EB1927

Thinning Young Douglas-fir west of the Cascades for Timber and Wildlife

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Many woodland owners want to manage for timber and wildlife. How a forest functions to produce these outputs depends on its structure: the numbers, types, sizes, shapes, and arrangement of trees, shrubs, and groundcover. Trees are especially important because they yield revenue, alter the environment controlling understory plant growth, and create structural diversity for wildlife habitat as snags, dead and dying trees, and downed logs. This publication shows ways of thinning young even-aged Douglas-fir on woodland properties to benefit wildlife while producing timber. For additional aspects of timber and wildlife management, see Extension and other publications listed at the end.

Wildlife Habitat and Thinning

Wildlife in west-side Douglas-fir forests includes more than 400 various amphibians, birds, mammals, and reptiles. Different types of wildlife use different types of food and shelter or habitat. Thus wildlife presence is related to diversity in forest structure. For example, some forest birds increase in abundance with hardwood trees and shrubs growing in more open Douglas-fir stands; other birds are more abundant in dense stands; and some species do not appear affected by stand density.

Structural diversity is provided by a range of tree species, sizes, and spacing (Figure 1), by shrubs, herbs, snags, downed logs, other coarse woody debris, and by components such as water sources. Forest structure has vertical and horizontal components. Vertical components are layers formed by trees, shrubs, and groundcover, whereas horizontal components comprise side-by-side patterns of plant distribution.

Having various types of wildlife habitat arranged in a mosaic pattern across the forest landscape ensures maintaining viable wildlife populations. Wildlife trees such as snags (dead and dying trees), open grown trees, especially excessively large and branchy (wolfy) conifers, double-topped trees, and abnormally large or misshapen conifers and hardwoods have long-term structural value as legacies lasting from one timber rotation to another. Decomposing downed logs support soil microorganisms and give extra insurance in helping forest functions recover after disturbances from fire or timber harvesting. Such legacies provide long-term habitat and structure for up to about one-third of wildlife species, ranging from mammals to birds, regardless of the condition of the surrounding stand. For a good discussion of legacies, see Perry (1994).

Planted, even-aged second growth Douglas-fir stands often lack structural diversity benefiting wildlife because they are composed mostly of one same-aged tree species located at regular intervals. In managing these stands for timber, you can rearrange forest structure to produce fewer but larger trees more quickly by thinning surplus trees and maintaining high growth rates. Thinning also can provide intermediate income before final harvest. When managing for wildlife, research and experience now indicate that thinning can enhance structural habitat for many wildlife species while continuing to produce timber. A more open tree spacing than traditionally used for timber promotes ground-cover and shrub growth and can initiate legacy development. When combined with unthinned areas, thinning for timber or wildlife creates structural diversity benefiting a range of wildlife species. Creating small openings varying from $^1/_5$ acre to one acre and underplanting these with plants suitable for wildlife adds further structure. For specifics on wildlife habitat development, see

- MISC0160 *Managing Small Woodlands for Cavity Nesting Birds*,
- MISC0189 *Managing Deer on Small Woodlands*,

