Sustainable Resources Institute, Inc.

October 26, 2017

Dear Prospective Timber Marking/Cruising Project Bidder,

The Sustainable Resources Institute, Inc. (SRI) is accepting bids on the Northern Lights Timber Marking/Cruising Project on the Ottawa National Forest - Watersmeet Ranger District and the Countyline Timber Marking/Cruising Project on the Ottawa National Forest - Ontonagon Ranger District.

The Northern Lights Timber Marking/Cruising Project includes 534 acres of cut tree marking including, 525 acres of thinning and 9 acres of clearcut. Note that the Forest Service will mark a 1-acre right-of-way clearing in addition to these acreages.

The Countyline Timber Marking/Cruising Project includes 454 acres including, 221 acres of thinning, 72 acres of selection harvest – aspen component, and 162 acres of selection harvest (the Forest Service will mark a 1-acre right-of-way clearing).

This work is being conducted as part of a Stewardship Agreement, whereby the SRI administers the One Fifty timber sale and the resulting funds stay on the Forest to perform service work including the Northern Lights and Countyline timber marking/cruising projects. All communications, direction, and inspection related to this work will be conducted by SRI staff or representatives. The Timber Sale Establishment Packets, including maps, prospectuses, and bid sheets can be accessed at www.sustainableinc.org.

Bids are due no later than noon on December 1, 2017 according to the instructions on the bid sheet.

Direct questions to Sustainable Resources Institute, 1353 W HWY US 2, Suite 2, Crystal Falls, MI 49920; 906.875.3720; don@sustainableinc.org or kari@sustainableinc.org. Thank you for your interest in the Countyline Timber Sale Establishment project.

Kari Divine

Kari Divine
Sustainable Resources Institute
1353 W Highway US 2, Suite 2
Crystal Falls, MI 49920

Northern Lights Timber Sale Highlights

This timber marking/cruising contract is part of a Stewardship Supplemental Project Agreement between Sustainable Resources Institute, Inc. and the USDA Forest Service. Funds generated from the One Fifty timber sale will be used to award this timber marking contract.

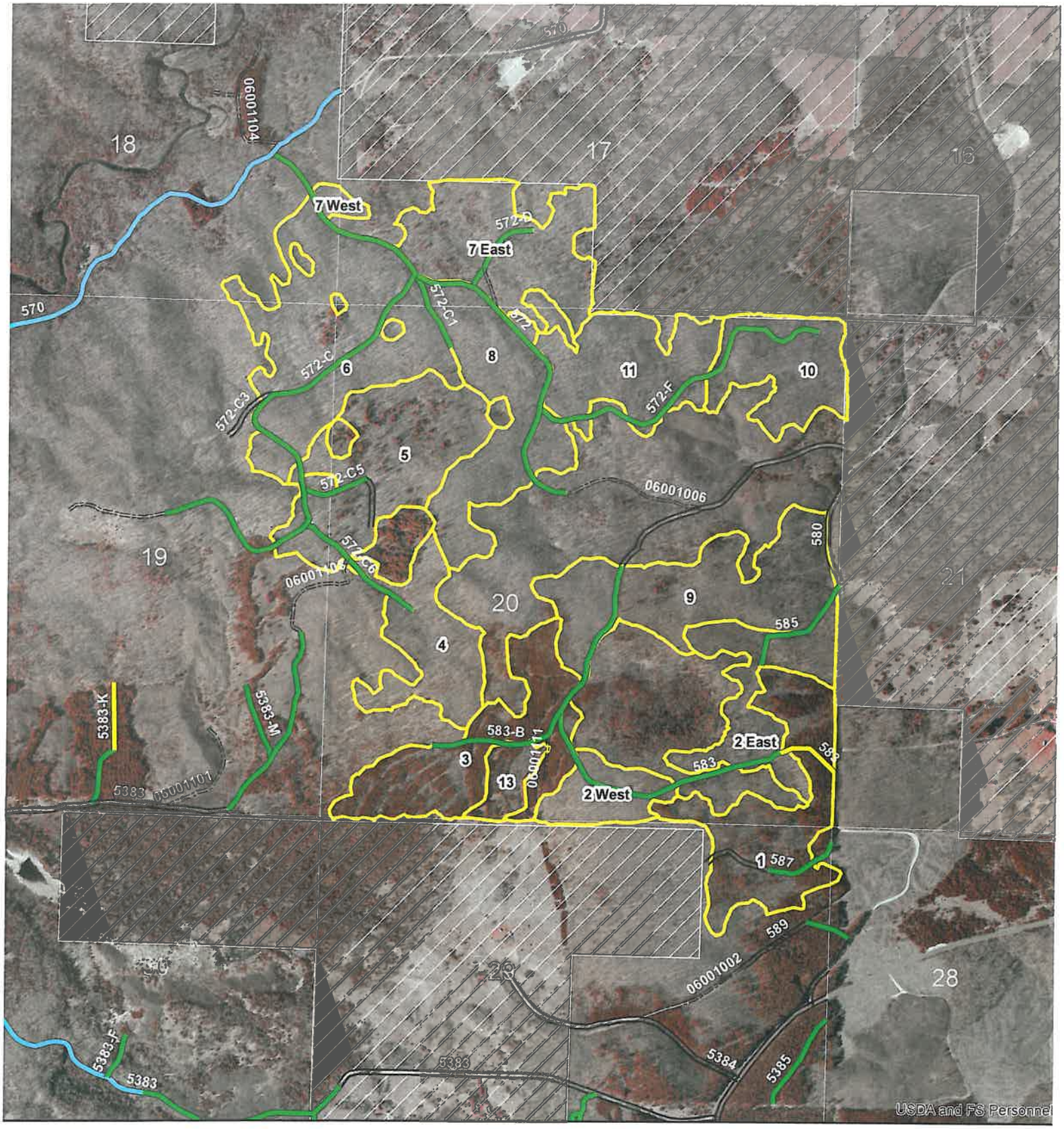
- Project Area: On the Ottawa National Forest, Watersmeet Ranger District.
- This contract includes cut-tree marking/cruising on 534 acres of northern hardwoods, red pine and aspen for thinning and clearcut.
- The overarching goals of this timber sale are to remove trees to increase the stand quality and health, improve stem quality, and develop an un-even-aged stand of northern hardwoods with aspen and conifer components.
- The contractor will submit for approval an operating plan that outlines the schedule of performance. Work must be completed by June 15, 2018.
- Payment will be made upon completion of the project by the contractor and approval by Sustainable Resources Institute, Inc.
- All timber cruisers must be certified on the Ottawa and/or Chequamegon – Nicolet National Forests prior to doing any timber cruising and must maintain certification throughout the marking contract.
- A pre-work meeting is required.

Payment Unit	Est. Quantity (Acres)	Activity
1	48	Thinning
2	47	Thinning
3	46	Thinning
4	31	Thinning
5	54	Thinning
6	76	Thinning
7	51	Thinning
8	48	Thinning
9	57	Thinning
10	30	Thinning
11	37	Thinning
13	9	Clearcut
12	1	Right-of-way clearing – the Forest Service will mark
Total	534	

Please visit www.sustainableinc.org to download the marking specifications.

Direct questions to Sustainable Resources Institute, 1353 W HWY US 2, Suite 2, Crystal Falls, MI 49920; 906.875.3720; don@sustainableinc.org or kari@sustainableinc.org.

Bids are due December 1, 2017 at 12:00 p.m. CST

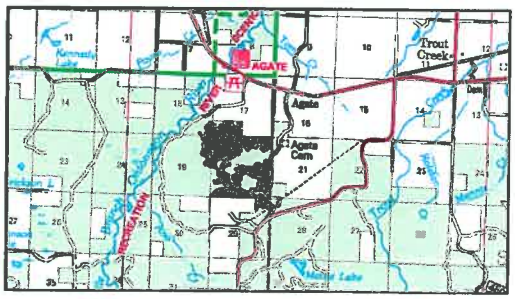


NORTHERN LIGHTS
Final PUs

N

0 0.25 0.5 1 Mile

- Decom
- New
- No Maint
- Other Jurisdiction
- Recon
- Use
- NON-FS



NORTHERN LIGHTS TIMBER SALE ESTABLISHMENT BIDDING SHEET

Due by: 12:00 PM CST Friday, December 1, 2017

Payment Unit	Est. Quantity (Acres)	Activity	Bid Price per Acre	Total Bid Price per Unit
1	48	Thinning		
2	47	Thinning		
3	46	Thinning		
4	31	Thinning		
5	54	Thinning		
6	76	Thinning		
7	51	Thinning		
8	48	Thinning		
9	57	Thinning		
10	30	Thinning		
11	37	Thinning		
13	9	Clearcut		
12	1	Right-of-way clearing – the Forest Service will mark		
Total	534			

BY 12:00 PM CST – DECEMBER 1, 2017 - SEND BIDS TO:

Sustainable Resources Institute, Inc.
Attn: Northern Lights Timber Sale Establishment
1353 W HWY US 2, Suite 2
Crystal Falls, MI 49920 *or*
(Fax) 906.875.3724 *or*
kari@sustainableinc.org

Signed by: _____ Printed Name: _____

Address: _____ Representing: _____

_____ Phone: _____

SRI reserves the right to reject any and/or all bids.

NORTHERN LIGHTS TIMBER SALE CRUISE DESIGN

Sale Number: 60248
Estimated Sale Value: $400,000.00
Estimated CV Ranges: 19-47%
Maximum Sampling Error: 10%
Cruise Method: Sample Tree (STR), Pre-Cruise Plots.
[Reference attached Minimum Tree and Piece Utilization Standards, dated 6/11/2008]

STRATA 1: Intermediate Thinning: Payment Units: 04, 05 & 06 (161 Acres). Payment Unit 12 R.O.W. (1 Dummy Acre) will be marked and cruised by USFS.

Sample Group	Species/Product (Unit)	DBH Range	Sample Interval
HS	Hardwood/Pulpwood (02) Small	5.0"-10.99"	1:200
HL	Hardwood/Pulpwood (02) Large	11.0" +	1:50
SS	Sugar Maple/Sawtimber (01) Small	11.0" – 15.99"	1:15
SL	Sugar Maple/Sawtimber (01) Large	16.0" +	1:5
OS	Other Hardwood/Sawtimber (01) Small*	11.0" – 15.99"	1:15
OL	Other Hardwood/Sawtimber (01) Large*	16.0" +	1:5
KS	Red Oak/Sawtimber (01) Small	11.0" – 17.99"	1:40
KL	Red Oak/Sawtimber (01) Large	18.0" +	1:20
A	Aspen Pulpwood (02)	5.0" +	1:10
CP	Mixed Conifer/Pulpwood (02)	5.0" +	1:10
CW	Spruce/Sawtimber (01)	9.0" +	1:1
PP	Red Pine Pulpwood (02)	5.0" +	1:10
PW	Red and White Pine Sawtimber (01)	9.0" +	1:5

Note: Cruise all Aspen and Balsam Fir as pulpwood. Mixed Conifer pulpwood includes Balsam Fir, Spruce, Tamarack, Cedar, White Pine, and Hemlock.

Note: Cruise all Jack Pine as Red Pine pulpwood.

*** Other Hardwood Sawtimber includes all Red Maple, Basswood, Black Cherry, Black & White Ash and Yellow & White Birch.**

Note: Sale should be marked with Green paint due to abundance of old Blue Boundary paint from previous sales in this area.

A random start should be used for each sample group at the start of marking in each payment unit. Select a random interval that is less than the required sample interval for the first tally in each sample group, thereafter, sample at the specified sample interval.

Maintain an accurate tree count by payment unit for each sample group. Original field records used for tracking tree counts must be with the tally cards or data recorder sheets when each unit is completed. Do not recopy field notes of tree counts or tally cards.

STRATA 2: Intermediate Thinning: Payment Units: 02, 07, 08, 09, 10 & 11 (270 Acres).

Sample Group	Species/Product (Unit)	DBH Range	Sample Interval
HS	Hardwood/Pulpwood (02) Small	5.0"-10.99"	1:300
HL	Hardwood/Pulpwood (02) Large	11.0" +	1:75
SS	Sugar Maple/Sawtimber (01) Small	11.0" – 15.99"	1:30
SL	Sugar Maple/Sawtimber (01) Large	16.0" +	1:20
OS	Other Hardwood/Sawtimber (01) Small*	11.0" – 15.99"	1:20
OL	Other Hardwood/Sawtimber (01) Large*	16.0" +	1:10
KS	Red Oak/Sawtimber (01) Small	11.0" – 17.99"	1:10
KL	Red Oak/Sawtimber (01) Large	18.0" +	1:5
A	Aspen Pulpwood (02)	5.0" +	1:10
CP	Mixed Conifer/Pulpwood (02)	5.0" +	1:10
CW	Spruce/Sawtimber (01)	9.0" +	1:1
PP	Red Pine Pulpwood (02)	5.0" +	1:10
PW	Red and White Pine Sawtimber (01)	9.0" +	1:5

Note: Cruise all Aspen and Balsam Fir as pulpwood. Mixed Conifer pulpwood includes Balsam Fir, Spruce, Tamarack, Cedar, White Pine, and Hemlock.

Note: Cruise all Jack Pine as Red Pine pulpwood.

*** Other Hardwood Sawtimber includes all Red Maple, Basswood, Black Cherry, Black & White Ash and Yellow & White Birch.**

Note: Sale should be marked with Green paint due to abundance of old Blue Boundary paint from previous sales in this area.

A random start should be used for each sample group at the start of marking in each payment unit. Select a random interval that is less than the required sample interval for the first tally in each sample group, thereafter, sample at the specified sample interval.

Maintain an accurate tree count by payment unit for each sample group. Original field records used for tracking tree counts must be with the tally cards or data recorder sheets when each unit is completed. Do not recopy field notes of tree counts or tally cards.

STRATA 3: Intermediate Thinning: Payment Units 01 and 03 (94 Acres) and Payment Unit 13 Clearcut with Retained (by species) Trees: Payment Unit 13 (9 Acres).

Sample Group	Species/Product (Unit)	DBH Range	Sample Interval
HP	Hardwood/Pulpwood (02)	5.0" +	1:10
A	Aspen Pulpwood (02)	5.0" +	1:25
CP	Conifer Pulpwood (02)	5.0" +	1:10
CW	Spruce/Sawtimber (01)	9.0" +	1:1
HW	Hardwood Sawtimber*	11.0 +	1:1
PP	Red Pine Pulpwood (02)	5.0" +	1:50
RS	Red Pine Sawtimber (01) Small	9.0" -11.99"	1:100
RL	Red Pine Sawtimber (01) Large	12.0" +	1:100

Note: Cruise all Aspen and Balsam Fir as pulpwood. Mixed Conifer pulpwood includes Balsam Fir, Spruce, Tamarack, Cedar, and Hemlock.

Note: Cruise all Jack Pine as Red Pine pulpwood.

***Hardwood Sawtimber includes all Sugar Maple, Red Maple, Basswood, Black Cherry, Red Oak, Black & White Ash and Yellow & White Birch.**

Note: Sale should be marked with Green paint due to abundance of old Blue Boundary paint from previous sales in this area.

A random start should be used for each sample group at the start of marking in each payment unit. Select a random interval that is less than the required sample interval for the first tally in each sample group, thereafter, sample at the specified sample interval.

Maintain an accurate tree count by payment unit for each sample group. Original field records used for tracking tree counts must be with the tally cards or data recorder sheets when each unit is completed. Do not recopy field notes of tree counts or tally cards.

Note: Oak is not to be marked or cruised in Payment Units 7 or 11.

P.U. #	Acres	Forest Type	Marking Method	Species
P.U. 01	48	02 9	CTM	All - Except**
P.U. 02	47	85 6	CTM	All - Except**
P.U. 03	46	02 6	CTM	All - Except**
P.U. 04	31	55 6	CTM	All - Except**
P.U. 05	54	55 6	CTM	All - Except**
P.U. 06	76	85/89 6	CTM	All - Except**
P.U. 07	51	89 6	CTM	All - Except**
P.U. 08	48	85 6	CTM	All - Except**
P.U. 09	57	85 6	CTM	All - Except**
P.U. 10	30	82 6	CTM	All - Except**
P.U. 11	37	85 6	CTM	All - Except**
P.U. 13	9	95 6	DBYSPP	Select
P.U. 12	1 (Dummy)	R.O.W.	CTM	All - Except**
	534	**Contract Acres**		
	535	**Total Sale Acres**		

****PUs: 01 & 03 - white pine and paper birch, unless needed for safe harvest operations**
****PUs: 02 & 09 - hemlock, cedar, and elm, unless needed for safe harvest operations**
****PUs: 04 & 05 - white/red pine, cedar, and elm, unless needed for safe harvest operations**
****PUs: 06, 08, & 10 - hemlock, cedar and elm, unless needed for safe harvest operations**
****PUs: 07 & 11 - hemlock, white/red pine, cedar, oak and elm, unless needed for safe harvest operations**

Cruise Design Prepared by: Craig Johnson, Forest Technician Date: 08/16/2017

Cruise Design Reviewed by: Paul Dashner, Forest Check Cruiser Date: 08/16/2017

Cruise Design Approved by: Theodore Frank, Silviculturalist Date: 08/16/2017

MINIMUM TREE AND PIECE UTILIZATION STANDARDS

		Minimum Tree Specifications	Minimum Piece Specifications		
SPECIES	**PRODUCT**	**DBH (inches)**	**Length (feet)**	**DIB (inches)**	**Minimum Net Scale in % of Gross**
Hardwoods (except aspen)	Sawlogs	11.0	8	9.6-11.5	95% [1/]
Hardwoods	Sawlogs	11.0	8	11.6+	50% [1/]
Softwood	Sawlogs	9.0	8	7.6	40
All Species	Pulpwood	5.0	8	4.0	70 and reasonably straight [2/]

[1/] In Timber Sale Contracts, all hardwood sawlogs will use 50% minimum net scale in gross %, due to limitations in TIM. Cruising will use 95% minimum net scale for small diameter logs (9.6 – 11.5 DIB).

[2/] Seventy percent applies to rot, voids, and char. Mechanical type defects such as sweep, crook, spider heart, and ring shake will not be considered.

Reasonably straight - When the true line of a minimum length piece does not deviate more than ½ the inside diameter of the small and plus two inches from a straight line drawn between the centers of the ends of a piece. The maximum deflection allowed is what will fit in a 20-inch cylinder.

A minimum tree must include at least one piece that meets minimum specifications.

** Product heights are now measured to the nearest foot. All heights are measured in feet from the ground on the high side of the stump.

1. **Conifers – measure total height (to the tip) in feet and the cruise program will calculate the 4" cut-off.**
2. **Hardwoods (includes Aspen) – measure the height in feet to the 4" top.**
3. **Sawtimber – cut-off point or "stoppers" will follow our regular practices. Measure sawtimber height in feet. Secondary product height will be measured as described in item 1 or 2 depending on the species.**
4. **Default dib's are already built into the equations;**
   Pulpwood = 4.0"
   Sawtimber = 9.6" (hardwood)
   = 7.6" (mixed conifers, pine)

5. On trees with a broken, dead, or deformed top, record the height to the point where the 4" top or the tip would have been if the tree were still growing normally, then record defect to account for the missing volume.

Ottawa National Forest

Northern Lights Timber Sale - Silvicultural Prescription-Marking Guides

SALE INFORMATION

SALE NAME: **Northern Lights TS** **DATE** 8/15/2017

SALE NUMBER 60248 NEPA DOCUMENT: Interior VMP

DISTRICT(S): Watersmeet DECIDING OFFICIAL: Norman E. Nass [7/6/2014]

PREPARED BY: Theodore J. Frank/Silviculturist

PAYMENT UNIT INFORMATION

Payment Unit/Stand Summary

PU	PU ACRES	Forest Type	Ave. DBH	Basal Area* [Ft²/Ac]	Cruise Method	Mark Method	Retain Trees	*REMARKS*
001	48	29	10	150	STR	CTM	N/A	
002	47	856	9	100	STR	CTM	N/A	
003	46	26	10	190	STR	CTM	N/A	
004	31	556	9	115	STR	CTM	N/A	
005	54	556	12	135	STR	CTM	N/A	
006	76	85/896	10	120	STR	CTM	N/A	*4220 [Commercial Thinning]*
007	51	896	10	100	STR	CTM	N/A	
008	48	856	9	120	STR	CTM	N/A	
009	57	856	9	110	STR	CTM	N/A	
010	30	826	10	150	STR	CTM	N/A	
011	37	856	9	90	STR	CTM	N/A	
013	9	956	8	100	STR	DBYSPP	N/A	*4113 [Clearcut]*
012	1				STR	CTM	N/A	*4270 [ROW Clearing]*

Total Sale Acres: 535

STEWARDSHIP AGREEMENT

CRUISE/MARK LEGEND: **Gray Shade – Marked by FS**

- **STR:** Sample Tree Cruising Method
- **PCMTRE:** Point Count Measure Tree Method (Variable)
- **CTM:** Cut-Tree marking on opposite sides of tree at eye-level with one (pulp) or two (saw) stump marks.
- **DxSpp:** Designation by Species. If STR, then marking shall occur on one side of the tree and generally no stump mark to demonstrate 100% count.
- **CTM/DxSpp:** STR only, incorporating both marking methods determined by species.
- **TBD; to be determined.**

FOREST TYPE LEGEND:

- **95:** Aspen and Aspen-Mix Conifer
- **89:** Mixed Hardwoods
- 85: Sugar Maple
- 82: Basswood/Hardwoods
- 55: Red Oak
- **2:** Red Pine

SIZE DENSITY LEGEND:

- 5: Poletimber – about 1/2 the acres in understocked condition.
- 6: Poletimber – over 70% of the acres fully- or overstocked
- 8: Sawtimber – .about 1/2 the acres are in understocked condition.
- 9: Sawtimber – over 70% of the acres fully- or overstocked.

SALE SUMMARY

The Northern Lights Timber Sale is located on the Watersmeet Ranger District. The project involves thinning and clearcut in multiple forest types. The sale is located approximately 8 miles east of Paulding, MI Bond Falls/Calderwood Road (see map).

DESIGN CRITERIA

- **Be aware of small, unmapped wetlands or drainways** nested within the unit and notify TMA and/or Forester. Look for signs of bed/bank along with plant species that are known to occupy wet sites.
    - Thinning treatments can extend up to the apparent bank of these areas, or ideally ending at the top of the slope while maintaining 70-80% cover.
    - Clearcut treatment requires a one-tree length buffer where the outside ½ tree length corridor maintains 50% crown cover; if not feasible, then buffer the entire tree length. Again, consider boundary placement at top of slope.
    - If these areas are found to be more extensive that could make logging/skidding problematic, notify COR and/or Silviculturist to determine if Resource Specialists are needed. Document these areas in "Notes to Sale Administrator" including a map of these unmapped riparian areas.
    - See riparian matrix for all direction pertaining to **mapped** aquatic features. REMEMBER: The apparent absence of a mapped riparian feature must be confirmed by Soils/Hydro.
- **Be aware of all slopes** and notify TMA and/or Forester for:
    - All slopes greater than 35%, and note the length of these slopes. Generally these sites should be excluded, but shorter lengths may support operations with established skid trails that need approval by sale administration personnel and ideally in consultation with a soil scientist on a case by case basis.
    - All slopes between 18% - 35%. These can support logging operations but should nevertheless be evaluated on a case by case basis by Forest Service personnel. If necessary, sale area layout may exclude these slopes within cutting units or areas will not be marked and is perfectly appropriate to contribute structural variety throughout the unit.
- Retain 2 to 3 wildlife trees/acre. Preferably, these will be live cavity trees, with large healthy crowns, and species that provide wildlife foods as well (e.g. oaks, yellow birch, black cherry, conifers), if they exist in the stand.
- All stick nests, sensitive plants and sightings or signs of TES or Regional Forester Sensitive animals and plants should be reported to COR immediately and then be reported to Silviculturist and project Biologist.
- Protection measures for newly discovered Threatened, Endangered, and Sensitive (TES) species (either by Purchaser or the Forest Service) will be promptly reported to the other party and the additional special measures for protection will be reviewed on a case-by-case basis and collaboratively developed by project's botanist and/or biologist and the Responsible Official; incorporating conservation strategies contained in approved recovery plans, conservation approaches, as well as the 2006 Forest Plan, and professional judgment.
- To preserve rock plant habitat, maintain existing shade on and around large boulders and rock outcrops, eight feet (approximately) in diameter and larger, implement a 75 foot no-cut zone during sale layout or marking. For areas of exposed (forest floor) rock larger than approximately 20 feet in diameter, implement a 75-foot (one tree length) no-cut zone from the perimeter during sale layout or marking (Forest Plan Guideline, page 2-33
- Any changes in the project (location, methods, etc.) must be reported to the Forest Archaeologist so that the affects to cultural resources can be reviewed.
- Regarding Design Criterion #37: There are no clearcut payment units adjacent to classified old growth. Compartment 20 Stand 8 was approved for clearcut harvest. The FSVeg data base indicated a significant aspen component that simply is not there and a result of faulty Silvex data gathering. Therefore the stand will be treated with single-tree selection.

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT: INTERIOR | **TIMBER SALE:** NORTHERN LIGHTS | **PUS:** 001 & 003

STAND INFORMATION											
Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA (FSVeg)
06	1-12	52	3.1a	1	72B/C; 73D	TM	2	500	1971	6	203
	1-13	8					2		1943	9	151
	1-18	84					2		1943	6	162

STAND DESCRIPTION

Red pine plantations with inclusions of hardwood and aspen. Last entry was in the late 1990's and established forwarding trails throughout most of unit 3 (except vary northern portion). Densities can greatly vary from 80-90 FT2 in hardwood/aspen areas to over 200 FT2 in areas of pure red pine. These stands are slowly converting to hardwood species such as sugar maple and some red oak.

PU 001

Dbh Range	Red Pine	Aspen	Red Oak	Sugar/Red Maple	Paper Birch	Cherry	Ironwood	Basswood	Spruce/Fir	Total BA
6"-10"	30	12	9	3	2	<1	<1	0	<1	56
12"-14"	70	9	1	2	2	0	0	<1	0	84
16"-18"	<1	1	<1	<1	<1	0	0	0	0	1
20"-22"	0	4	1	0	0	0	0	0	0	5
24"+	0	0	6	0	0	0	0	0	0	6
Total	100	26	17	5	4	0	0	0	0	152

PU 003

Dbh Range	Red Pine	Aspen	Red Oak	Sugar/Red Maple	Paper Birch	Cherry	Ironwood	Basswood	Spruce/Fir	Total BA
6"-10"	62	2	1	10	3	<1	2	0	<1	80
12"-14"	92	2	1	5	<1	0	0	0	0	100
16"-18"	2	1	<1	2	0	0	0	0	0	5
20"-22"	0	<1	<1	<1	0	0	0	0	0	0
24"+	0	0	3	1	0	0	0	0	0	4
Total	156	5	5	18	3	0	2	0	0	189

SHORT AND LONG TERM OBJECTIVES

- The short term objective is to reduce stand densities in these overstocked stands through primarily removing the suppressed, poor quality, and high risk trees. Long term is to maintain healthy and productive red pine stands with structural and compositional complexity.
- To provide for future sustainability and maintain a long-term source of timber products.
- Future harvests should be on a 12-15 year cutting cycle; 15 years after the next entry.
- Maintain and/or enhance the adaptation, resistance and resilience of the stand by reducing competition and improving vigor; thinning for quality development; and maintaining/enhance species diversity, where possible (specifically, hemlock, white pine, and oak regeneration) respectively in response to uncertainties in future climate.

DESIRED CONDITION OF PAYMENT UNITS

The desired future condition is to promote healthy, vigorous, and resilient red pine plantations that are fully utilizing the site and putting growth on the best quality stems, while supporting small inclusions of aspen/birch and the diversity of other species such as eastern white pine and northern red oak. Eventually, the expectation is that the plantations would develop a heterogeneous structure and composition.

REMARKS

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NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	001 & 003

MARKING GUIDE:		
Name of Treatment - COMMERCIAL THINNING	**Desired Residual BA: 90-100 ft^2 Ac**	**PU Acres: See Table**

NOTE: Most areas within units have existing skidding/forwarding corridors. Ensure these existing corridors are wide enough to accommodate skidding/forwarding activities; a general rule of thumb would be 12' wide and generally straight with gradual turns.Trails that serve as "*main skid trails*" can be 16' wide. In some areas, marking row(s) can also create forwarding corridors, or establishing corridors in perpendicular fashion if rows are indistinct or discontinuous.

- **Mostly Red Pine: Mark to 90-100 FT^2/Ac, or marking no more than 40% of initial basal area.**
- DO NOT MARK white pine, or paper birch in a manner that will not interfere with safe harvest operation. These retained trees will enhance vertical diversity and maintain or create potential wildlife snags, mast, dens and perch trees.
- The main objective will be to favor the best red pine crop trees, but also improving the growing space by reducing stand density. Crop trees should exhibit the following criteria:
  - Live Crown Ratio >30%.
  - Dominant or co-dominant trees w/ good crown vigor and stem quality
  - Low risk of mortality or failure [e.g. main stem breakage].

Marking Criteria:

1. Retain most non-red pine species in areas where red pine densities are high – accept some risk and/or poor quality in non-red pine species; this will contribute to structural/habitat diversity objectives for the stand.
2. Mark all high risk and poor vigor red pine; consider most red pine with crown decline as low vigor.
3. Thin from below; red pine crop trees will typically be the most competitive stems and will be in the larger diameter classes, therefore most red pine in the pole-sized classes should be marked in most cases.
4. If density still above desired then mark red pine within the small and larger sawtimber category that exhibit sweep, crook and forks within the merchantable bole.
5. If density still above desired then mark red pine to improve the relative spacing; provide about 12-15 foot spacing.
6. **Mix of Red Pine/Hwds/Aspen: These units becomes a mixed stand to the west. Mark hardwood inclusions in the same manner to about 70 FT2; favoring red oak, yellow birch, basswood, and pine species. In some of these areas it would be acceptable to retain young, healthy aspen to hold stocking, otherwise mark most aspen.**

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx				
Year	Facts Activity Code	Description		
2018-2019	4220	Commercial Thinning	XXXX	N/A
2033-2034	4220	Commercial Thinning	XXXX	N/A

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT: INTERIOR | **TIMBER SALE:** NORTHERN LIGHTS | **PUS:** 002 & 009

STAND INFORMATION

Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA (FSVeg)
06	1-1	188	3.1a	1	72B/C; 73D/E; 186C	TM	89	500	1930s	6	107
	1-9	59					85			6	137
	1-10	52					85			6	106
	1-11	19					89			6	117
	1-17	48					85			6	112

STAND DESCRIPTION

The units consist of predominantly sugar maple stands with small amounts of other hardwood species usually occurring in scattered distribution; red oak the only species that can form small concentrations. Quality can greatly vary from pockets of trees where most are unacceptable growing stock to trees with impressive quality and height. The red oak component is typically large sawtimber-sized and occurring in multiple stem clumps. The yellow birch quality is marginal at best. Regeneration is mostly sugar maple with some red oak; advanced regeneration mostly ironwood.

PU 002

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	Cherry	Ironwood	Yellow Birch	Spruce/Fir	Total BA
6"-10"	50	10	<1	0	0	<1	1	0	<1	61
12"-14"	24	2	1	<1	1	0	0	0	0	28
16"-18"	1	<1	<1	<1	1	0	0	1	0	3
20"-22"	<1	3	0	0	0	0	0	0	0	3
24"+	0	2	0	0	0	0	0	1	0	3
Total	75	17	1	<1	2	0	1	2	0	98

PU 009

Dbh Range	Sugar/Red Maple Maple	Red Oak	Red Maple	Red Pine	Aspen	Hemlock	Ironwood	Yellow Birch	Spruce/Fir	Total BA
6"-10"	44	1	2	3	6	0	2	2	<1	60
12"-14"	25	<1	1	1	1	0	<1	1	0	29
16"-18"	2	2	0	0	0	0	0	5	0	9
20"-22"	0	1	0	0	0	0	0	2	0	3
24"+	0	6	0	0	0	<1	0	1	0	7
Total	71	10	3	4	7	0	2	11	0	108

REMARKS

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NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	002 & 009

MARKING GUIDE:

Name of Treatment - COMMERCIAL THINNING	Desired Residual BA: 75 ft^2 Ac	PU Acres: See Table

Mark between 70-80 FT^2/Ac, but can vary depending on size/structure. Avoid reducing basal area below 50 FT^2/Ac, however this may occur at times within lower stocked areas needing removal of risk trees, releasing red oak, and/or improve the relative spacing where crowns are touching.

