Attachment C

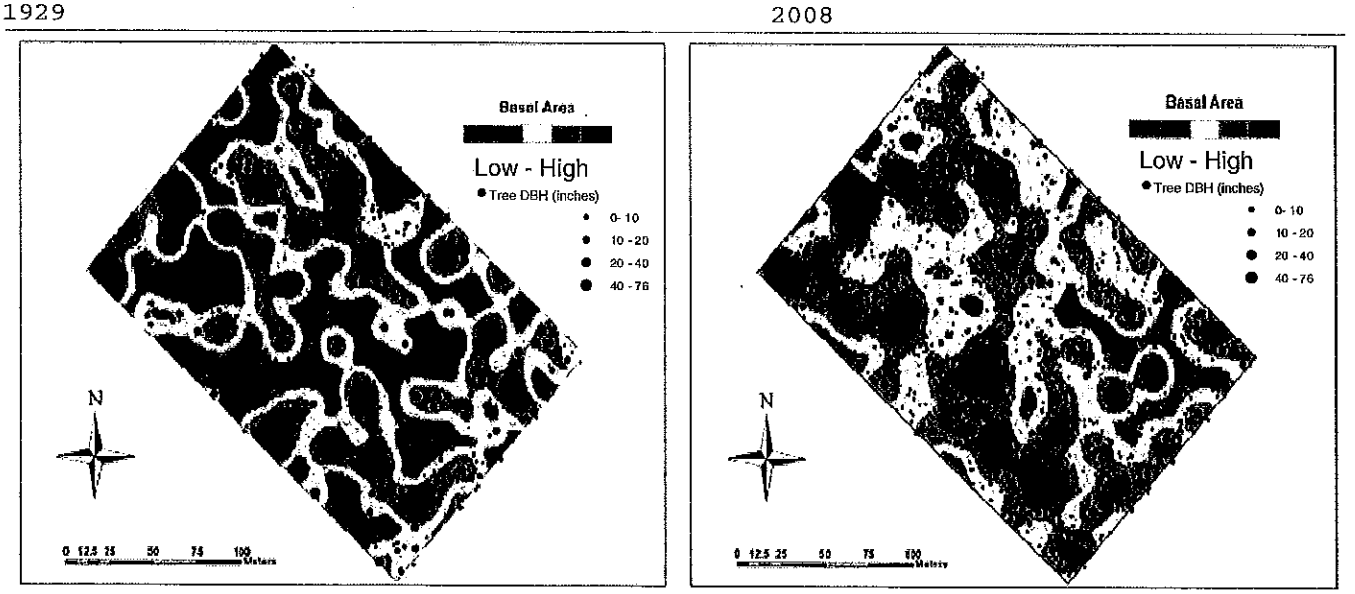
General Tree Marking Guide
Objective: Retain a residual stand of fire tolerant tree species, stand structure and size to restore forest complexity and resilience to fire.

Using historical stands as a guide to move toward spatial patterns for restoring forest complexity and resilience to fire, the **Commercial Thinning** prescription will primarily be a variable density thinning from below (d/D=.8)[1] emphasizing irregular spacing by creating gaps/openings & groups or clusters of trees/clumps (size & number based on historical stand data and existing stand conditions), among group variation (thin to variable basal area/ SDI/ density targets) and within group variation (retain largest/"best" trees regardless of crown spacing). Densities are approximations and would vary around the average residual stocking. Retention and growth of large fire tolerant tree species (PP, DF) is emphasized. On dry sites the residual stand will be primarily ponderosa pine and Douglas-fir at an average of 33-67 trees per acre in groups of trees and individual trees and openings moving toward the 1929 spatial patterns (Figure 1). On mesic sites and microsites with dry sites target basal area will be between 50 and 125 square feet per acre. There will be 30 to 80 residual trees per acre that range from 23 to 38 feet in spacing. Target basal area will be between 50 and 125 square feet per acre. There will be 30 to 80 residual trees per acre that range from 23 to 38 feet in spacing. Grand fir has priority for removal on all sites.

The **Selection System, Uneven-aged Management** prescription the target basal area will be between 90 and 125 square feet per acre. There will generally be 30 to 80 residual trees per acre that range from 38 to 23 feet in spacing. Grand fir has priority for removal.