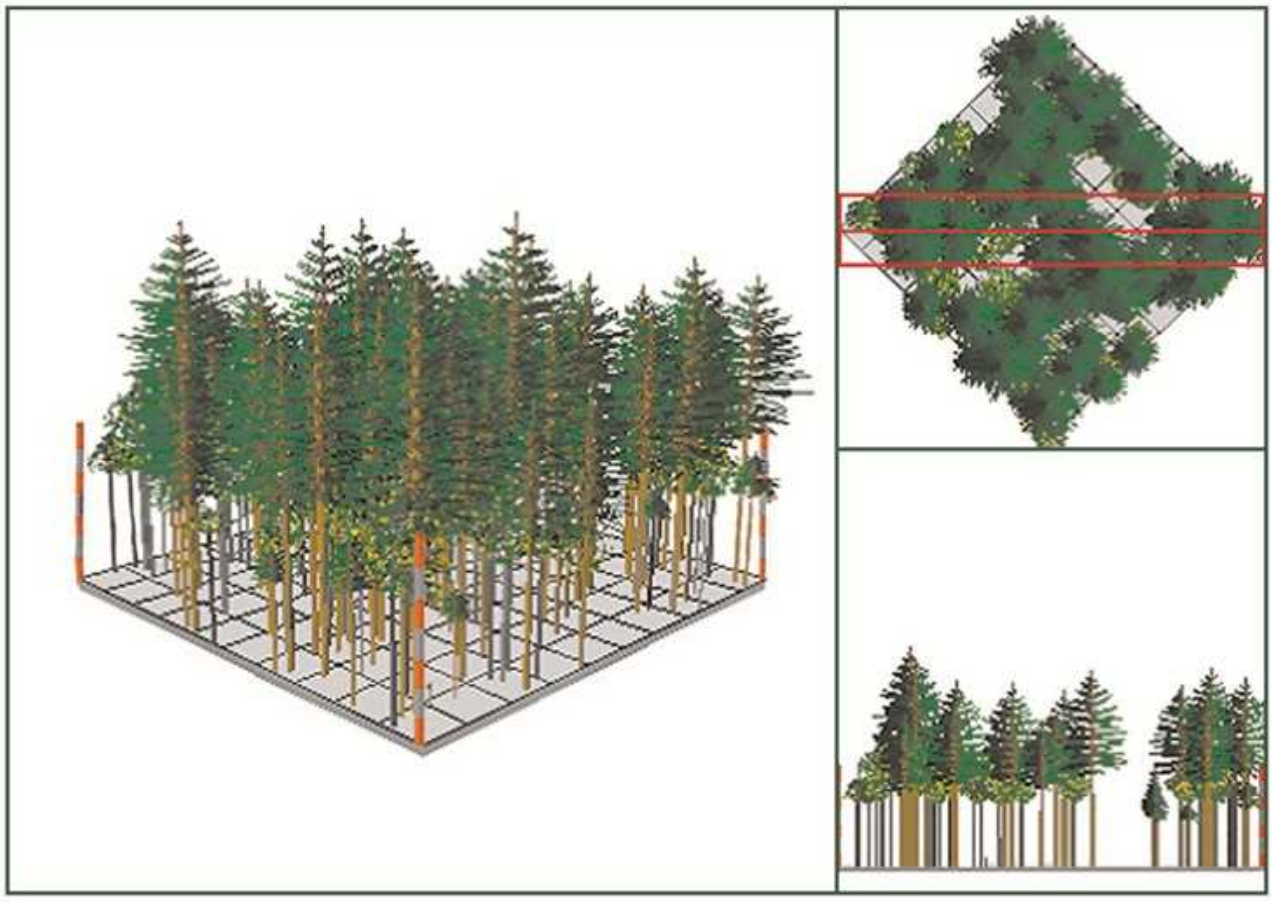

Figure 1. *This simulated 67-year-old stand (SI 120) is composed mostly of dominant Douglas-fir, with bigleaf maple, red alder, and western hemlock underneath. The differing tree heights and openings create variation in vertical and horizontal structure benefiting wildlife. The openings could be expected to hold shrubs and groundcover such as vine maple, beaked hazel, Oregon grape, and others, adding even more structural diversity. In this 1-acre LMS depiction, the range poles are 75 feet tall and the grid lines are about 20 feet apart. The cross-section in the lower right panel illustrates trees from within a 40-foot-wide strip depicted in the overhead view.*

- MISC0198 *Managing Forest Habitats for Migrant Songbirds*,
- MISC0168 *Coastal Douglas-fir Forests and Wildlife*,
- MISC0141 *Managing Small Woodlands for Grouse*,
- MISC0226 *Habitat Management for Bats on Small Woodlands*,
- EB1866 *Wildlife Ecology and Forest Habitat*,
- EB1899 *Silvicultural Alternatives: Variable Retention Harvests in Forest Ecosystems of Western Washington*,
- Chan, Maas-Hebner and Emmingham (1999),
- Hayes, Weikel and Huso (2002), and
- Muir et al. (2002).

How Even-aged Stands Change Over Time

In even-aged stands, as a given number of trees per acre (TPA) grow in size, they differentiate into larger dominant and codominant trees and smaller intermediate and suppressed trees (Figure 2). The suppressed trees die, reducing the number of trees per acre as average tree size increases. This period of stem exclusion, from the time when tree canopies cover the entire ground area until the stand starts to naturally develop more diverse structure can last for decades. As stem exclusion progresses, full stocking portrays the approximate max-imum number of live trees of average size that a site can support (Figure 3), although some stands may have higher values. Because structural diversity is poor for most wildlife during stem exclusion, opening a stand by thinning can create beneficial structural diversity while producing larger trees for timber more quickly.

Thinning Basics

Thinning decisions depend on the numbers, species, sizes, and quality of your trees, and on your management objectives. For timber or wildlife objectives, or a mix, you can leave trees un-thinned, thin them before they have commercial value (precommercial thinning), thin when the cut trees have reached merchantable size (commercial thinning), or use a combination of these practices. Commercial thinning can occur more than once. Thinning trees increases light, water, and nutrients available to remaining trees and understory plants, increasing their growth. However, understory development can include non-native noxious weeds, such as scotch broom, that displace beneficial wildlife plants and complicate future reforestation.

Precommercial Thinning for Timber

In precommercial thinning, woodland owners typically thin Douglas-fir 10 to 15 years after planting. Cutting lower quality, slower growing trees allows larger, better formed trees to grow faster. Precommercial thinning can encourage wind firmness and large crowns. For timber production, especially on more productive sites, diameter growth should stay at a good rate after precommercially thinning Douglas-fir from greater stand densities to about 355 TPA or to as few as 275 TPA. The lower stocking level may delay time to a commercial thinning by a few years but produce more usable wood. Even if timber production is a primary goal, wildlife will benefit from

To estimate spacing from TPA, use Table 1. Or, take the square root of 43,560 square feet per acre divided by TPA. Thus average spacing for 355 TPA would equal $\sqrt{43{,}560 \div 355}$ or about 11 feet. Tree spacings are average because trees rarely grow at exact intervals. See EC1190* Forest Measurements—Stand Volume and Growth: Getting the Numbers *for methods of measuring average tree spacing.