- DO NOT MARK HEMLOCK, CEDAR, OR ELM unless needed for harvest operations.
  - Generally follow the order of removal for marking trees until desired-residual BA is met
    1. Risk: Remove most high risk trees that are likely to die between cutting cycles (assume 15 years). Consider as high risk most mature aspen, ironwood, red maple with defects, and unhealthy paper birch; in addition to all merchantable-sized balsam fir and white spruce.
    2. Provide a 50 foot radius release from bole of tree around most healthy, dominant red oak. This may result in other less dominant oak being marked that fall in the radius.
    3. Release Crop Trees: Remove 1-2 poorer quality competitors to encourage crown development of dominant and co-dominant species.
    4. Vigor: Most times are the trees in suppressed and intermediate crown position.
    5. Form & Quality: Remove poorly formed stems, based on usable/potential log length; in addition trees with noticeable defects (seams, sweep, cankers, low forks, etc.).
    6. Spacing: Look for closely-spaced trees and areas where crowns are overlapping or near-touching and mark tree(s) that would provide uniform
    7. Desirable Species: Generally favor (in order) white pine, red oak, yellow birch over all other species accepting some marginal quality in yellow birch; if near equal quality, favor basswood over sugar & red maple.

SHORT AND LONG TERM OBJECTIVES

- The short term objective is to improve stand health and quality via crop tree marking principles while providing better growing space and capturing eventual mortality to improve overall volume growth and add one more cycle of volume growth to high value trees.
- Favor mid-tolerant species and improve conditions for regeneration by retaining seed source and applying even-aged system.
- Maintain and/or enhance the adaptation, resistance and resilience of the stand by reducing competition and improving vigor; thinning for quality development; and maintaining/enhance species diversity, where possible (specifically, hemlock, white pine, and oak regeneration) respectively in response to uncertainties in future climate.

DESIRED CONDITION OF PAYMENT UNITS

A stand of dominant, well-spaced hardwood stand with significant representation of mid-tolerant species overtopping an understory of mid-tolerant species; mid-tolerant species will have better abundance and distribution but will also have abundant sugar maple and ironwood too. This stand will have a strong two-aged condition that would support either an overstory removal or shelterwood treatment next entry.

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx

Year	Facts Activity Code	Description		
2018-2019	4220	Commercial Thinning	XXXX	N/A
2033-2034	4143	Overstory Removal	XXXX	N/A

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT: INTERIOR | **TIMBER SALE:** NORTHERN LIGHTS | **PUS:** 004 & 005

STAND INFORMATION

Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA (FSVeg)
06	1-1	188	3.1a	1	72B/C; 73D/E; 186C	TM	89	500	1930s	6	107
	1-9	59					85			6	137
	1-10	52					85			6	106
	1-11	19					89			6	117
	1-17	48					85			6	112

STAND DESCRIPTION

The units consist of predominantly sugar maple stands with small amounts of other hardwood species usually occurring in scattered distribution; red oak the only species that can form small concentrations. Quality can greatly vary from pockets of trees where most are unacceptable growing stock to trees with impressive quality and height. The red oak component is typically large sawtimber-sized and occurring in multiple stem clumps. The yellow birch quality is marginal at best. Regeneration is mostly sugar maple with some red oak; advanced regeneration mostly ironwood.

PU 004

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	Cherry	Ironwood	Yellow Birch	Spruce/Fir	Total BA
6"-10"	42	<1	12	0	0	<1	<1	5	<1	59
12"-14"	10	2	6	<1	<1	0	0	<1	0	18
16"-18"	<1	12	<1	<1	0	0	0	<1	0	12
20"-22"	0	10	0	0	0	0	0	<1	0	10
24"+	0	14	0	0	0	0	0	1	0	15
Total	**48**	**38**	**18**	<1	**0**	**0**	**0**	**6**	**0**	**114**

PU 005

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	Hemlock	Ironwood	Yellow Birch	Spruce/Fir	Total BA
6"-10"	11	<1	4	0	0	<1	<1	1	3	19
12"-14"	1	7	3	0	<1	1	0	3	0	15
16"-18"	4	33	<1	<1	0	4	0	7	0	48
20"-22"	0	29	0	0	0	2	0	3	0	34
24"+	0	14	0	0	0	3	0	0	0	17
Total	**16**	**83**	7	**0**	**0**	**10**	**0**	**17**	3	**133**

REMARKS

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NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	004 & 005

MARKING GUIDE:		
Name of Treatment - COMMERCIAL THINNING	**Desired Residual BA: 85 ft^2 Ac**	**PU Acres: See Table**

Mark between 80-90FT^2/Ac, but can vary depending on size/structure. Avoid reducing basal area below 60 FT^2/Ac, however this may occur at times within lower stocked areas needing removal of risk trees, releasing red oak, and/or improve the relative spacing where crowns are touching.

- **DO NOT MARK HEMLOCK, WHITE/RED PINE, CEDAR, or ELM** unless needed for harvest operations.
  - Generally follow the order of removal for marking trees until desired-residual BA is met
    1. Risk: Remove most high risk trees that are likely to die between cutting cycles (assume 15 years). Consider as high risk most mature aspen, ironwood, red maple with defects, and unhealthy paper birch; in addition to all merchantable-sized balsam fir and white spruce.
       Release Crop Trees: Remove 1-2 poorer quality competitors to encourage crown development of dominant and co-dominant species. Favor red oak over all other trees in most cases, but some oak will need to be marked to release other, better quality oak.
    2. Vigor: Most times are the trees in suppressed and intermediate crown position.
    3. Form & Quality: Remove poorly formed stems, based on usable/potential log length; in addition trees with noticeable defects (seams, sweep, cankers, low forks, etc.). Consider stump origin red oak that grow at >20% angle as poor form.
    4. Spacing: Look for closely-spaced trees and areas where crowns are overlapping or near-touching and mark tree(s) that would provide more uniform spacing. When marking within areas of oak, at times a "*mark all or none*" approach should be considered with multiple stem, stump origin trees. Single trees may be marked from these groups but should have at least 2" separation between stems lower than breast height.
    5. Desirable Species: Generally favor (in order) red oak, yellow birch over all other species accepting some marginal quality in yellow birch; if near equal quality, favor basswood over sugar & red maple.

SHORT AND LONG TERM OBJECTIVES

- The short term objective is to improve stand health and quality via crop tree marking principles while providing better growing space and capturing eventual mortality to improve overall volume growth and add one more cycle of volume growth to high value trees.
- Favor mid-tolerant species and improve conditions for regeneration by retaining seed source and applying even-aged system.
- Maintain and/or enhance the adaptation, resistance and resilience of the stand by reducing competition and improving vigor; thinning for quality development; and maintaining/enhance species diversity, where possible (specifically, hemlock, white pine, and oak regeneration) respectively in response to uncertainties in future climate.

DESIRED CONDITION OF PAYMENT UNITS

A stand of dominant, well-spaced hardwood stand with significant representation of mid-tolerant species overtopping an understory of mid-tolerant species; mid-tolerant species will have better abundance and distribution but will also have abundant sugar maple and ironwood too. This stand will have a strong two-aged condition that would support either an overstory removal or shelterwood treatment next entry.

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx

Year	Facts Activity Code	Description		
2018-2019	4220	Commercial Thinning	XXXX	N/A
2033-2034	4143	Overstory Removal	XXXX	N/A

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT: INTERIOR | **TIMBER SALE:** NORTHERN LIGHTS | **PUS:** 006, 008 & 010

STAND INFORMATION

Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA (FSVeg)
06	1-1	188	3.1a	1	72B/C; 73D/E; 186C	TM	89	500	1930s	6	107
	1-9	59					85			6	137
	1-10	52					85			6	106
	1-11	19					89			6	117
	1-17	48					85			6	112

STAND DESCRIPTION

The units consist of predominantly sugar maple stands with small amounts of other hardwood species usually occurring in scattered distribution; red oak the only species that can form small concentrations. Quality can greatly vary from pockets of trees where most are unacceptable growing stock to trees with impressive quality and height. The red oak component is typically large sawtimber-sized and occurring in multiple stem clumps. The yellow birch quality is marginal at best. Regeneration is mostly sugar maple with some red oak; advanced regeneration mostly ironwood.

PU 006

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	White Pine	Ironwood	Yellow/Paper Birch	Spruce/ Fir	Total BA
6"-10"	36	<1	3	0	0	0	<1	0	<1	39
12"-14"	28	11	3	0	1	<1	0	1	0	44
16"-18"	3	13	1	<1	0	0	0	1	0	18
20"-22"	1	5	1	0	0	4	0	0	0	11
24"+	0	8	0	0	0	3	0	0	0	11
Total	68	37	8	0	1	7	0	2	<1	123

PU 008

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	White Pine	Ironwood	Yellow/Paper Birch	Spruce/ Fir	Total BA
6"-10"	55	<1	2	0	0	0	2	0	<1	59
12"-14"	23	<1	4	0	<1	0	0	1	0	28
16"-18"	9	3	1	<1	0	0	0	0	0	13
20"-22"	0	10	1	0	0	0	0	0	0	11
24"+	0	10	0	0	0	0	0	0	0	10
Total	87	23	8	0	0	0	2	1	0	121

PU 010

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	White Pine	Ironwood	Yellow/Paper Birch	Spruce/Fir	Total BA
6"-10"	32	0	<1	12	0	0	4	0	<1	48
12"-14"	20	0	0	38	0	0	0	0	0	58
16"-18"	3	<1	5	22	<1	0	0	<1	0	30
20"-22"	0	0	2	8	0	0	0	0	0	10
24"+	0	0	0	2	0	0	0	0	0	2
Total	55	0	7	82	0	0	4	0	0	148

NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	006, 008 & 010

MARKING GUIDE:

Name of Treatment - COMMERCIAL THINNING	Desired Residual BA: 80 ft^2 Ac	PU Acres: See Table

Mark between 70-80 FT^2/Ac, but can vary depending on size/structure. It would be acceptable to have areas of 90-100 FT^2/Ac in areas of basswood concentrations as long as the marking criteria (below) is met. Avoid reducing basal area below 50 FT^2/Ac, however this may occur at times within lower stocked areas needing removal of risk trees, releasing red oak, and/or improve the relative spacing where crowns are touching.

- **DO NOT MARK HEMLOCK, CEDAR, OR ELM** unless needed for harvest operations.
  - Generally follow the order of removal for marking trees until desired-residual BA is met
    1. Risk: Remove most high risk trees that are likely to die between cutting cycles (assume 15 years). Consider as high risk most mature aspen, ironwood, red maple with defects, and unhealthy paper birch; in addition to all merchantable-sized balsam fir and white spruce.
    2. Release Crop Trees: Remove 1-2 poorer quality competitors to encourage crown development of dominant and co-dominant species. Favor white pine, and then red oak over all other species. However some white pine and oak will need to be marked to release better quality tree white pine and oak.
    3. Vigor: Most times are the trees in suppressed and intermediate crown position.
    4. Form & Quality: Remove poorly formed stems, based on usable/potential log length; in addition trees with noticeable defects (seams, sweep, cankers, low forks, etc.).
    5. Spacing: Look for closely-spaced trees and areas where crowns are overlapping or near-touching and mark tree(s) that would provide uniform
    6. Desirable Species: Generally favor (in order) white pine, red oak, yellow birch over all other species accepting some marginal quality in yellow birch; if near equal quality, favor basswood over sugar & red maple.

SHORT AND LONG TERM OBJECTIVES

- The short term objective is to improve stand health and quality via crop tree marking principles while providing better growing space and capturing eventual mortality to improve overall volume growth and add one more cycle of volume growth to high value trees.
- Favor mid-tolerant species and improve conditions for regeneration by retaining seed source and applying even-aged system.
- Maintain and/or enhance the adaptation, resistance and resilience of the stand by reducing competition and improving vigor; thinning for quality development; and maintaining/enhance species diversity, where possible (specifically, hemlock, white pine, and oak regeneration) respectively in response to uncertainties in future climate.

DESIRED CONDITION OF PAYMENT UNITS

A stand of dominant, well-spaced hardwood stand with significant representation of mid-tolerant species overtopping an understory of mid-tolerant species; mid-tolerant species will have better abundance and distribution but will also have abundant sugar maple and ironwood too. This stand will have a strong two-aged condition that would support either an overstory removal or shelterwood treatment next entry.

REMARKS

-

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx

Year	Facts Activity Code	Description		
2018-2019	4220	Commercial Thinning	XXXX	N/A
2033-2034	4143	Overstory Removal	XXXX	N/A

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT: INTERIOR | **TIMBER SALE:** NORTHERN LIGHTS | **PUS:** 007 & 011

STAND INFORMATION

Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA (FSVeg)
06	1-1	188	3.1a	1	72B/C; 73D/E; 186C	TM	89	500	1930s	6	107
	1-9	59					85			6	137
	1-10	52					85			6	106
	1-11	19					89			6	117
	1-17	48					85			6	112

STAND DESCRIPTION

The units consist of predominantly sugar maple stands with small amounts of other hardwood species usually occurring in scattered distribution; red oak the only species that can form small concentrations. Quality can greatly vary from pockets of trees where most are unacceptable growing stock to trees with impressive quality and height. The red oak component is typically large sawtimber-sized and occurring in multiple stem clumps. The yellow birch quality is marginal at best. Regeneration is mostly sugar maple with some red oak; advanced regeneration mostly ironwood.

PU 007

Dbh Range	Sugar Maple	Red Oak	Hemlock	Basswood	Aspen	White Pine	Ironwood	Yellow/Paper Birch	Spruce/Fir	Total BA
6"-10"	25	<1	1	0	0	0	<1	0	<1	26
12"-14"	47	<1	0	4	<1	0	0	<1	0	51
16"-18"	9	<1	0	3	2	0	0	1	0	15
20"-22"	2	<1	<1	0	1	1	0	<1	0	4
24"+	0	2	0	0	0	1	0	0	0	3
Total	**83**	**2**	1	7	**3**	**2**	**0**	**1**	0	99

PU 011

Dbh Range	Sugar Maple	Red Oak	Red Maple	Basswood	Aspen	Red Maple	Ironwood	Yellow Birch	Spruce/Fir	Total BA
6"-10"	33	3	1	<1	0	1	1	1	<1	40
12"-14"	21	0	1	11	0	1	0	2	0	36
16"-18"	2	<1	0	7	<1	0	0	2	0	11
20"-22"	1	<1	0	<1	0	0	0	1	0	2
24"+	0	1	0	0	0	0	0	0	0	1
Total	**57**	**4**	2	18	**0**	2	1	**6**	0	90

REMARKS

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NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	007 & 011

MARKING GUIDE:		
Name of Treatment - COMMERCIAL THINNING	**Desired Residual BA: 70 ft^2 Ac**	**PU Acres: See Table**

These units vary from densely stocked to desired BA levels. Therefore mark between 60-80 FT^2/Ac; sometimes only marking high risk trees and improving some spacing in lower stocked areas. Avoid reducing basal area below 50 FT^2/Ac, though this may occur in areas of releasing oak.

- **DO NOT MARK HEMLOCK, WHITE/RED PINE, CEDAR, OAK OR ELM** unless needed for harvest operations.
  - Generally follow the order of removal for marking trees until desired-residual BA is met
    1. Risk: Remove most high risk trees that are likely to die between cutting cycles (assume 15 years). Consider as high risk most mature aspen, ironwood, red maple with defects, and unhealthy paper birch; in addition to all merchantable-sized balsam fir and white spruce.
    2. Provide a 50 foot radius release from bole of tree around most healthy, dominant red oak. This may result in other less dominant oak being marked that fall in the radius.
    3. Release Crop Trees: Remove 1-2 poorer quality competitors to encourage crown development of dominant and co-dominant species.
    4. Vigor: Most times are the trees in suppressed and intermediate crown position.
    5. Form & Quality: Remove poorly formed stems, based on usable/potential log length; in addition trees with noticeable defects (seams, sweep, cankers, low forks, etc.).
    6. Spacing: Look for closely-spaced trees and areas where crowns are overlapping or near-touching and mark tree(s) that would provide uniform
    7. Desirable Species: Generally favor (in order) red oak, yellow birch over all other species accepting some marginal quality in yellow birch; if near equal quality, favor basswood over sugar & red maple.

SHORT AND LONG TERM OBJECTIVES

- The short term objective is to improve stand health and quality via crop tree marking principles while providing better growing space and capturing eventual mortality to improve overall volume growth and add one more cycle of volume growth to high value trees.
- Favor mid-tolerant species and improve conditions for regeneration by retaining seed source and applying even-aged system.
- Maintain and/or enhance the adaptation, resistance and resilience of the stand by reducing competition and improving vigor; thinning for quality development; and maintaining/enhance species diversity, where possible (specifically, hemlock, white pine, and oak regeneration) respectively in response to uncertainties in future climate.

DESIRED CONDITION OF PAYMENT UNITS

A stand of dominant, well-spaced hardwood stand with significant representation of mid-tolerant species overtopping an understory of mid-tolerant species; mid-tolerant species will have better abundance and distribution but will also have abundant sugar maple and ironwood too. This stand will have a strong two-aged condition that would support either an overstory removal or shelterwood treatment next entry.

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx

Year	Facts Activity Code	Description		
2018-2019	4220	Commercial Thinning	XXXX	N/A
2033-2034	4143	Overstory Removal	XXXX	N/A

OTTAWA NATIONAL FOREST
SILVICULTURAL PRESCRIPTION / MARKING GUIDES

NEPA DECISION DOCUMENT:	INTERIOR	TIMBER SALE:	NORTHERN LIGHTS	PUS:	013

STAND INFORMATION

Ranger District	Comp-Stand	Acres	MA	LTA	ELTP	Habitat Type	Cover Type	LSC	Year of Origin	Size Density	Total BA
	20-8	173	3.1a	2	39B	AVO	89		1930	6	120

STAND DESCRIPTION

Overmature aspen inclusion large enough to make into a stand. There is some hardwoods in the mix along with some conifer. Apparently this was excluded from the last harvest as visual screening along the Choate Road. Basal area can be as high as 140-150 and is a mix of big-tooth and trembling aspen.

SHORT AND LONG TERM OBJECTIVES

- Apply silvicultural treatment to best capture carbohydrate reserves and effectively regenerate aspen before opportunity is lost.
- Change the growing space to accommodate intolerant species and capture mortality by removing diseased and poor formed trees.
- Retain remnant long-lived conifer that healthy and tolerate the changing environment.
- Accept that native pathogens occur in retained trees to provide unique habitat niches for cavity nesting birds, insects, and mammals.
- Attention is given to maintaining ecological processes and functions in and around riparian areas where they occur in the sale area.
- Strike a balance between ecological considerations and providing for improved resistance and resilience for uncertain future climate. This should also include timely rotations between harvests to avoid stand becoming overmature and regressing in ability to regenerate.
- Acceptable stocking would achieve approximately 5000-6000 seedlings per acre for native species.

DESIRED CONDITION OF PAYMENT UNITS

An even-aged aspen stand that is growing vigorously, free of suppression and differentiating mainly through competition. The canopy should be singular with some breaks due to small inclusions of failed response and larger remnant trees (mostly white pine) occupying a larger growing space. Hardwood and conifer species are still present but are subordinate to a near dominated aspen overstory. The stand should be growing at about one-half cord per acre per year.

MARKING GUIDE:

Name of Treatment - Clearcut	Desired Residual BA: see below	PU Acres: 9

RETAIN ALL: HEMLOCK, WHITE PINE, OAK AND ELM. However, this is a small unit, do not allow this component to dominate unit.

- **Mark/Cruise** all aspen, spruce species; balsam fir, red pine, jack pine, and hardwood species to prepare the area for the regeneration of a new stand (See Cruise design for specifications).

POST HARVEST SURVEYS AND TREATMENTS

FACTS Code	Name of Treatment	Prescription
4341	Stocking Survey 1st Year	Assess existing regeneration and take some 1/300th acre plots (6.8 feet radius) to see where the stand is for 3000 TPA for uneven-aged hardwood levels at 70% plots stocked with at least 10 seedlings of acceptable species (but note ironwood too).
4493	Site Prep Other	Cut/fell all sub-merchantable-sized stems to allow for competitions free growing space for aspen regeneration.
4341	Stocking Survey 3rd Year	Conduct 3rd year survey same as above; ensure samples have equal representation within gap and non-gap areas. Provide an estimate of acres within gaps and matrix to adequately reflect representation. Provide observations on sedge and raspberry component.
4382	Certification	For a stand to be fully stocked at least 70% of the plots should be stocked with 3000 trees per acre of acceptable growing stock trees. In addition, no more than 20% of the plots should be non-stocked (FSH 2409.17 2.31)

ACTIVITIES SUMMARY FOR ALL PAYMENT UNITS WITHIN THIS Rx

Year	Facts Activity Code	Description		
2018	4113	Clearcut	XXXX	N/A
2019	4341	Stocking survey	CWKV	$6.00
2019	4493	Aspen Site Prep		
2021	4341	Stocking Survey	CWKV	$6.00
2021	4381	Certification	CWKV	$3.00
2068	4113	Clearcut	XXXX	N/A

APROVAL

PRPARED BY:	Theodore J. Frank	**DATE:**	08/15/2017
TITLE:	Forester – Bessemer RD		
APPROVED BY:	/s/ ***Theodore J. Frank***	**DATE:**	08/15/2017
TITLE:	Certified Silviculturist		
REVIEWED BY:		**DATE:**	
TITLE:			

LAKE STATES ACQUISITION TEAM

BASIC ORDERING AGREEMENT # AG-569R-BOA-14-0001

TIMBER MARKING AND VOLUME ESTIMATION ON THE OTTAWA NATIONAL FOREST

Period of BOA
January 24, 2014 through January 23, 2019
Updated March 2017

Issued
January 24, 2014

Contracting Officer: Annette C. Caliguri
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Gladstone, MI 49837
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SECTION B – SUPPLIES OR SERVICES

This is a Basic Ordering Agreements (BOA) with those parties determined to be qualified to perform the services identified in Section C. As stipulated in Federal Acquisition Regulation (FAR) 16.703, the BOA will not be considered a contract.

When a future project is identified, a project-specific RFQ will be issued to all parties listed on the BOA. Maps, marking/cruising prescriptions, and any site-specific information for the particular areas will be included in the RFQ. Optional data requirements and/or any modifications to the BOA will also be outlined in the RFQ. Those parties who are available and interested in the specific project may submit quotes, including pricing and any other pertinent information. Contracts will be awarded based on the best value to the Government. Award may not necessarily be made to the lowest quote or for technical capabilities that would appear to exceed those needed for successful performance of the work. The Government reserves the right to make cost/technical trade-offs that are in the best interest and most advantageous to the Government.

The BOA will be incorporated by reference into future contracts, with the same force and affect as if included in full text. Terms such as "contract" and "contractor" are used here to be applicable when this BOA is incorporated into those future contracts.

GOVERNMENT ADMINISTRATIVE CONTRACTING OFFICE:

USDA FOREST SERVICE
LAKE STATES ACQUISITION TEAM
ANNETTE CALIGURI, CONTRACTING OFFICER
820 RAINS DRIVE
GLADSTONE, MI 49837
(906) 428-5842

SECTION C - DESCRIPTION/SPECIFICATION/WORK STATEMENT

452.211-72 Statement of Work/Specifications. (FEB 1988)
The Contractor shall furnish the necessary personnel, material, equipment, services and facilities (except as otherwise specified), to perform the Statement of Work/Specifications below and referenced in Section J.
(End of Clause)

452.211-73 Attachments to Statements of Work/Specifications. (FEB 1988)
The attachments to the Statement of Work/Specifications listed in Section J are hereby made part of this solicitation and any resultant contract.
(End of Clause)

PROJECT-SPECIFIC RFQs WILL BETTER CLARIFY THIS SECTION FOR EACH INDIVIDUAL CONTRACT ISSUED UNDER THIS BOA. REQUIREMENTS STATED IN THIS SECTION MAY DIFFER SLIGHTLY UNDER EACH PROJECT-SPECIFIC RFQ, BUT TYPICAL WORK CAN BE EXPECTED TO CONSIST OF THE FOLLOWING:

C.1 SCOPE OF CONTRACT

(a) This BOA calls for the layout, marking, and/or volume estimation of timber sales on the Ottawa National Forest. Timber sales contain separate payment units (10-20 per sale of about 20-50 acres in size each on average).

(b) The Contractor shall furnish all labor, materials, equipment, tools, instruments, supplies, transportation, professional services and supervision EXCEPT that which is designated in the Government Furnished Property clause.

C.2 LOCATIONS AND DESCRIPTIONS

(a) Project areas will be on the Ottawa National Forest and may be located on the Bergland, Bessemer, Kenton, Iron River, Ontonagon, and Watersmeet Ranger Districts. These Districts are located in the Michigan Counties of: Baraga, Iron, Gogebic, Houghton, and Ontonagon.

(b) Any one or a combination of the following types of harvests, cruising systems, layout, and remarking may be included in future projects. Site specific prescriptions providing further detail will be provided for those projects. Specific methodology and standards for the Technical Requirements to accomplish the GENERAL descriptions given below are defined elsewhere in this Contract.

(c) Keep in mind how the tree will be felled, which will require access for equipment and drop zones for larger trees to avoid damage to residual trees during logging. Marking objectives include establishing skid trails prior to thinning to the desired residual basal area and spacing

guidelines between trails, which may result in the target basal area being achieved. There may be scattered inclusions of small, poorly drained pockets, seeps, steep slopes, perched water tables, or shallow bedrock areas; do not designate any trees for removal in these areas unless specifically identified in the prescriptions.

MARKING AND CRUISING DESCRIPTIONS

(1) HARDWOOD SELECTION, IMPROVEMENT, THINNING (Marking & Cruising)

Uneven aged stands or even-aged stands with uneven-aged or even-aged objectives consisting of a mixture of Northern Hardwood types of various size classes. These stands contain both pulpwood and sawtimber Species/Product/Unit mixes. Marking objectives are to remove trees considered high risk, defective, poor form, or mature and to maintain or develop size class structure with optimum growing stock, per the specific marking instructions.

(2) PINE AND SPRUCE THINNING (even-age) (Marking & Cruising)

These stands are second and third entries, and generally are heavier to sawtimber-sized trees. The objectives are to remove high risk trees and thin the remainder of the stand to the desired residual basal area and spacing specifications. Skid trails are generally in place from previous harvest. When applicable and at the discretion of the COR, marking objectives include establishing skid trails prior to thinning to the desired residual basal area and spacing guidelines between trails.

(3) PINE AND SPRUCE THINNING (even-age, 1st Thinning) (Marking & Cruising)

First thinning's in pine and spruce stands. These stands consist of a higher basal area of pole-sized trees, and are predominately uniform plantations. Some stands may contain damage from disease or insects. Stands that have not been on "regular entry cycle for thinning" could also include a sawtimber-sized component. Marking objectives include establishing skid trails prior to thinning to the desired residual basal area and spacing guidelines between trails.

(4) WHITE PINE THINNING – (Marking & Cruising)

These stands are mixtures of white pine, mixed conifer, aspen and hardwood species. Some stands may contain damage from disease or insects. The objectives are to remove high risk, disease or insect infected trees and undesirable tree species while maintaining a residual stand of healthy trees. Residual basal areas in these stands may vary along with the species composition.

(5) SHELTERWOOD/SEED CUT/OVERSTORY REMOVAL CUT (Marking & Cruising)

Treatments may be applied to hardwood, aspen, pine and mixed conifer stands. Some of which may be high risk trees and contain undesirable species prescribed for removal. The objective is to

remove or reduce the overstory competition and regenerate or release stocked stands with desirable species.

(6) CLEARCUT/REMOVAL CUT (Marking & Cruising - where all trees are counted)

Generally in a clearcut or removal cut, where all LIVE and/or DEAD trees that meet minimum specifications for size or species are designated for removal EXCEPT for trees marked as RESERVE TREES, LEAVE TREES or trees within PROTECTED AREAS.

In Payment Units where designated Species are too variable for Area Estimate Cruising methods, trees designated for removal will be marked with a paint spot at eye level to verify the tree was counted – a stump mark is not generally required.

(7) LEAVE TREE MARKING (LTM) - (MARKING ONLY)

Trees that are marked will be left uncut in the stand after harvest operations are complete. Each tree to be left will be ringed/banded at eye-level with paint and a corresponding stump mark. Leave Tree Marking would generally occur in Payment Units where a greater number of merchantable trees are included for removal than will remain as residual.

(8) SAMPLE TREE CRUISING METHOD

The Sample Tree cruising method (STR) involves measuring a specified proportion (Sample Interval) of trees in the defined sub-population. The remaining trees included for removal are tallied as count trees. With this cruising method, every tree included for removal must be visited and marked.

(9) VARIABLE PLOT CRUISING (CRUISING ONLY)

The Contractor will establish variable plots and cruise volume with a 5, 10, or 20 Basal Area Factor (BAF) prism in units to be clearcut, species designated units (DxSPP) or Leave Tree Marked units. This method could be Point Cruising (every tree on the point is measured) or Point Count Measure (not all of the trees on the point are measured, but all are counted). Generally, plots are systematically distributed at the rate of approximately one plot per two acres or as specified in the cruise design (higher or lower intensity). Variable plot cruises may be used on Leave Tree Marking Payment Units or even-aged, uniform stands of aspen, hardwoods and pine.

For CLEARCUT/REMOVAL CUT Payment Units where volume is cruised using Variable Plot these trees will not be marked with paint (EXCEPT for cruise trees on plots/points).

(10) FIXED PLOT CRUISING (CRUISING ONLY)

The Contractor will establish fixed size plots (uniform circle of a fixed radius, generally 1/10th or 1/20th acre in size) in which all trees included for removal will be measured. This cruising method may be used in salvage situations associated with storm events; or, in stands containing a biomass component. Plots are uniformly distributed across the defined area per the Cruise Design.

For CLEARCUT/REMOVAL CUT Payment Units where volume is cruised using Fixed Plot these trees will not be marked with paint (EXCEPT for cruise trees on plots/points).

(11) LAYOUT TIMBER SALE UNIT BOUNDARIES

Layout includes painting Payment Unit and sale boundaries at eye-level, with corresponding stump marks on predetermined Payment Unit lines delineated on aerial photos, stand maps, or other resource maps, supplied by the Forest Service. Boundaries will be monumented per specifications defined in the Contract.

(12) TRAVERSE PAYMENT UNIT BOUNDARIES USING A GLOBAL POSITIONING SYSTEM (GPS)

Traverse is for use to determine area per specified standards. Product to be provided includes a corrected (and the original un-corrected) data file down-loaded in computer readable format (compatible with Forest Service system) and a printed plot of the traverse at 15,840 scale.

(13) REMARKING (Payment Unit Boundaries)

Remarking includes repainting of Payment Unit boundaries where the original paint is no longer satisfactory. This includes painting marks at eye-level and at the stump, per the original specifications.

(14) REMARKING (Included trees)

Remarking includes painting of included trees where the original paint is no longer satisfactory, per the original specifications. All trees originally marked in a Payment Unit would be remarked. This does not include re-cruising the "marked" trees. Contractor shall not put new paint over original paint.

(15) OTHER MARKING SYSTEM NOT LISTED ABOVE

Specific marking instructions different than those listed above which generally do not include "typical" timber management as the primary objective for timber removal. Examples include: removal of trees in administrative sites, campgrounds, old growth, and road right-of-way clearing.