Figure 1: Example of Basal area heterogeneity (Erick E Knapp et al, Pacific SW Research Station, 2009 Methods of Cutting Study, Stanislaus-Tuolumne Experimental Forest established 1929)

1929 2008



[1]d= Average diameter of tree cut. D= Average diameter of the stand.

Table 1: Target stocking levels for hot-dry and warm-dry sites

Average diameter of residual trees contributing to target stocking	Target SDI	Approximate range of average trees per acre	Average range of basal area per acre
7 to 12 inches	60	50 to 60	30 to 40 ft^2
13 to 18 inches	60 to 70	30 to 40	50 ft^2
19 inches and larger	80 to 90	30 to 80	60 to 80 ft^2

On **average dry sites** (PP and/or DF dominant overstory trees) the target basal area will be between an average of **40 and 80** square feet per acre. There will generally be an average range of 30 to 50 residual trees per acre with spacing quite variable based on existing stand conditions, location of large trees, clumps, gaps and complex patches. Thinning from below would usually remove 40 to 60 percent of the existing basal area from fully stocked stands. Most dominant trees of the desired species would be retained. Usually some codominant trees would be retained to meet density targets. Target stocking level for hot-dry warm-dry sites is stand density index (SDI) 60-90. On **moderate more productive sites microsites** the average basal area per acre retained would increase, **generally 80 to 120 square feet per acre. Canopy gaps** (openings) would range in size depending on fire regime and occur on up to a third of the stand. **Clumps** are defined as two or more trees in close enough proximity that their crowns are interlocking. Clump sizes should range from about 0.01 acres to 0.5 acres (Harrod et al. 1999). Clumps of old large diameter trees would be retained at existing SDI providing adjacent area are reduced to achieve overall density objectives. The sizes of clumps retained would vary within the unit. **Complex patches** are those with more structural and species complexity than the surrounding area. Patch characteristics include large snags, soft down logs, and mistletoe brooms. Utilize micro-sites, topography, and existing conditions to select locations to leave complex patches. In some stands, complex patches are not present and time will be required for them to develop.

The target stocking level for more productive warm-mesic and cool-dry sites is stand density index (SDI) 80-120. Target average basal areas will be 70 to 90 square feet per acre. The desired range of vigorous conifer stocking by size class for these types of sites is displayed in the following table:

Table 2: Target stocking level for more productive warm-mesic and cool-dry sites

Average diameter of residual trees contributing to target stocking	Target SDI	Approximate range of average trees per acre	Average range of basal area per acre
7 to 12 inches	80 to 90	70 to 90	40 to 50 ft^2
13 to 18 inches	100	40 to 70	60 to 70 ft^2
19 inches and larger	110 to 120	30 to 40	80 to 90 ft^2
DF Mesic	110 to 190	30 to 80	90 to 125 ft^2

Priority for selection of leave trees based on existing pattern, tree health, species composition:

1) Keep all **old** trees (thick bark/deep furrows, often established before 1900/generally >150 years at least 20" in diameter) or by Van Pelt book *Identifying Old Trees and Forests in Eastern Washington*.
   a. Retain (unthinned) clumps of old trees and large/old tree structure and defective trees in grouped/clumped or clustered arrangement. In these clumps, if some ponderosa pine trees are smaller diameter but same cohort (disturbance), retain as part of clump. Acre density targets can be exceeded providing adjacent patches are reduced by the same amount.
   b. Retain all PP ≥ 30-inches DBH.
2) Emphasize retention of the existing large tree (≥28" dbh in Low Pole) component while meeting fuel objectives and target densities.
   a. Maintain 12-15 trees per acre of the largest conifers available with the best form and vigor by considering growth, dbh, height, and live crown ratio, with the least amount of mistletoe, mechanical damage, or defect.
   b. Vary tree clump/cluster size (number of trees) from 1 to 10+ within units to retain combinations of small, moderate, large and even groups of trees using existing locations of old trees and retaining replacement clumps of younger trees.
   c. Give PP enough room (generally ≥ 25-28" dbh in Lowpole Project Area). To OPEN UP AROUND OLD AND LARGE INDIVIDUAL PP consider fuel ladder and trees ability to survive fire disturbance. Taking out <u>younger</u> (<150 year old) dominant/codominant DF is an option **if** the young/large DF has a long crown and would be a fuel ladder. Old and or large DF would be left nearby if the PP is released on three sides and the DF does not have a fuel ladder (a fuel ladder would include dead or live crown within 10-feet of ground). Remove most UNDERSTORY TREES (ladder fuels and moisture competitors) that are within about 1 to 2 driplines of large diameter ponderosa pine trees- this includes all grand fir and excess Douglas-fir that are not old.
3) CREATE SPATIAL PATTERN OF LEAVE TREES: Irregular spacing is desired. Densities are approximations and would vary around the target densities. Leaving the largest diameter trees with the healthiest crowns is more important than spacing. Dominant PP or DF with healthy live crowns (full green needles, LCR > 50%) should only be marked for cutting where too many of them exist relative to the prescribed density targets.
   a. CLUMPS are several trees in close proximity with interlocking crowns. For diversity within the unit and to retain character of the natural stand, clumps of 2 to 10+ trees closely spaced (1' to 8' apart), patches of healthy regeneration or clumps of old trees would be left. Trees that fork below DBH count as two trees; leave both or take both trees forked below DBH. When a clump is selected to retain do not thin mature (>20" dbh, age 150+) PP or mixed PP/DF. Feature the largest diameter trees with the healthiest live crown ratios where possible.
   b. In CANOPY GAPS (fewer than about 0-5 TPA) created opening between 1/10 to 1 ac will be created and occur on up to a third of the stand. Examples of gaps include: patches of intermediate trees (especially DF); patches of closed canopy trees where LCR <35% especially when near remnant PP; patches of unhealthy regeneration (latent dmt, etc); where DF mistletoe or root rot buffers are create, etc.

c. COMPLEX PATCHES are those with more structural and species complexity than the surrounding area. Patch characteristics include large snags, soft down logs, and mistletoe brooms. Utilize micro-sites, topography, and existing conditions to select locations to leave complex patches. In some stands, complex patches are not present and time will be required for them to develop.

4) Because inter-tree spacing is not a primary criterion, the resulting stand can be quite variable. VARY residual density thinning targets by species, site stockability, microsite (dry or mesic), and objective. At the stand scale, the density target should leave the majority of dominant trees in good condition. Outside clumps, open residual trees up on all sides so that no crowns are touching.
5) THIN FROM BELOW retaining enough of the largest trees (usually the next oldest cohort) with live crown ratios (LCR) ≥35 % to meet the density objective. Favor BEST LIVE CROWN RATIO.
   a) Ponderosa pine needs a minimum of 40 percent live crown to be competitive in mixed conifer stands. In areas where existing ponderosa pine have less than 40 percent live crown ratio, leave trees if needle length is long and live crown volume is high (dense foliage).
   b) Largest Douglas-fir with over 50% live crown ratio.
6) OPEN RESIDUAL TREES UP SO THAT CROWNS ARE NOT TOUCHING.
7) Priority for selection of cut trees: GF has priority for removal. Overtopped and suppressed trees of all species, PP with LCR <25%, DF with LCR <20%, DF DMT rating >4, Trees with active bark beetle attacks, DF and GF with fading crowns adjacent to root disease infections.
8) CONFINE Douglas-fir dwarf mistletoe. Isolate or kill in place infected old Douglas-fir and isolate retained infected young Douglas-fir. At the margin of removed or retained trees, a dwarf-mistletoe free zone (DMZ) would be created by removing most apparently clean Douglas-fir for up to 50 feet. This would be to remove trees with incipient, undetectable infection.
9) GF has priority for removal. CONFINE Grand Fir leave trees to wet areas or moist upland microsites, upland transition from flood-plains, usually clumped, to individuals mixed with DF. GF are thin bark and susceptible to low-intensity fires and units are scheduled for prescribed fire. Van Pelt page 133-144 Figure 125 for upper crowns of old grand fir.
10) Don't discriminate against trees with POOR FORM until about 5% of the residual stand has poor form. A healthy forked tree is better than a small codominant tree or an understocked clump. When too many nice dominant trees are present, and then discriminate against the tree with poor form.
11) LAMINATED ROOT DISEASE Laminated root rot centers would contain 3 or more adjacent symptomatic trees. Multiple tree laminated root rot centers have a much greater potential to contribute to disease spread than single tree infections. Where laminated root disease centers exist, designate for removal all Douglas-fir and grand fir within 50 feet of trees killed by or with crown symptoms of laminated root.
12) Retain wildlife trees. These are retained mistletoes infected trees, live trees with dead, broken, forked tops or obvious sign of use. Retain in small clumps when possible.
13) Mark to facilitate yarding and cutting. Do not mark to cut "branch bound" trees. If trees are forked below DBH and clearly part of the same root collar leave both or cut both.