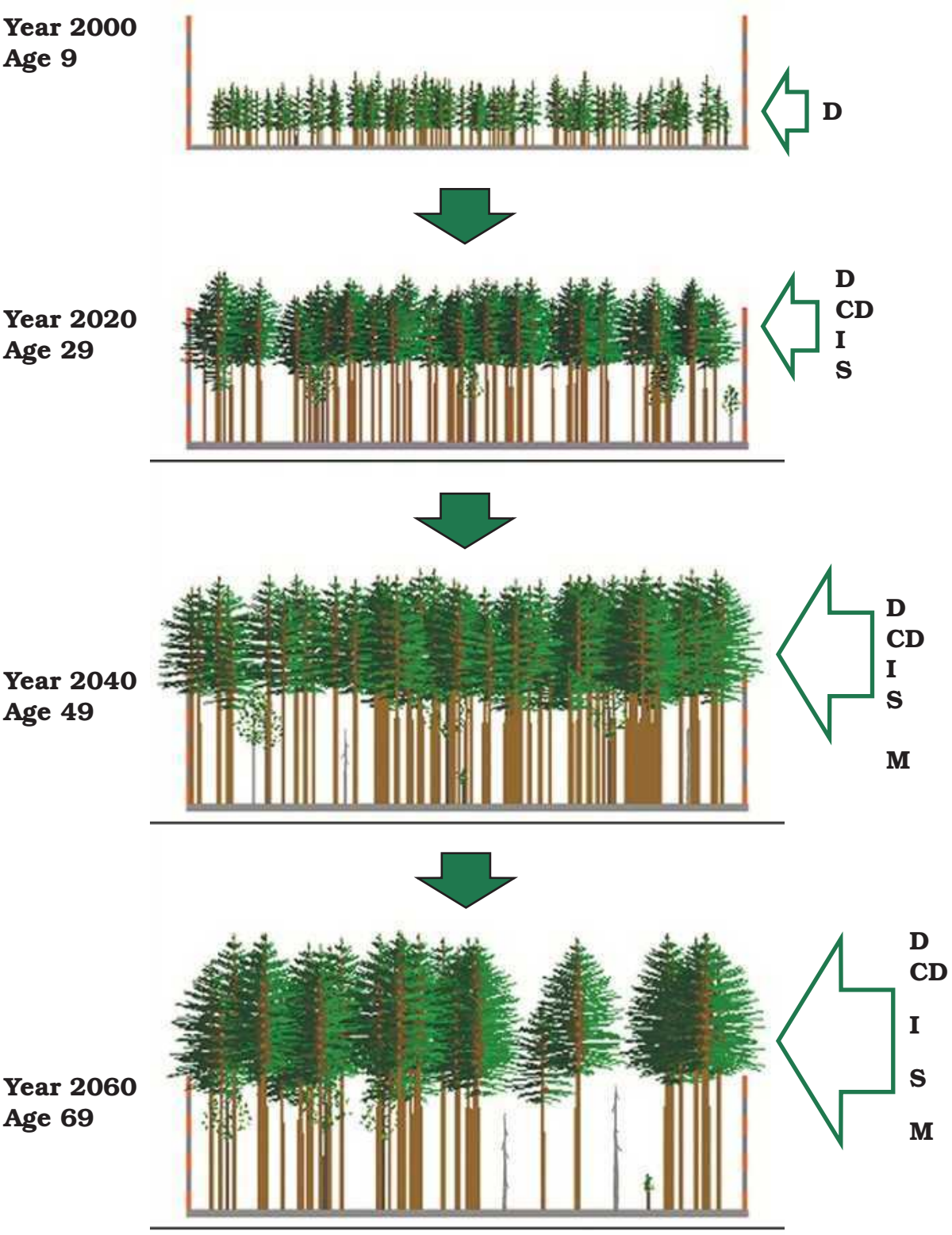

Figure 2. *In even-aged stands, trees grow larger at different rates, differentiating over time into four general crown classes (**D** dominant, **CD** co-dominant, **I** intermediate, and **S** suppressed). The larger trees eventually kill suppressed trees (**M**) due to competition. Thus a site holds fewer and fewer trees as trees grow larger. Mortality from competition becomes fairly evident at full stocking levels of about RD70. In this LMS simulation, the range poles are 75 feet tall.*

your designating at this stage the wildlife legacy trees you will be required to leave at final harvest.

Precommercial thinning has drawbacks. It temporarily increases fire hazard and access difficulty for humans and big game until the cut trees decompose. Also, thinning costs are not recovered until the crop trees are harvested. Because of this and the trend toward commercial use of smaller trees, many landowners are choosing to bypass precommercial thinning and wait until their trees are large enough to sell commercially. On productive sites, this can be as soon as age 20. However, delaying thinning for too long into the stem exclusion stage can slow growth of remaining trees for several years after thinning. The trees remaining after thinning also may be more prone to windthrow and snow breakage, especially trees having height-to-diameter (H/D) ratios greater than 80 and small live crowns.

***The H/D ratio is total tree height divided by DBH ("diameter breast height") using the same units. DBH is measured outside bark 4.5 feet above the ground on the uphill side of the tree. Thus an 80-foot tall tree with a 12-inch DBH (one foot) has an H/D ratio of (80/1) or 80. For methods of measuring DBH and height, see EC1129* Tools for Measuring Your Forest *and EC1190* Forest Measurements—Stand Volume and Growth: Getting the Numbers.**

Precommercial Thinning for Wildlife

Creating understory structural diversity by precommercial thinning brings greater benefit to wildlife earlier than waiting for a commercial thinning. One recommendation to increase understory plant growth is to precommercially thin Douglas-fir to spacings ranging from 200 to 250 TPA or about 15- by 15-feet to 13- by 13-feet average spacing. Expect the more open-grown trees to develop fuller live crowns, benefiting some wildlife species. For legacies, retain as many wildlife trees as compatible with your timber goals.

On north-facing slopes more open spacing may benefit big game by increasing growth and development of understory forage plants. Irregular thinning helps provide horizontal diversity. Locate unthinned areas to provide corridors between water and habitat areas and to provide hiding cover for big game animals and nesting cover for birds. A wildlife biologist can assist in the specifics of laying out thinned and unthinned areas for wildlife.

Commercial Thinning

In commercial thinning, when market value is greater than logging costs, the landowner receives revenue before final harvest. Commercial thinning costs (from the stump to loaded on the truck) are typically greater than for clearcutting.

Two general commercial thinning approaches exist. High thinning, or thinning from above, takes mostly larger overstory trees from above, provides the greatest immediate financial returns, but can reduce future tree growth and financial returns—perhaps into negative numbers. The smaller and more slender understory trees left behind can have less leaf area for growth, take longer for their growth to respond to thinning, are prone to sunscald, logging damage, windthrow, and snow breakage, and may be genetically less fit. Damaged trees, however, have value as wildlife habitat, especially trees greater than 20 inches DBH.

Low thinning, or thinning from below, harvests mostly smaller understory trees from below, recovering their value before

they die from being crowded, and harvests surplus, larger overstory trees. While immediate financial returns are less, future growth and financial returns are greater.

Windthrow and stem breakage may occur whether you are thinning for timber or wildlife. Trees at least risk for stem breakage have H/D ratios less than 60; trees at most risk for breakage or windthrow have H/D ratios greater than 80. High risk locations are ridgelines or the upper third of leeward slopes, narrow valleys parallel to storm winds, or saddles or gaps in ridges perpendicular to winds. High risk stand factors include stands with sides exposed to about southwest, excessively dense stands, root disease, shallow or poorly drained soils, or pit and mound microtopography indicating a history of windthrow. For high risk trees and stands, consider not commercially thinning; clearcutting is likely the best option. For healthy stands with deeper soils on high risk locations, you can reduce windthrow risk by leaving a stable windward edge 60 to 100 feet wide, removing only 15% to 20% of the stems and leaving hardwoods. Inside the stand, create no openings larger than one-half dominant tree height, leave hardwoods, thin from below no more than 20% of the stand basal area, and remove all unstable trees or trees on unstable areas. Do not thin single storied, high density stands. For an extensive description of windthrow hazard, see Stathers, R.J., T.P. Rollerson, and S.J. Mitchell. 1994.* Windthrow Handbook for British Columbia Forests*. B.C. Ministry of Forestry, Victoria, B.C. Working Paper 9401.