C.3 MONUMENTING BOUNDARY TREES and OTHER LEAVE TREES

(a) The Forest Service or a Contractor will mark boundaries with **ORANGE paint** prior to the Contractor entering the Payment Units to commence marking and cruising work. Boundary trees will be marked with a "slash" that is "wrapped" in such a way as to be visible from 3 faces of the boundary tree. Each "slash" is approximately 2-3 inches in width spaced approximately 5-7 inches apart, at eye-level or higher. Boundary trees will be of sufficient diameter (at least 3" DBH when available) to be visible by equipment operators. Any brush or limbs that hinder the visibility of the boundary marks will be removed. Boundary trees will be inter-visible during the leaf-on period. The only exception permitted would be where the payment unit is intended to follow a dominant feature on the land and will be shown on the sale area map; such as a system road or powerline.

(b) **Exterior Payment Unit boundaries** will be designated with a **3 slash ORANGE** line facing into the Sale Area or Payment Unit. Exterior boundary trees will include a stump mark (1 spot with an 18" – 24" tail, a minimum 2" in width). Stump marks should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump mark shall be placed on the downhill side of the tree.

(c) **Interior Payment Unit boundaries** will be designated with a **2 slash ORANGE line**, on opposite sides of the tree facing into the respective Payment Units. Interior boundary trees will include a stump mark (1 spot with an 18" – 24" tail, a minimum 2" in width). Stump mark should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump marks shall be placed on the downhill side of the tree.

(d) **No Equipment Zone boundaries** will be designated with a **1 slash ORANGE** line facing into the Payment Unit where it is easily visible to approaching logging equipment. **Stump marks will NOT be placed on these boundaries.**

(e) **Protected Area boundaries** will be designated with a **3 slash ORANGE** line facing away from the Protected Area. Protected Area boundary trees will include a stump mark (1 spot with an 18" – 24" tail, a minimum 2" in width). Stump marks should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump marks shall be placed on the downhill side of the tree. In addition, **"PA"** will be painted on random boundary trees (particularly on corners in the line) to avoid confusion with Sale Area or Payment Unit boundaries. **Protected Areas** may protect archeological sites, sensitive plants and animal species, Ecological Classification System plots, or other resources. Trees are not to be marked within Protected Areas.

(f) **Reserve Trees** shall be marked with a single two-inch wide band of **ORANGE** paint encircling the tree and "RT" at eye level along with two stump marks (two spots with two 18"-24" tails) placed on opposite sides of the tree. Reserve trees are designated for a specific reason (i.e. wildlife tree, superior tree). Stump marks should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump mark shall be placed on the downhill side of the tree.

(g) **Leave Trees** in Leave Tree Marking Payment Units will use a single **ORANGE paint BAND** at eye level eye level and will include a stump mark (1 spot with an 18" – 24" tail, a minimum 2" in width). Bands are approximately 2 inches in width completely circling the tree. Stump marks should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump mark shall be placed on the downhill side of the tree.

C. 4 TRAVERSE PAYMENT UNIT BOUNDARIES USING A GLOBAL POSITIONING SYSTEM (GPS) *(look in updated FSH for new requirements)*

Contractor will traverse Payment Unit boundaries using the following standards:

(a) Global Positioning System (GPS) Standards

(1) All crew members using the GPS equipment for timber sale preparation shall be trained in its use and have a basic understanding of how GPS works before collecting field data.

(2) All positional fixes shall be differentially corrected to a reference/base station that is no farther than 300 miles away. Position fixes collected by the remote GPS receiver shall be collected under the following conditions:

(i) Position Dilution of Precision (PDOP) no greater than 6,
(ii) minimum satellite elevation angle of 15 degrees,
(iii) minimum signal level of 6 or the manufacturer's recommended level for good signal quality, and
(iv) in the 3-D manual mode.

(3) The reference/base station shall be of a third order (or better), North American Datum (NAD) 83 datum position.

(4) Position fixes shall be collected while moving around the perimeter and shall be collected at a time interval that will accurately define the perimeter of the traverse. A 5-second interval is suggested for a walk file; however if moving more rapidly, a 1-second interval may be appropriate. Loss of position fixes (signal) for a short duration while moving in a straight line is acceptable; however, position fixes must be received while moving through all turning points in order to portray the true representation of the traverse.

(5) Only 3-D positions that are differentially corrected will be used for area determination. A computer display or plot of the file should show positional fixes lying one after another in a relative sequential pattern, defining the perimeter of the traverse. There should be only slight irregularities (jumping from side to side) of positional fixes. If some of these are outliers (do not represent the traverse), they shall be edited from the file. The person who collected the data shall review a computer display or large-scale plot of the data. It should be reviewed for the following:

(i) consistency of data collection (look for a smooth string of fixes);
(ii) large spacing between points, which would indicate loss of signal and the possibility of missing positional fixes at critical turning points that would define the traverse; and
(iii) the polygon resembling the traverse walked in the field; (it is acceptable to run the traverse in "line feature" or "area feature".

(6) Calculate area using the NAD 83 datum when the data collected meet the established standards outlined in the preceding paragraphs 1 to 5.

(7) Re-collect the data if the established standards are not met. Data for a portion of a traverse, such as in the case of a large traverse, or satellite reception is lost, may be collected at different dates and times as long as collection occurs while moving in the same direction as the original traverse and the GPS unit is in "line mode".

(8) Keep the following information in the final record:

a. The corrected data file containing the differentially corrected position fixes in NAD 83 datum, and a printed plot of the corrected traverse at 1:15,840 scale. Contractor will also submit the original un-corrected data file. Data files will be down-loaded in a computer readable format that is compatible with our system.
b. The date and name of the person who collected the data.
c. The name of the reference/base station used for the differential corrections.

C.5 SELECTING TIMBER FOR HARVEST

(a) The Forest Service or a Contractor will mark unit boundaries with ORANGE or another designated color of paint with slashes prior to the Contractor entering the units to commence marking work. Trees shall be selected and designated (marked with paint) for harvest in the appropriate unit according to the General Marking Instructions and Detailed Prescriptions included for each solicitation. Boundary trees and Reserve Trees will be marked as described above in Section C.3. ***Trees selected for harvest must be capable of being economically felled and removed without damage to the residual stand.*** No marking will occur within Protected Areas. For a tree to be designated for harvest it must meet minimum tree specifications and include one minimum piece. **Refer to Section J – Minimum Tree and Piece Specifications.**

(b) Trees are NOT to be marked outside of Sale Area or Payment Unit boundaries (visually "draw" a line from boundary tree to boundary tree). If there is a potential for a designated tree (designated by species/diameter, DxSPP, in a clearcut) to appear to be outside of a unit boundary, then place a stump mark on that tree along with the required mark at eye level.

C.6 MARKING TREES FOR HARVEST

(a) Marking in **Cut Tree Mark (CTM)** Units (Intermediate harvest unit). Paint is for marking trees for cutting, tallying trees, and strip lines. Prior to application, Contractor shall vigorously shake each can of paint to assure tracer element and pigment are incorporated. Strip lines are to be confined to ribbon lines or sub-merchantable trees (less than 3-inch DBH), as approved by the Contracting Officer's Representative.

(b) Mark **sawtimber trees** with a single two inch wide horizontal stripe of paint on opposite sides of the tree at eye level along with two stump marks (18 inch – 24 inch "tail" approximately 2 inches in width). Eye level marks shall cover the entire face of the bole. On sloped ground, eye level marks shall be on the uphill and downhill side of the tree.
Mark **pulpwood trees** with a single two inch wide horizontal stripe of paint on opposite sides of the tree at eye level along with one stump mark (18 inch – 24 inch "tail" approximately 2 inches in width). Eye level marks shall cover the entire face of the bole. On sloped ground, eye level marks shall be on the uphill and downhill side of the tree.

(c) If there are multiple stems on a single stump (or where 2 trees have grown together) with each qualifying as an individual tree, there will be a corresponding stump mark for EACH tree in the "clump". All trees in the clump will be marked.

(d) All cut trees will be marked on two sides at eye level unless specified otherwise (example: along sensitive travel corridors).

(e) Non-merchantable/substandard trees marked to be cut in drop zones; cut trees that present a felling hazard for merchantable marked trees; or trees in right-of-way clearings >= 3" dbh will be marked with an "X" at eye level with a stump mark (only a **spot** is required without a "tail"). —

Apply paint with a sweeping motion to eye level marks, forming horizontal stripes covering the entire face of the bole. All eye level marks shall face approximately the same direction in the individual units. When 2 or more shots are used for an individual mark, shots should only overlap by a minimal amount on edges. DO NOT PUT 2 OR MORE SHOTS DIRECTLY OVER EACH OTHER since this will increase drying time and can significantly increase potential for wash off if heavy rains occur prior to paint drying. Avoid marking topside of leaning trees where mark has greater exposure to weather and water is likely to run during periods of heavy rainfall.

Place stump marks inside butt flanges where possible to protect from damage during felling and skidding. Stump marks shall be applied using proper technique. The stump marks shall be placed on clean bark or wood, not moss or dirty stumps. Moss or other debris may need to be removed, without damaging tree. Marks shall be located on the LOW SIDE of the stump in recessed portions of the stump. A liberal amount of paint shall be used on stump marks, since these are very important marks and must be durable. Stump mark shall include a "tail" or "comet" extending 18-24 inches above ground. Paint must not be diluted.

(g) Some prescriptions may require the creation of canopy gaps. If specified in marking guides, all undesirable nonmerchantable trees shall be marked at eye level on two sides of the tree and one stump mark applied. A different color of paint than used to mark merchantable trees will be designated for this work.

C.7 SPECIAL CONDITIONS

(a) Any survey corner monument (Bearing Tree) or any tree that has been blazed as a line tree along an established land line, or any tree which is designated as a Superior Tree shall not be designated for cutting. Superior trees are designated with a white ring around the tree bole, generally at breast height. Survey trees generally have red paint marks on the blazes (there is potential for blazed trees without paint).

(b) Unit specific marking guides may identify other special conditions such as wildlife den trees, raptor nests, or riparian inclusions which should not be marked. Contractor may be required to demark any areas which did not follow guidelines for special conditions without any additional cost to the Government. Contractor will notify the Government immediately of any changed conditions – such as new raptor nests or previously un-identified archeological sites.

C.8 DESIGNATION BY SPECIES AND DIAMETER (DxSPP)

(a) Generally, in a clearcut or removal cut, where all LIVE and/or DEAD trees that meet minimum specifications (Appendix J.) are designated for removal EXCEPT for trees marked as RESERVE TREES, LEAVE TREES, or trees within PROTECTED AREAS. For Payment Units where volume is cruised using Variable Plot or Fixed Plot Cruising these trees will not be marked with paint (EXCEPT for trees on plots/points – discussed elsewhere). In Payment Units where designated Species are too variable for Area Estimate Cruising methods (using Sample Tree Measure cruise method), trees designated for removal shall be intentionally marked with a stripe of paint at eye level to verify the tree was counted.

C.9 CRUISING ROAD RIGHTs-OF-WAY (ROW's)

(a) Some projects may require road ROW's to be cruised as a separate Payment Unit. ROW's are generally 20-24 feet wide (10-12' each side of road centerline). Road ROW's will usually be marked with YELLOW paint as CTM units.

C.10 VOLUME ESTIMATION USING CUT TREE MARKING/SAMPLE TREE CRUISING METHOD

(a) **General Requirements**. Contractor will perform volume estimation accurately to insure that net volume estimates are within +/- 5% of cubic foot volume of ALL check cruised sample trees and +/- 10% of check cruised sawtimber trees; in addition to Elements identified in the **Field Measurements Evaluation Form** (dated 11/08/2012) for all elements evaluated and acceptable tolerances for error (Section J.).

(b) **Sample Tree Selection**. The Contractor will use an unbiased selection of sample trees marked by the timber cruisers. Sampling intensities for each stratum and sample groups are found in the marking instructions/cruise design. Details concerning sampling will be finalized at the pre-work conference.

(c) **Instrument Acceptance and Calibration**. If requested by the COR, Contractor will provide for inspection and acceptance by COR all instruments used for tree measurements. Instruments will be checked for calibration periodically. Measurements will be made against known and established measures, to insure accurate measurements.

(d) **Sample Tree Measurements**. Sample tree measurements will be made according to methods outlined in (see Section J.):

1. Qualified Cruiser Reference Guide – Eastern Region, **(revised 10/25/2006)**
2. Guide to Hardwood Log Grading, USDA Forest Service, General Technical Report NE-1, 1973.
3. Defects in Hardwood Timber, USDA Forest Service, Agriculture Handbook No. 678, dated 1989
4. Guide for Hardwood Tree Grading Based on Butt Log, Forest Service – Eastern Region, Timber Management Field Book, pages 1.31a – 1.31b
5. **Volume Distribution Guide (for determining % defect)**
6. Sawlog Scale Deduction for Sweep
7. Minimum Tree and Piece Utilization Standards (for the Ottawa National Forest), (dated 11/08/2012)

Required measurements include:

1) DBH (Diameter at Breast Height taken at points other than 4.5' above ground on the high side of the tree because of swell or other bole deformities, shall be identified with a horizontal paint mark on the tree bole at the point of measurement). For all DBH measurements (measured to the nearest 1 tenth of an inch) a tolerance of +/- 2 tenths of an inch will be accepted before an error is assessed.

2) Merchantable height will be measured in feet according to methods described in **"Cruising Changes Guide", (dated 5/5/2008)** (see Section J.):

a. Sawtimber heights will be measured to the nearest foot, with a tolerance of +/- 4 feet. Topwood heights will be measured to the nearest foot, with a tolerance of +/- 4 feet. For hardwood trees this is to a 4" top dib (diameter inside bark); for conifer trees this is to the top of the tree.

b. Pulpwood heights will be measured to the nearest foot, with a tolerance of +/- 4 feet. Hardwood trees would be measured to a 4" top dib; conifers would be measured to the top of the tree.

[Note: applies to sawtimber and pulpwood heights: **The butt piece shall be a minimum of 9-feet in height in order to account for the automatic 12-inch deduction (for sawtimber) and 6-inch deduction (for pulpwood) by the Volume Equation. The remaining pieces shall be in 8-foot increments. Measurement will be taken from the high side of the stump at ground level.]**

3) Determination of internal and external defects including sweep, crook, rot, etc.

4) All sawtimber sample trees will meet minimum Grade 3 standards according to the following guides for Forest Service standard grades for hardwood factory-lumber logs, unless specified otherwise in project specific instructions. (Refer to Section J)

a. Guide to Hardwood Log Grading, USDA Forest Service, General Technical Report NE-1, 1973.
b. Defects in Hardwood Timber, USDA Forest Service, Agriculture Handbook No. 678, dated 1989
c. Guide for Hardwood Tree Grading Based on Butt Log, Forest Service – Eastern Region, Timber Management Field Book, pages 1.31a – 1.31b

(e) **Identifying Sample Sawtimber Trees**. In addition to the marking instructions above for sawtimber primary product trees (and multi-product trees), a unique tree number that matches the tree number on the Payment Unit tally card (R9 Timber Sale Cruise Tally Card – See Section J) will be painted on the sample tree, in addition to the assigned Cruiser identification letter. The following information will be written on a flagging ribbon with permanent marker, with the ribbon turned with the information facing to the inside against the bole of the tree (to protect the information):

1) Unique tree number assigned to that Sample Tree
2) Sample Group # in the Cruise Design
3) Species (use the applicable Species Code shown in Species Code Guide, Section J.)
4) DBH (nearest tenth of an inch)
5) Sawlog height in feet
6) Percent of saw defect (rounded to nearest **5%**) percent of Recoverable volume (rounded to nearest **5%**)
7) Non-sawlog height in feet (to a 4 inch top dib for hardwood species and total height for conifer species)
8) Percent of non-saw defect (rounded to nearest **5%**)
9) Marker's cruising identification as agreed to with the Forest Service COR.

[Note: Calculate defect and recoverable volume to the nearest % then round to the nearest 5%]

Ribbon the sample tree with flagging ribbon at DBH with two foot tails. Flagging ribbon color will be agreed upon, in writing, at the pre-work conference.

(f) **Identifying Sample Pulpwood Trees**. In addition to the marking instructions above for pulpwood primary product trees, a unique tree number that matches the tree number on the Payment Unit tally card (R9 Timber Sale Cruise Tally Card – See Section J) will be painted on the sample tree, in addition to the assigned Cruiser identification letter. Each pulpwood sample tree will contain the following information written on a flagging ribbon with permanent marker, with the ribbon turned with the information facing to the inside against the bole of the tree (to protect the information):

1) Unique tree number assigned to that Sample Tree
2) Sample Group # in the Cruise Design
3) Species (use the applicable Species Code shown in Species Code Guide, Section J.)
4) DBH (nearest tenth of an inch)
5) Pulpwood (non-saw) height in feet (4 inch top dib for hardwood species and total height for conifer species.
6) Percent of defect (rounded to nearest 5%)
7) Marker's cruising identification as agreed to with the Forest Service COR.

[Note: Calculate defect to the nearest % then round to the nearest 5%]

Ribbon the sample tree with flagging ribbon at breast height with two foot tails. Flagging ribbon color will be agreed upon, in writing, at the pre-work conference.

C.11 VOLUME ESTIMATION USING AREA ESTIMATE SAMPLING METHOD

(a) Variable plot sampling. Where specified in the contract, the Contractor will use variable plot sampling to determine volumes after acreage is computed. The plots shall be sampled with a 5, 10, or 20 BAF prism, Relaskop, or other equivalent approved optical instrument. The BAF will be specified in the Marking Guides. Grid size will be specified for each project. The point sampling method is generally used in clearcuts and Leave Tree Marking, but may include other applications. Methodology is discussed in Section J – **"Qualified Cruiser Reference Guide – Eastern Region",** (dated 10/25/2006). Limiting distance tables are also included in this document.

(b) General Requirements. Contractor will perform volume estimation accurately to insure that net volume estimates are within +/- 5% of net volume for all species and products combined of plots checked on an area estimate cruises.

(c) Several point sampling methods may be required in a project.

(1) Point Sampling (PNT) – Involves measuring all of the trees on the variable radius (or BAF) points scattered throughout the Payment Unit.

(2) Point Count Measure (PCMTRE) - All of the trees on every variable radius point are counted, with a sample interval assigned to the measure trees in each Sample Group.

(3) Fixed Plot (FIX) – Involves measuring all of the trees on plots of a fixed size, generally 1/10th or 1/20th acre in size.

(d) Variable Plot Operational Features.

(1) **Sample Plot Location**. Location of sample points/plots should result in a representative sample of the population and be free of bias. Number of samples to be taken will be determined by the Forest Service and intensity of points may vary based upon stand variability. Sample points should be located so they reflect stand variations which may occur in the Payment Unit. Cruise lines should cross drainages or topographic patterns rather than parallel them. The Forest Services shall plan location of points/plots and grid on the Contract Map, prior to cruising on the ground.

Establish cruise lines using a compass and proceed in a north, south, east, or west direction. Refer to Section J – **"Qualified Cruisers Reference Guide – Eastern Region"**, (dated 10/25/2006).

(2) **Marking Variable Plots**. Plots shall be clearly marked with the plot number identified at the top of the plot marker. The plot marker shall consist of a stake, engineering flag, or other straight object which will show where the plot center is located. The actual plot center will be where the stake goes into the ground. Plot number will be written as Payment Unit Number/Plot (or point) Number (i.e. 01/01). Plot "Marker" type will be agreed to in writing by the Contractor and Forest Service at the pre-work conference.

(3) **Sample Tree Selection**. In most cases selection of sample and measure trees will follow direction given below. Variations in sampling design may include other methods which would be described in project cruise designs.

(i) Proceeding clockwise from direction of travel, check each tree around the point, normally at DBH, as a possible sample tree.

(ii) Generally the first tree clockwise from direction of travel that falls within the basal area factor shall be the first tree measured and shall be flagged unless specified otherwise in the cruise design. Every first sample group species/product tree which falls within the basal area factor shall be tallied. Depending on sampling method used, all or a selected interval of the remaining "in" trees will be measured. Variations in selection of measure trees may be specified in project specific cruise designs. The Point Sampling Guide for BAF 5, 10, or 20 in Section J – **"Qualified Cruiser Reference Guide – Eastern Region"**, **(dated 10/25/2006)**, shall be used to assess borderline or other questionable trees.

(iii) Trees to be left need not be tallied, unless specified otherwise for each project.

(4) **Sample Tree Measurements**. Sample tree measurements for variable plot sample cruising shall be the same as that described above for Cut Tree Marking/Sample Tree cruising method. Measured trees on the plot, or point, will be identified in the same manner as described in Section C.10, items 4(e) and 4(f). Other trees that meet minimum specifications and fall within the plot/point, and are designated species, will be marked with a paint spot at eye-level. All paint marks must face the plot/point center.

C.12 MARKING RECORDS.

(a) Contractor shall ensure accurate recording of all marking records including a tree counts for each sample group in each unit. The following procedures will be applied:

(1) Measurements from each sample tree shall be recorded on the R9 Timber Sale Cruise Tally Card according to techniques on Instruction side of the Tally Card.

(2) Diameter Breast Height (DBH) shall be measured to the nearest lower 0.1 inch (i.e. 12.96 = 12.9), and recorded as measured. A tolerance of +/- 2 tenths of an inch will be granted before an error is assessed. Rounding protocol depends on the measuring instrument and is described in the **Qualified Cruiser Reference Guide.**

(3) Sawtimber or multi-product tree heights will be determined using the procedures described in Section J. Tolerance level is +/- 4 feet of height measurement.

(4) Internal and external defect shall be determined for the sample tree in total then rounded to the nearest 5% using the Volume Distribution Chart. Tolerance level on defect is +/- 5% for each product. Round up to 5% if defect is >=3%, otherwise round down to 0%; if greater than 10% defect, then use the even-odd rounding protocol (i.e., if % is even # such as 18% would round to 20%, if 17% would round done to 15%)

(5) Tally sheet data entries shall be complete and legible. Original tally sheets for each unit will be turned in together within 5 business days when unit work is completed. No recopying of field records is permitted. **Tally sheets should not contain erasures**. Any data that needs correcting will be marked through with a single line and the correct data written next to that entry; or the entire line of data marked through with a single line and the correct data written below. Any sheets used to track and record tree counts should be attached to the corresponding tally sheet and submitted for each unit cruised. This will be discussed at the pre-work conference. All data fields will be completed by the Contractor. Within each Payment Unit the Tree Line Number will start with 1 and continue consecutively through all cards as this will be the unique tree number to be written on Sample Trees, as described above, unless agreed otherwise in writing.

(6) A **Timber Sale Payment Unit Information Sheet (Section J.)** will be filled out by the Contractor for each unit listing unusual circumstances such as raptor nests, archaeological sites, permanent deer blinds, riparian inclusions and so on.

(7) On a copy of the timber sale map, daily marking progress and location of any sites discussed under (6) above will be indicated. This record will be made available for the Forest Service Contracting Officer or his designated representative on a daily basis.

C.13 PRE-WORK CONFERENCE

A conference will be held prior to the start of work. The Contracting Officer and/or Contracting Officer's Representative (COR) will meet with Contractor to discuss contract items, work performance requirements, anticipated rate of production, scheduling of work, Government furnished materials and work conditions pertaining to the contract. Contractor will submit **Operating Plan** and **Safety Plan** prior to/or at the Pre-Work Conference for approval prior to the Notice to Proceed being issued. A SAMPLE Operating Plan format will be provided to Contractor upon request for optional use. Operating Plans shall include how and where Contractor will be storing Government provided property (Paint).

SECTION E - INSPECTION AND ACCEPTANCE

E.1 Clauses Incorporated by Reference

52.252-2 Clauses Incorporated by Reference. (FEB 1998)

This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):
www.arnet.gov/far/
(End of clause)

52.246-4 Inspection of Services - Fixed-Price. (AUG 1996)

E.2 SITE VISIT

(a) Potential contractors for specific projects are urged and expected to inspect the site where services are to be performed and to satisfy themselves regarding all general and local conditions that may affect the costs of contract performance, to the extent that the information is reasonably obtainable. In no event shall failure to inspect the site constitute grounds for a claim after contract award.

(b) Potential contractors will be shown actual unit boundaries on aerial photos, if requested. Photocopies of aerial photos for specific projects can be obtained from the applicable Ranger District office.

E.3 INSTRUMENT ACCEPTANCE AND CALIBRATION

If requested by COR, the Contractor shall provide for inspection and acceptance by the Government of all instruments used for tree measurement. Instruments shall be checked for

calibration periodically. Measurements shall be made against known and established measures, to insure accurate measurements.

E.4 QUALITY ASSURANCE SURVEILLANCE PLAN

Surveillance by the Government of the Contractor's quality assurance will be based on three types of inspections:

(a) adherence to marking prescription,
(b) adherence to Payment Unit requirements, and
(c) accuracy of volume estimation.

(a) Inspection for Adherence to Marking Prescription.

(1) The Government will locate points within each intermediate harvest unit to check for adherence to marking prescriptions. Location of points will be at the discretion of the Government to ensure compliance and identify areas of a Payment Unit that need correction to meet specifications. Check plots will be recorded on **Ottawa Timber Marking Silviculture Inspection Form** (Section J.) by the COR/Inspector. The following factors will be considered in determining whether or not a stand has been marked to the prescription.

(i) **Residual Basal Area (BA)** - The Contractor and the Forest Service shall use a 10 BAF wedge prism, Relaskop or other equivalent optical instrument to check residual stand basal area during the marking of intermediate harvest units. **The residual BA must be +/-10 square feet of target BA residual for that unit.** If target BA is shown as a range, then Contractor must maintain the residual BA within this range (Example: 70 – 90 BA is considered a "Range" versus 80 BA which allows +/-10 square feet of variation). Residual BA and/or specified spacing guidelines are factors used to determine if the stand has been marked properly, regardless of the amount of BA specified to be removed. The adherence to +/- 10% variation (or defined Range in BA) is not an average across the Payment Unit but is within each check plot in order to determine consistency across the Payment Unit. This can be varied at the discretion of the COR based on criteria below in item (2) and will be documented in writing. Contractor is required to maintain records of self-inspection of BA and/or spacing and record them on the **Ottawa Timber Marking Silviculture Inspection Form** (Section J.). COR/Inspector may request copies of this form from the Contractor at any time. These forms then become the Property of the Government.

(2) When differences do occur, one of the following explanations should apply (and be documented in writing):

(i) It will be obvious to the inspector why a change was made to the prescription. This could be due to the need to leave more or less BA than stated in the prescription because of variation in species, DBH, or spacing.

OR

(ii) When not obvious to the inspector, the Contractor or representative can explain why the deviations were made and the reason is acceptable to the inspector.

(3) If neither of the above conditions is met, the Contractor may be required to remark the stand to the satisfaction of the Government.

(b) Inspection for Adherence to Payment Unit Requirements.

(1) Adherence to unit prescription specifications and silvicultural objectives must be met. This will include spacing of residual trees, quality, health and form of trees left compared to those marked for removal, and application of project design criteria incorporated into marking guides.

(2) The marking of individual sample trees will be noted to make sure information on cruise trees are legible and other markings conform to the direction given in this contract. Physical quality of paint application will also be assessed. If not acceptable, the contractor will be required to remark the Payment Unit.

(3) The Contractor will be provided with regular critiques based on these observations. If changes in marker's practices are indicated, that adjustment will be expected within 24 hours.

(4) The Government will perform periodic tracer paint security inspections. This may include inspection of off-site temporary storage facilities. By signing this Contract, Contractor is agreeing to allow the COR and Law Enforcement to inspect any of the Contractor's storage facilities. Contractor does not have to be present to conduct this inspection (but it is recommended in order to allow access). Final payment is contingent on reconciling the paint issues and return of empties/full cans.

(c) Inspection for Accuracy of Volume Estimation.

(1) Each Payment Unit will be inspected for accurate volume estimation. Inspectors will notify Contractor of any discrepancies found. Contractor may be required to re-evaluate Sample Tree data based on the Inspector's input if cruising methodology is deficient (will be documented on the **Ottawa Timber Marking Contract Volume Estimation Inspection Form** – Section J.). Acceptance of individual Payment Unit volume estimates will be at the discretion of the Inspector, but will be based on accurate Tree Measurements as defined in the **Field Measurement Evaluation Form** (Section J.).

(2) The percent variance of net volume will be calculated using the methodology shown on the **Field Measurement Evaluation Form** (Section J).

(3) If the Contractor's Volume of Measured Trees and Tree Measurements is outside of tolerance levels and the Contractor requests it, the Government will check an additional number of trees. If, however, the Contractor fails the second sample inspection, the Contractor shall re-measure all the cruise trees in the Sale and pay the cost of the re-inspection. The cruise trees in the Sale will then be inspected again as if it was the first time. This process could be repeated. **Final payment is contingent upon an acceptable Check Cruise on the Sale as a whole.** A Check Cruise will require that a minimum of 25 trees be inspected by the Check Cruiser.

(4) Marked trees will be evaluated for proper product differentiation, as defined in Section C.6 – Marking Trees for Harvest. Trees must meet the minimum specifications for the marked product as defined in Section J. Product determination will be monitored and accepted by Payment Unit. A re-cruise of products, remarking and re-sampling as necessary will occur if outside of the tolerance level.

SECTION F - DELIVERIES OR PERFORMANCE

F.1 Clauses Incorporated by Reference

52.242-15 Stop-Work Order. (AUG 1989)

52.242-17 Government Delay of Work. (APR 1984)

F.2 CONTRACT TIME

(a) This Basic Ordering Agreement will remain in effect for 5 years from the date of issuance, unless cancelled by the Government. Annually, the number of Basic Ordering Agreement holders as well as anticipated future work will be evaluated to determine whether there is a need to expand the contracting pool. If a need does exist, there will be a competitive window of opportunity for the Forest Service to add new contractors.

(b) Contract time for marking and volume estimation will be shown in each individual contract. There is a likelihood that a winter shutdown could occur depending on conditions for satisfactory paint application. This is factored into total contract time and delivery date.

F.3 SCHEDULE OF PERFORMANCE

(a) The Contractor shall submit an operating plan at the post award conference for each contract that outlines a schedule of performance. The plan shall be subject to the approval of the Contracting Officer and shall be updated if the Contractor falls behind scheduled dates by more than 10 percent.

(b) The Contractor shall plan on rainy/wet days when trees cannot be marked. The tree marking paint provided for this contract is either water soluble or rain resistant formulation, and needs drying time prior to exposure to heavy rainfall or wash-off problems can occur.

Marking of damp trees and smooth-barked species (such as aspen) prior to periods of high temperature (80+F) with high relative humidity preceding forecast heavy rain (thunderstorms) should also be avoided. Potential for wash off problem is most critical in closed canopy hardwoods where dry time is extended by higher relative humidity, less air movement and less exposure of bark to direct sunlight than in open stands or most conifer types. See item C.11 for additional recommendations on paint application.

The Contractor shall exercise prudent judgment as to when to start marking during rainy periods and when to stop once precipitation has begun. Resumption of marking following rainfall is at the Contractor's option. The Government reserves the right to stop the Contractor's marking if it is determined that weather is unsuitable and normal paint retention quality cannot be assured. Contractor will notify Government 2 business days PRIOR to resumption of work if shut down for more than 10 consecutive days.

F.4 MEASUREMENT AND PAYMENT

(a) Acreages (or other units of measure) shown in the contract may be estimated. If acreages are estimated, final determination of acreages included within the unit boundaries will be made by the Government using a GPS (Global Positioning System).

A digital planimeter with rectified orthophotoquads may be used to determine payment unit acreage in circumstances where there are clearly defined boundaries such as roads, swamps, or easily seen timber type breaks. Method and acreage determination that serves as basis for payment will be agreed to by both Government and Contractor in writing.

(b) Payment will be by the item, as shown in the Schedule of Items in each contract. Payment will be upon completion by the Contractor and acceptance by the Contracting Officer of the entire item, unless otherwise agreed to by the Contracting Officer.