14) In areas where the leave tree diameters are 4.0" to 8.0" DBH use a Diameter + 8 foot spacing. PP 18 to 20 foot spacing combined with leaving some in clumps.
15) Retain all HARDWOOD TREES. Reduce conifer encroachment in aspen clones and promote clone expansion. Most conifers, estimated to be less than 100 years of age or less than 20" dbh, would be removed within about 75 feet of existing ASPEN stands to help reverse conifer encroachment and allow aspen expansion.
16) Retain a few of each of the existing tree species that occur in the stand.

NON-FOREST INCLUSIONS WITHIN UNITS: Occasionally there will be small patches of non-forest or very low productivity forest land within units. These inclusions are variable in size and physical characteristics. Rock outcrops, tallus slopes, and shallow soils may be evident. In these areas no trees should be marked for removal within 30 to 50 feet of these areas.

SELECT TREES: Protect all Select Trees from logging and yarding damage and fire treatments. Remove or modify ground and ladder fuels adjacent to the select tree to increase chance of survival in the event of a wildfire or during site preparation burn activities.

Leave trees should have GOOD GENETIC QUALITIES: Good diameter and height growth evidenced by dominance and codominance within a particular age group; evidence of resistance to insects and pathogens, few branches per whorl with little or no branching between whorls.

Where they exist, retain all healthy and moderate quality western white pine.

Example of Marking: Retain a mix of basal areas (20 ft^2 to 90 ft^2) leaving clumps of trees combined with individual tree selection. Create irregularly shaped group opening (¼ to 5 acres in size) where dead/dying or poor quality trees exist. Average residual basal area will vary between 60 ft^2 (areas poor quality leave trees or insects/disease) and 80 ft^2 (areas where the manageable component is good condition).

General Tree Marking Guide For Selection Harvest

Individual tree vigor should determine retention priority. The removal of selected trees from specified size and age classes over the entire stand in order to meet a predetermined goal of size or age distribution and species composition in remaining stand. The result of this treatment is a fully stocked stand that exhibits a variety of stocking density, and may have small openings created where a new crop of seedlings will become established. Cutting methods that develop and maintain uneven-aged stands are Single Tree Selection - The removal of selected trees from specified size and age classes over the entire stand in order to meet a predetermined goal of size or age distribution and species composition in the remaining stand; Group Selection - The removal of small groups of trees to meet a predetermined goal of size distribution and species in the remaining stand. Up to 50 percent of the existing trees would be harvested in each unit, with up to 25 percent emphasizing regeneration objectives using group openings. This treatment will move early structural stage stands to middle, or maintain stands as middle structure by allowing the understory to develop or be released by

treatment. Similar to the HTH, this treatment will accelerate the growth of the residual overstory trees moving the stand more rapidly toward late structural stage.

This silvicultural system calls for conversion of even-age stands over an 80 year time frame, putting 25% of the area in a regeneration status every 20 years. The remaining portions of the stands receive an improvement cut with each entry. Openings provide for regeneration large group openings 3 to 5 acres in size or small group openings less than 1½ acres in size. Individual tree selection will be used in stands with an existing uneven-age size class distribution. Opening less than 2 acres in size promote shade tolerant vegetation.

General Tree Marking Guide For Regeneration Harvest

Forest Plan standards and guides (C-41) require that about 15% of the area associated with each regeneration unit would be retained as standing green trees. Outside of unit to be marked, about 70% of these trees would be retained in unharvested patches (GTR) of at least one half acre, unit size permitting. About 30% of these trees would be left as scattered green trees (5 to 10 TPA) within the unit. This even-age regeneration system cuts the majority of the stand. Retain all old trees.

Where available, large leave (20"+dbh) trees help create a more complex stand structure in the new stand while also helping to soften the visual impact. Favor fire tolerant species and those with thick bark that could with stand a fire. If available, approximately five to ten trees per acre of the larger, healthier ponderosa pine, and if necessary, larger, healthier (disease-free) Douglas-fir, would be retained. Lodgepole pine can be retained in small groups (2-5 trees) or as individuals if windfirm. Where insufficient dominant/codominant leave trees exist, based on logging system design, site preparation needs, and topography, small groups of trees may be left.