Faster growth accumulates on higher value larger trees, where fuller crowns are better able to utilize the increased light, water and nutrients provided by thinning. These larger trees are less prone to physical damage by logging or weather. However, they may afford less snag production for wildlife.

Various methods can determine when to thin a stand based on how close it comes to full stocking. Relative Density (RD) is an easily calculated method based on numbers of trees per acre (TPA) and average DBH. For west-side Douglas-fir, an RD70 indicates full stocking; the site is holding about all the trees it can for a particular average diameter (Figure 3). Such a stand would contain dead and dying suppressed trees. For wildlife, this would correspond to a “closed canopy” of between 70% and 100% canopy cover.

Measuring DBH on sample plots before thinning is relatively easy and will give you an estimate of the range of tree sizes. This can provide a good initial estimate of the trees to cut and those to leave for a desired average DBH for leave trees and associated trees per acre. After thinning, use RD to estimate the future average size when a second thinning could occur.

As with precommercial thinning, you can make the following commercial thinning choices when trees are large enough to sell: conduct no thinning, thin for timber, or thin for wildlife. Be aware that RD provides only a general guide and it may not always be feasible to thin at exact RD recommended sizes.

Commercial Thinning for Timber

For an intermediate financial return from thinning and to maintain full stocking for timber production, the RD thinning guidelines indicate landowners should grow Douglas-fir to about RD55 (the Timber Upper Limit) and then harvest enough

trees to give about RD35 (the Timber Lower Limit) (Figure 3). Thinning to this level helps ensure that increased light, water and nutrients made available by thinning go into wood production on the leave trees, and do not greatly enhance understory plant development. In terms of canopy cover for wildlife habitat, thinning to this level corresponds to "moderate cover" (40% to 69% canopy cover).

Depending on log markets, it may be better to grow Douglas-fir trees to larger sizes and greater RD values before the first commercial thinning if the trees are too small to sell at about RD55. While this practice may lose some growth, landowners may find the larger trees easier to sell. Delaying thinning for too long, however, can create trees that will not respond as well in growth after thinning. As a "real world" check on using RD, also observe the live crown ratio (lcr) of the overstory trees: the portion of total tree height mostly covered with green live branches or the living crown. Try to thin before average lcr drops below about one-third of total tree height.

As an exercise, apply the RD thinning guides in Figure 3 and Table 1 for timber production for trees growing at about an 11-foot average spacing (355 TPA), a good spacing for early timber growth. Follow the dark line indicating about 355 TPA in Figure 3 right to the Timber Upper Limit and then down to the Timber Lower Limit. To maintain good growth, thinning should occur when average DBH is between 9 and 10 inches, an average spacing of about 14 feet. From there following the dark line to the right indicates hypothetically that thinning could be repeated when trees average about 13 inches DBH and again at about 17 inches DBH.

In the real world, staying strictly within "timber" or "wildlife" guidelines or exactly following the dark line "stairstep" probably will not happen due to market needs, immediate shifts in average diameter caused by thinning from above or below, future tree death, or in-growth. In an actual setting, you can re-check your target leave tree TPA for a given RD using the estimated average size of the leave trees.

Even if your primary goal is timber management, you will need to leave a requisite number of standing wildlife trees at final harvest. Defective trees retained for this purpose during thinning can benefit wildlife as they grow.

Mathematically, RD = Stand Basal Area (ba) in square feet per acre divided by the square root of the quadratic average of DBH in inches. The quadratic average is the square root of the average of squared diameters. For smaller areas, a simple average DBH can work about as well as the quadratic average in calculating RD.

Stand ba is equal to the sum of the cross sectional area of trees at breast height on an acre of land. It is also equal to the ba of a tree of average diameter multiplied by TPA. To convert tree DBH to ba, square the DBH and multiply by 0.0054. Thus, a 10-inch DBH tree would have a basal area equal to (10 x 10 x 0.0054) or 0.54 square feet. If that tree represented average tree diameter in our example stand of 355 TPA, the stand ba would equal (355 x 0.54) or 194 square feet. The RD for this stand would be equal to (194 ÷ $\sqrt{10}$), or (194 ÷ 3.16) or RD61, a stand approaching full stocking.

Commercial Thinning for Wildlife

Thinning to enhance understory shrub and herb growth for wildlife follows the same step-wise manner as does thinning for timber. A landowner would consider thinning the example 355 TPA when they approached the Wildlife Upper Limit of RD45, or when they were 8 to 9 inches DBH, assuming such small trees had market value. If these trees were too small to have commercial value, then thinning for wildlife could be deferred until they were large enough. Potentially, the example 355 TPA would be thinned to the Wildlife Lower Limit of about RD25 (Figure 3), leaving about 200 TPA spaced on the average between 14 to 15 feet apart (Table 1). For wildlife habitat, this level of thinning corresponds to an "open canopy," ranging from about 10% to 39% cover. The leave trees could continue to grow to the Wildlife Upper Limit RD45, about a 12-inch DBH (Figure 3) before they would start crowding out understory plants.