SECTION G - CONTRACT ADMINISTRATION DATA

G.1 GOVERNMENT - FURNISHED PROPERTY

(a) The Government shall deliver to the Contractor the following listed materials, supplies, property or services (hereinafter referred to as ("Government-furnished property") at the place and times specified below. The Contractor shall be liable for all loss or damage of such delivered Government-furnished property until completion and final acceptance of work. If the Government fails to make timely (within three business days of request by Contractor, or unless otherwise agreed to) delivery of such Government-furnished property suitable for its intended use, and upon written request from the Contractor, the Contracting Officer shall make an equitable adjustment of contract delivery or performance dates or contract price, or both, pursuant to the "changes" clause of the general provisions of this contract.

Government-furnished property shall consist of: 1) tree marking paint; 2) R9 Timber Sale Cruise Tally Card & Instructions Sheet (copied on Rain Resistant paper); 3) Marking guides that include: cruise plan, marking prescriptions, designation method, and resource maps.

(b) **Tree-marking paint**. Tree-marking paint shall be furnished by the Forest Service by signing out (using the Marking Paint Sign In/Sign Out Sheet) to the Contractor the expected amount needed for the work week for each Bid Item. The Forest Service will issue paint to and receive paint and empty cans from the Contractor **each week** at the District Office agreed to at the pre-work conference. Unless agreed otherwise, contractors must reconcile paint within 10 business days.

All paint empty paint cans, partially used or unused cans, will be returned to the agreed upon location and secured there as outlined during the pre-work conference. The empty cans will be drained, then sanded (or other acceptable material agreed to) or rinsed with the lids left off. Rain resistant paint cans cannot be rinsed. The objective is that any residual paint in the cans are dry or otherwise treated so that paint is no longer "useable". There will be strict accountability for all paint cans regardless of amount of content or lack thereof. Paint must be secured in a manner that is acceptable to the Government – either in locked vehicles or other storage devices.

Paint cans taken to the field for use that day should be reconciled at the end of each day. If a paint can is lost, a good faith effort should be made to find any missing cans. **Contractor will notify the Government within 1 business day of the loss.** For each unreturned paint can, the contractor will be required to submit a written report describing in detail the circumstances which caused the misplacement of the paint can(s), along with security measures implemented in order to prevent further losses. The contractor shall bear the costs of any investigation (est. cost $200.00 to $400.00) that results from losses of government-furnished paint and or paint cans do to negligent storage and/or handling.

(c) **R9 Timber Sale Cruise Tally Card**. The Contractor shall, upon the completion of each unit, deliver the completed timber sale cruise program tally sheets and other unit specific records for each unit to the Government within 5 business days following completion of the Payment Unit or before moving to the next area, whichever comes first, unless agreed otherwise.

Upon the receipt and acceptance thereof, the cruise data for each area shall become the sole property of the Government. Unused timber sale cruise program tally sheets shall be returned to the Contracting Officer's Representative upon completion of the job.

(d) **Layout Timber Sale Payment Unit Boundaries**: items the Forest Service will supply include: all stand maps, aerial photos, acetate overlays with boundaries delineated, transportation maps, and site specific instructions for implementing project design criteria which represent work to be completed.

G.2 CONTRACTING OFFICER'S REPRESENTATIVE DESIGNATION

A Contracting Officer's Representative (COR) will be designated for each order placed against the BOA. The name of the COR will be shown on the face of the issued purchase order. The COR will have full contract authority with the exceptions shown on the COR designation form in Section J. The COR will designate inspectors as needed to assist in administering elements of the contract. The two key elements of the contract to be administered and assessed are: a) implementation of the silvicultural prescriptions, and b) evaluation of the tree measurements. These items will be evaluated by the COR or inspectors skilled in Lake States silviculture for Northern Hardwoods, spruce, and pine and shall be a Certified Forest Service cruiser.

SECTION H - SPECIAL CONTRACT REQUIREMENTS

H.1 KEY PERSONNEL

452.237-74 Key Personnel. (FEB 1988)

(a) All timber cruisers are considered key personnel, in accordance with AGAR 452.236-77, and shall meet minimum qualifications for marking and cruising experience listed in Section M. Before work begins, the Contractor shall designate a Contractor's Representative in writing. The Contractor's Representative shall be knowledgeable of contract requirements, meet the "Minimum Requirements of Contractor" (Section M) and act for the Contractor in his absence. The Contractor or Contractor's Representative shall be at the job site whenever work is in progress. In the absence of the Contractor, the Contractor's Representative may receive instructions from the Contracting Officer or COR.

(b) General Requirements. **All Contractors will be required to be certified by the Government in Volume Estimation before the start of any awarded contract**. The certification process will include the following:

1. a classroom session covering Government merchantability specifications, cruise methods, defect, and grading rules;
2. passing a written test covering topics covered in the classroom session;
3. passing a field test which will consist of measuring a minimum of 25 trees.

For certification, the cruiser must be within +/- 5% of the total net cubic foot volume estimate determined by the Government. Sawtimber volume estimate must be within +/- 10% of the net cubic foot volume estimate determined by the Government. The cruiser must also meet the tolerance requirements for individual tree measurements, as shown in the Field Measurements Evaluation Form (Section J.). The 25 tree field requirement may be met by an individual Contractor who has successfully passed a timber sale Check Cruise of at least 25 trees within the last 12 months

Contractors currently certified to mark National Forest timber in the Lake States will have their certification accepted on the Ottawa National Forest also.

Contractor certification is indefinite. Inactive Cruisers (less than 25 Sample Trees checked in a year) can be rated as "Active" after a cruising specification review conducted during the pre-work conference, followed by satisfactory performance of a volume estimation check of the first Payment Unit that is marked and cruised.

Trainee Marker: In the event a Contractor needs to acquire additional help in the completion of a contract, they may utilize Cruise Assistants who may not be currently certified by the Government for volume estimation. Cruise Assistants must meet the minimum qualifications and experience described in Section M.2 (A). All volume estimation must be personally supervised on-site by a Government certified cruiser when collecting data. All measure trees

evaluated by a Cruise Assistant must be initialed with the assigned initial by the Cruise Assistant AND the approving Certified Cruiser.

H.2 CONFIDENTIAL NATURE OF INFORMATION

(a) **Timber Sale Data**.

(1) The Contractor shall not divulge, and shall take all reasonable steps to insure that no member of its organization divulges, any information concerning this timber sale data to any person other than those duly authorized representatives of the Contracting Officer.

(2) In addition, neither the Contractor nor any of the Contractor's employees may be involved in bidding on any timber sale(s) resulting from this contract.

(b) **Archaeological Sites.** Any archeological sites encountered are protected by law and shall not be disturbed. The Contractor is encouraged to be alert for potential archeological sites and report their location to the Contracting Officer. Disclosure of any archeological information to any persons, other than those duly authorized as representatives of the Contracting Officer, may be subject to legal penalties.

(c) **Threatened, endangered, or Sensitive Species (Plant, Animal, or Bird)**. Any of these species encountered are protected by law and shall not be disturbed. The Contractor is encouraged to be alert for potential indicators (such as nests) or actual sightings and report their location to the Contracting Officer. Disclosure of any information associated with these species to any persons, other than those duly authorized as representatives of the Contracting Officer, may be subject to legal penalties.

H.3 EMPLOYMENT OF ELIGIBLE WORKERS

a) **Labor standards for contracts involving H-2B workers or migrant and seasonal agricultural workers**
   1. **General**
      This contract is subject to the Migrant and Seasonal Agricultural Worker Protection Act (MSPA),2 29 United States Code (U.S.C) 1801-1872, and to the U.S. Department of Labor (DOL) regulations implementing MSPA 29 Code of Federal Regulations (CFR) Part 500. MSPA eliminates activities detrimental to migrant and seasonal agricultural workers, requires registration of Farm Labor Contractors, and ensures necessary protection for the workers. Information regarding MSPA can be found at http://www.dol.gov/whd/mspa/index.htm.
      If workers are hired under the H2B program, (8 CFR Section 274A provisions of the Immigration and Nationality Act (INA) for the admission of nonimmigrants to the U.S. to perform temporary labor or services) a Temporary Employment Certification issued by the Office of Foreign Labor Certification (OFLC) in the Department of Labor Employment and Training Administration is required. For further information on the requirements of the H-2B program, visit OFLC's website at

http://www.foreignlaborcert.doleta.gov/ or Wage and Hour's website at http://www.dol.gov/whd/immigration/H2BFinalRule/index.htm. Compliance with MSPA and the INA is a material condition of this contract. If the contractor employs any unauthorized worker(s) during the performance of this contract that violates section 274A of the INA, the Government may terminate the contract, in addition to other remedies or penalties prescribed by law.

2. **Definitions**
   a) **H-2B worker:** as used in this part means a nonimmigrant holding a visa authorizing the individual to legally work in the US to perform temporary labor or services. A worker with an H-2B visa ("H-2B worker") may also be considered a migrant agricultural worker under MSPA depending on the type and nature of work performed.
   b) **Migrant Agricultural Worker and Seasonal Agricultural Worker**: as used in this part means individuals employed for agricultural (including forestry) work on a seasonal or temporary basis.
      i. A worker, moving from one seasonal activity to another, is employed on a seasonal basis even though the worker may continue to be employed during a major portion of the year.
      ii. An overnight absence from the migrant workers permanent place of residence is required.
      iii. Members of the contractor's immediate family are not considered migrant or seasonal workers. Immediate family includes:
         - Spouse
         - Children, stepchildren, or foster children
         - Parents, stepparents, or foster parents, or
         - Brothers and sisters
   c) **Farm Labor Contractor (FLC).** As used in this part means a person including an individual, partnership, association, joint stock company or a corporation, who, for any money or other valuable consideration, paid or promised to be paid, performs any recruiting, soliciting, hiring, employing, furnishing, or transporting of any migrant or seasonal agricultural worker.
3. **Registration Requirements**
   a) Any contractor providing or hiring H-2B nonimmigrants for work under this contract shall provide a copy of their Temporary Employment Certificate. General information about the H-2B program can be found on Fact Sheet # 78 at http://www.dol.gov/whd/regs/compliance/whdfs78.htm. Contractors can apply for the certificate through the US DOL Employment & Training Administration's on line iCERT Visa Portal System at https://icert.doleta.gov/ or by paper application.
   b) Any contractor who meets the definition in (2.c.) above providing or hiring migrant or seasonal workers to perform agricultural or manual forestry work shall first obtain a Federal DOL Farm Labor Contractor Certificate of Registration (http://www.dol.gov/whd/forms/fts_wh530.htm). The contractor shall carry the certificate at all times while engaged in contract performance and shall display it upon request. Any of the contractor's employees who perform any one or more of the activities defined as an FLC in paragraph (2.c.) must have their own FLC

Employee Certificate. General information about MSPA can be found on Fact Sheet #49 at DOL Wage and Hour Divisions webpage http://www.dol.gov/whd/regs/compliance/whdfs49.htm.

4. **Certifications**

   The Contractor shall provide applicable H-2B Temporary Employment Certificate or Farm Labor Contractor Certificate as part of their representations, certifications, and acknowledgements. Subcontractor(s) meeting the definitions above shall follow the same requirements as the Prime Contractor. It is the Prime Contractor's responsibility to ensure the Subcontractor's information is provided to the Contracting Officer.

5. **Worker Protections**

   a) **Worker Information Posters**

      i. A contractor who uses the H-2B program to meet its temporary employment needs must post and maintain the H-2B poster (WH-1505) in a conspicuous location accessible to workers at the job site.

      ii. The contractor shall display and maintain the MSPA poster (WH-1376) on the job site in a conspicuous location accessible to workers during the contract performance period.

   b) **Personal protective equipment**

      i. 29 CFR 1910 Subpart I, OSHA's personal protective equipment (PPE) standard contains the general requirements for the provision of personal protective equipment and requires employers to perform a hazard assessment to select appropriate PPE for hazards that are present or likely to be present in the workplace. OSHA requires that many categories of personal protective equipment meet or be equivalent to standards developed by the American National Standards Institute (ANSI).

      ii. Before a worker begins operating equipment, the contractor shall train the workers on the safe operation and use of the equipment.

      iii. The contractor shall provide the appropriate personal protective equipment for the work required to be performed in the contract, wherever necessary by reason of hazards or processes encountered that may cause injury or impairment in the function of any part of the body. Except for foot protection, all PPE must be provided by the employer at no cost to the employee. Includes:

      - Head Protection
      - Hearing Protection
      - Eye/Face Protection
      - Leg Protection
      - Foot Protection
      - Hand Protection

      iv. PPE must be sanitary and in reliable condition. Do not use defective or damaged PPE. PPE must be inspected prior to use on each work shift to ensure it is in serviceable condition.

      v. A checklist of applicable PPE guidelines typical for the work performed under this contract is provided. This does not relieve the contractor of the

responsibility of performing a risk assessment or providing the necessary PPE for their operations. Reference https://www.osha.gov/SLTC/personalprotectiveequipment/index.html or OSHA 3151-12R 2003 Personnel Protective Equipment Booklet.

- MSPA – Forestry Working Conditions Checklist

c) **Field Sanitation.** OSHA established minimum standards for field sanitation in covered agricultural settings. Refer to FACT Sheet # 51 Field Sanitation Standards under the Occupational Safety and Health Act.

6. **Employment Requirements** - Fact Sheets with relevant information may be found at http://www.dol.gov/WHD/fact-sheets-index.htm.
   a) Contractors employing workers in forestry related work are required to comply with wage and payroll standards and recordkeeping requirements. Refer to Fact Sheet #63: Application of Federal Labor Laws to Reforestation found on the DOL Wage and Hour Division webpage.
   b) **Contractor Employee List**. Contractors are required to provide/maintain an active list of all employees performing work on the job site under this contract. The Employee List will identify employees by full name (aliases), supervisory duties if applicable, and appropriate labor Occupation Code for work performed under the Service Contract Act Wage Rates applicable to this contract. If Subcontractors are utilized, all tiers of subcontractor(s) are responsible for providing the same information for their employees to the Prime for submittal to the Contracting Officer.
7. **Transportation**
   a) The contractor shall be registered to transport employees, unless employees provide their own transportation or carpool by their own arrangement in one of their own vehicles. Authorization for each vehicle that will be used to transport employees must appear on the contractor's certificate. If the contractor directs or requests employees to carpool, the registration requirement is applicable. Any driver, who transports workers for a fee or at the direction of the contractor, shall be registered as an FLC or an FLC employee.
   b) See Fact Sheet #50: Transportation Under MSPA, for more information about the vehicle safety standards, driver's licensing requirements, and vehicle insurance requirements. Note that separate transportation requirements may apply if there are H-2B workers.
8. **Housing**
   a) The authorization to furnish housing, other than commercial lodging-certified by a health authority or other appropriate agency, must appear on the contractor's certificate. Contractors should contact their local Wage and Hour Division of the DOL for further information on the requirements of the Act.
   b) **Camping Requirements.** The Forest Service (FS) has various camping opportunities. Check with local FS unit for camping requirements, camping permits may be required. Verify local fire restriction policies.
   If camps will be used to house workers subject to MSPA, they are also subject to the temporary labor camp standards at 29 CFR 1910.142. The Forest Service reserves the right to terminate a camping permit at any time. These requirements are in

addition to those contained in or provided for under the clause titled "452.236-72 Use of Premises" in this contract. Any violation of these conditions constitutes a breach of contract and may result in revocation of camping approval.

i. Every structure used as shelter must provide protection from the elements. Where adequate heat is not provided, make other arrangements to protect workers from the cold. Cut firewood only after a District Firewood Permit is obtained.

ii. The campsite must not encroach beyond the boundaries designated by the Forest Service. The campsite location must minimize impacts on streams, lakes, and other bodies of water. Camping is not permitted within developed recreational sites or along primary recreational roads.

iii. The campsite must have a clean appearance at all times. Upon abandonment of any campsite, or termination, revocation, or cancellation of camping privileges, the contractor shall remove, within 10 calendar days, all structures and improvements except those owned by the United States, and shall restore the site, unless otherwise agreed upon in writing or in the camping permit. Structures or improvements the contractor fails to remove within the 10 calendar day period becomes the property of the United States, however, the contractor remains liable for the cost of the removal and restoration of the site.

iv. Unless otherwise designated by the CO, the use of the area is not exclusive and may be granted to other permittees, contractors, or recreating public. Disorderly conduct is not permitted.

v. Damaging or removing any natural feature or other property of the Forest Service is prohibited.

vi. Servicing of equipment in the campsite is not permissible unless the campsite is within the project area.

vii. Provide sanitary facilities for storing food. Provide ice chests or coolers, with ice supply made from potable water, and replenish as necessary. Provide sufficient storage for perishable food items.

viii. Provide an adequate and convenient potable water supply in each camp for drinking and cooking purposes.

ix. Provide adequate toilet facilities and toilet paper for the capacity of the camp. Service and maintain facilities in a sanitary condition.

x. Collect, store, and dispose of garbage in a manner to discourage rodent access, minimize attraction of flies, and prevent scattering by wind.

xi. Maintain basic first aid supplies available, which must be under the charge of a person trained to administer first aid.
The basic supplies must include:

- Gauze pads (at least 4x4 inches)
- Two large gauze pads (at least 8x10 inches)
- Box adhesive bandages (band-aids)
- One package of gauze roller bandage (at least 2-inches in width)
- Two triangular bandages
- Scissors
- At least one blanket

- Tweezers
- Adhesive tape
- Latex gloves, and
- Resuscitation device such as resuscitation bag, airway, or pocket mask.

xii. Wash laundry in such a way that washing and rinsing will not pollute lakes, streams, or other flowing water.

xiii. Dispose waste water away from living and eating areas and in such a way that minimizes pollution to lakes, streams, and other flowing water.

xiv. The contractor shall take all reasonable precautions to prevent and suppress forest fires. Do not dispose of material by burning in open fires during the closed season established by law or regulation without the written permission from the Forest Service.

xv. If authorized to have an open fire, the Contractor shall comply with the following fire regulations:

- A shovel, axe or Pulaski, a 10-quart pail, which is full of water for immediate use, and a fire extinguisher with an Underwriters Laboratory (UL) rating of at least 1:A 10:BC is required.
- All fire rings or outside fireplaces must be approved by the Forest Service representative. The area must be cleared down to mineral soil for a distance of one foot outside of the ring or fireplace, and it must not have any overhanging material. Fire rings must be dismantled and material disposed prior to leaving the site.
- All generators and other internal combustion engines must be equipped with Forest Service approved spark arrestors and/or factory designed muffler and exhaust system in good working order. They will be located in a cleared area with the same requirements as in described in the previous paragraph.
- All fuel must be stored in UL approved flammable storage containers and be located at least 50 feet from any open flame or other source of ignition.

H.4 CONTRACTOR PERFORMANCE ASSESSMENT REPORTING SYSTEM

(a) General. This contract is subject to Federal Acquisition Regulations (FAR), Agriculture Acquisition Regulations (AGAR), and Forest Service Acquisition Regulations (FSAR) that require past performance evaluations to be completed and entered into the Contractor Performance Assessment Reporting System (CPARS). Although the expected amount of this project is below the automatic reporting threshold, an evaluation may be entered into the CPARS system at the CO's discretion.

H.5 EQUIPMENT CLEANING

All soil moving equipment shall be thoroughly cleaned to make it free of soil, noxious weed seeds, vegetative matter or other debris that could contain or hold seeds prior to being delivered to the project site. Equipment shall be considered free of soil, noxious weed seeds and other such debris when a visual inspection by the C.O.R., prior to the equipment being delivered to the

site, does not disclose such material present. Disassembly of equipment components is not required. The Contractor shall notify the Forest Service at least five (5) working days prior to moving each piece of soil moving equipment onto the project site, unless otherwise agreed.

The Contractor shall thoroughly clean all soil moving equipment prior to moving them off a project site or between work areas on a project site that are known to be infested with noxious weed species of concern and other work areas, if any, that are free of noxious weed species of concern. Areas known to be infested with specific noxious weed species of concern to the Forest Service shall be noted in the Schedule of Work. The Contractor and the Forest Service shall agree on the methods of cleaning, location for the cleaning and control of off-site impacts, if any.

When new areas of infestation of noxious weeds of concern to the Forest Service are identified on the project site by either the Forest Service or Contractor they shall be promptly reported to the other party.

PART II--CONTRACT CLAUSES

SECTION I--CONTRACT CLAUSES

I.1 Clauses Incorporated by Reference (FEB 1998)

This BOA, and any resultant orders placed against it, incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es):

www.acquisition.gov/far/
www.usda.gov/procurement/policy/agar.html

FEDERAL ACQUISITION REGULATION (48 CFR CHAPTER 1) CLAUSES

52.202-1 Definitions (NOV 2013)
52.203-5 Covenant Against Contingent Fees. (MAY 2014)
52.203-6 Restrictions on Subcontractor Sales to the Government. (SEP 2006)
52.203-7 Anti-Kickback Procedures. (OCMAY 2014)
52.203-18 Prohibition on Contracting with Entities that Require Internal Confidentiality Agreements or Statements – Representation (JAN 2017)
52.203-19 Prohibition on Requiring Certain Internal Confidentiality Agreements or Statements (JAN 2017)
52.204-4 Printed or Copied Double-Sided on Postconsumer Fiber Content Paper. (MAY 2011)
52.204-12 Unique Entity Identifier Maintenance (OCT 2016)
52.204-13 System for Award Management Maintenance (OCT 2016)
52.211-18 Variation in Estimated Quantity (APR 1984)
52.219-6 Notice of Total Small Business Set-Aside (NOV 2011)
52.222-17 Non displacement of Qualified Workers under Service Contracts (MAY 2014) (E.O.13495)
52.223-6 Drug-Free Workplace (MAY 2001) *(Applicable if contract is awarded to an individual)*
52.223-18 Encouraging Contractor Policies to Ban Text Messaging While Driving (AUG 2011)
52.224-1 Privacy Act (APR 1984)
52.224-3 Privacy Training (JAN 2017)
52.225-13 Restrictions on Certain Foreign Purchases (JUN 2008)
52.232-18 Availability of Funds (APR 1984)
52.232-23 Assignment of Claims (MAY 2014)
52.236-2 Differing Site Conditions (APR 1984)
52.236-7 Permits and Responsibilities. (NOV 1991)
52.236-8 Other Contracts (APR 1984)
52.236-9 Protection of Existing Vegetation, Structures, Equipment, Utilities, and

Improvements. (APR 1984)
52.236-10 Operations and Storage Areas (APR 1984)
52.236-12 Cleaning Up (APR 1984)
52.236-13 Accident Prevention (NOV 1991)
52.237-2 Protection of Government Buildings, Equipment, and Vegetation (APR 1984)
52.243-1 Changes--Fixed-Price (AUG 1987)
52.245-1 Government Property (JAN 2017)
52.246-1 Contractor Inspection Requirements. (APR 1984)
52.249-1 Termination for Convenience of the Government (Fixed-Price) (Short From) (APR 1984)
52.249-8 Default (Fixed-Price Supply and Service) (APR 1984)
52.249-14 Excusable Delays (APR 1984)

AGRICULTURE ACQUISITION REGULATION (48 CFR CHAPTER 4) CLAUSES

452.204-70 Inquiries (FEB 1988)
452.236-72 Use of Premises (NOV 1996)
452.236-73 Archaeological or Historic Sites (FEB 1988)
452.236-74 Control of Erosion, Sedimentation, and Pollution (NOV 1996)
452.236-77 Emergency Response (NOV 1996)
452.237-70 Loss, Damage, Destruction or Repair (FEB 1988)
452.237-75 Restrictions Against Disclosure (FEB 1988)

52.203-17 Contractor Employee Whistleblower Rights and Requirement To Inform Employees of Whistleblower Rights. (APR 2014)

(a) This contract and employees working on this contract will be subject to the whistleblower rights and remedies in the pilot program on Contractor employee whistleblower protections established at 41 U.S.C. 4712 by section 828 of the National Defense Authorization Act for Fiscal Year 2013 (Pub. L. 112-239) and FAR 3.908.

(b) The Contractor shall inform its employees in writing, in the predominant language of the workforce, of employee whistleblower rights and protections under 41 U.S.C. 4712, as described in section 3.908 of the Federal Acquisition Regulation.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in all subcontracts over the simplified acquisition threshold.

(End of clause)

52.204-7 -- System for Award Management. (Oct 2016)

(a) Definitions. As used in this provision—

"Electronic Funds Transfer (EFT) indicator" means a four-character suffix to the unique entity identifier. The suffix is assigned at the discretion of the commercial, nonprofit, or Government entity to establish additional System for Award Management records for identifying alternative EFT accounts (see subpart 32.11) for the same entity.

"Registered in the System for Award Management (SAM) database" means that—

(1) The Offeror has entered all mandatory information, including the unique entity identifier and the EFT indicator, if applicable, the Commercial and Government Entity

(CAGE) code, as well as data required by the Federal Funding Accountability and Transparency Act of 2006 (see subpart 4.14), into the SAM database;
(2) The offeror has completed the Core, Assertions, and Representations and Certification, and Points of contact sections of the registration in the SAM database;
(3) The Government has validated all mandatory data fields, to include validation of the Taxpayer Identification Number (TIN) with the Internal Revenue Service (IRS). The Offeror will be required to provide consent for TIN validation to the Government as a part of the SAM registration process.
(4) The Government has marked the record "Active".

"Unique entity identifier" means a number or other identifier used to identify a specific commercial, nonprofit, or Government entity. See www.sam.gov for the designated entity for establishing unique entity identifiers.

(b)

(1) By submission of an Offer, the offeror acknowledges the requirement that a prospective awardee shall be registered in the SAM database prior to award, during performance, and through final payment of any contract, basic agreement, basic ordering agreement, or blanket purchasing agreement resulting from this solicitation.
(2) The Offeror shall enter, in the block with its name and address on the cover page of its offer, the annotation "Unique Entity Identifier" followed by the unique entity identifier that identifies the Offeror's name and address exactly as stated in the offer. The Offeror also shall enter its EFT indicator, if applicable. The unique entity identifier will be used by the Contracting Officer to verify that the Offeror is registered in the SAM database.

(c) If the Offeror does not have a unique entity identifier, it should contact the entity designated at www.sam.gov for establishment of the unique entity identifier directly to obtain one. The Offeror should be prepared to provide the following information:

(1) Company legal business name.
(2) Tradestyle, doing business, or other name by which your entity is commonly recognized.
(3) Company physical street address, city, state and Zip Code.
(4) Company mailing address, city, state and Zip Code (if separate from physical).
(5) Company telephone number.
(6) Date the company was started.
(7) Number of employees at your location.
(8) Chief executive officer/key manager.
(9) Line of business (industry).
(10) Company Headquarters name and address (reporting relationship within your entity).

(d) If the Offeror does not become registered in the SAM database in the time prescribed by the Contracting Officer, the Contracting Officer will proceed to award to the next otherwise successful registered Offeror.

(e) Processing time, which normally takes 48 hours, should be taken into consideration when registering. Offerors who are not registered should consider applying for registration immediately upon receipt of this solicitation.

(f) Offerors may obtain information on registration at https://www.acquisition.gov.

(End of Provision)

Alternate I (Jul 2013). As prescribed in 4.1105(a)(2), substitute the following paragraph (b)(1) for paragraph (b)(1) of the basic provision:
(b)

(1) By submission of an offer, the offeror acknowledges the requirement that a prospective awardee shall be registered in the System for Award Management prior to award, during performance, and through final payment of any contract, basic agreement, basic ordering agreement, or blanket purchasing agreement resulting from this solicitation. If registration prior to award is not possible, the awardee shall be registered in the System for Award Management within 30 days after award or before three days prior to submission of the first invoice, whichever occurs first.

52.213-4 Terms and Conditions—Simplified Acquisitions (Other Than Commercial Items). (JAN 2017)

(a) The Contractor shall comply with the following Federal Acquisition Regulation (FAR) clauses that are incorporated by reference:

(1) The clauses listed below implement provisions of law or Executive order:

(i) 52.222-3, Convict Labor (Jun 2003) (E.O. 11755).

(ii) 52.222-21, Prohibition of Segregated Facilities (Apr 2015).

(iii) 52.222-26, Equal Opportunity (Sept 2016) (E.O. 11246).

(iv) 52.225-13, Restrictions on Certain Foreign Purchases (Jun 2008) (E.O.s, proclamations, and statutes administered by the Office of Foreign Assets Control of the Department of the Treasury).

(v) 52.233-3, Protest After Award (Aug 1996) (31 U.S.C. 3553).

(vi) 52.233-4, Applicable Law for Breach of Contract Claim (OCT 2004) (Pub. L. 108-77, 108-78 (19 U.S.C. 3805 note)).

(2) Listed below are additional clauses that apply:

(i) 52.232-1, Payments (Apr 1984).

(ii) 52.232-8, Discounts for Prompt Payment (Feb 2002).

(iii) 52.232-11, Extras (Apr 1984).

(iv) 52.232-25, Prompt Payment (Jan 2017).

(v) 52.232-39, Unenforceability of Unauthorized Obligations (Jun 2013).

(vi) 52.232-40, Providing Accelerated Payments to Small Business Subcontractors (Dec 2013)

(vii) 52.233-1, Disputes (May 2014).

(viii) 52.244-6, Subcontracts for Commercial Items (Jan 2017).

(ix) 52.253-1, Computer Generated Forms (Jan 1991).

(b) The Contractor shall comply with the following FAR clauses, incorporated by reference, unless the circumstances do not apply:

(1) The clauses listed below implement provisions of law or Executive order:

(i) 52.204-10, Reporting Executive Compensation and First-Tier Subcontract Awards (OCT 2016) (Pub. L. 109-282) (31 U.S.C. 6101 note) (Applies to contracts valued at $30,000 or more).

(ii) 52.222-19, Child Labor—Cooperation with Authorities and Remedies (Oct 2016) (E.O. 13126) (Applies to contracts for supplies exceeding the micro-purchase threshold.)

(iii) 52.222-20, Contracts for Materials, Supplies, Articles, and Equipment Exceeding $15,000 (May 2014) (41 U.S.C. chapter 65) (Applies to supply contracts over $15,000 in the United States, Puerto Rico, or the U.S. Virgin Islands).

(iv) 52.222-35, Equal Opportunity for Veterans (Oct 2015) (38 U.S.C. 4212) (applies to contracts of $150,000 or more).

(v) 52.222-36, Equal Employment for Workers with Disabilities (Jul 2014) (29 U.S.C. 793) (Applies to contracts over $15,000, unless the work is to be performed outside the United States by employees recruited outside the United States.) (For purposes of this clause, "United States" includes the 50 States, the District of Columbia, Puerto Rico, the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, and Wake Island.)

(vi) 52.222-37, Employment Reports on Veterans (Feb 2016) (38 U.S.C. 4212) (Applies to contracts of $150,000 or more).

(vii) 52.222-41, Service Contract Labor Standards (May 2014) (41 U.S.C. chapter 67) (Applies to service contracts over $2,500 that are subject to the Service Contract Labor Standards statute and will be performed in the United States, District of Columbia, Puerto Rico, the Northern Mariana Islands, American Samoa, Guam, the U.S. Virgin Islands, Johnston Island, Wake Island, or the outer Continental Shelf).

(viii)(A) 52.222-50, Combating Trafficking in Persons (Mar 2015) (22 U.S.C. chapter 78 and E.O 13627) (Applies to all solicitations and contracts).

(B) Alternate I (Mar 2015) (Applies if the Contracting Officer has filled in the following information with regard to applicable directives or notices: Document title(s), source for obtaining document(s), and contract performance location outside the United States to which the document applies).

(ix) 52.222-55, Minimum Wages Under Executive Order 13658 (Dec 2015) (Applies when 52.222-6 or 52.222-41 are in the contract and performance in whole or in part is in the United States (the 50 States and the District of Columbia)).

(x) 52.222-62, Paid Sick Leave Under Executive Order 13706 (JAN 2017) (E.O. 13706) (Applies when 52.222-6 or 52.222-41 are in the contract and performance in whole or in part is in the United States (the 50 States and the District of Columbia.))

(xi) 52.223-5, Pollution Prevention and Right-to-Know Information (MAY 2011) (E.O. 13423) (Applies to services performed on Federal facilities).