Some dwarf mistletoe infected trees over 20" dbh would be retained in clumps of more than 2 or 3. Isolated individuals with DMT would generally be removed to prevent widespread infection of Douglas-fir regeneration. To protect susceptible tree regeneration from dwarf mistletoe infection, placement of mistletoe leave trees would be along lower edges of unit or stressed or killed by a variety of methods (leaving slash levels adjacent to tree, torching large broom near ground, varying lighting patterns to help kill or stress the tree to increase susceptibility by secondary agents) to minimize spread.

Snag Recruitment

The desired future condition is to retain snags and down wood at levels within the natural range of variability to contribute to the viability of species dependent on this habitat.

Table 1: Snag Density Retention Levels (landscape level natural range of variability)

	Snag Size (dbh - in)			
Land-use Allocation	10-14	15-19	>20	**Total**
Dry Forest Type				
Matrix	1.2	1.1	0.9	**3.2**
LSR/MLSA	2.8	2.0	1.3	**6.1**
Mesic Forest Type				
Matrix	3.0	2.2	0.7	**5.9**
LSR/MLSA	9.3	2.0	1.7	**13.0**

The largest snags with the best longevity should be retained for wildlife trees. An obvious hazard tree (logger safety) should not be counted toward meeting snag targets.

Favor leaving Douglas-fir snags greater than 28-inches DBH over beetle killed PP less than 28-inches DBH. Favor retaining a mix of dead trees, dead topped trees, green trees with dead/decayed parts or severely deformed trees.

Green Douglas-fir with large DMT brooms and limb deformities can be used for wildlife trees. Leave isolated from other DF trees to limit spread of infection. DO NOT retain in regeneration units (refer to unit marking guide for exceptions where it is desired to kill most of these trees by prescribed fire). If torching is desired (wildfire or underburn) pile fuels to promote severely stressing or promoting secondary attacks to kill the tree before susceptible regeneration is approximately 4.5 feet in height.

When possible retain old persistent snags (no bark) and consider lighting methods, protection buffer or pullback. Low vigor trees that will die soon can be used for wildlife trees, especially those with low commercial value such as grand fir with heavy Indian paint (cull) or evidence of woodpecker or nest use.

Grouping of snag recruitment trees is preferred over marking individual trees. Groups should be spaced no further than 5 acres apart. In some stands laminated root disease centers can be left to serve for snag recruitment. An unthinned green tree buffer can be left to reduce logger safety concerns. This would work well where lodgepole pine or ponderosa pine surrounds the root rot pocket.

Down Material

In dry forest, an average of at least 3 to 10 tons per acre would be retained. In mesic forest, an average of at least 5 to 10 tons per acre would be retained. Logs greater than 10 inch diameter and greater than 16 feet long would be counted, as well as standing dead trees expected to fall in the short term.

Preference for logs left un-harvested are those of large diameter and those which have large, intact root wads that are of little risk to developing a brood of bark beetles.

Existing down logs, snags and green wildlife recruitment trees should meet down log goals of 160 linear feet per acre, providing down logs are not bucked and piled to reduce fuels. The majority of the fuels treatment is leave tops of trees attached (LTA) removing most of the larger down material to landing piles. Care should be taken to maintain down material to ensure long term site productivity; not over simplify the forest floor; and to retain these structural elements to incorporate into the managed stand.

Buffers Adjacent to Sensitive Plant Populations
Marking in buffers has been done within units. Should additional plants be found during marking of unit, make contract inspector or COR aware of locations.

Aquatic Conservation Areas- Riparian Reserves
Unit layout would address known streams. Should a stream be located during layout apply the following buffers:

For Intermittent Streams: There would be no silvicultural treatment or planned ignition within one "drip line" on the outside edge of the inner gorge, or within 50 feet of the stream channel.

For Perennial Non-Fish Bearing Streams: No silvicultural treatment or planned ignition would occur within 50 feet of these streams to maintain vegetative ground cover and prevent erosion next to the stream.