To increase horizontal structural diversity, selectively apply commercial thinning as you would precommercial thinning, retaining wildlife trees when possible as legacies. If your goal is to accelerate development of wildlife habitat found in late-successional forest structure, use repeated thinnings to create a mosaic of unthinned areas, timber and wildlife thinned areas, and small openings holding underplanted trees and shrubs. Retain wildlife trees and create snags and coarse woody debris during the thinning processes (see Chan, Maas- Hebner and Emmingham 1999, MISC0198 and MISC0226). You may want to combine retention patterning with patch cutting or group selection harvest methods (see Curtis et al. 1998, EB1899 *Silvicultural Alternatives: Variable Retention Harvests in Forest Ecosystems of Western Washington*). A professional wildlife biologist can help determine a layout of snags, wildlife trees, unthinned, thinned, and open areas benefiting wildlife. Work with your logger

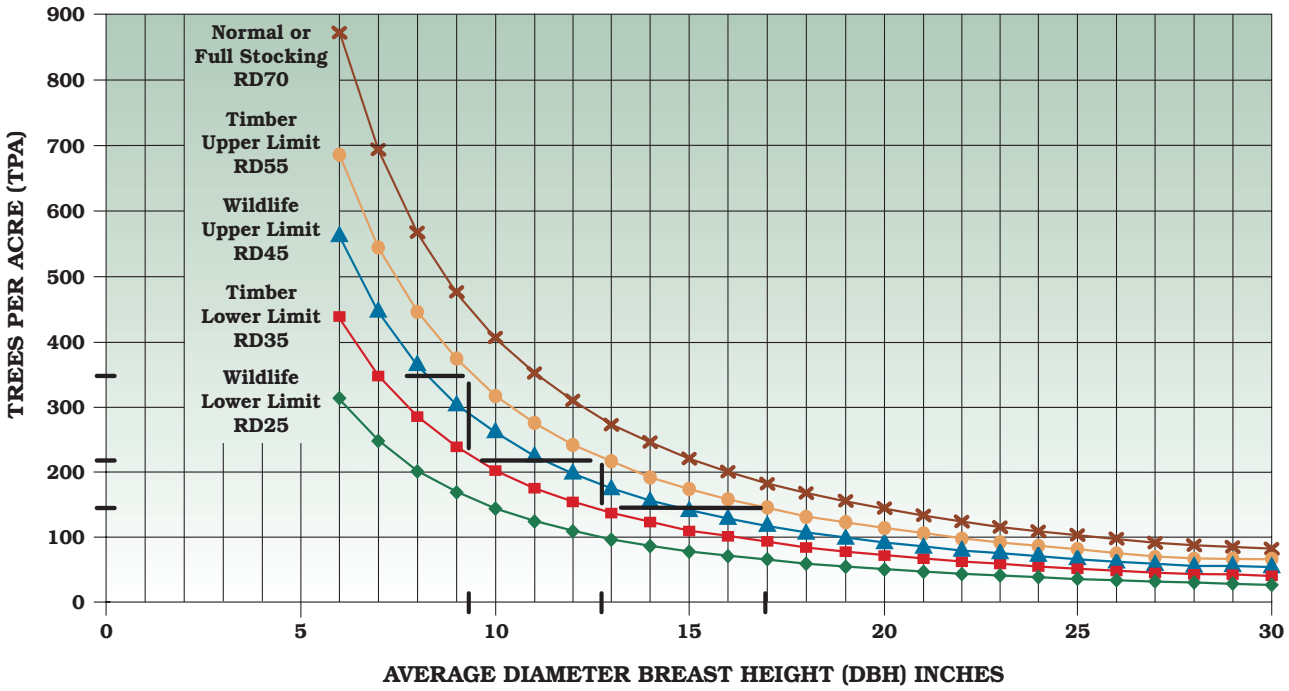

Figure 3. *Stand density diagram for west-side even-aged Douglas-fir showing general guidelines for normal or full stocking RD70, the upper timber limit RD55, the upper wildlife limit RD45, the lower timber limit RD35 and the lower wildlife limit RD25.*

or consulting forester to ensure this layout is compatible with the proposed logging system and is clearly identified for the logger. Crew safety around snags is especially at risk during commercial thinning. Leaving unthinned timber around snags is required in Washington and increases thinning crew safety.

Create short snags by leaving stumps at least 3 feet tall on trees felled for timber. This is an easy way to provide habitat for some snag-dependant cavity nesting birds, bats, and other mammals. Trees with excessive butt swell, sweep, rot, or other defect are excellent candidates. Locate high stumps where they will not interfere with

	Wildlife Lower Limit RD25		Timber Lower Limit RD35		Wildlife Upper Limit RD45		Timber Upper Limit RD55	
Avg. Leave Tree DBH (inches)	TPA	Avg. Tree Spacing (feet)	TPA	Avg. Tree Spacing (feet)	TPA	Avg. Tree Spacing (feet)	TPA	Avg. Tree Spacing (feet)
6	312	11.8	437	10.0	561	8.8	686	8.0
7	248	13.3	347	11.2	446	9.9	545	8.9
8	203	14.7	284	12.4	365	10.9	446	9.9
9	170	16.0	238	13.5	306	11.9	373	10.8
10	145	17.3	203	14.7	261	12.9	319	11.7
11	126	18.6	176	15.7	226	13.9	276	12.6
12	110	9.9	154	16.8	198	14.8	243	13.4
13	98	21.1	137	17.8	176	15.7	215	14.2
14	88	22.3	123	18.9	158	16.6	193	15.0
15	79	23.5	110	19.9	142	17.5	174	15.8
16	72	24.7	100	20.8	129	18.4	158	16.6
17	65	25.8	92	21.8	118	19.2	144	17.4
18	60	26.9	84	22.8	108	20.1	132	18.2
19	55	28.1	77	23.7	100	20.9	122	18.9
20	51	29.2	72	24.6	92	21.7	113	19.7
21	48	30.2	67	25.6	86	22.5	105	20.4
22	44	31.3	62	26.5	80	23.3	98	21.1
23	42	32.4	58	27.4	75	24.1	91	21.8

Table 1. *Upper and lower west-side Douglas-fir spacing guides for achieving wildlife and timber goals. To use this table or corresponding Figure 3, first determine average tree diameter and trees per acre of your unthinned trees (see EC1190, EC1129). After deciding whether to thin to a more open Wildlife Lower Limit spacing or the tighter Timber Lower Limit, look for the TPA and average spacing that correspond to the desired average leave tree DBH. Note that spacings are* ***average*** *distances. Irregular spacing after thinning is acceptable as long as the numbers and sizes of leave trees per acre are acceptable to the landowner. For measuring average tree spacing, see EC1190.*

logging operations or create logging safety hazards. Mechanical tree harvesters may be able to leave higher stumps more safely than hand felling; check with your logger.