(xii) 52.223-11, Ozone-Depleting Substances and High Global Warming Potential Hydrofluorocarbons (JUN 2016) (E.O. 13693)(applies to contracts for products as prescribed at FAR 23.804(a)(1)).

(xiii) 52.223-12, Maintenance, Service, Repair, or Disposal of Refrigeration Equipment and Air Conditioners (JUN 2016) (E.O. 13693) (Applies to maintenance, service, repair, or disposal of refrigeration equipment and air conditioners).

(xiv) 52.223-15, Energy Efficiency in Energy-Consuming Products (DEC 2007) (42 U.S.C. 8259b) (Unless exempt pursuant to 23.204, applies to contracts when energy-consuming products listed in the ENERGY STAR® Program or Federal Energy Management Program (FEMP)) will be—

(A) Delivered;

(B) Acquired by the Contractor for use in performing services at a Federally-controlled facility;

(C) Furnished by the Contractor for use by the Government; or

(D) Specified in the design of a building or work, or incorporated during its construction, renovation, or maintenance).

(xv) 52.223-20, Aerosols (JUN 2016) (E.O. 13693) (Applies to contracts for products that may contain high global warming potential hydrofluorocarbons as a propellant or as a solvent; or contracts for maintenance or repair of electronic or mechanical devices).

(xvi) 52.223-21, Foams (JUN 2016) (E.O. 13693) (Applies to contracts for products that may contain high global warming potential hydrofluorocarbons or refrigerant blends containing hydrofluorocarbons as a foam blowing agent; or contracts for construction of buildings or facilities.

(xvii) 52.225-1, Buy American—Supplies (May 2014) (41 U.S.C. chapter 67) (Applies to contracts for supplies, and to contracts for services involving the furnishing of supplies, for use in the United States or its outlying areas, if the value of the supply contract or supply portion of a service contract exceeds the micro-purchase threshold and the acquisition—

(A) Is set aside for small business concerns; or

(B) Cannot be set aside for small business concerns (see 19.502-2), and does not exceed $25,000).

(xviii) 52.226-6, Promoting Excess Food Donation to Nonprofit Organizations (May 2014) (42 U.S.C. 1792) (Applies to contracts greater than $25,000 that provide for the provision, the service, or the sale of food in the United States).

(xix) 52.232-33, Payment by Electronic Funds Transfer—System for Award Management (Jul 2013) (Applies when the payment will be made by electronic funds transfer (EFT) and the payment office uses the System for Award Management (SAM) database as its source of EFT information).

(xx) 52.232-34, Payment by Electronic Funds Transfer—Other than System for Award Management (JUL 2013) (Applies when the payment will be made by EFT and the payment office does not use the SAM database as its source of EFT information).

(xxi) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (Feb 2006) (46 U.S.C. App. 1241) (Applies to supplies transported by ocean vessels (except for the types of subcontracts listed at 47.504(d)).

(2) Listed below are additional clauses that may apply:

(i) 52.204-21, Basic Safeguarding of Covered Contractor Information Systems (JUN 2016) (Applies to contracts when the contractor or a subcontractor at any tier may have Federal contract information residing in or transiting through its information system.

(ii) 52.209-6, Protecting the Government's Interest When Subcontracting with Contractors Debarred, Suspended, or Proposed for Debarment (OCT 2015) (Applies to contracts over $35,000).

(iii) 52.211-17, Delivery of Excess Quantities (Sept 1989) (Applies to fixed-price supplies).

(iv) 52.247-29, F.o.b. Origin (Feb 2006) (Applies to supplies if delivery is f.o.b. origin).

(v) 52.247-34, F.o.b. Destination (Nov 1991) (Applies to supplies if delivery is f.o.b. destination).

(c) FAR. This contract incorporates one or more clauses by reference, with the same force and effect as if they were given in full text. Upon request, the Contracting Officer will make their full text available. Also, the full text of a clause may be accessed electronically at this/these address(es): http://www.acquisition.gov/far

(d) Inspection/Acceptance. The Contractor shall tender for acceptance only those items that conform to the requirements of this contract. The Government reserves the right to inspect or test any supplies or services that have been tendered for acceptance. The Government may require repair or replacement of nonconforming supplies or reperformance of nonconforming services at no increase in contract price. The Government must exercise its postacceptance rights—

(1) Within a reasonable period of time after the defect was discovered or should have been discovered; and

(2) Before any substantial change occurs in the condition of the item, unless the change is due to the defect in the item.

(e) Excusable delays. The Contractor shall be liable for default unless nonperformance is caused by an occurrence beyond the reasonable control of the Contractor and without its fault or negligence, such as acts of God or the public enemy, acts of the Government in either its sovereign or contractual capacity, fires, floods, epidemics, quarantine restrictions, strikes, unusually severe weather, and delays of common carriers. The Contractor shall notify the Contracting Officer in writing as soon as it is reasonably possible after the commencement of any excusable delay, setting forth the full particulars in connection therewith, shall remedy such occurrence with all reasonable dispatch, and shall promptly give written notice to the Contracting Officer of the cessation of such occurrence.

(f) Termination for the Government's convenience. The Government reserves the right to terminate this contract, or any part hereof, for its sole convenience. In the event of such termination, the Contractor shall immediately stop all work hereunder and shall immediately cause any and all of its suppliers and subcontractors to cease work. Subject to the terms of this contract, the Contractor shall be paid a percentage of the contract price reflecting the percentage of the work performed prior to the notice of termination, plus reasonable charges that the Contractor can demonstrate to the satisfaction of the Government, using its standard record keeping system, have resulted from the termination. The Contractor shall not be required to comply with the cost accounting standards or contract cost principles for this purpose. This paragraph does not give the Government any right to audit the Contractor's records. The Contractor shall not be paid for any work performed or costs incurred that reasonably could have been avoided.

(g) Termination for cause. The Government may terminate this contract, or any part hereof, for cause in the event of any default by the Contractor, or if the Contractor fails to comply with any contract terms and conditions, or fails to provide the Government, upon request, with adequate assurances of future performance. In the event of termination for cause, the Government shall not be liable to the Contractor for any amount for supplies or services not accepted, and the Contractor shall be liable to the Government for any and all rights and remedies provided by law. If it is determined that the Government improperly terminated this contract for default, such termination shall be deemed a termination for convenience.

(h) Warranty. The Contractor warrants and implies that the items delivered hereunder are merchantable and fit for use for the particular purpose described in this contract.

52.219-28 Post-Award Small Business Program Rerepresentation. (JUL 2013)

(a) *Definitions*. As used in this clause-

Long-term contract means a contract of more than five years in duration, including options. However, the term does not include contracts that exceed five years in duration because the period of performance has been extended for a cumulative period not to exceed six months under the clause at 52.217-8, Option to Extend Services, or other appropriate authority.

Small business concern means a concern, including its affiliates that is independently owned and operated, not dominant in the field of operation in which it is bidding on Government contracts, and qualified as a small business under the criteria in 13 CFR part 121 and the size standard in paragraph (c) of this clause. Such a concern is "not dominant in its field of operation" when it does not exercise a controlling or major influence on a national basis in a kind of business activity in which a number of business concerns are primarily engaged. In determining whether dominance exists, consideration shall be given to all appropriate factors, including volume of business, number of employees, financial resources, competitive status or position, ownership or control of materials, processes, patents, license agreements, facilities, sales territory, and nature of business activity.

(b) If the Contractor represented that it was a small business concern prior to award of this contract, the Contractor shall rerepresent its size status according to paragraph (e) of this clause or, if applicable, paragraph (g) of this clause, upon the occurrence of any of the following:

(1) Within 30 days after execution of a novation agreement or within 30 days after modification of the contract to include this clause, if the novation agreement was executed prior to inclusion of this clause in the contract.

(2) Within 30 days after a merger or acquisition that does not require a novation or within 30 days after modification of the contract to include this clause, if the merger or acquisition occurred prior to inclusion of this clause in the contract.

(3) For long-term contracts-

(i) Within 60 to 120 days prior to the end of the fifth year of the contract; and

(ii) Within 60 to 120 days prior to the date specified in the contract for exercising any option thereafter.

(c) The Contractor shall rerepresent its size status in accordance with the size standard in effect at the time of this rerepresentation that corresponds to the North American Industry Classification System (NAICS) code assigned to this contract. The small business size standard corresponding to this NAICS code can be found at *http://www.sba.gov/content/table-small-business-size-standards*.

(d) The small business size standard for a Contractor providing a product which it does not manufacture itself, for a contract other than a construction or service contract, is 500 employees.

(e) Except as provided in paragraph (g) of this clause, the Contractor shall make the rerepresentation required by paragraph (b) of this clause by validating or updating all its representations in the Reprensentations and Certifications section of the System for Award Management (SAM) and its other data in SAM, as necessary, to ensure that they reflect the Contractor's current status. The Contractor shall notify the contracting office in writing within the timeframes specified in paragraph (b) of this clause that the data have been validated or updated, and provide the date of the validation or update.

(f) If the Contractor represented that it was other than a small business concern prior to award of this contract, the Contractor may, but is not required to, take the actions required by paragraphs (e) or (g) of this clause.

(g) If the Contractor does not have representations and certifications in SAM, or does not have a representation in SAM for the NAICS code applicable to this contract, the Contractor is required to complete the following rerepresentation and submit it to the contracting office, along with the contract number and the date on which the rerepresentation was completed:

The Contractor represents that it ___ is, ___ is not a small business concern under NAICS Code [*insert NAICS Code*] assigned to contract number [*insert contract number*]. (*Contractor to sign and date and insert authorized signer's name and title).*

(End of clause)

52.222-42 Statement of Equivalent Rates for Federal Hires. (MAY 2014)

In compliance with the Service Contract Labor Standards statute and the regulations of the Secretary of Labor (29 CFR part 4), this clause identifies the classes of service employees expected to be employed under the contract and states the wages and fringe benefits payable to each if they were employed by the contracting agency subject to the provisions of 5 U.S.C. 5341 or 5332.

This Statement is for Information Only:
It Is Not A Wage Determination.

Employee Class	**Monetary Wage - Fringe Benefits**
Forestry Aid: GS-3	$12.53 + fringes
Forestry Technician: GS-5	$15.74 + fringes
Forestry Technician: GS-9	$23.85 + fringes

(End of clause)

52.223-2 Affirmative Procurement of Biobased Products Under Service and Construction Contracts. (SEP 2013)

(a) In the performance of this contract, the contractor shall make maximum use of biobased products that are United States Department of Agriculture (USDA)-designated items unless-

(1) The product cannot be acquired-

(i) Competitively within a time frame providing for compliance with the contract performance schedule;

(ii) Meeting contract performance requirements; or

(iii) At a reasonable price.

(2) The product is to be used in an application covered by a USDA categorical exemption (see 7 CFR 3201.3(e)). For example, all USDA-designated items are exempt from the preferred procurement requirement for the following:

(i) Spacecraft system and launch support equipment.

(ii) Military equipment, *i.e.*, a product or system designed or procured for combat or combat-related missions.

(b) Information about this requirement and these products is available at http://www.biopreferred.gov.

(c) In the performance of this contract, the Contractor shall-

(1) Report to *http://www.sam.gov*, with a copy to the Contracting Officer, on the product types and dollar value of any USDA-designated biobased products purchased by the Contractor during the previous Government fiscal year, between October 1 and September 30; and

(2) Submit this report no later than-

(i) October 31 of each year during contract performance; and

(ii) At the end of contract performance.

(End of clause)

52.232-16 Progress Payments. (APR 2012)

The Government will make progress payments to the Contractor when requested as work progresses, but not more frequently than monthly, in amounts of $2,500 or more approved by the Contracting Officer, under the following conditions:

(a) *Computation of amounts*. (1) Unless the Contractor requests a smaller amount, the Government will compute each progress payment as 80 percent of the Contractor's total costs incurred under this contract whether or not actually paid, plus financing payments to subcontractors (see paragraph (j) of this clause), less the sum of all previous progress payments made by the Government under this contract. The Contracting Officer will consider cost of money that would be allowable under FAR 31.205-10 as an incurred cost for progress payment purposes.

(2) The amount of financing and other payments for supplies and services purchased directly for the contract are limited to the amounts that have been paid by cash, check, or other forms of payment, or that are determined due and will be paid to subcontractors-

(i) In accordance with the terms and conditions of a subcontract or invoice; and

(ii) Ordinarily within 30 days of the submission of the Contractor's payment request to the Government.

(3) The Government will exclude accrued costs of Contractor contributions under employee pension plans until actually paid unless-

(i) The Contractor's practice is to make contributions to the retirement fund quarterly or more frequently; and

(ii) The contribution does not remain unpaid 30 days after the end of the applicable quarter or shorter payment period (any contribution remaining unpaid shall be excluded from the Contractor's total costs for progress payments until paid).

(4) The Contractor shall not include the following in total costs for progress payment purposes in paragraph (a)(1) of this clause:

(i) Costs that are not reasonable, allocable to this contract, and consistent with sound and generally accepted accounting principles and practices.

(ii) Costs incurred by subscontractors or suppliers.

(iii) Costs ordinarily capitalized and subject to depreciation or amortization except for the properly depreciated or amortized portion of such costs.

(iv) Payments made or amounts payable to subcontractors or suppliers, except for -

(A) Completed work, including partial deliveries, to which the Contractor has acquired title; and

(B) Work under cost-reimbursement or time-and-material subcontracts to which the Contractor has acquired title.

(5) The amount of unliquidated progress payments may exceed neither (i) the progress payments made against incomplete work (including allowable unliquidated progress payments to subcontractors) nor (ii) the value, for progress payment purposes, of the incomplete work. Incomplete work shall be considered

to be the supplies and services required by this contract, for which delivery and invoicing by the Contractor and acceptance by the Government are incomplete.

(6) The total amount of progress payments shall not exceed 80 percent of the total contract price.

(7) If a progress payment or the unliquidated progress payments exceed the amounts permitted by subparagraphs (a)(4) or (a)(5) above, the Contractor shall repay the amount of such excess to the Government on demand.

(8) Notwithstanding any other terms of the contract, the Contractor agrees not to request progress payments in dollar amounts of less than $2,500. The Contracting Officer may make exceptions.

(9) The costs applicable to items delivered, invoiced, and accepted shall not include costs in excess of the contract price of the items.

(b) *Liquidation.* Except as provided in the Termination for Convenience of the Government clause, all progress payments shall be liquidated by deducting from any payment under this contract, other than advance or progress payments, the unliquidated progress payments, or 80 percent of the amount invoiced, whichever is less. The Contractor shall repay to the Government any amounts required by a retroactive price reduction, after computing liquidations and payments on past invoices at the reduced prices and adjusting the unliquidated progress payments accordingly. The Government reserves the right to unilaterally change from the ordinary liquidation rate to an alternate rate when deemed appropriate for proper contract financing.

(c) *Reduction or suspension.* The Contracting Officer may reduce or suspend progress payments, increase the rate of liquidation, or take a combination of these actions, after finding on substantial evidence any of the following conditions:

(1) The Contractor failed to comply with any material requirement of this contract (which includes paragraphs (f) and (g) below).

(2) Performance of this contract is endangered by the Contractor's-

(i) Failure to make progress; or

(ii) Unsatisfactory financial condition.

(3) Inventory allocated to this contract substantially exceeds reasonable requirements.

(4) The Contractor is delinquent in payment of the costs of performing this contract in the ordinary course of business.

(5) The fair value of the undelivered work is less than the amount of unliquidated progress payments for that work.

(6) The Contractor is realizing less profit than that reflected in the establishment of any alternate liquidation rate in paragraph (b) above, and that rate is less than the progress payment rate stated in subparagraph (a)(1) above.

(d) *Title.* (1) Title to the property described in this paragraph (d) shall vest in the Government. Vestiture shall be immediately upon the date of this contract, for property acquired or produced before that date. Otherwise, vestiture shall occur when the property is or should have been allocable or properly chargeable to this contract.

(2) "Property," as used in this clause, includes all of the below-described items acquired or produced by the Contractor that are or should be allocable or properly

chargeable to this contract under sound and generally accepted accounting principles and practices.

(i) Parts, materials, inventories, and work in process;

(ii) Special tooling and special test equipment to which the Government is to acquire title;

(iii) Nondurable (*i.e.*, noncapital) tools, jigs, dies, fixtures, molds, patterns, taps, gauges, test equipment, and other similar manufacturing aids, title to which would not be obtained as special tooling under subparagraph (ii) above; and

(iv) Drawings and technical data, to the extent the Contractor or subcontractors are required to deliver them to the Government by other clauses of this contract.

(3) Although title to property is in the Government under this clause, other applicable clauses of this contract; *e.g.*, the termination clauses, shall determine the handling and disposition of the property.

(4) The Contractor may sell any scrap resulting from production under this contract without requesting the Contracting Officer's approval, but the proceeds shall be credited against the costs of performance.

(5) To acquire for its own use or dispose of property to which title is vested in the Government under this clause, the Contractor must obtain the Contracting Officer's advance approval of the action and the terms. The Contractor shall (i) exclude the allocable costs of the property from the costs of contract performance, and (ii) repay to the Government any amount of unliquidated progress payments allocable to the property. Repayment may be by cash or credit memorandum.

(6) When the Contractor completes all of the obligations under this contract, including liquidation of all progress payments, title shall vest in the Contractor for all property (or the proceeds thereof) not-

(i) Delivered to, and accepted by, the Government under this contract; or

(ii) Incorporated in supplies delivered to, and accepted by, the Government under this contract and to which title is vested in the Government under this clause.

(7) The terms of this contract concerning liability for Government-furnished property shall not apply to property to which the Government acquired title solely under this clause.

(e) *Risk of loss*. Before delivery to and acceptance by the Government, the Contractor shall bear the risk of loss for property, the title to which vests in the Government under this clause, except to the extent the Government expressly assumes the risk. The Contractor shall repay the Government an amount equal to the unliquidated progress payments that are based on costs allocable to property that is lost (see 45.101).

(f) *Control of costs and property*. The Contractor shall maintain an accounting system and controls adequate for the proper administration of this clause.

(g) *Reports, forms, and access to records*. (1) The Contractor shall promptly furnish reports, certificates, financial statements, and other pertinent information (including estimates to complete) reasonably requested by the Contracting Officer for the

administration of this clause. Also, the Contractor shall give the Government reasonable opportunity to examine and verify the Contractor's books, records, and accounts.

(2) The Contractor shall furnish estimates to complete that have been developed or updated within six months of the date of the progress payment request. The estimates to complete shall represent the Contractor's best estimate of total costs to complete all remaining contract work required under the contract. The estimates shall include sufficient detail to permit Government verification.

(3) Each Contractor request for progress payment shall:

(i) Be submitted on Standard Form 1443, Contractor's Request for Progress Payment, or the electronic equivalent as required by agency regulations, in accordance with the form instructions and the contract terms; and

(ii) Include any additional supporting documentation requested by the Contracting Officer.

(h) *Special terms regarding default.* If this contract is terminated under the Default clause, (i) the Contractor shall, on demand, repay to the Government the amount of unliquidated progress payments and (ii) title shall vest in the Contractor, on full liquidation of progress payments, for all property for which the Government elects not to require delivery under the Default clause. The Government shall be liable for no payment except as provided by the Default clause.

(i) *Reservations of rights.* (1) No payment or vesting of title under this clause shall-

(i) Excuse the Contractor from performance of obligations under this contract; or

(ii) Constitute a waiver of any of the rights or remedies of the parties under the contract.

(2) The Government's rights and remedies under this clause-

(i) Shall not be exclusive but rather shall be in addition to any other rights and remedies provided by law or this contract; and

(ii) Shall not be affected by delayed, partial, or omitted exercise of any right, remedy, power, or privilege, nor shall such exercise or any single exercise preclude or impair any further exercise under this clause or the exercise of any other right, power, or privilege of the Government.

(j) *Financing payments to subcontractors.* The financing payments to subcontractors mentioned in paragraphs (a)(1) and (a)(2) of this clause shall be all financing payments to subcontractors or divisions, if the following conditions are met:

(1) The amounts included are limited to-

(i) The unliquidated remainder of financing payments made; plus

(ii) Any unpaid subcontractor requests for financing payments.

(2) The subcontract or interdivisional order is expected to involve a minimum of approximately 6 months between the beginning of work and the first delivery; or, if the subcontractor is a small business concern, 4 months.

(3) If the financing payments are in the form of progress payments, the terms of the subcontract or interdivisional order concerning progress payments-

(i) Are substantially similar to the terms of this clause for any subcontractor that is a large business concern, or this clause with its Alternate I for any subcontractor that is a small business concern;
(ii) Are at least as favorable to the Government as the terms of this clause;
(iii) Are not more favorable to the subcontractor or division than the terms of this clause are to the Contractor;
(iv) Are in conformance with the requirements of FAR 32.504(e); and
(v) Subordinate all subcontractor rights concerning property to which the Government has title under the subcontract to the Government's right to require delivery of the property to the Government if-

(A) The Contractor defaults; or
(B) The subcontractor becomes bankrupt or insolvent.

(4) If the financing payments are in the form of performance-based payments, the terms of the subcontract or interdivisional order concerning payments-

(i) Are substantially similar to the Performance-Based Payments clause at FAR 52.232-32 and meet the criteria for, and definition of, performance-based payments in FAR Part 32;
(ii) Are in conformance with the requirements of FAR 32.504(f); and
(iii) Subordinate all subcontractor rights concerning property to which the Government has title under the subcontract to the Government's right to require delivery of the property to the Government if-

(A) The Contractor defaults; or
(B) The subcontractor becomes bankrupt or insolvent.

(5) If the financing payments are in the form of commercial item financing payments, the terms of the subcontract or interdivisional order concerning payments -

(i) Are constructed in accordance with FAR 32.206(c) and included in a subcontract for a commercial item purchase that meets the definition and standards for acquisition of commercial items in FAR Parts 2 and 12;
(ii) Are in conformance with the requirements of FAR 32.504(g); and
(iii) Subordinate all subcontractor rights concerning property to which the Government has title under the subcontract to the Government's right to require delivery of the property to the Government if-

(A) The Contractor defaults; or
(B) The subcontractor becomes bankrupt or insolvent.

(6) If financing is in the form of progress payments, the progress payment rate in the subcontract is the customary rate used by the contracting agency, depending on whether the subcontractor is or is not a small business concern.
(7) Concerning any proceeds received by the Government for property to which title has vested in the Government under the subcontract terms, the parties agree that the proceeds shall be applied to reducing any unliquidated financing payments by the Government to the Contractor under this contract.
(8) If no unliquidated financing payments to the Contractor remain, but there are unliquidated financing payments that the Contractor has made to any subcontractor, the Contractor shall be subrogated to all the rights the Government

obtained through the terms required by this clause to be in any subcontract, as if all such rights had been assigned and transferred to the Contractor.

(9) To facilitate small business participation in subcontracting under this contract, the Contractor shall provide financing payments to small business concerns, in conformity with the standards for customary contract financing payments stated in FAR 32.113. The Contractor shall not consider the need for such financing payments as a handicap or adverse factor in the award of subcontracts.

(k) *Limitations on undefinitized contract actions*. Notwithstanding any other progress payment provisions in this contract, progress payments may not exceed 80 percent of costs incurred on work accomplished under undefinitized contract actions. A "contract action" is any action resulting in a contract, as defined in Subpart 2.1, including contract modifications for additional supplies or services, but not including contract modifications that are within the scope and under the terms of the contract, such as contract modifications issued pursuant to the Changes clause, or funding and other administrative changes. This limitation shall apply to the costs incurred, as computed in accordance with paragraph (a) of this clause, and shall remain in effect until the contract action is definitized. Costs incurred which are subject to this limitation shall be segregated on Contractor progress payment requests and invoices from those costs eligible for higher progress payment rates. For purposes of progress payment liquidation, as described in paragraph (b) of this clause, progress payments for undefinitized contract actions shall be liquidated at 80 percent of the amount invoiced for work performed under the undefinitized contract action as long as the contract action remains undefinitized. The amount of unliquidated progress payments for undefinitized contract actions shall not exceed 80 percent of the maximum liability of the Government under the undefinitized contract action or such lower limit specified elsewhere in the contract. Separate limits may be specified for separate actions.

(l) *Due date*. The designated payment office will make progress payments on the [Contracting Officer insert date as prescribed by agency head; if not prescribed, insert "30th"] day after the designated billing office receives a proper progress payment request. In the event that the Government requires an audit or other review of a specific progress payment request to ensure compliance with the terms and conditions of the contract, the designated payment office is not compelled to make payment by the specified due date. Progress payments are considered contract financing and are not subject to the interest penalty provisions of the Prompt Payment Act.

(m) *Progress payments under indefinite-delivery contracts*. The Contractor shall account for and submit progress payment requests under individual orders as if the order constituted a separate contract, unless otherwise specified in this contract.

52.236-1 Performance of Work by the Contractor (1984)

The Contractor shall perform on the site, and with its own organization, work equivalent to at least one hundred (100) percent of the total amount of work to be performed under the contract. This percentage may be reduced by a supplemental agreement to this contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

52.246-20 Warranty of Services. (MAY 2001)

(a) *Definition.*

"Acceptance," as used in this clause, means the act of an authorized representative of the Government by which the Government assumes for itself, or as an agent of another, ownership of existing and identified supplies, or approves specific services, as partial or complete performance of the contract.

(b) Notwithstanding inspection and acceptance by the Government or any provision concerning the conclusiveness thereof, the Contractor warrants that all services performed under this contract will, at the time of acceptance, be free from defects in workmanship and conform to the requirements of this contract. The Contracting Officer shall give written notice of any defect or nonconformance to the Contractor [*Contracting Officer shall insert the specific period of time in which notice shall be given to the Contractor; e.g., "within 30 days from the date of acceptance by the Government,"; within 1000 hours of use by the Government;" or other specified event whose occurrence will terminate the period of notice, or combination of any applicable events or period of time*]. This notice shall state either-

(1) That the Contractor shall correct or reperform any defective or nonconforming services; or

(2) That the Government does not require correction or reperformance.

(c) If the Contractor is required to correct or reperform, it shall be at no cost to the Government, and any services corrected or reperformed by the Contractor shall be subject to this clause to the same extent as work initially performed. If the Contractor fails or refuses to correct or reperform, the Contracting Officer may, by contract or otherwise, correct or replace with similar services and charge to the Contractor the cost occasioned to the Government thereby, or make an equitable adjustment in the contract price.

(d) If the Government does not require correction or reperformance, the Contracting Officer shall make an equitable adjustment in the contract price.

(End of clause)

452.236-78 Fire Suppression and Liability. (MAR 2016)

(a) *Contractor's Responsibility for Fire Fighting*. The Contractor, under the provisions of FAR clause at 52.236-9, *Protection of Existing Vegetation, Structures, Equipment, Utilities, and Improvements*, shall immediately extinguish all fires on the work site other than those fires in use as a part of the work. The Contractor may be held liable for all damages and for all costs incurred by the Government for labor, subsistence, equipment,

supplies, and transportation deemed necessary to control or suppress a fire set or caused by the Contractor or the Contractor's agents or employees subject to the following fire classifications listed in subsection (b).

(b) *Fire Suppression Costs*. The Contractor's obligations for cost of fire suppression vary according to three classifications of fires as follows:

(1) *Operations Fire*. An "operations fire" is a fire caused by the Contractor's operations other than a negligent fire. The Contractor agrees to reimburse Forest Service for such cost for each operations fire, subject to a maximum dollar amount of [Contracting Officer insert amount]. The cost of the Contractor's actions, supplies, and equipment on any such fire, or otherwise provided at the request of Forest Service, shall be credited toward such maximum. If the Contractor's actual cost exceeds contractor's obligation stated above, Forest Service shall reimburse the contractor for the excess.

(2) *Negligent Fire*. A "negligent fire" is a fire caused by the negligence or fault of the Contractor's operations including, but not limited to, one caused by smoking by persons engaged in the Contractor's operations during the course of their employment, or during rest or lunch periods; or if the Contractor's failure to comply with requirements under this contract results in a fire starting, or permits a fire to spread. Damages and the cost of suppressing negligent fires shall be borne by the Contractor.

(3) *Other Fires on Contract Area*. Forest Service shall pay the Contractor, at firefighting rates common in the area or at prior agreed rates, for equipment or personnel furnished by the Contractor at the request of Forest Service, on any fire on contract area other than an operations fire or a negligent fire.

(c) *Contractor's Responsibility for Notification in Case of Fire*. The Contractor shall immediately notify the Government of any fires sighted on or in the vicinity of the work site.

(d) *Contractor's Responsibility for Responding to Emergencies*. When directed by the Contracting Officer, the Contractor shall temporarily redirect employees and equipment from the work site for emergency work (anticipated to be restricted to firefighting). This is considered to be within the general scope of the contract. An equitable adjustment for any such redirection of employees and equipment will be made under the FAR clause at 52.243-4, Changes.

(e) *Performance by the Contractor*. Where the Contractor's employees, agents, contractors, subcontractors, or their employees or agents perform the Contractor's operations in connection with fire responsibilities, the Contractor's obligations shall be the same as if performance was by Contractor.

(f) *State Law*. The Contractor shall not be relieved by the terms of this contract of any liability to the United States for fire suppression costs recovered in an action based on State law, except for such costs resulting from operations fires. Amounts due to the Contractor for firefighting expenditures on operations fires shall not be withheld pending settlement of any such claim or action based on State law.

(End of Clause)

SECTION J - LIST OF ATTACHMENTS

TITLE	PAGE NO.
1) "A Guide To Hardwood Log Grading - USDA Forest Service, GTR-NE-1, Dated 1973"(32 Pages, Also Available On CD, Or http://treesearch.fs.fed.us/pubs/3948)	** or link
2) "Cruising Changes Guide" – 5/5/2008 ***(includes measurement of tree heights in feet)***	**
3) "Defects In Hardwood Timber - USDA Forest Service, Ag. Handbook No. 678, Dated 1989" (88 Pages, Also Available On CD, Or http://treesearch.fs.fed.us/pubs/13	** or link
4) "Qualified Cruiser Reference Guide – Eastern Region", Revised 10/25/2006 (76 Pages, Also Available On CD)	**
5) "Table Of Contents – Qualified Cruiser Reference Guide", 5/5/2008	55
6) Contractor Daily Log	56
7) Cruise Design Example	57
8) Guide For Hardwood Tree Grading Based On Butt Log (From Forest Service – Eastern Region, Timber Management Field Book, Pages 1.31a, 1.31b)	58
9) Hardwood Log Grading	59
10) Ottawa National Forest - MINIMUM TREE AND PIECE SPECIFICATIONS	60
11) Ottawa National Forest Field Measurements Evaluation Form	61
12) Ottawa Timber Marking Contract Silviculture Inspection Form	62
13) Ottawa Timber Marking Contract Volume Estimation Inspection Form	63
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16) Pertinent Wage Determination Info -- No. 1981-0136,** Rev. No. 42 Dated 12/29/2015	**
17) R9 Timber Sale Cruise Tally Card & Instructions Sheet	**
18) Sawlog Scale Deduction For Sweep Guide	67
19) Species Code Guide Updated	68
20) Volume Distribution Guide Revised Reference	**
21) Ottawa National Forest Vicinity Map	**

**** SEPARATE DOCUMENTS**

DEFINITIONS

10 BAF Check Plot - A plot located in a unit, employed to check designated basal area against the desired basal area indicated by the silvicultural prescription, using a 10 Basal Area Factor wedge prism or equivalent instrument. This would typically be used in Cut Tree Marking Payment Units.

Archeological Site (also Cultural Resource site, or Heritage Resource site) - Any cultural, historic, or prehistoric site of significance so determined by an archaeologist and requiring protection under Federal law. In the Forest locality, those can include but are not limited to shelters, old logging camps, old railroad grades, cemeteries, graves, homesteads, buildings, and so one.