For Fish Bearing Streams: No silvicultural treatment or planned ignition would be allowed within 100 feet of fish bearing streams. Treatment would be precluded within the inner 100 feet of the reserve to maintain vegetative ground cover and prevent erosion next to the stream.

For All Riparian Areas: As specified in the Northwest National Fire Plan Consultation Process (NFP 2002) and the Okanogan and Wenatchee National Forests Programmatic BA (USDA Forest Service 2002c), prescriptions designed for fire severity effects would not exceed a rating of **low** for 90% of the affected (total amount of the riparian reserve associated with a stream, wetland, seep lake, etc. within the burn prescription perimeter) Riparian Reserve, with no more than 10% of the affected Riparian Reserve in a moderate severity rating. All burning activities would be consistent with the Okanogan and Wenatchee 2002 Programmatic Biological Assessment (USDA Forest Service 2002c).

Basal Area/Spacing Tatum Aid:

BA/ac	60 sq. ft.		70 sq. ft.		80 sq. ft.		90 sq. ft.		100 sq. ft.		110 sq. ft.		120 sq. ft.		BA/ac
Leave-tree Dbh	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Bole-to-bole Spacing	Average # Trees per Acre.	Leave-tree Dbh
In.	Ft.	#	Ft.	#	Ft.	#	Ft.	#	Ft.	#	Ft.	#	Ft.	#	In.
22"+	44'	23	41'	26	38'	30	36'	34	34'	38	32'	42	31'	45	22"+
20"	40'	27	37'	32	34'	37	33'	41	31'	46	29'	50	28'	55	20"
18"	36'	34	33'	40	31'	45	29'	51	28'	57	26'	62	25'	68	18"
16"	32'	43	29'	50	28'	57	26'	64	25'	72	24'	79	23'	86	16"
14"	28'	56	26'	65	24'	75	23'	84	22'	94	21'	103	20'	112	14"
12"	24'	76	22'	89	21'	102	19'	115	18'	127	18'	140	17'	153	12"
10"	20'	110	18'	128	17'	147	16'	165	15'	183	15'	202	14'	220	10"
8"	16'	172	15'	201	14'	229	13'	258	12'	287	12'	315	11'	344	8"
6"	12'	306	12'	357	10'	408	10'	459	9'	510	9'	561	8'	612	6"
5"	10'	441	9'	515	9'	588	8'	662	8'	735	7'	809	7'	882	5"

A silviculturist shall be available to marking crew to provide guidance. Sample plots shall be taken and documented as part of the prescription card. The check plots should include leave species, DBH, crown diameter, purpose of leave tree (e.g. snag recruitment, down log, etc.). If contracted, Contractor is responsible for meeting target densities.