What are Potential Results?

A Landscape Modeling System (LMS) desktop computer growth simulation of a second-growth Douglas-fir stand indicates possible outcomes at a final harvest age of 49 years for no thinning or thinning for wildlife or timber. LMS is public domain software available from the University of Washington College of Forest Resources. For information see Nelson and others (1999), or http://lms.cfr.washington.edu/.

LMS stand visualizations and statistics are suitable for comparing thinning alternatives in a general manner. Tree sizes and locations will vary somewhat among visualizations, and wildlife habitat such as snags, downed logs, and understory vegetation cannot be depicted. The LMS program, as in real situations, may not always achieve target RD values when thinning. As with all computer models, LMS simulations should be carefully compared with "real world" knowledge and experience when making site-specific decisions.

The simulations are based on a 15.2-acre stand located at 1500 feet elevation, site index 120 (50 years), sloping about 30% to the south-west on the University of Washington Pack Forest near Eatonville, WA. It was planted in 1991 and at age 9 (year 2000) held 349 TPA of Douglas-fir and 30 TPA of red alder as understory trees. It was selected as an example of similar young stands lacking standing snags or wildlife trees. A single thinning from below for timber or wildlife was simulated at age 24 when average stand DBH was 10.9 inches (Douglas-fir 11.2 inches; red alder 4.6 inches), at RD61, a bit above the RD55 guideline. Such Douglas-fir are about the smallest size feasible for small log saw mills. If no local market exists, waiting and thinning when the trees are larger is feasible, but at some risk of not having subsequent stand growth respond as well. The decision was made to leave the alder in the unthinned and wildlife-thinned stands where it was counted as contributing to RD on an equal basis with the Douglas-fir, and to remove all red alder in the timber-thinned stand. Immediately after thinning, LMS indicated that leave trees in the timber stand averaged 12.6 inches DBH (RD37) and in the wildlife stand averaged 11.9 inches DBH (RD28) (Douglas-fir 13.1 inches; red alder 4.6 inches).

***Site index is the most commonly used method of estimating forest productivity. It is the anticipated height in feet of the taller trees in a stand referenced to a specific age, commonly 50 or 100 years. To learn how you can measure site index, see EC 1128* Estimating Site Productivity on Your Woodland.**

Timber and Wildlife Scenarios

The LMS simulations indicate that most total wood volume at harvest age 49 (Table 2) is produced by the single timber thinning (37,400 bf/acre), followed closely by the wildlife thinning (36,400 bf/acre; about 1.5% red alder) with least in the unthinned stand (32,600 bf/acre; about 1% red alder). The wildlife thinning offers the prospects of greater revenues from thinning at age 24, with 5,900 bf/acre removed against 3,800 bf/acre for the timber thinning, but produces about 10% less wood at final harvest. Despite removing about one-third of volume at age 24, the timber thinning held more wood on fewer trees at age 49 than did the unthinned stand. These volume estimates ignore log grade and trees left behind to meet forest practices regulations.

Table 2. *Estimated volume per acre (Scribner scale rounded to the nearest 100 board feet per acre) harvested by size class from thinning at age 24 and clear cutting at age 49 for the three thinning scenarios. At age 24 before thinning, the stand held 11,500 bf/acre; nearly evenly split between pole and small sawtimber with no large sawtimber volume.*

	Harvest volume by size class			
Stand age (years since planting) for thinning and final harvest	**Pole Sawtimber (<12")**	**Small Sawtimber (12" to 24")**	**Large Sawtimber (>24")**	**Volume harvested (*thinning*, final, total)**
NO THINNING				
24	*0*	*0*		*0*
49	600	32,000	0	32,600
				32,600
WILDIFE THINNING				
24	*5,600*	*300*		*5,900*
49	500	24,300	5,700	30,500
				36,400
TIMBER THINNING				
24	*3,300*	*500*		*3,800*
49	0	33,600	0	33,600
				37,400

At final harvest, the timber-thinned stand trees have the largest average DBH, 18.5 inches, all small sawtimber Douglas-fir. In the wildlife-thinned stand, trees average 18.1 inches DBH (red alder 8.6 inches, Douglas-fir 19.6 inches). Accordingly, most pole sawtimber volume is small red alder, but about 19% of final volume is large saw- timber Douglas-fir. The unthinned stand has the smallest trees averaging 15.5 inches DBH (red alder 8.1 inches, Douglas-fir 15.9 inches) mostly all small sawtimber (Figure 4, Table 2), with the pole-sized tree volume about evenly divided between red alder and Douglas-fir.

Regarding wildlife habitat, the wildlife-thinned stand may have the most structural diversity due to the greater range of tree sizes and openings and the understory red alder (Figure 4). The unthinned stand, potentially lower in structural diversity with its smaller and fewer openings, provides nesting, denning, foraging, hiding, and shelter areas for species requiring dense stands and could be located to screen other wildlife habitat such as water sources and travel corridors. The more uniform timber-thinned stand may offer the least diverse habitat structure. Based on opening sizes, ground cover and shrub development would likely be least in the unthinned stand and increase in the timber- and wildlife-thinned stands.

Which of these simulated thinning options is best for you? Depending on market conditions and your goals for timber production and wildlife habitat, any of them or a mixture could suffice. Selecting and laying out thinning types to complement existing habitat should provide greatest wildlife benefit while also providing timber revenue.