Cut Tree Marking (CTM – Individual Tree) – Individual trees to be CUT are marked with approved tree marking paint above and below stump height in all or parts of a Payment Unit. In addition to CTM, a Payment Unit may include trees included for removal by Species Designation (DxSPP). The Marking Guides will include instructions as to which Species these are and indicate if all LIVE and/or DEAD trees of this Species that meet minimum specifications (cite reference) are designated for removal EXCEPT for trees marked as RESERVE TREES or trees within PROTECTED AREAS. Unless otherwise indicated, these trees will be marked with a paint spot at eye level to verify the tree was counted – a stump mark will not be required.

Designation by Species and Diameter (DxSPP) – Generally in a clearcut or removal cut, where all LIVE and/or DEAD trees that meet minimum specifications (cite reference) are designated for removal EXCEPT for trees marked as RESERVE TREES or trees within PROTECTED AREAS. For Payment Units where volume is cruised using Variable Plot or Fixed Plot Cruising these trees will not be marked with paint (EXCEPT for trees on plots/points – discussed elsewhere). In Payment Units where designated Species are too variable for Variable Plot or Fixed Plot Cruising, trees designated for removal will be marked with a paint spot at eye level to verify the tree was counted – a stump mark is not generally required.

Intermediate Harvest - A harvest method whereby a portion of trees are removed leaving a residual, merchantable stand for harvest consideration within ten to twenty years. For this contract, a thinning, selection cut, and shelterwood seed tree cut shall be considered intermediate harvest.

Leave Tree Marking (LTM – Individual Tree) – Individual trees which are NOT TO BE CUT are marked with approved tree marking paint above and below stump height in all or parts of a Payment Unit.

Multi-Product Tree - A tree containing two different wood products, i.e. sawtimber and pulpwood (referred to as topwood) within the same bole.

Payment Unit - (or sometimes Stand(s)) - Individual areas to be marked for timber harvest, comprised of one or more stands of timber with a specific silvicultural prescription.

Payment Unit Boundary – Exterior boundary trees are marked with 3 ORANGE paint slashes above stump height (generally eye level or higher) with a corresponding stump mark. Interior boundary trees are marked with 2 ORANGE paint slashes above stump height (generally eye level or higher) on opposite sides of the tree, facing into the Payment Unit, with a corresponding stump mark. There may be single-slash boundaries within a Payment Unit to indicate "no equipment" zones.

Protected Area - An area of trees selected to remain undesignated for marking or harvest within a Payment Unit. Boundary trees along the perimeter of Protected Areas will be identified by 3 ORANGE painted slashes, and "PA", at eye level (facing AWAY from the Protected Area) with a corresponding stump mark.

Reserve Tree - A tree selected to remain undesignated for marking or harvest within a unit. LIVE and/or DEAD tree(s), within a Payment Unit, identified by an ORANGE painted band(s) ringing the tree at eye level, with a corresponding stump mark. These trees may have more than one painted band depending on the reason the tree is to be left uncut.

Sample Tree - A tree randomly selected for measurement to represent a portion of the tree population being sampled.

Stump Marks - All stump marks shall be made so the so the mark is touching the ground, and will remain once the tree has been cut to contract specifications. Stump marks shall be a minimum of 12 square inches (four inch diameter spot or two inch by six inch horizontal stripe). Mark should be concentrated in a crevice of the tree relatively free of moss or lichens. On sloped ground, the stump mark shall be placed on the downhill side of the tree. A long tail will be incorporated on boundary trees, reserve trees, and cut trees (CTM/DxSPP) to help verify presence of the mark during deep snow/winter logging operations.

Timber Cruiser - An individual certified by the Government to have sufficient knowledge and skill capable of applying a silvicultural prescription to a stand of trees and making accurate measurements necessary to estimate volume within an acceptable range of variation.

R9 Timber Sale Cruise Tally Card & Instructions Sheet - Used to record sample tree measurement data and tree counts; used to estimate individual unit volume and total timber sale volume.

Volume Distribution Chart - A graphic representation of tree volume based upon number of eight (8) foot logs per tree and their relative position, displayed in four (4) foot increments. Used for estimating percentage of volume lost to defect.

Qualified Cruiser Reference Guide – USDA Forest Service
Eastern Region (5/4/2008)

-Attachment 5-

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CONTRACTOR DAILY LOG
-Attachment 6-

Sale Name _____ **Contractor** _____

Date	Payment Unit	Paint Color	Paint Used (Quantity)

OTTAWA TIMBER SALE **-Attachment 7-**
CRUISE DESIGN EXAMPLE

Estimated Sale Value: $200,000.00
Estimated CV Range: 30-75%
Maximum Sampling Error: 10%
Cruise Method: All Hardwood Payment Units, STR; All Aspen Clearcuts, PCMTRE

STRATA 1: All Hardwood Payment Units, Cut Tree Marking/Sample Tree Cruise

Sample Group	Species/Product	DBH Range	Sample Interval
1	Hardwood pulp (02)	5.0 - 10.9	1-300
2	Hardwood pulp (02)	11.0 +	1-50
3	Sugar maple saw (01)	11.0 - 16.9	1-20
4	Sugar maple saw (01)	17.0" +	1-10
5	Yellow birch saw (01)	11.0' +	1-10
6	Other hard saw (01)	11.0 - 16.9	1-20
7	Other hard saw (01)	17.0" +	1-10
8	Aspen pulp* (02)	5.0" +	1-50
9	Balsam fir pulp* (02)	5.0" +	1-50
10	Spruce saw (01)	16.0" +	1-5

* Cruise all aspen and balsam fir as pulpwood.

To avoid bias and clumping of tallies, a random start should be used for each sample group at the start of marking in each payment unit. Select a random interval that is less than the required sample interval for the first tally in each sample group. Thereafter, sample at the specified sample interval.

Strata 2: Aspen Clear Cuts, Variable Plot Sampling, Point Count/Measure Tree Payment Units:

Sample Group	Species/Product	Size Class	Tally Interval
1	Aspen/Pulp* (02)	5.0" +	1st and every 3rd
2	Conifer/Pulp (02)	5.0" +	1st and every 3rd
3	Conifer/Saw (01)	9.0" +	All
4	Hardwood/Pulp (02)	5.0" +	1st and every 3rd
5	Other Hard/Saw (01)	11.0" +	All

* Cruise all aspen as pulpwood only

Place one plot per 2 acres in clearcut units over 30 acres in size and one plot per acre in units less than 30 acres as directed in FSH 2409-24, Section 302.16.

Starting from due North, proceed clockwise around plot and measure the first tree as specified in the table above. Thereafter, measure the species/products at the interval specified. For example, the first aspen tree on plot will be measured. The second will be dot counted and the 3rd tree will be measured. The fourth and fifth tree will be dot tallied and the 6th tree measured and so forth.

GUIDE FOR HARDWOOD TREE GRADING BASED ON BUTT LOG -Attachment 8-
(Forest Service – Eastern Region, Timber Management Field Book, pages 1.31a – 1.31b)

Minimum DBH Based on Form Class 80			Clearcutting in Grading Face of Best 12' Section [1/]			Cull Percent in Grading Section	
0-12'	2-14'	4-16'	Minimum Length per Cutting	Maximum # of Cuttings per Face	Minimum Total Length/Face	Maximum Sweep	Maximum Total Cull %
	Grade 1						
13.5 [2/]	14.0 [2/]	14.5 [2/]	10'	1	10'		
14.7	15.3	15.8	10'	1	10'	15%	40%
18.2	18.9	19.5	5'	2	10'		
22.5	23.5	24.5	3'	2	10'		
	Grade 2						
(10.8) 11.2	11.6	12.0	**Surface**	**Must Be**	**Grade 1**	15%	40%
(11.5) 12.4	12.9	13.3	3'	2	8' (6')	30%	50% [4/]
(12.6) 13.5	14.0	14.5	3'	3 [3/]	8' (6')	30%	50% [4/]
	Grade 3						
(8.2) 8.9	9.2	9.5	2'	Unlimited	6' (4')	50%	50% [5/]

1/ Specs in ( ) are applicable to trees with only 8' of merchantable height – 8 foot grading section
2/ Ash and Basswood Only
3/ Limited to two cuttings for trees with 8-11' of merchantable height
4/ 60% allowed if otherwise Grade 1 quality
5/ 60% allowed if otherwise Grade 2 quality

Hardwood Log Grading

-Attachment 9-

A hardwood log must meet three specifications. It must have at least the minimum specified diameter inside bark (DIB) at the small end, must meet the minimum specified net scale, and be at least grade 3 quality. Grade is determined by the amount of clear cuttings on the 2nd worst face. A clearcutting is the length between grading defects. A grading defect is an abnormality or irregularity that lowers strength, takes away appearance, or otherwise limits utility of the quality zone.

The 2nd worst face is determined by dividing the log surface in to 4 equal quarters or faces. Place as many grading defects into one face as possible. The face with the next most defects is the 2nd worst or grading face.

A log must have at least 50% clearcutting to meet grade 3 quality. A clearcutting has to be at least 2' in length to be considered. Therefore, an 8' log would need to have a minimum of 4' of clearcutting that could be achieved with two 2' clearcuttings. Refer to Technical Report NE-1, a Guide to Hardwood Log Grading for more information.

Common Grading Defects

Bulges & bumps
Burls
Butt scars
Cankers
Conks
Limbs
Knots
Deep holes
Heavy bark distortions

Defects not to be considered

-Straight seams that can be placed between faces
-Frost cracks, seams, and splits that are not deeper than 15% of the log diameter
-Bird peck

MINIMUM TREE AND PIECE UTILIZATION STANDARDS (6/11/2008)
-Attachment 10-

		Minimum Tree Specifications	Minimum Piece Specifications		
SPECIES	**PRODUCT**	**DBH (inches)**	**Length (feet)**	**DIB [3/] (inches)**	**Minimum Net Scale in % of Gross**
Hardwoods (except aspen) Factory-Lumber Log Class	Sawlogs [1/]	11.0	8	9.6-11.5	95%
(grade 3 or better)		11.0	8	11.6+	50%
Aspen	Sawlogs [1/]	9.0	8	7.6	70% [2/]
Softwood	Sawlogs [1/ 5/]	9.0	8	7.6	40%
All Species	Pulpwood	5.0	8	4.0	70% [2/] sound and reasonably straight [4/]

[1/] Only logs which meet Factory log grade 3 or better specifications are considered sawlogs.

[2/] Seventy percent applies to rot, voids, and char. Mechanical type defects such as sweep, crook, spider heart, and ring shake will not be considered.

[3/] Diameter Inside Bark (DIB)

[4/] Reasonably straight - When the true line of a minimum length piece does not deviate more than ½ the inside diameter of the small end plus two inches from a straight line drawn between the centers of the ends of a piece. The maximum deflection allowed requires the piece to slide through an 8-foot-long, 20-inch diameter cylinder.

[5/] On softwoods, sawlog height may be terminated because of limb size when the sum of the diameter of limbs 2 inches or larger within a 1-foot span exceeds Diameter Outside Bark (DOB) of the main stem at that point.

A minimum tree must include at least one piece that meets minimum specifications.

** Product heights are now measured to the nearest foot. All heights are measured in feet from the ground on the high side of the stump.

1. **Conifers – measure total height (to the tip) in feet and the cruise program will calculate the 4" cut-off.**
2. **Hardwoods (includes Aspen) – measure the height in feet to the 4" top.**
3. **Sawtimber – cut-off point or "stoppers" will follow our regular practices. Measure sawtimber height in feet. Secondary product height will be measured as described in item 1 or 2 depending on the species.**
4. **Default dib's are already built into the equations;**
   pulpwood = 4.0"
   sawtimber = 9.6" (hardwood)
   = 7.6" (mixed conifers, pine)
5. **On trees with a broken, dead, or deformed top, record the height to the point where the 4" top or the tip would have been if the tree were still growing normally, then record defect to account for the missing volume.**

Ottawa National Forest
Field Measurements Evaluation Form (Revised 7/30/2008)
-Attachment 11-

Tree Measurements:

CHECK CRUISE ELEMENTS	TOLERANCE	TOTAL POSSIBLE CORRECT ANSWERS	NUMBER OF INCORRECT ANSWERS	ERROR WEIGHT	TOTAL ERROR (bxc)	% CORRECT (1-(d/a))x100
		(a)	(b)	(c)	(d)	(e)
In/Out Trees (Area Est.)	None			2		
Species	None			2		
DBH	+/- 0.2 inch			1		
Saw Height	+/- 4 ft. 1/			1		
Total Height	+/- 4 ft. 1/			1		
Saw Defect	+/- 10%			1		
Pulp Defect	+/- 10%			1		
Tree Grade	None 2/			1		
Product Call	None			1		
1/ Product heights are measured to the nearest foot. 2/ Minimum Grade 3 required to make a sawlog						**Overall % Correct:**

Overall percent correct = Total of (e) / number of elements checked

Note: For an individual Cruiser to pass this check, each element checked must be 80% accurate and overall accuracy must be at least 85% as compared to the Check Cruiser.

Volume of Measured Trees:

ELEMENT	TOLERANCE	MARKER	CHECK	% Difference
Total Cubic Volume	+/- 5%			
Sawtimber Cubic Volume	+/- 10%			

Note: In order to PASS, in addition to individual elements listed above, the Total Volume of the Checked Trees and the Sawtimber Volume must be within Tolerance levels.

Recommendations:

_____ _____
Signature, Forest Check Cruiser Date

OTTAWA TIMBER MARKING CONTRACT
SILVICULTURAL INSPECTION FORM
-Attachment 12-

Sale Name_____ **Payment Unit #**_____ **Date**_____
Contract #_____ **Inspector**_____ **Target BA**___

#	5.0-8.9"	9.0-10.9"	11.0-14.9	15.0-19.9	20" plus	B.A. / CUT	Plot Remarks
1							
2							
3							
4							
5							
6							
7							
8							
9							

Stump Marks_____ **Reserve Trees Unmarked**_____
Breast Marks_____ **Paint Direction Consistent**_____
Tree Selection_____ **Wildlife Trees Retained**_____
Riparian Mitigation Applied Properly (where applicable)_____
Marking Guide Specifics_____
_____
On-Site Tracer Paint Security_____
Leave Spacing for Equipment Operability_____

OTTAWA TIMBER MARKING CONTRACT
VOLUME ESTIMATION INSPECTION FORM

-Attachment 13-

Sale Name_____ **Payment Unit #**_____ **Date**_____

Contract #_____ **Inspector**_____ **Cruise** TM

Tree #	Cruiser	Species	DBH	Saw Feet	Saw Defect	Recoverable Defect	4" Height	Total Height	Pulp Defect	Remarks	
1	Contractor										
1	Inspector										
2	Contractor										
2	Inspector										
3	Contractor										
3	Inspector										
4	Contractor										
4	Inspector										
5	Contractor										
5	Inspector										
6	Contractor										
6	Inspector										
7	Contractor										
7	Inspector										
8	Contractor										
8	Inspector										
9	Contractor										
9	Inspector										
10	Contractor										
10	Inspector										
11	Contractor										
11	Inspector										
12	Contractor										
12	Inspector										

Products Evaluated Correctly_____

Tallies Legible and Ribboned_____

Cruise Design Implemented Correctly_____

Tallies on Trees Are Consistent With Submitted Tally Cards_____

Measurements Requiring Attention_____

MARKING CONTRACTOR
-Attachment 14-
DAILY RECORD OF ISSUES - TREE MARKING PAINT

PAINT COLOR: _____ **CONTAINER SIZE:** _____

Brand: _____ **Batch/Lot Number:** _____ **Date Manufactured:** _____

Contractor Name: _____ **Sale Name:** _____

CONTAINERS ISSUED

	Issued		Returned		Balance Out			
Date	Full	Empty	Full	Empty	Full	Empty	Forest Service Signature	Contractor Signature

Sale Area Layout/Prep Field Record
(one record for EACH Payment Unit) – Page 1 of 2
(indicate N/A for Not Applicable)

-Attachment 15-

(for all paint note if Rain Resistant or Water Soluable)

Sale Name:	VMP:
District:	Compartment/Stand:
Type of Harvest:	GPS Acres:

BOUNDARIES

Layout:	**Who/Date (no initials)**
1. Boundary Painted	
2. Stump Marked (if not done during 1.)	
3. Boundary GPS'd	
4. GPS file corrected/downloaded	
5. GPS file name/number (saved to J:/ and to CD)	
6. Paint Type	
7. Batch/Lot #	
8. Any areas where boundary was "blacked out"? show on traverse map	
9. No-equipment boundaries/zones?	
10. Boundary Posters (location on SAM)	

FEATURES (all to be shown on attached PU Map – approx location)

RA's (type & #)	
RT's (type & #)	
Heritage Sites confirmed by Para? (show on MAP & assigned site #)	
Landlines to Standard	
Monumented Corners	
Electric Lines (overhead or buried)	
Telephone Lines (buried?)	
Pipelines (buried)	
Gates or other improvements	
Existing Roads	
Existing Landings	
Riparian Features (adjacent & within)	
T&E or sensitive – wildlife (what)	
T&E or sensitive – botany (what)	

MARKING/DESIGNATION

CTM (paint color/batch #)	
DxSpp (counted or plots) designated species	
DxSpp (paint color @ eye level/batch #)	
LTM (paint color of cruise trees in plots/batch #	
Roads ROW Marked/Yellow Batch #	

Sale Area Layout/Prep Field Record
(one record for EACH Payment Unit) – Page 2 of 2

Sale Name:	VMP:
District:	Compartment/Stand:
Type of Harvest:	GPS Acres:

Insert GPS Traverse Here @ 8" = 1 mile (with noted Features from Page 1)
[Note: if Payment Unit was Area Estimate cruised, add additional traverse map showing the cruise GRID to scale, note the spacing between plots and the plot numbers on each point]

SAWLOG SCALE DEDUCTION FOR SWEEP
PERCENT OF GROSS SCALE
-Attachment 18-

Absolute Sweep Inches	Scale Diameter - Inches													
	8	9	10	11	12	13	14	15	16	17	18	19	20	22
	8-Foot Logs													
2	12	11	10	9	8	8	7	7	6	6	6	5	5	5
3	25	22	20	18	17	15	14	13	12	12	11	11	10	9
4	38	33	30	27	25	23	21	20	19	18	17	16	15	14
5	50	44	40	36	33	31	29	27	25	24	22	21	20	18
6	c	56	50	45	42	38	36	33	31	29	28	26	25	23
7	c	c	60	54	50	46	43	40	38	35	33	32	30	27
8	c	c	c	64	58	54	50	47	44	41	39	37	35	32

SPECIES CODE GUIDE
-Attachment 19-

CODE #	SPECIES
012	Balsam fir
071	Tamarack
091	Norway spruce
094	White spruce
095	Black spruce
105	Jack pine
125	Red pine
129	Eastern white pine
130	Scotch pine
241	Northern white cedar
261	Hemlock
316	Red maple
318	Sugar maple
371	Yellow birch
375	Paper birch
541	White ash
543	Black ash
544	Green ash
701	Ironwood
741	Balsam poplar
743	Big tooth aspen
746	Quaking aspen
762	Black cherry
809	Northern pin oak
833	Northern red oak
951	American basswood
972	American elm

United States
Department
of Agriculture

Forest Service

Eastern Region

October, 2006

QUALIFIED CRUISER REFERENCE GUIDE

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Foreword

This document was developed as a reference manual for use in the training and certification of qualified cruisers for the Eastern Region of the USDA Forest Service as specified in the Timber Cruising Handbook (FSH 2409-12, Chapter 60). This is one part of a suite of tools that were developed for this purpose.

In order to be certified as a qualified cruiser, a passing score is required on both a regionally approved written test and a regionally approved field test conducted on a prepared certification test area.

1. ROLE OF THE TIMBER CRUISER

The role of a timber cruiser is an extremely important one. Timber cruisers collect field data used for the determination of timber product volumes and values. This information is used in the preparation of timber sales.

The timber product volumes and values determined by cruising are even more important in Region 9 than in western regions. In Region 9 payment for a timber sale is based directly on the cruised volume. There is no additional measurement of the harvested products to determine final payment.

Cruisers usually work as part of a marking crew or cruising crew, but each individual is responsible for their own precise and accurate measurements. The reliability of the cruise will depend on the skill of each individual cruiser. Good observation skills and good judgment must be used at all times.

Timber cruising is more than just taking measurements. There is a great deal of skill involved in recognizing the form, soundness, and overall condition of the trees. In many cases the cruiser has the final decision as to which trees will be harvested and which will be left to grow and reproduce.

1.1 – Cruiser Certification Levels

There are four levels of certification for cruisers. They are described below in order of increasing responsibility. Each higher level of certification includes all of the responsibilities of the lower levels. These responsibilities, as well as many of the other things discussed in this document, are discussed in the Timber Cruising Handbook. This is also known as the Forest Service Handbook 2409-12. Every district is required to keep printed copies of the Forest Service Handbooks.

1.1.1 – Qualified Cruiser A qualified cruiser is responsible for applying correct volume determination techniques while working alone, as a crew member, or as a crew leader. The required knowledge and training are described below.

1. Proficiency in timber cruising fundamentals, including as a minimum:
    a. Tree measurement (diameters and heights).
    b. Species identification.
    c. Defect recognition and determination.
    d. Quality determination.
    e. Use of timber cruising tools.
    f. Map reading and compass use.
    g. Traverses.
    h. Elementary use of aerial photography.
2. A working knowledge of the cruise systems used in the region.
3. Demonstrated ability to interpret and follow the timber cruise plan and cruise data recording instructions.
4. Passing scores on both a regionally approved written test and a regionally approved field test, conducted on prepared certification test areas. Topics tested will include species, measurements, defects, and other information representative of what the cruiser normally encounters.

1.1.2 – Advanced Cruiser An advanced cruiser has all of the responsibilities of a qualified cruiser, and in addition must be able to train prospective qualified cruisers and design cruises. Experience, technical aptitude, and ability to train others are required. Training is required, and a regionally approved written test must be passed.

1.1.3 – Check Cruiser A check cruiser is responsible for check cruising, cruiser training, and conducting evaluations to recommend certification of qualified and advanced cruisers. A check cruiser also maintains records of cruiser certifications. The forest field test course for certification of qualified cruisers is established and maintained by a check cruiser.

1.2 – Maintenance of Certification

As long as a cruiser's performance continues at a satisfactory level the certification is indefinite. This is true for all levels of cruisers. The following criteria must also be considered.

1. If a cruiser has been inactive for a period of more than one year, refresher training is required *prior* to resuming cruising.
2. All levels of cruisers, whether active or inactive, must attend formal training or workshops intended to update their skills *at least once every four years* to maintain knowledge appropriate to the level of certification.
3. Check cruisers may recommend *loss* of a cruiser's certification based on unsatisfactory performance.

2. SPECIES IDENTIFICATION

A timber cruiser must be able to correctly identify all of the species that will be encountered, in all of the seasons of the year. This is a learned skill, and may take time and practice to master. Cruisers learn to identify species by foliage, bark, buds, branching patterns, overall shape, cones or seeds, and other characteristics.

Merchantability specifications and product value depend on correct identification of species. The volume equations used to calculate the product volumes produce different volumes for different species due to variations in the tree forms between the species.

Region 9 is a very diverse region in terms of the number of commercial tree species. Table 2 contains a list of all of the commercial species currently recognized in the region for the purposes of cruising. There are over 100 species listed. Notice that in addition to the scientific name and "official" common name there is a unique numeric code used to identify each species. Cruisers must know the numeric codes for species common to their area since all of the software used to process the cruise data requires these numeric codes.

Table 2 – List of commercial tree species for the Eastern Region of the USDA Forest Service.

Numeric	Scientific Name	Common Name
012	Abies balsamea	Balsam Fir
068	Juniperus virginiana	Eastern Redcedar
071	Larix laricina	Tamarack
091	Picea abies	Norway Spruce
094	Picea glauca	White Spruce
095	Picea mariana	Black Spruce
097	Picea rubens	Red Spruce
105	Pinus banksiana	Jack Pine
110	Pinus echinata	Shortleaf Pine
123	Pinus pungens	Table Mountain Pine
125	Pinus resinosa	Red Pine
126	Pinus rigida	Pitch Pine
129	Pinus strobus	Eastern White Pine
130	Pinus sylvestris	Scotch Pine
131	Pinus taeda	Loblolly Pine
132	Pinus virginiana	Virginia Pine

221	Taxodium distichum	Baldcypress
241	Thuja occidentalis	Northern White-Cedar
261	Tsuga canadensis	Eastern Hemlock
313	Acer negundo	Boxelder
314	Acer nigrum	Black Maple
315	Acer pensylvanicum	Striped Maple
316	Acer rubrum	Red Maple
317	Acer saccharinum	Silver Maple
318	Acer saccharum	Sugar Maple
319	Acer spicatum	Mountain Maple
330	Aesculus	Buckeye Spp.
331	Aesculus glabra	Ohio Buckeye
332	Aesculus flava	Yellow Buckeye
356	Amelanchier	Serviceberry
371	Betula alleghaniensis	Yellow Birch
372	Betula lenta	Sweet Birch
373	Betula nigra	River Birch
375	Betula papyrifera	Paper Birch
379	Betula populifolia	Gray Birch
391	Carpinus caroliniana	Blue-Beech/Hornbeam
400	Carya	Hickory Spp.
402	Carya cordiformis	Bitternut Hickory
403	Carya glabra	Pignut Hickory
404	Carya illinoinensis	Pecan
405	Carya laciniosa	Shellbark Hickory
407	Carya ovata	Shagbark Hickory
408	Carya texana	Black Hickory
409	Carya alba	Mockernut Hickory
421	Castanea dentata	American Chestnut
452	Catalpa speciosa	Northern Catalpa
460	Celtis	Hackberry Spp.
462	Celtis occidentalis	Common Hackberry
471	Cercis canadensis	Eastern Redbud
481	Cladrastis kentukea	Kentucky Yellowwood
490	Cornus	Dowood Spp.
491	Cornus florida	Flowering Dogwood
521	Diospyros virginiana	Common Persimmon
531	Fagus grandifolia	American Beech
541	Fraxinus americana	White Ash
543	Fraxinus nigra	Black Ash
544	Fraxinus pennsylvanica	Green Ash
552	Gleditsia triacanthos	Honeylocust
571	Gymnocladus dioicus	Kentucky Coffeetree
601	Juglans cinerea	Butternut
602	Juglans nigra	Black Walnut
611	Liquidambar styraciflua	Sweetgum
621	Liriodendron tulipifera	Yellow-Poplar/Tuliptree
641	Maclura pomifera	Osage Orange
651	Magnolia acuminata	Cucumbertree
654	Magnolia macrophylla	Bigleaf Magnolia
655	Magnolia fraseri	Mountain Magnolia
691	Nyssa aquatica	Water Tupelo
694	Nyssa sylvatica	Blackgum

701	Ostrya virginiana	Ironwood/Hophornbeam
731	Platanus occidentalis	American Sycamore
741	Populus balsamifera	Balsam Poplar
742	Populus deltoides	Eastern Cottonwood
743	Populus grandidentata	Bigtooth Aspen
744	Populus heterophylla	Swamp Cottonwood
746	Populus tremuloides	Quaking Aspen
761	Prunus pensylvanica	Pin Cherry
762	Prunus serotina	Black Cherry
800	Quercus	Oak Spp.
802	Quercus alba	White Oak
804	Quercus bicolor	Swamp White Oak
806	Quercus coccinea	Scarlet Oak
809	Quercus ellipsoidalis	Northern Pin Oak
812	Quercus falcata	Southern Red Oak
813	Quercus pagoda	Cherrybark Oak
816	Quercus ilicifolia	Bear Oak
817	Quercus imbricaria	Shingle Oak
822	Quercus lyrata	Overcup Oak
823	Quercus macrocarpa	Bur Oak
824	Quercus marilandica	Blackjack Oak
825	Quercus michauxii	Swamp Chestnut Oak
826	Quercus muehlenbergii	Chinkapin Oak
830	Quercus palustris	Pin Oak
831	Quercus phellos	Willow Oak
832	Quercus prinus	Chestnut Oak
833	Quercus rubra	Northern Red Oak
834	Quercus shumardii	Shumard Oak
835	Quercus stellata	Post Oak
837	Quercus velutina	Black Oak
901	Robinia pseudoacacia	Black Locust
920	Salix	Willow Spp.
922	Salix nigra	Black Willow
931	Sassafras albidum	Sassafras
935	Sorbus americana	American Mountain Ash
951	Tilia americana	American Basswood
952	Tilia americana v. heterophylla	White Basswood
970	Ulmus	Elm Spp.
971	Ulmus alata	Winged Elm
972	Ulmus americana	American Elm
975	Ulmus rubra	Slippery Elm
977	Ulmus thomasii	Rock Elm

Some of the listings in table 01 are for an entire genus. These have only the genus name in the column for scientific name, and have the designation "Spp." in the common name. These codes are for use with species of that genus that are not any of the particular species listed. These codes may also be used when cruisers are instructed not to differentiate between species of a particular genus.

3. PRODUCT DETERMINATION

After trees are harvested, they are usually made into some sort of product that people use. Some common products are boards, veneer for plywood, power poles, fence posts, house logs, railroad ties, mining timbers, chips, pulp, firewood, and more. Different parts of the same tree may be converted into different products.

There are several different product categories into which trees, or parts of trees, can be placed. Table 3 lists the products most commonly used in Region 9, along with the numeric code for each. Not all of the products mentioned above have codes. Cruisers will need to become familiar with the products and codes used on their forest.

Table 3 – Products and Codes

Product Code	Product
01	Sawtimber
02	Pulpwood
03	Poles
06	Posts
07	Fuelwood
14	Miscellaneous Convertible

Every tree will be assigned a *primary product* code. This represents the main product category into which the tree has been placed. The assignment of a primary product code is usually based on things like species, diameter, length, and quality of the wood in the tree. It is important to note here that the tree may *not* necessarily be made into the product assigned by the cruiser. In fact, many products don't even have codes. The product codes are assigned so we have an estimate of the amount of volume that can be expected to meet different sets of criteria. In a timber sale contract, the different products typically have different prices bid for them. Once purchased, the trees can be made into any product the purchaser wants to make.

If a tree is assigned a primary product code for sawtimber (01), a *secondary product* may also be assigned. Sawtimber usually does not represent the entire usable amount of tree stem. There are quality and diameter standards for sawtimber. Parts of the tree stem not meeting these standards are not considered sawtimber. The usable part of sawtimber trees above the sawtimber part is called *topwood*. Cruisers will need to become familiar with the topwood products that are used on their forest. If topwood is not to be harvested, it might not be recorded at all.

All products have specifications associated with them. There is usually a minimum diameter that must be met, and there may be quality specifications as well. The specifications may vary by species. In addition, some species may be prevented from having a particular product code. For example, on a particular cruise it may be specified that aspen will not be coded as sawtimber regardless of tree size.

4. DIAMETER MEASUREMENT TOOLS

One of the most important measurements made in a timber cruise is tree bole diameter. Bole diameter is a main determinant of the volume calculated for a tree. It may also determine which product category the tree falls into.

The goal of a timber cruise is usually to determine the volume of wood in the stem of the trees (inside the bark). It might seem logical, then, to measure the diameter inside the bark (DIB). This is not practical in the field, however, so stem diameters are almost always measured as diameter outside bark (DOB). Bark thickness is taken into account in the computer programs that calculate the volume of the wood.

Tree bole diameters are nearly always measured using one of two tools: a steel tape or tree calipers. Use of these two tools will be discussed separately below.

4.1 – Steel Diameter Tape

A steel diameter tape is the most common tool used to measure tree bole diameters. The tape is wrapped tightly around the tree stem perpendicular to the axis of the stem at that point. Care must be taken to get the tape straight around the tree, with no twists and no objects between the tape and the bark.

Small protrusions of surface bark sticking abnormally high above the regular surface of the rest of the bark should be removed so the tape rests tightly against the remaining bark. Examples of this might be a curl of bark on a birch, or loose bark protrusions at a seam. Any more substantial protrusion would be considered a stem abnormality, and would be handled as described in a later section devoted to measuring diameters when abnormalities are present.

