have many small trees and increasingly fewer in the larger diameter classes. Creating a two-aged stand with the 1997 harvest was a first step towards this desired outcome, but further management will be needed in order to recruit more age classes (with **regeneration**) over time.

uneven-aged stand—A stand with trees of three or more distinct age classes, either intimately mixed or in small groups.

regeneration—Young trees (seedlings) that start by planting, natural seeding, or sprouting.

The Hayes have to carefully consider options for managing stand density into the future. They can approach this in a number of ways with their next harvest entries. Some general options, with pros and cons, include:

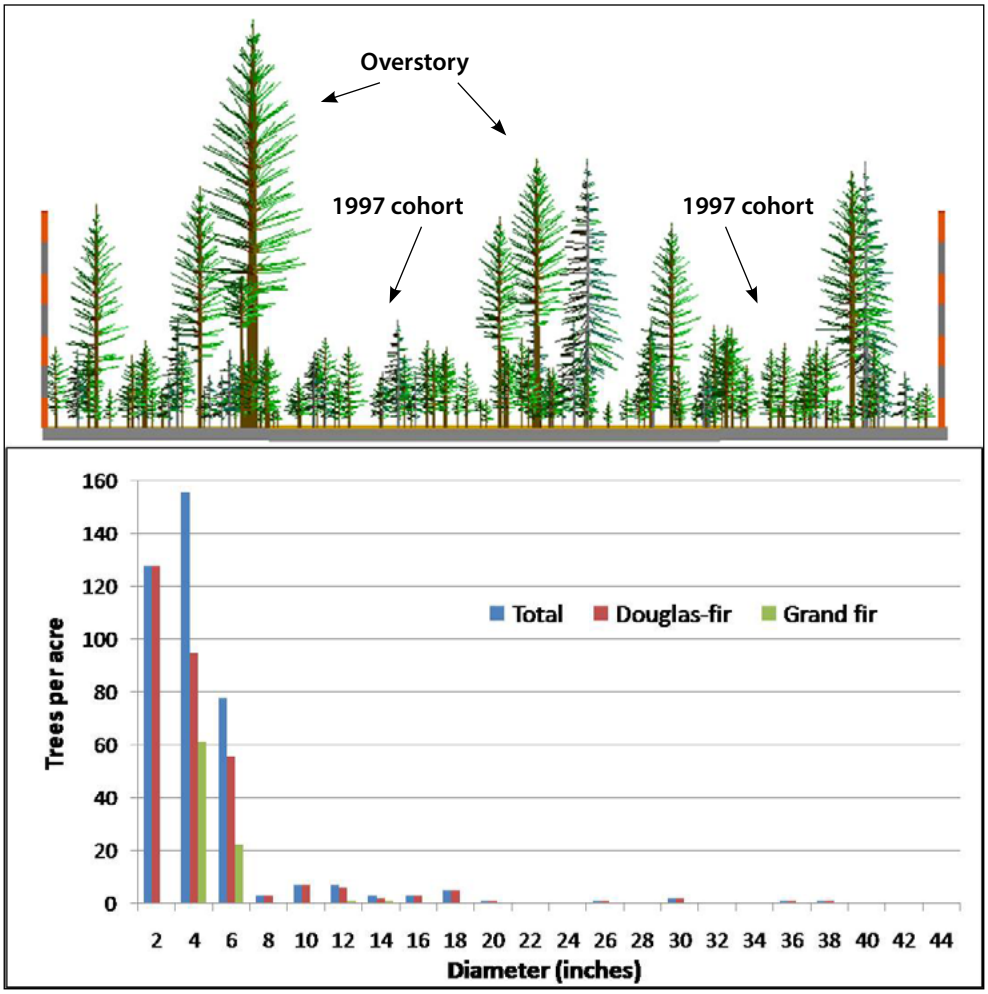


Figure 4. 2011 stand visualization and diameter distribution. Each orange and each gray segment on poles in image equals 10 feet.

- **Thin the 1997 cohort as needed.**

With the overstory trees controlling their development, it will take a long time before the 1997 cohort reaches commercial size. Because of the overstory competition effects, thinning the understory alone will not result in a substantial improvement in growth of the younger trees. Recruitment of a third cohort of young trees (to create an uneven-aged stand) would be difficult unless a shade-tolerant species (such as western redcedar, hemlock, or grand fir) is planted and actions to minimize deer and elk browsing are taken.

However, the large overstory trees will continue to grow in diameter and add volume, which may bring a premium price, depending on markets.

- **Create plantable gaps.**

Removing some of the remaining overstory trees in one or possibly a series of entries will create plantable gaps/openings. Although the large trees were intentionally retained to diversify the stand structure (habitat), especially for birds, removing some large trees to establish another age class may still provide adequate habitat while moving this stand toward an uneven-aged structure. The few remaining large trees will continue to grow and add value.

However, while the larger trees have more economic value, it may be difficult to remove them without some damage to the understory trees.

- **Take out some of all size classes.**

This option depends on individual trees and marketing opportunities, and on the harvest being done with patch cuts that create openings large enough to allow more natural regeneration. This approach has the most

flexibility and may be the most effective at achieving the desired uneven-aged stand structure in the long run.

It also may be the most complicated to plan, given that the entire stand is only about 9 acres. But, the Hayes family has implemented small patch harvests elsewhere in their forests, so they have some experience to draw from.