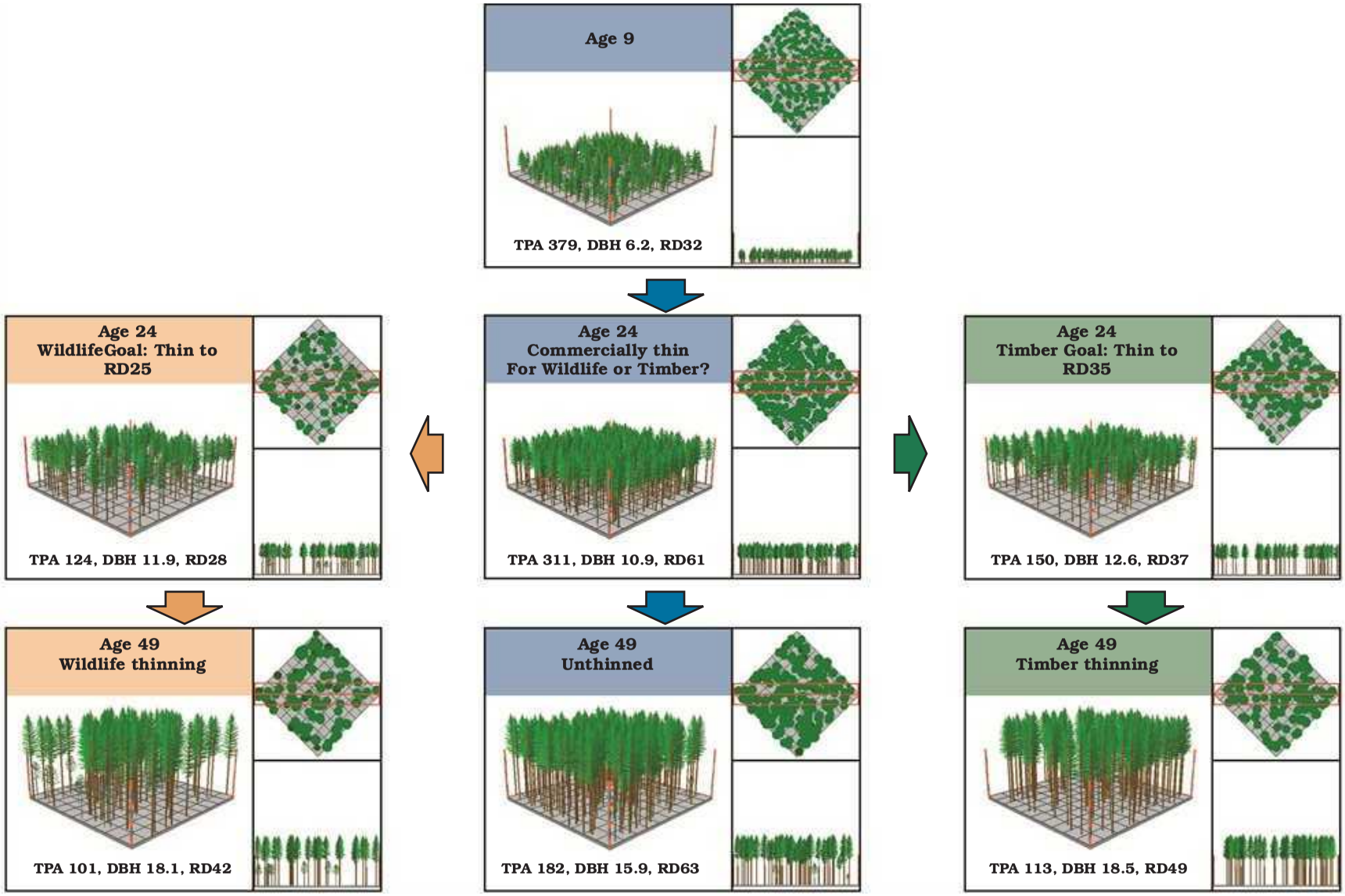

Figure 4. *A young Douglas-fir plantation offers the opportunity to manage for timber or wildlife values. Here the stand has been commercially thinned once for wildlife or timber at age 24 or left unthinned and then left to grow to final harvest age 49. The size depicted in the perspective view is one acre, the grid lines are about 20 feet apart and the range poles are 75 feet tall. The cross-section view is taken from the narrow rectangle seen in the overhead view. [Trees per acre (TPA), average DBH in inches and relative density (RD) are shown at the bottom of each panel.]*

On the Ground Tree Selection

A good thinning plan for timber and wildlife considers existing average tree size and spacing, slope, aspect, snag placement, and locations of water or other habitat. The plan should denote areas to be left unthinned, wildlife-thinned, or thinned for timber and hazard trees. For commercial thinning, incorporate this map as part of the thinning timber sale contract "Exhibit A," a diagram depicting sale boundaries, fences, roads, culvert locations, and other features.

Wildlife Trees, High Stumps, and Clumps

Locate and mark to save desired wildlife habitat trees to meet forest practices, safety and wildlife goals. You can find mapping methods in EC 1133 *Mapping and Managing Poorly Stocked Douglas-fir Stands*.

Clearly mark wildlife leave trees with a large, visible "W" and mark high stump trees using an "S." Use these trees and other wildlife habitat areas as location points for surrounding unthinned clumps and adjoining wildlife-thinned clumps. Do not locate high stumps in skid trails. Also, clearly mark boundary trees surrounding wildlife-thinned and unthinned clumps with plastic flagging before logging, using colors different than those for the boundary surrounding the entire thinning project. Explain the flagging and marking systems clearly to the precommercial thinning crew or the logger conducting the commercial thinning; use a written contract.

One recommendation for clearly flagging boundary trees is to tie a band of flagging around each tree about breast height and leave a tail long enough to move with wind on the outside of the boundary. The flagging should be easily visible from tree to tree and from outside the boundary.

Timber Trees

Thinning to exact tree spacing is not necessary and is usually not feasible. When choosing between achieving spacing or leaving a good timber tree for the future, leave the good tree. Especially when commercially thinning, look at each tree before marking or cutting to ensure future timber trees possess desirable characteristics in addition to larger size. Suggested characteristics are

- intact tops,
- straight, defect-free stems,
- nonspindly stems (H/D ratio less than 80) for commercial thinning, and
- suitable live crown ratios (ratio of live portion of crown to total tree height) preferably about one-third to two-thirds of total tree height.

In commercial thinning, deciding to mark trees is an important choice. A skilled cutter, experienced with thinning, who clearly understands your objectives, may not need to have the trees marked. But, if you decide to mark trees, the question becomes whether to mark "leave" or "cut" trees.

When working with smaller trees in dense stands, likely to be sold by weight as "ton wood," leave tree marking is easier. With larger, more valuable trees, cut tree marking is easier. Either way, apply paint spots at about breast height visible from four sides. A paint spot on the stump provides a post-logging record of whether appropriate trees were cut. If you are unsure of your tree selection skills, practice marking trees with removable flagging to see how the stand will look before marking with paint.