A diameter tape is graduated to read the diameter directly, with no additional calculations necessary. It relies on the mathematical relationship between circumference (the distance around) and diameter, assuming the tree bole is circular in cross-section. The scale graduated for diameter measurements is usually on the reverse side of a tape reading in standard measurements. For example, a loggers tape may read in inches on one side and in diameter-equivalent-inches on the other.

A diameter tape is quite accurate and fairly easy to read if used correctly. There are four basic types of diameter tapes, differing only in whether the tape case is typically held in the right hand or left hand when passing the tape around the tree, and in whether the graduations are on the top or bottom of the tape (figure 4.1b).

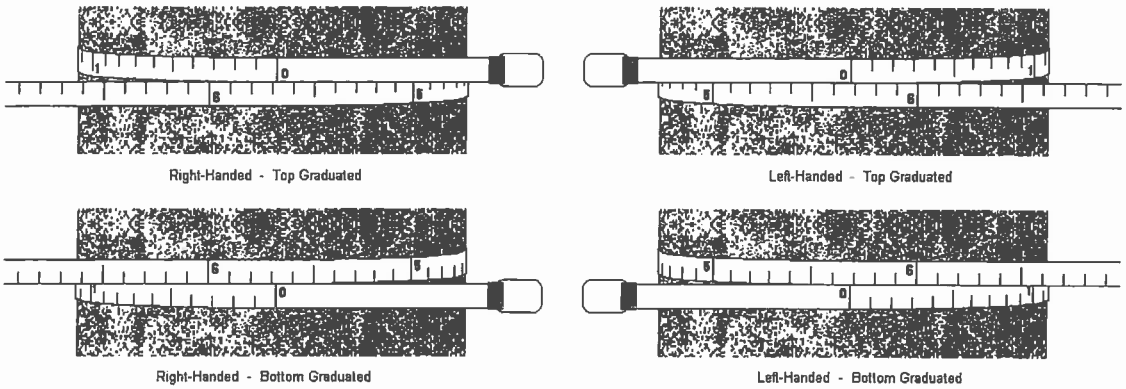


Figure 4.1b – The four types of diameter tapes

All diameter tapes have an index mark, usually labeled with a zero, which is used to read the diameter. The end of the tape with the index mark should be wrapped either above or below the other part of the tape so the index mark touches the graduated edge of the other part of the tape (figure 4.1b). The tape must be held so the index mark and the graduations where the diameter is to be read are both tight against the tree. This means the tape makes contact with the tree for slightly more than a full rotation around the tree (figure 4.1c). Note in the "incorrect" image in figure 4.1c how the tape is lifted off the tree where the tape crosses itself. This will result in a diameter reading that is too large.

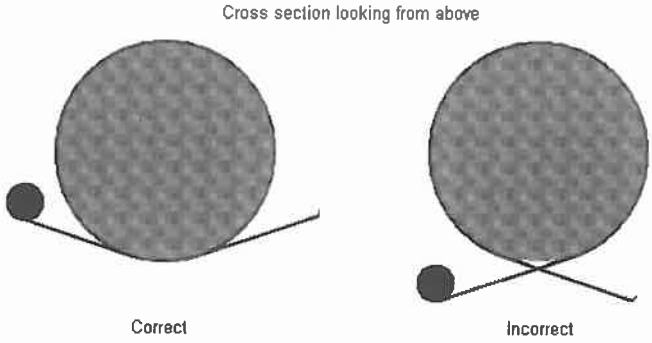


Figure 4.1c – Wrapping a diameter tape

On diameter tapes with English units the graduations are one-tenth inch. If the index mark falls exactly on a tenth-inch mark the diameter is read directly. If the index mark falls between tenth-inch marks, *always round down* to the next lower tenth-inch. This is done because trees tend not to be perfectly round, so the diameter is slightly overestimated using a tape.

Figure 4.1d shows three diameter tape measurements. All three of the diameters should be read as 9.3 inches. The third example reads nearly 9.4 inches, but the diameter is always rounded down.

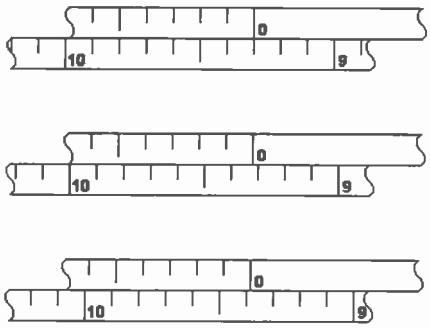


Figure 4.1d – Example diameter tape readings

4.2 – Tree Calipers

Tree calipers are made up of three main parts: a graduated main beam, a fixed arm at the end of the main beam, and a sliding arm. The calipers are held perpendicular to the axis of the tree and the arms are closed so they touch the bark on both sides of the tree. The diameter is read from the scale at the inside of the sliding arm, rounded to the *nearest* tenth-inch (not always rounded down).

Figure 4.2a shows a tree caliper being used on a tree stem (shown in cross-section). The close-up in the inset shows a diameter reading that would round up to 12.7 inches.

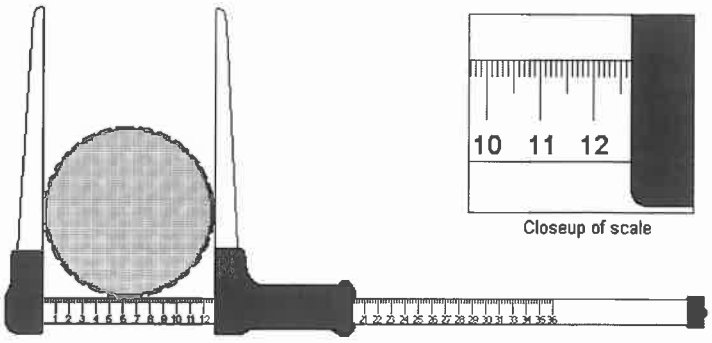


Figure 4.2a – Tree caliper

Because trees tend to not be perfectly round, two measurements should be taken and the average of the two measurements should be recorded. The two measurements should be made perpendicular to each other whenever possible. Figure 4.2b shows two perpendicular measurements on the same tree.

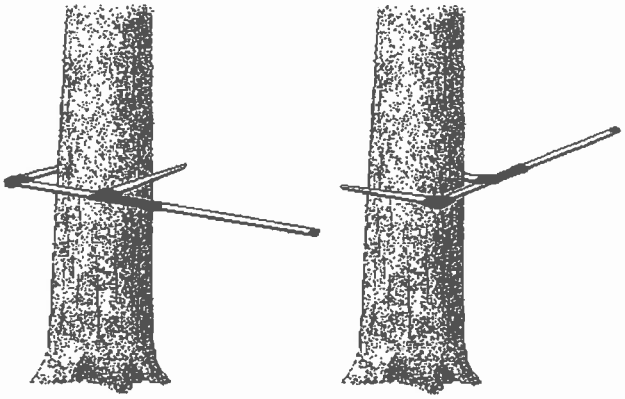


Figure 4.2b – Perpendicular diameter measurements using tree calipers

5. DIAMETER AT BREAST HEIGHT

In order for bole diameters to be meaningful, they have to be measured in a consistent way for all trees. A nearly universally accepted method measures diameter at breast height, or DBH. This is a measurement made outside the bark, perpendicular to the axis (or centerline) of the tree, at a height of 4.5 feet above the forest floor on the high-ground side of the tree (figure 5).

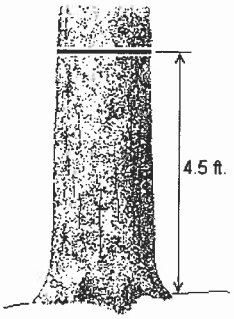


Figure 5 – Normal location of DBH

Some conditions and abnormalities require DBH to be measured at a different location on the bole. These are discussed individually later.

5.1 – Sloping Ground

This is not really a special condition since the procedure is exactly as described, but it is included here for clarity. DBH is measured perpendicular to the axis of the tree at a height of 4.5 feet above the high-ground side (figure 5.1).

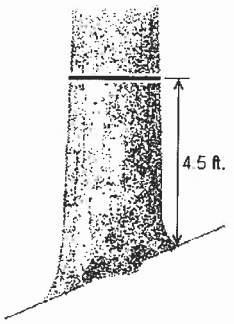


Figure 5.1 – Location of DBH on sloping ground

5.2 – Leaning Tree

DBH is measured on a leaning tree just like a tree on sloping ground, as if everything has been rotated so the ground is horizontal. The distance of 4.5 feet is measured parallel to the axis of the tree, and DBH is measured perpendicular to the axis of the tree (figure 5.2). Notice that figure 5.2 is just figure 5.1 rotated so the ground is horizontal.

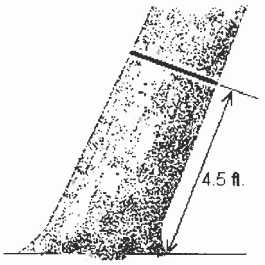


Figure 5.2 – Location of DBH on a leaning tree

5.3 – Forked Tree

A tree is said to fork when the bole divides into two or more main stems. The fork is considered to begin at the point where daylight can be seen between the two stems.

When a tree forks below 4.5 feet it is considered two trees. The diameter of each stem is measured at 4.5 feet above the high-ground side (figure 5.3, tree A).

When a tree forks at or above 4.5 feet it is considered a single tree, and DBH is measured at the smallest diameter *at or below* 4.5 feet. Tree B in figure 5.3 shows an example where DBH is measured below 4.5 feet because the diameter is smallest below the swelling near the fork.

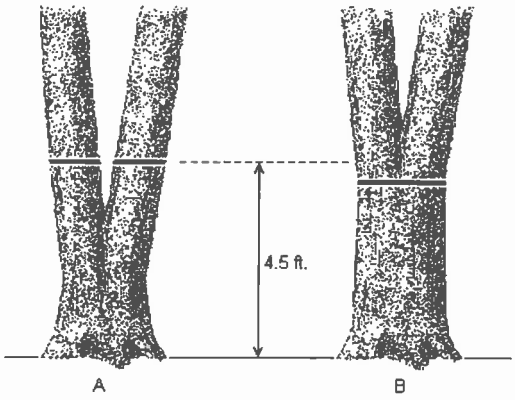


Figure 5.3 – Location of DBH on forked trees

If the fork occurs very near a height of 4.5 feet, leaf litter and loose bark should be removed to see where the fork actually begins.

5.4 – Tree Growing on an Object

When a tree is growing on top of an object, or when the roots are exposed, the forest floor is no longer where it was when the tree began to grow. DBH is measured 4.5 feet above the root crown instead of 4.5 feet above the forest floor (figure 5.4). The root crown is the top part of where the roots all come together. It can be thought of as imagining where the forest floor would be if it were raised up to cover the exposed roots.

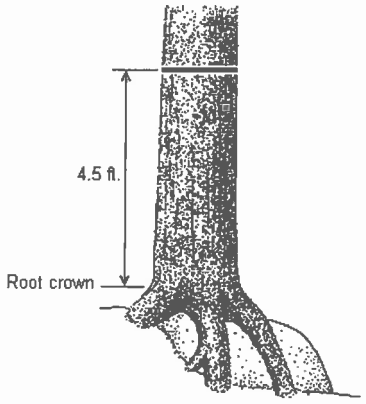


Figure 5.4 – Location of DBH above root crown

If roots are exposed on only one side of the tree, the forest floor on the other side may still be in its original position. In this case, measure 4.5 feet above the forest floor. If the forest floor is obviously lower than normal, the root crown should be used as described above.

5.5 – Abnormalities at 4.5 Feet

There are a variety of situations that make it difficult or impossible to get an accurate DBH reading at a height of 4.5 feet. Special procedures are designed to deal with these situations in a consistent manner.

Tree calipers can be used to measure DBH for trees with any abnormality at 4.5 feet, as long as the abnormality is confined to less than half the circumference of the tree at that point. Measurements are be made in a direction that results in a diameter unaffected by the abnormality. If the abnormality is large enough to prevent a second measurement with the tree calipers, a single caliper measurement is used.

A diameter tape is generally not stretched across an abnormality because a diameter will result that is not representative of the tree at that point. Other methods of measurement are used in most cases where an abnormality occurs at 4.5 feet.

5.5.1 – Small Catface If the abnormality is a fairly small catface, a tape may be wrapped so that it is extended out to the normally rounded shape the tree would have had without the catface (figure 5.5.1). The tape should *not* be stretched tight across the catface or the resulting diameter will be too small.

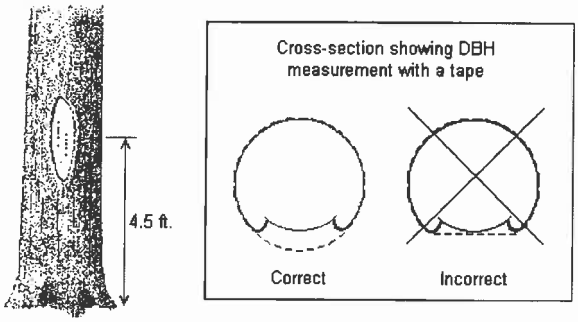


Figure 5.5.1 – Measuring DBH across a catface with a diameter tape

5.5.2 – Short Abnormality If the abnormality is confined to a small enough area that a representative diameter can be measured above and below the abnormality, then use an averaging method. Take two diameter measurements spaced equally above and below 4.5 feet and average the two measurements. Figure 5.5.2 shows three situations where an abnormality (limb, catface, and burl) prevents measurement of DBH at 4.5 feet. A measurement is taken a distance A above 4.5 feet, and a measurement is taken a distance A below 4.5 feet. These two measurements are averaged for DBH.

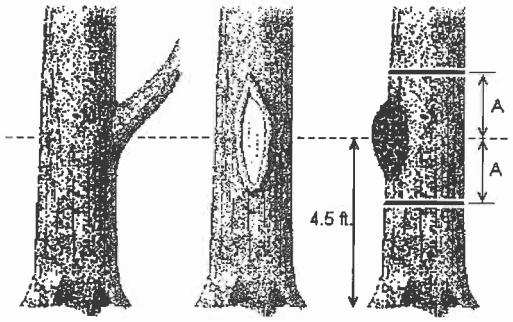


Figure 5.5.2 – Measurement of DBH using the averaging method

5.5.3 – Long Abnormality If the abnormality is long enough that measurements can not be made above and below it, or if it extends down far enough that it enters the swelling near the stump, then use what is called the half-tree diameter method. Mark two points opposite each other on the stem, and to the sides of the abnormality. With a diameter tape, measure the distance between the marks on the side away from the abnormality (distance A in figure 5.5.3) and then double the measurement.

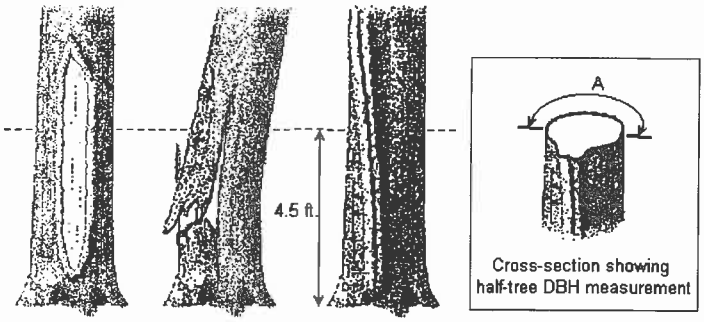


Figure 5.5.3 – Measurement of DBH using the half-tree diameter method

5.5.4 – Trees Grown Together Two separate trees that have grown together over time are always considered separate trees, and a DBH must be measured for each. If there is no way to get a tape between them at 4.5 feet, the half-tree diameter method described above is used for each of the trees (figure 5.5.4). Tree calipers could also be used on each of the trees.

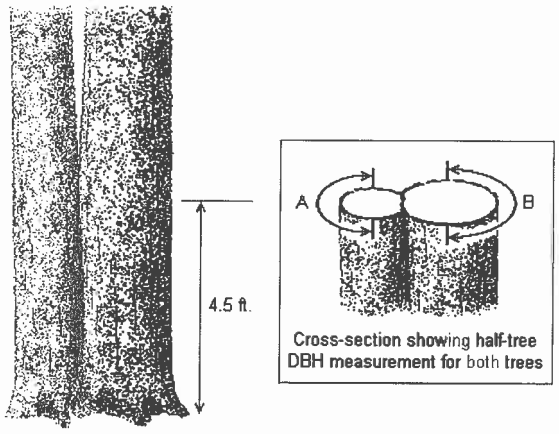


Figure 5.5.4 – Measurement of DBH on two trees that have grown together

Two trees that have grown together are never considered a single forked tree, even if the first daylight is above 4.5 feet high. This is because the bark that formed before the trees grew together will form a permanent divider, and the wood will always be separated at that point.

5.6 – Down Tree

DBH is measured on a down tree in the same place it would have been measured if the tree were still standing. Find the point that would have been 4.5 feet above the high ground side of the original groundline and measure perpendicular to the axis of the tree (figure 5.6). Measure normally with a diameter tape or tree calipers. If the tree is tight to the ground it may be necessary to dig under the tree to pass a tape around. If there is an abnormality where DBH would normally be measured, it is measured as described in a section 5.5.

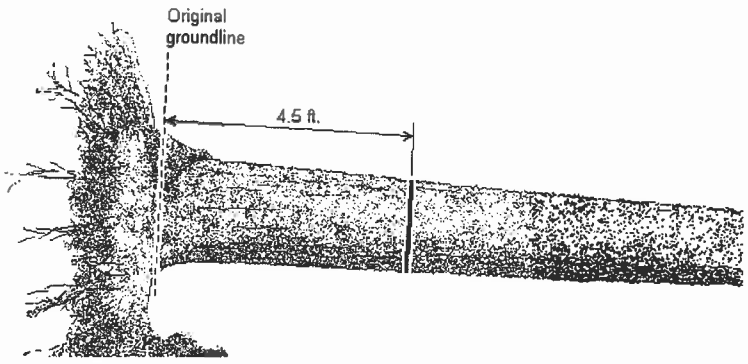


Figure 5.6 – Location of DBH on a down tree

Soil and duff material often falls off the roots of a down tree and covers the base of the tree. This material may need to be removed in order to determine the location of the original ground line on the tree.

5.7 – Broken tree

DBH on a broken tree is measured at the point that was 4.5 feet above the high ground side when the tree was still standing vertically. If DBH is to be measured below the breakage (labeled A in figure 5.7) measure it normally.

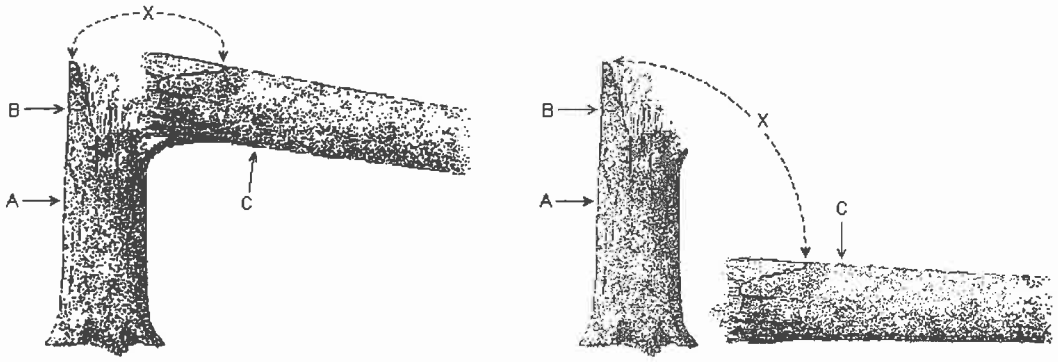


Figure 5.7 – Location of DBH on a broken tree

If DBH must be measured above the breakage (labeled C in figure 5.7) a point must be found where the tree was continuous before the breakage occurred (labeled X in figure 5.7). The height is measured up the stump to that point, and then continued from the matching point above the break until a total of 4.5 feet is measured. For example, if the height to point X is 2 feet, then 2.5 feet is measured above the matching point X on the upper part. If the tree is tight to the ground it may be necessary to dig under the tree to pass a tape around.

If DBH must be measured within the area of breakage (labeled B in figure 5.7) it is measured using either the averaging method or the half-tree diameter method as described in section 5.5. If at least half the circumference remains intact at 4.5 feet (on either piece) tree calipers can be used as well.

5.8 – Felled tree

DBH is measured on a felled tree in the same place it would have been measured if the tree were still standing. Find the point that would have been 4.5 feet above the high ground side and measure the diameter perpendicular to the axis of the stem at that point. A point must be found where the tree was continuous before the breakage occurred (labeled X in figure 5.8). The height is measured up the stump from the high ground side to that point (labeled A in figure 5.8), and then continued on the severed stem above that point (labeled B in figure 5.8) until a total of 4.5 feet is measured. For example, if the height to point X is 1 foot, then 3.5 feet is measured above the matching point X on the severed stem. If the tree is tight to the ground it may be necessary to dig under the tree to pass a tape around. If there is an abnormality where DBH would normally be measured, it is measured as described in a section 5.5.

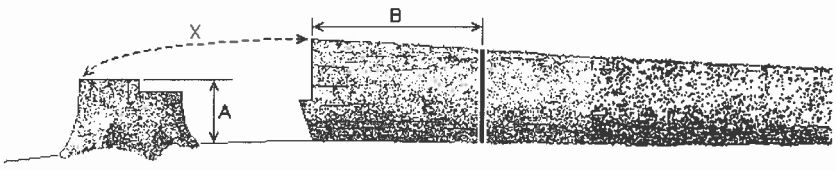


Figure 5.8 – Location of DBH on a felled tree

6. HEIGHT MEASUREMENT TOOLS

There are many tools used to measure heights. A tape or graduated pole could be extended up along the stem of the tree and the height measured directly. In most cases this is not practical for cruising applications. Most of the instruments used to measure tree heights while cruising timber are known as inclinometers, because they are used to measure inclines or angles. They require the user to stand some distance from the tree and measure angles to the top and bottom of the tree. All such methods use rules of geometry to calculate tree heights.

6.1 – Geometry

There are three pieces of information needed to calculate a height. These are shown in figure 6.1a, where A is the horizontal distance from the tree, B is the angle to the bottom of the tree, and C is the angle to the reference point on the tree where height is to be measured.

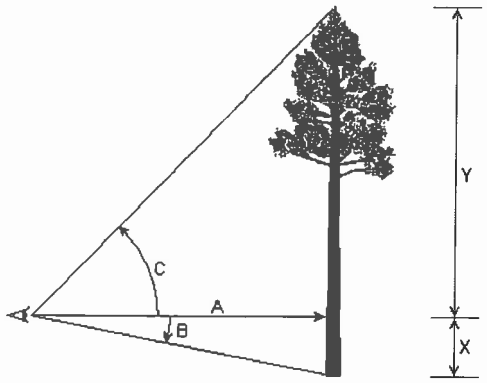


Figure 6.1a – Tree height geometry

Two triangles are formed, with the tree making the right side for both. Knowing A and B allows for calculation of X, the height from the bottom of the tree to eye level. Knowing A and C allows for calculation of Y, the height from eye level to the reference point where height is to be measured. The tree height equals X + Y.

Angle B has a negative sign (for example, -5%) and angle C has a positive sign (for example, +85%). *When the angles have opposite signs the corresponding heights are always added together*, as shown above.

If a tree is not on level ground *it is usually most accurate to measure tree height from a point either uphill from the tree or on the same contour as the tree.* Avoid measuring from the downhill side of the tree whenever possible.

If, for some reason, the height must be measured from downhill, below the base of the tree, the geometry changes slightly, as shown in figure 6.1b.

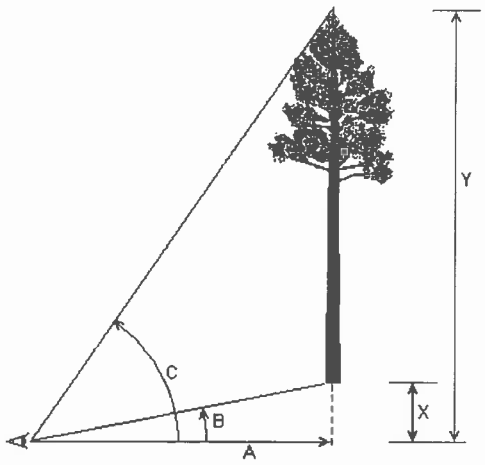


Figure 6.1b – Tree height geometry when below the tree

In this case the two triangles that are formed actually overlap. Knowing A and B allows for calculation of X, the height from eye level to the bottom of the tree. Knowing A and C allows for calculation of Y, the height from eye level to the reference point where height is to be measured. Note that Y is greater than the height being measured. In this case, the tree height equals Y - X.

Angle B has a positive sign (for example, +5%) and angle C has a positive sign (for example, +85%). *When the angles have the same sign the smaller height is always subtracted from the larger*, as shown above.

6.2 – Slope Correction

It is important to note that the distance from the tree is always measured as a horizontal distance. Some electronic devices have built-in systems to correct for slope. A tape, however, has no built-in correction system. A slope correction factor is used to convert a horizontal distance to a distance that can be measured along a slope. *Any slope of 10 percent (5 degrees) or greater requires a slope correction.* Slope correction is described in detail in section 7.1.

6.3 – Mechanical Instruments

There are several mechanical instruments commonly used to measure heights. Some examples are clinometers, altimeters, and relaskops. All such devices require the user to be a specified horizontal distance from the tree. They all measure angles, and use the geometry discussed earlier to calculate heights.

When used for height measurements, these instruments use one of two different scales (or variations of these two). The first is called the *topographic scale*, which is graduated for direct height readings when the user is a horizontal distance of 66 feet from the tree. The second is the *percent scale*, which is graduated for direct height readings when the user is a horizontal distance of 100 feet from the tree. The percent scale can actually be used from any horizontal distance. Simply multiply the percent reading by the horizontal distance to get the height represented. An example of this is shown below.

6.3.1 – Clinometer A clinometer is an instrument that displays the angle of inclination at which the instrument is being held. The most common models have an internal scale and are held up to the eye so a crosshair in the display appears to be at the level of the target where a height measurement is needed. Figure 6.3.1a shows a popular clinometer design.

Figure 6.3.1a – Clinometer

The display is not a see-through type, so either both eyes are kept open to line up the crosshair, or one eye is used so that both the crosshair and the target are visible. The display must be read while the crosshair is on the target. Each clinometer has a display with two of the following three scales: degrees, percent, and topographic.

Figure 6.3.1b shows two readings from a clinometer where the left half of the scale is a degree scale (used primarily for slope measurements) and the right half of the scale is a topographic scale (used for height measurements). The angle is read where the crosshair crosses the scale. Values are rounded to the nearest whole number.

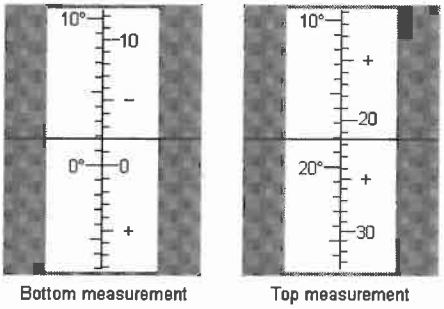


Figure 6.3.1b – Clinometer readings, topographic scale

Using the topographic scale, the bottom measurement is -2 (the bottom of the tree is below the user's eye level, so the sign is negative) and the top measurement is about 21 (the top is above the user's eye level, so the sign is positive). Since the signs of the angles are opposite, the corresponding heights will be added. At a horizontal distance of 66 feet the topographic scale reads directly in feet, so the tree would have a height of 23 feet (2 feet from the bottom to eye level + 21 feet from eye level to the top).

Figure 6.3.1c shows two readings from a clinometer where the right half of the scale is a percent scale. The reading for the bottom measurement is -3% and the reading for the top measurement is +33%. Since the signs of the angles are opposite, the corresponding heights will be added.

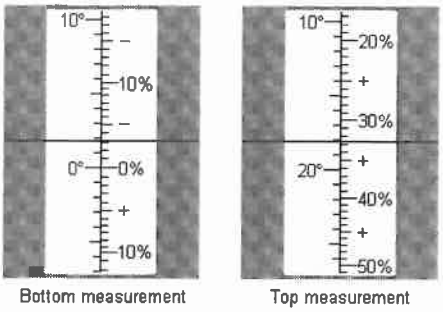


Figure 6.3.1c – Clinometer readings, percent scale

If the readings in figure 6.3.1c were read while standing a horizontal distance of 100 feet from the tree, the percent scale would convert directly to height in feet. It would be 3 feet from the bottom of the tree to eye level, and it would be 33 feet from eye level to the top. The height is therefore 36 feet (3 feet + 33 feet).

If the user is standing a horizontal distance other than 100 feet from the tree, the percent scale value (used as its decimal equivalent) must be multiplied by the horizontal distance to get height. For example, if the readings in figure 6.3.1c were read with the user standing a horizontal distance of 75 feet from the tree, the height would be 27 feet (0.36 * 75 feet).

The clinometer is unique among height measuring instruments in that it can be used for certain measurements without looking through the eyepiece. For example, tree lean can be measured by lining up the straight side of the instrument with the stem of the tree, and then reading the angle directly from the visible wheel. This is discussed in greater detail in the sections describing measurement of tree lean.

6.3.2 – Relaskop A relaskop is an instrument that is designed to measure heights in addition to other things. For now we'll focus only on the height measurement capabilities. Figure 6.3.2a shows a relaskop.

Figure 6.3.2a – Relaskop

Heights are measured with a relaskop in a manner very similar to that used with a clinometer. There are two key differences. First, the display on a relaskop is a see-through type, so the target is always seen with the same eye as is looking at the scale. Second, the scale is read at the top of the visible portion of the scale instead of at a crosshair.

Figure 6.3.2b shows the left half of a relaskop display with measurements for the tree bottom and top. The scale (American style) always has the percent scale on the left and the degree scale on the right. The top half of the

display is see-through and is used to sight the target. The target is placed right at the intersection of the see-through section and the top of the scale. The scale is read at the top of the visible portion.

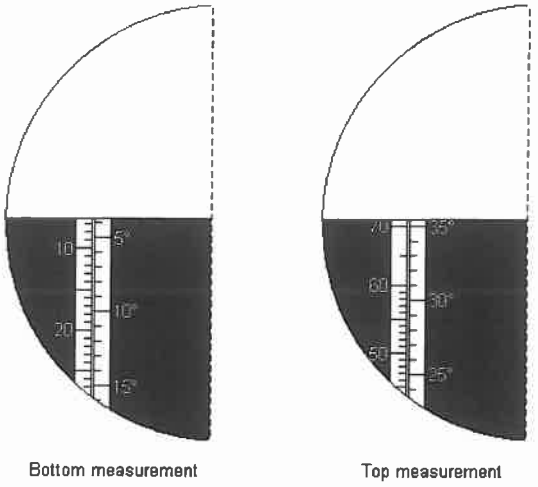


Figure 6.3.2b – Relaskop readings, height scale

The bottom measurement in figure 6.3.2b is -4% (the negative side of the scale is showing) and the top measurement is about 71%. The height would be calculated exactly the same as done with the percent scale for a clinometer, as described earlier.

If a height is to be measured to a point other than the tip of the tree, the relaskop is useful in determining the diameter of an upper portion of the tree stem. The right part of the display has a series of equal-width black and white bars, each of which represents a particular diameter at a particular horizontal distance from the tree. Figure 6.3.2c shows the point on a tree where the upper stem diameter is 4 inches in diameter. At a horizontal distance of 66 feet from the tree, each of the equal-width bars represents 4 inches.