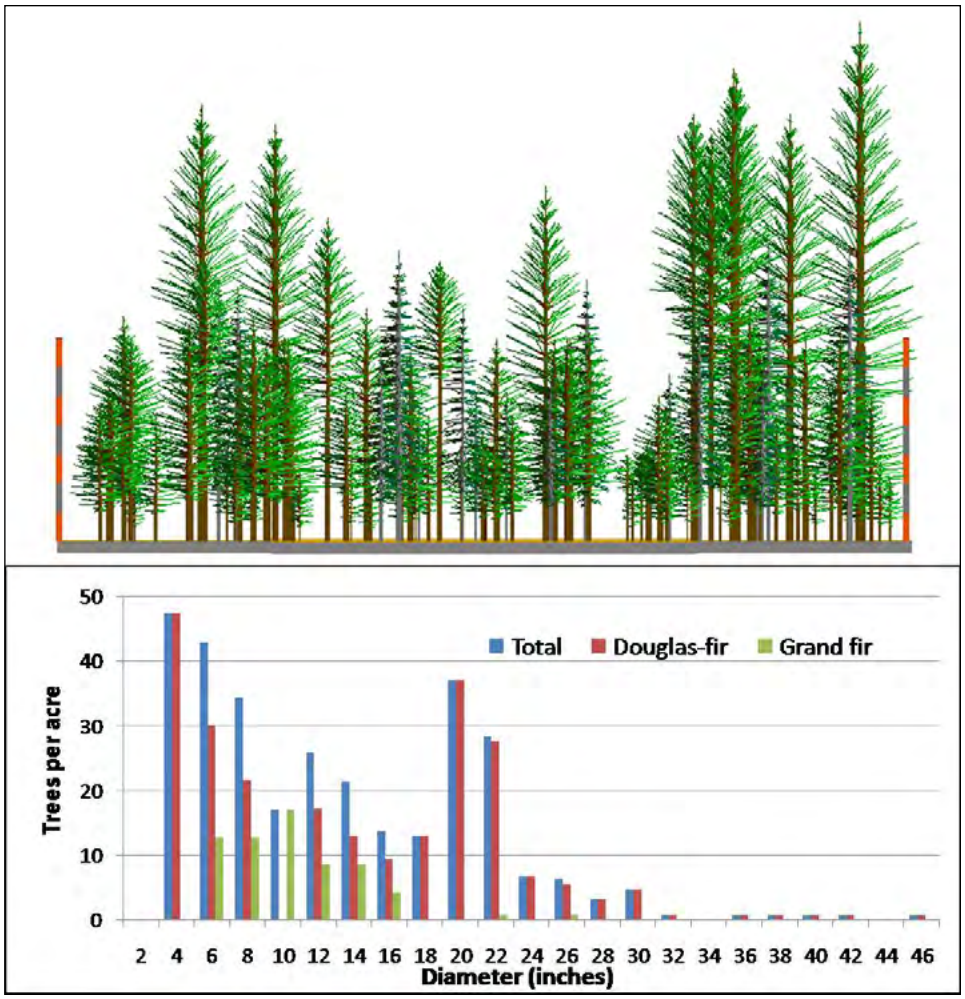


Figure 5. Projected stand structure and diameter distribution in 2037, or approximately 40 years after shelterwood harvest. A growth model (FVS, Pacific Northwest variant) was used to create this projection from the 2011 inventory data.

Lessons Learned

- The previous history of selective harvesting and patchy stocking at the time of the 1997 harvest meant that the overstory trees had developed long crowns and good wind-firmness, so that there was little risk of wind throw after the harvest. The residual trees were vigorous, leading to good seed production. If this shelterwood harvest had been implemented in a stand with higher initial density, the results may not have been as successful.
- Natural regeneration was highly successful in this stand. In retrospect, the owners didn't need to plant trees to achieve adequate stocking. By and large, the young trees are performing well due to the open overstory. If more overstory trees had been retained, then one would expect much less understory tree survival and growth.
- The growth performance of the young cohort is variable and controlled by the overstory. In open gaps within the stand, young trees are vigorous and growing at about the rate one would expect in an even-aged stand. Seedlings that have germinated closer to overstory trees are growing more slowly. Over time, this will create further variation in canopy layers and increased stand complexity, which is in line with the owners' objectives.
- There are many management options available to the landowners going forward. To move toward the uneven-aged stand that they desire, the

Hayes family will have to manage stand density carefully to avoid stagnation of the understory cohort.

- The owners' choice to use a shelterwood harvest was based on the assumption that retaining some large trees would create a better overall forest ecosystem than removing them. The Hayes family is monitoring wildlife. For example, they conduct ongoing bird surveys focusing on several indicator species that rely on large trees. The relationships between the number of large trees retained on a site and desired ecological benefits (such as nesting success) are still not well understood.
- Future economic return from this stand remains to be seen. But, by managing for a variety of species and sizes within the stand, the owners have some flexibility in tailoring future harvests to market conditions.

Past and Future Treatments and Events

~1925	Site is logged by railroad; natural regeneration results in subsequent stand
1970s–'80s	Periodic, selective harvest by previous owner
1986	Hayes family acquires property
1997	Partial harvest of ~60% of the standing volume; residual trees make up the overstory of the current stand
1998–2008	Douglas-fir, grand fir, western redcedar, and western hemlock planted in the understory
2006	Permanent inventory plots established by Doug Maguire and Doug Mainwaring, OSU College of Forestry. Overstory and understory trees measured
2011	Permanent plots measured again
~2020	Possible harvest to allow for regeneration of a third cohort

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