Clearly explain the tree marking system, including colors, to the logging crew before harvest starts. Instead of painting, one landowner pruned leave trees to 18 feet, making them easy to identify for a cut-to-length harvester operator. The tree marker should recognize that not all designated cut trees might be safely felled or yarded. Allow the cutter to substitute trees for safety, log quality, or yarding considerations.

Protecting Your Green Capital

Points to consider in choosing to thin for timber or wildlife include:

- Commercial thinning for timber or wildlife may provide intermediate income and increase total wood volume harvested compared to not thinning
- Wildlife thinning may provide most income from thinning but lower timber volume at final harvest compared to timber thinning
- Wildlife thinning may produce the greatest range of tree sizes
- Wildlife thinning may increase timber sale costs due to more complex sale layout
- In areas where bright warm winter days alternate with cold nights, thinning a young stand on south-facing slopes may cause sun-scalded stems
- Carefully evaluate thinning on windthrow-prone areas
- Understory grass and shrub development in more open thinned stands may create fuel loads near the ground, difficulty in working in the stand, and future reforestation problems
- Noxious weeds may develop under thinned stands
- Coordinate location of high stumps, snags and other wildlife habitat trees with your logger
- Negotiate leeway with your logger to substitute trees or relocate skid trails once logging is underway for safety, log quality, or yarding considerations

A commercial thinning operation should not damage either trees or soil. The following can help you achieve this goal:

- Pre-locating and marking skid trails with smooth corners leading to the landing
- Felling trees to lead to the trails
- If necessary, protecting corner trees with rub trees or plastic culverts
- Avoiding logging when tree bark is loose and soils are wet
- Using appropriate equipment
- Leaving tree limbs in the stand instead of at the landing; cut-to-length harvesters drop tree limbs on the forest floor, retaining nutrients on-site and protecting the soil from compaction; if logs are limbed at the landing, consider redistributing the limbs back on the skid trails
- Clearly communicating your goals to your consultant or logger

For details on tree protection and logging methods, see Han and Kellog (2000) and EC 1110 *Designated Skid Trails Minimize Soil Compaction* and *Forest Practices Illustrated*. Control soil erosion by seeding skid trails after harvest with wildlife forage seed mixes. Explain damage expectations to your logger before harvesting, preferably in a written contract (see EC 1192 *Contracts for Woodland Owners and Christmas Tree Growers*). A good written contract protects the landowner, the logger, and the

timber purchaser. A logging contractor experienced in commercial thinning methods and who has equipment appropriate for your sale is more likely to protect your forest soil and future crop trees.

Marketing

Some landowners manage their own timber sales using procedures such as those described in EC 1384 *Selling Timber and Logs; Seven Steps to Success*. If you are unsure about thinning, marketing, and managing a timber sale, contact a consulting forester. Choose a consultant familiar with thinning practices, sale administration, and forest practice rules. Consulting foresters can be found on the Web at http://ext.nrs.wsu.edu

An important marketing decision is whether to sell logs mixed together as "camp run" or to recover value by sorting and selling by size and quality. You, your logger or consulting forester should be able to evaluate purchaser offers differing in log size, grade, measurement unit (board feet, tons or cubic feet) and hauling distance as indicated in EC 1487 *Managing Your Own Timber Sale: Guidelines for Success*. Check-scale sample loads leaving your property using methods found in EC 1127 *Measuring Timber Products Harvested from your Woodland*.

Thinning Checklist

- [ ] define goals of thinning for wildlife and timber
- [ ] obtain adequate information on tree size and spacing to decide which trees to cut and which to leave
- [ ] identify wildlife habitat areas (slope, aspect, water, rock piles, cliffs, hardwoods, den trees, snags, downed logs, brushpiles)
- [ ] identify windthrow prone areas
- [ ] lay out nonthinned and wildlife-thinned clumps compatible with terrain and harvest operations, including hazard tree identification (slope, aspect, snags, soil conditions)
- [ ] for commercial thinning, use density guides to estimate about how many trees to cut and average spacing of leave trees; decide whether or not to mark; and whether to mark cut or leave trees
- [ ] set up and use a written contract
- [ ] solicit and compare offers from wood purchasers
- [ ] ensure that the thinning crews, logger, or consultants are familiar with your thinning goals and stand layout, are bonded, and have good credentials and references
- [ ] conduct and monitor thinning and sale of timber
- [ ] record costs and revenues in your financial records
- [ ] control noxious weeds before they get established

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MISC0133 *Riparian Areas: Fish and Wildlife Havens*—WSU, WFW

MISC0141 *Managing Small Woodlands for Grouse*—WSU, WFW

MISC0168 *Coastal Douglas-fir Forests and Wildlife*—WSU, WFW

MISC0169 *Hawk, Eagle and Osprey Management on Small Woodlands*—WSU, WFW

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MISC0198 *Managing Forest Habitats for Migrant Songbirds*—WSU, WFW

MISC0226 *Habitat Management for Bats on Small Woodlands*—WSU, WFW

EC1110 *Designated Skid Trails Minimize Soil Compaction*—OSU

EC1127 *Measuring Timber Products Harvested from Your Woodland*—OSU

EC1128 *Estimating Site Productivity on Your Woodland*—OSU

EC1129 *Tools for Measuring Your Forest*—OSU

EC1132 *Thinning Systems for Western Douglas-fir Stands*—OSU

EC1133 *Mapping and Managing Poorly Stocked Douglas-fir Stands*—OSU

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EC1384 *Selling Timber and Logs; Seven Steps to Success*—OSU

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http://pubs.wsu.edu

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FS: USDA Pacific Northwest Research Station, 333 SW First Street, POB 3890, Portland, OR 97208

FRL: Forest Research Laboratory, Oregon State University, Corvallis, OR 97331

LL: Library loan

OSU: Extension and Experiment Station Publications, 422 Kerr Administration, Oregon State University, Corvallis, OR 97331 541-737-2513.
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