Michelle Satterfield, Silviculturist
February 2014

Source: Smith 1962. - MODIFIED

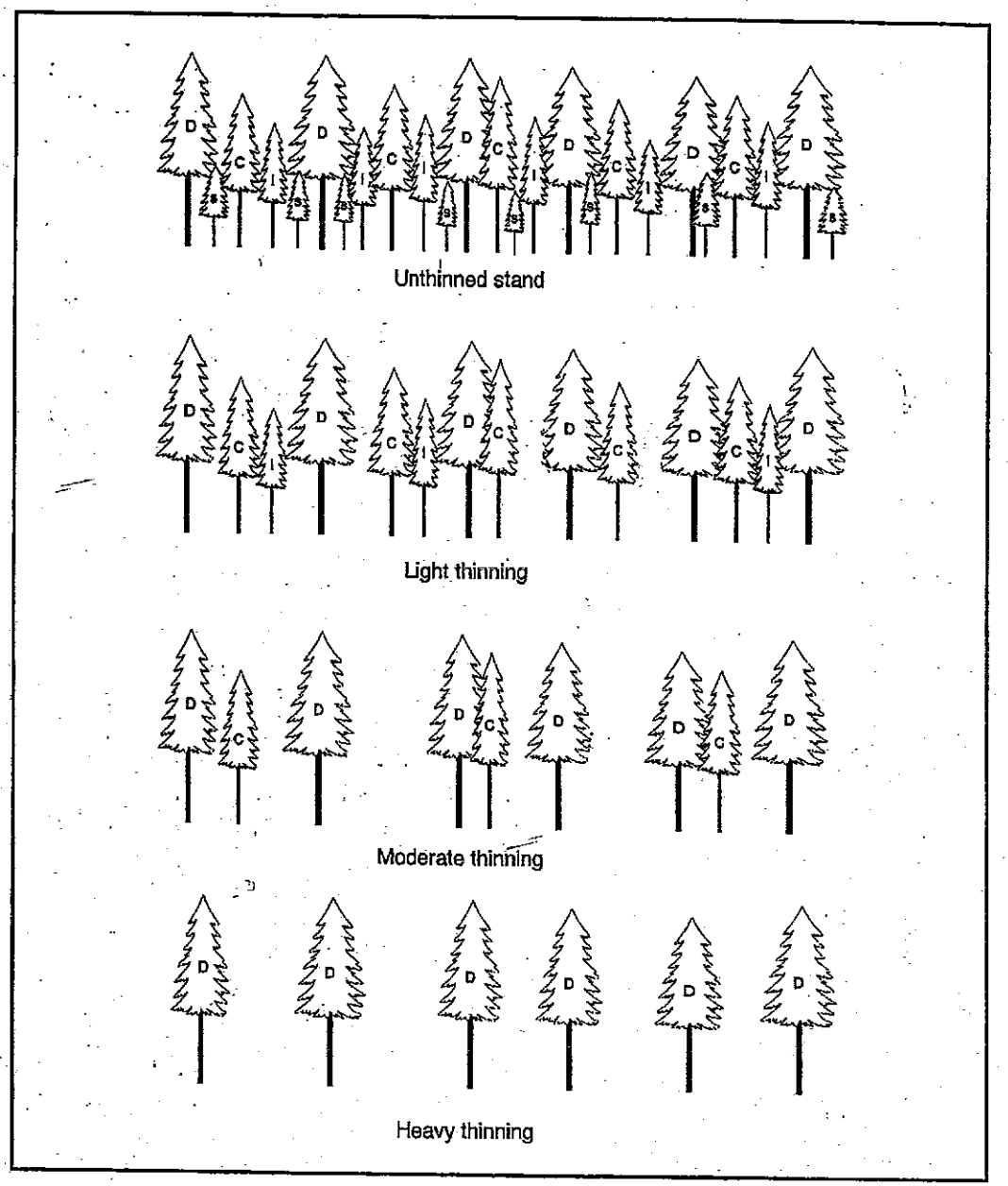
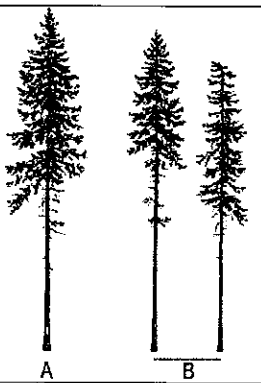
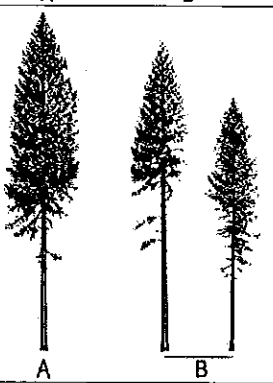
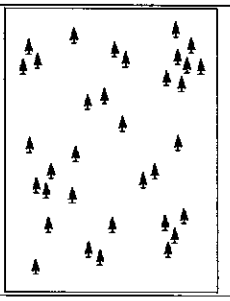
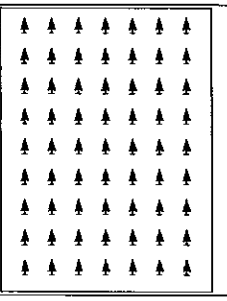


Figure 1—A . conifer stand containing a mixture of dominant (D), codominant (C), intermediate (I), and suppressed (S) trees thinned from below (low thinning) to three different intensities.

THINNING FROM BELOW & CROWN CLASS GRAPHIC

	PREFERRED LEAVE TREES A = good vigor B = fair vigor to good vigor	CUT TREE CANDIDATES C and D = poor vigor
Ponderosa pine		
Douglas-fir		
Western larch		

NOTE: Leave all old (≥ 150 years) remnant trees regardless of vigor. Retain PP >30" dbh. Use this artwork along with crown volume to judge vigor of other species.

DESIRED SPATIAL PATTERN Variable with clumps & gaps	UNACCEPTABLE SPATIAL PATTERN Uniform