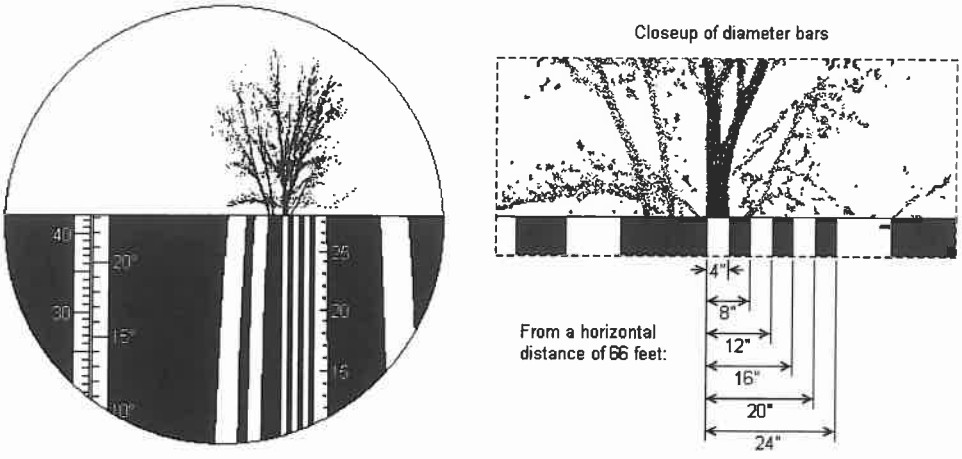


Figure 6.3.2c – Relaskop used to determine upper stem diameter

6.3.3 – Altimeter Altimeters used for cruising are not designed to measure altitudes. They are designed to measure tree heights in a manner similar to that used with clinometers and relaskops.

Altimeters typically have a see-through sight used to point at the target where a height reading is to be taken. The scale, however, is typically not visible in the sight. Instead, the scale is on the side of the instrument. While pointing at the target in the sight, a button is pressed locking the scale in place. The instrument is then lowered and the scale read. Figure 6.3.3a shows one type of altimeter. Note the scale visible along the side of the instrument.

Figure 6.3.3a – Altimeter

There are several scales in most altimeters. They typically have a percent scale in addition to several scales graduated for use at specific horizontal distances. In some models all of the scales are visible at the same time, and in other models only the selected scale is visible. Regardless of the configuration, the desired scale is read where the needle has been locked in place.

The percent scale is used exactly like described with the clinometer. The other scales display heights directly in feet when used at the specified horizontal distance. Figure 6.3.3b shows two readings from an altimeter where the percent scale is being used.

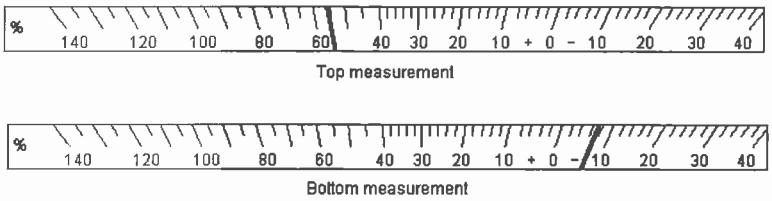


Figure 6.3.3b – Altimeter readings, percent scale

The bottom measurement is about -7%, and the top measurement is about +55%. Height calculations are done in the same way described earlier for the clinometer. If the user is standing a horizontal distance of 50 feet from the tree, the tree height would be 31 feet (0.62 * 50 feet).

6.4 – Electronic Instruments

There are two main types of electronic instruments that are commonly used to measure tree heights: laser-based instruments and ultrasonic instruments. The same geometric concepts discussed earlier are used for height calculation. The main difference is the instrument usually does all of the calculations internally and displays the height directly. Instead of using a tape, the horizontal distance from the tree is measured either with the laser or through an ultrasonic transmitter. An internal inclinometer records the angles to the bottom and top of the tree, and the height is calculated.

Laser-based instruments typically do a good job determining the horizontal distance to the tree if the bole of the tree can be hit with the laser with no interference from branches or foliage. Problems may be encountered in heavy underbrush. Most laser-based instruments have a "three point" system for determining heights. The first point is for horizontal distance only, and can be shot anywhere there is a clear shot to the bole (as long as the tree is primarily vertical). The other two shots are for the bottom and top of the tree. Those don't need a clear shot to the tree since the internal inclinometer is used instead of the laser.

Ultrasonic instruments work well in heavy underbrush since they don't need a clear view of the tree in order to get the horizontal distance. An ultrasonic transmitter is hung on the tree, and the instrument picks up the signal and can determine the distance. The transmitter must be at least partially visible, however, so the instrument can determine the angle to the transmitter, and then calculate the correct horizontal distance. The internal inclinometer records the angles to the bottom and top of the tree. Those don't need to be clear shots either.

7. TREE HEIGHT MEASUREMENT

In Region 9, measuring tree height is more complicated than measuring the distance from the ground to the tip of the tree. Heights are measured to the tops of certain products within the tree. This type of height is known as merchantable height. An example might be measurement of height to the top of the sawtimber product.

Merchantable height is defined as the height to a point on the stem where merchantability is limited by size, excessive branching, defect, deformity, or log grade. The specifications for merchantable height may vary depending on product. For example, sawtimber products may have different top diameters than pulpwood products.

There are two types of height typically measured. The first is the sawtimber height. This is the height to the top of the sawtimber portion of a tree. Only those trees containing a sawtimber product will have a sawtimber height recorded. The sawtimber portion stops at the highest point where sawtimber product can be cut. The limiting factor can be stem diameter, but it is often something else like branching or defect.

The second type of height is measured to the top of the non-sawtimber products. This height is known by several common names, but it will be referred to here as top height. Top height is a very important measurement because it determines the overall taper for the tree, which is used in the calculation of the volumes. Because it determines the tree taper, top height is determined by stem diameter alone. The height is measured to the point on the stem where the diameter becomes smaller than the specified minimum diameter. If the top part is not merchantable, it is removed as defect. (Defect calculations are discussed in a later section.)

The rules for measuring top height are different than for measuring sawtimber height. Sawtimber height is recorded only to the point where the sawtimber product stops, even if the stem is still larger than the minimum diameter. The upper portion must not be removed as defect because the defect volume is lost, and is not picked up as topwood. The only exception to this rule is a case where the sawtimber height is the only height recorded for a tree. In this case the sawtimber height will be used to determine the taper of the tree, so the height is recorded to the minimum diameter and the non-sawtimber portion is removed as defect.

Sawtimber trees may have two heights recorded: the sawtimber height and the top height. The top height includes the sawtimber portion, so it should always be at least as large as the sawtimber height. The merchantable portion of the tree above the sawtimber portion is known as topwood.

Heights measured for timber cruising in Region 9 are currently not recorded in feet, but rather in the number of 8-foot bolts. This adds one additional step to the calculation. Heights are first measured in feet, and then that value is converted to number of 8-foot bolts using a table like that found in Appendix D.

Examples:

Merchantable height in feet	Height in 8-foot bolts
21	3
40	5
53	6

Notice that heights are rounded to the nearest number of 8-foot bolts (*not* always rounded down). In the examples above, the height of 21 feet is less than three full 8-foot bolts, but the height is rounded up to 3.

7.1 – Slope Correction

All of the height measurement tools used in timber cruising require an accurate measure of the horizontal distance from the instrument to the tree. On relatively level ground this can simply be measured with a tape or any other distance measuring device. On sloping ground, however, the measured distance along the slope can be significantly different than the horizontal distance. Figure 7.1 illustrates this. The measured distance along the slope (C) is longer than the horizontal distance (A). The greater the slope angle (B), the greater the difference in the distances.

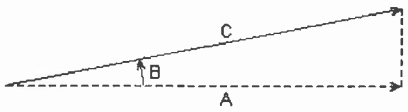


Figure 7.1 – Horizontal distance and slope distance

Slope is most often measured in percent or (less commonly) degrees. Slope is read directly from the instrument with no additional calculation necessary. The instrument should be sighted right along the tape used to measure the slope distance.

Any time the slope is 10 percent (5 degrees) or greater a slope correction is required. This is true whether the slope is uphill or downhill. Most electronic height measuring instruments have built-in systems to correct for slope. If a tape (or any other linear measuring device) is used to measure the distance along a slope, a calculation is needed to obtain the necessary slope distance corresponding to the required horizontal distance.

Appendix E contains a table of slope correction factors. When a taped distance is measured along a slope, the required horizontal distance is multiplied by the appropriate correction factor, and the resulting value is the distance that must be measured along the slope.

In order to ensure that the correct horizontal distance is being used, attach the tape to the tree, then move away the required distance and pull the tape tight. Measure the slope of the tape. If it is 10 percent (5 degrees) or greater, multiply the desired horizontal distance by the appropriate slope correction factor from Appendix E and adjust the taped distance to the resulting slope distance.

Example:

Desired horizontal distance	66 feet
Slope to the tree	35%

Slope correction factor (from Appendix E) 1.06
Calculated slope distance 66 feet * 1.06 = 70 feet

In order to be a horizontal distance of 66 feet from the tree, the taped distance along the slope would be 70 feet.

7.2 – Height Calculation

It is usually most accurate to measure tree height from a point either uphill from the tree or on the same contour as the tree. Avoid measuring from the downhill side of the tree whenever possible.

Regardless of the point on the tree to which the height is measured, or the instrument used to make the measurements, the method used to calculate the height always uses the same geometry, as described in section 6.1.

Throughout the discussion of height calculations, illustrations will depict height being measured to a spot convenient for demonstrating a concept. These same concepts hold true regardless of the actual spot on the tree to which the height is measured.

7.2.1 – Instrument Above The Tree Base Figure 7.2.1 shows the situation where the height measuring instrument is above the base of the tree. The angle to the base of the tree (B) has a negative sign, and the angle to the top (C) has a positive sign.

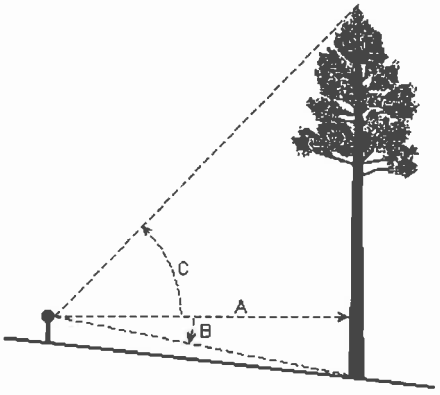


Figure 7.2.1 – Height measurement with instrument above tree base

When the angles have opposite signs the corresponding heights are always added together. Knowing the horizontal distance A and the angle B allows for calculation of the height from the tree base to eye level. Knowing the horizontal distance A and the angle C allows for calculation of the height from eye level to the tree top. These two heights are added together to get the height of the tree.

Example:

Taped distance to the tree	50 feet
Slope to the tree	5% (no slope correction needed)
Angle to tree base	-14%
Angle to tree top	48%
Tree height	(0.14 * 50 ft) + (0.48 * 50 ft) = 31 feet

Example:

A clinometer with a topographic scale is to be used to measure a tree height. A horizontal distance of 66 feet is needed so the topographic scale can be read directly as feet.

Horizontal distance to the tree	66 feet
Slope to the tree	25% (slope correction needed)
Slope correction factor (from Appendix E)	1.03
Taped distance to the tree	66 ft * 1.03 = 68 feet

The instrument is moved to a taped distance of 68 feet.

Angle to tree base	-21
Angle to tree top	55
Tree height	21 ft + 55 ft = 76 feet

7.2.2 – Instrument Below The Tree Base Figure 7.2.2 shows the situation where the height measuring instrument is below the base of the tree. The angle to the base of the tree (B) and the angle to the top (C) both have positive signs.

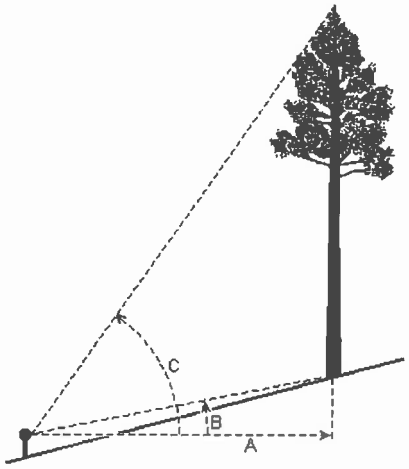


Figure 7.2.2 – Height measurement with instrument below tree base

When the angles have the same sign the smaller height is always subtracted from the larger. Knowing the horizontal distance A and the angle B allows for calculation of the height from eye level to the tree base. Knowing the horizontal distance A and the angle C allows for calculation of the height from eye level to the tree top (which is greater than the tree height). The height to the base is subtracted from the height to the top.

Example:

Desired horizontal distance to the tree	100 feet
Slope to the tree	32% (slope correction needed)
Slope correction factor (from Appendix E)	1.05
Taped distance to the tree	100 ft * 1.05 = 105 feet

The instrument is moved to a taped distance of 105 feet.

Angle to tree base	4%
Angle to tree top	76%

Tree height	76 ft - 4 ft = 72 feet

Example:

A clinometer with a topographic scale is to be used to measure a tree height. A horizontal distance of 66 feet is needed so the topographic scale can be read directly as feet.

Taped distance to the tree	66 feet
Slope to the tree	8% (no slope correction needed)
Angle to tree base	9
Angle to tree top	87
Tree height	87 ft - 9 ft = 78 feet

7.3 Forked Tree

The tree height discussions to this point have assumed single, intact, vertical tree stems. There are some special situations that require additional considerations or calculations when measuring tree heights. A forked tree is one such situation.

A tree is said to fork when the bole divides into two or more main stems. The fork is considered to begin at the point where daylight can be seen between the two stems.

7.3.1 – Tree Forked Above 4.5 Feet When a tree forks above 4.5 feet it is considered a single tree. The height of the *best* fork is measured. This is not necessarily the tallest fork. Figure 7.3.1 shows a forked tree where the height of the fork on the left (to point A) is greater than the height of the fork on the right (to point B). The fork on the right, however, is the better fork due to crook and branching, so the height (C) is measured using the right fork.

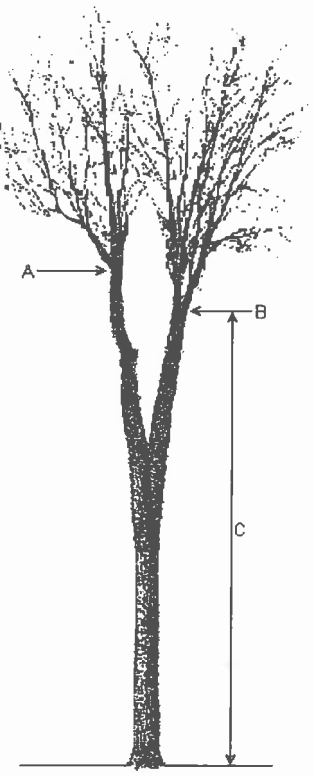


Figure 7.3.1 – Height of a forked tree

7.3.2 – Tree Forked Below 4.5 Feet When a tree forks below 4.5 feet it is considered two trees. The height of each stem is measured using the standard procedures.

7.4 Leaning Tree

Tree height is actually a measure of the length of the tree stem. When a tree stands vertically, the height measurement represents this length well. When a tree leans, however, the vertical height is less than the length of the stem.

Whenever possible, a leaning tree should have its height measured from a point perpendicular to the lean. From any other point the height will appear to be different than it actually is. Figure 7.4a illustrates what happens when measuring tree height from a point in line with the lean. The black tree image is leaning toward (image A) and away from (image B) the person measuring the height. The gray tree images show the height that the tree will appear to be.

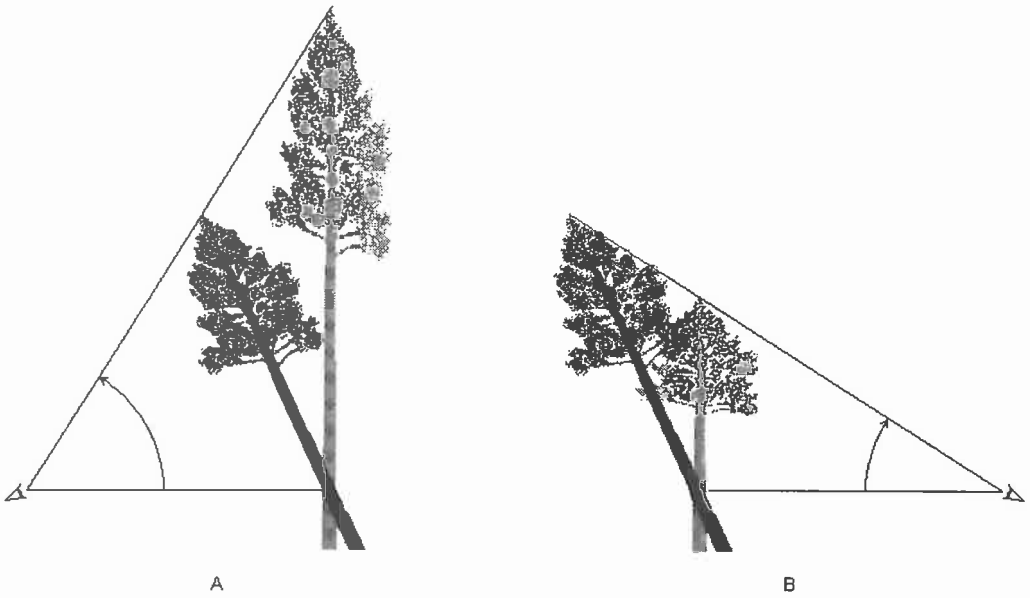


Figure 7.4a – Improper height measurement - in line with tree lean

When a tree leans toward the person measuring its height (image A) the angle to the top of the tree is greater than it would be if the tree were vertical. This causes the estimated tree height to be too large. When a tree leans away from the person measuring its height (image B) the angle to the top of the tree is less than it would be if the tree were vertical. This causes the estimated tree height to be too small.

When positioned correctly (perpendicular to the tree lean) the amount of lean can be accurately determined. *Any time a tree leans 15 degrees (25 percent) or more from vertical a lean correction is required for the height measurement.* Appendix E contains a table of lean correction factors used to correct the height measurement on leaning trees. These are the same factors used to correct horizontal distances for slope.

Figure 7.4b shows a leaning tree, viewed from a point perpendicular to the lean.

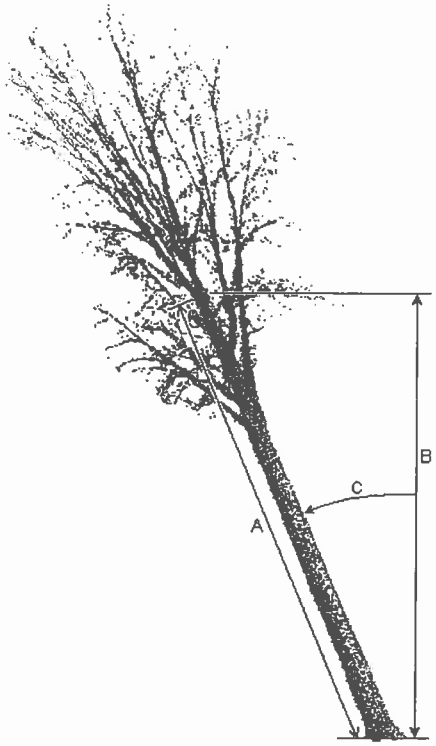


Figure 7.4b – Height measurement on a leaning tree

The desired height is shown as distance A, however this distance can't be measured directly. From the correct horizontal distance (perpendicular to the lean) the vertical height B is measured to the desired point. The lean angle C is then measured. If this angle is 15 degrees (25 percent) or greater, the appropriate lean correction factor from Appendix E is applied. Since B is a vertical distance, angle C is always measured from vertical.

Example:

Measured vertical height	50 feet
Tree lean angle	30% (lean correction needed)
Lean correction factor (from Appendix E)	1.04
Tree height, corrected for lean	50 ft * 1.04 = 52 feet

The lean angle of a tree can be measured with a clinometer or relaskop by standing adjacent to the tree and sighting along the tree stem. The instrument reads the angle from horizontal, so it needs to be converted to an angle from vertical. If measured in degrees, the angle from horizontal is simply subtracted from 90. For example, a measured angle of 75 degrees from horizontal would be 15 degrees from vertical (90 - 75). If the angle is measured in percent the calculation is a little trickier. The angle from vertical is equal to 1 divided by the decimal equivalent of the angle from horizontal. For example, a measured angle of 200 percent from horizontal would be 50 percent from vertical (1 / 2.00 = 0.50 or 50%).

Figure 7.4c shows how a clinometer or relaskop can be used to determine tree lean without looking through the sight. From a position perpendicular to the lean, hold the instrument in line with the centerline of the tree stem. With a clinometer, the straight side of the is held so it appears to lie along the centerline of the tree stem. While held in this position the scale is read directly from the wheel at the index line. This is an angle from horizontal, so the conversion to an angle from vertical is necessary, as described in the previous paragraph. With a relaskop, hold the release button in and hold the instrument so it appears to align with the centerline of the tree stem. Wait for the internal wheel to stop moving and then release the button. The angle from vertical is read from the internal scale.

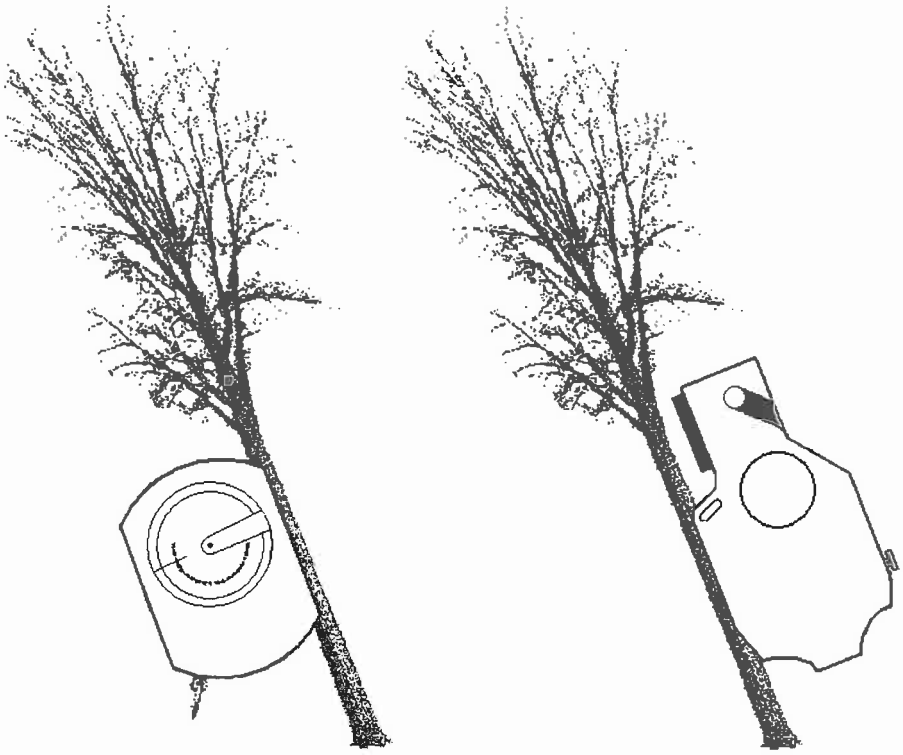


Figure 7.4c – Measuring tree lean with a clinometer or relaskop

7.5 Down Tree

A tree that has fallen over intact, and is lying more horizontally than vertically, is usually measured with a tape instead of a height measuring instrument. Figure 7.5 shows a tree that has blown over.

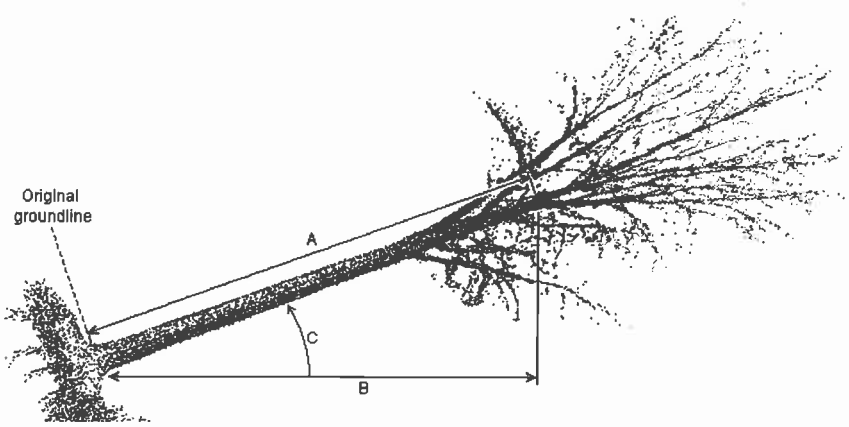


Figure 7.5 – Height measurement on a down tree

The desired height is shown as distance A. The original groundline from when the tree was still standing must be located in order to correctly measure the height. Soil and duff material often falls off the roots of a down tree and covers the base of the tree. This material may need to be removed in order to determine the location of the original ground line on the tree.

If the tree has fallen over so the entire stem is accessible, the height may be measured directly with a tape. If the upper part of the stem is out of reach, the tape is strung horizontally (B) to a spot directly below the point to which the height is being measured. Angle C is then measured, and if it is 15 degrees (25 percent) or greater, the corresponding lean correction factor from Appendix E is applied. Since B is a horizontal distance, angle C is always measured from horizontal.

Example:

Measured horizontal length	60 feet
Tree angle from horizontal	50% (lean correction needed)
Lean correction factor (from Appendix E)	1.12
Tree height, corrected for lean	60 ft * 1.12 = 67 feet

7.6 Broken Tree

A tree that has broken has two parts that need to be measured in order to determine the height: the remaining lower portion connected to the ground, and the broken upper portion. Figure 7.6a shows a tree in which the top has broken, but is hung up in other trees. The upper portion remains at a steep angle.

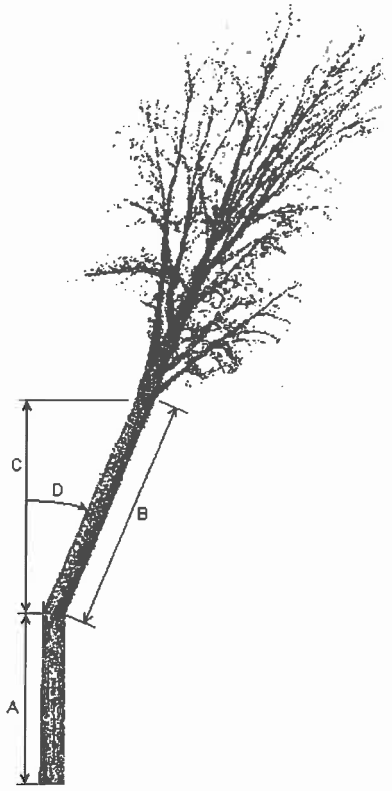


Figure 7.6a – Height on a broken tree with top oriented at a steep angle

The recorded height for this tree is the sum of lengths A and B. Length A is measured as a height with a height measurement instrument, or with a tape if it is short enough. Length B is measured similar to measuring the height on a leaning tree. The vertical distance C is measured with a height measuring instrument, and then the lean correction factor corresponding to angle D is applied. Since C is a vertical distance, angle D is always measured from vertical.

Example:

Height of lower portion	12 feet
Vertical height of upper portion	20 feet
Lean angle of upper portion	40% (lean correction needed)
Lean correction factor (from Appendix E)	1.08
Height of upper portion, corrected for lean	20 ft * 1.08 = 22 feet
Tree height	12 ft + 22 ft = 34 feet

If the lower portion of the tree is leaning at an angle of 15 degrees (25 percent) or greater from vertical and can't be measured with a tape, a lean correction factor must be applied to that portion as well.

If the upper portion of the tree has fallen to a point where it is more horizontal, it is better to measure that portion with a tape. Figure 7.6b shows a tree where the broken upper portion has fallen and is touching the ground.

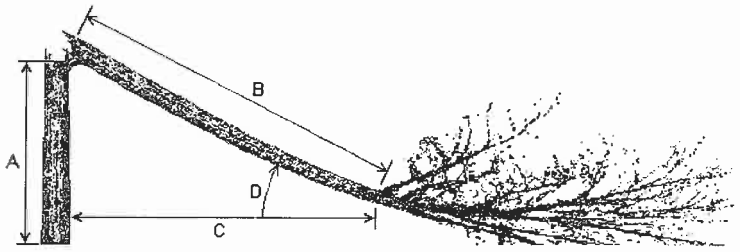


Figure 7.6b – Height on broken tree with top oriented at a flat angle

The recorded height for this tree is the sum of lengths A and B. Length A is measured as a height with a height measurement instrument, or with a tape if it is short enough. Length B is calculated by measuring length C with a tape, and then applying the lean correction factor corresponding to angle D. Since C is a horizontal distance, angle D is always measured from horizontal.

On any broken tree there will certainly be defect in the area surrounding the breakage, but this does *not* affect the height calculation.

7.7 Severed Tree

A severed tree is simply a broken tree in which the upper portion has become detached from the lower portion. The same rules for measuring the height apply. Figure 7.7a shows a tree with a severed top.

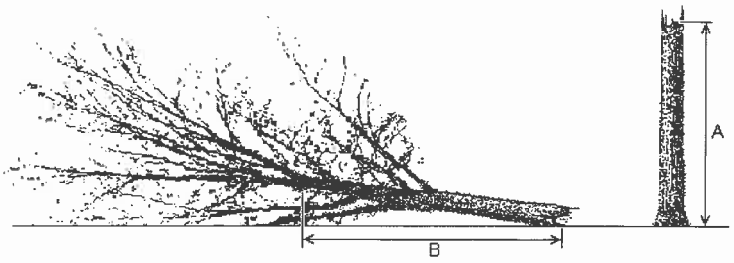


Figure 7.7a – Height on tree with severed top

The recorded height for this tree is the sum of lengths A and B. Length A is measured as a height with a height measurement instrument, or with a tape if it is short enough. Length B is measured with a tape. If the top is not entirely accessible with a tape and is laying at an angle of 15 degrees (25 percent) or greater from horizontal, a lean correction factor must be applied. Whenever a horizontal distance is measured, the angle is measured from horizontal.

Figure 7.7b shows a tree in which the upper portion is supported in some way and remains at a steep angle.

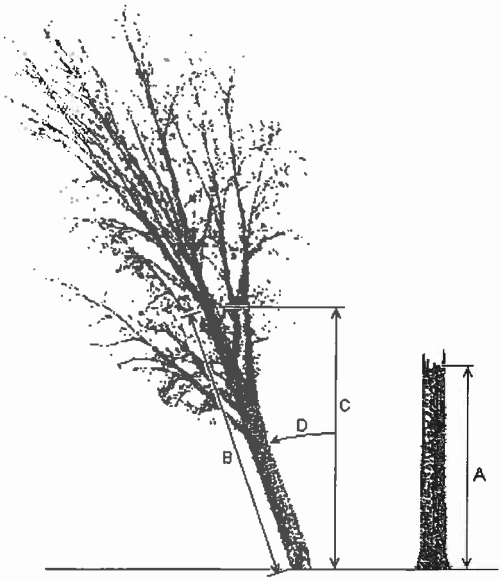


Figure 7.7b – Height on tree with leaning severed top

The recorded height for this tree is the sum of lengths A and B. Length A is measured as a height with a height measurement instrument, or with a tape if it is short enough. Length B is measured similar to measuring the height on a leaning tree. The vertical distance C is measured with a height measuring instrument, and then the lean correction factor corresponding to angle D is applied (if angle D is 15 degrees or greater). Since C is a vertical distance, angle D is always measured from vertical.

If the lower portion of the tree is leaning at an angle of 15 degrees (25 percent) or greater from vertical and can't be measured with a tape, a lean correction factor must be applied to that portion as well.

On any severed tree there will certainly be defect in the area surrounding the breakage, but this does *not* affect the height calculation.

7.8 Tree With Missing Top

When the top of a tree has broken off and can't be located, it is not possible to measure the height of the tree directly. It is not acceptable to simply measure the top height to the point of breakage. The equations used to calculate the volume for the tree assume the top height was measured to a particular top diameter. If the height was not measured to that diameter, then the volume calculations will be wrong.

When a tree has a missing top, several other trees of the same species and similar DBH and form are found, and their heights measured. The average height of those trees is recorded as the height of the tree with the broken top. The missing part of the stem above the break will be removed from the calculated tree volume as defect, so a defect calculation will need to be done. Image A in figure 7.8 shows a tree with a missing top. Image B shows what the tree would likely have looked like based on other trees in the area. The recorded height should be representative of image B.

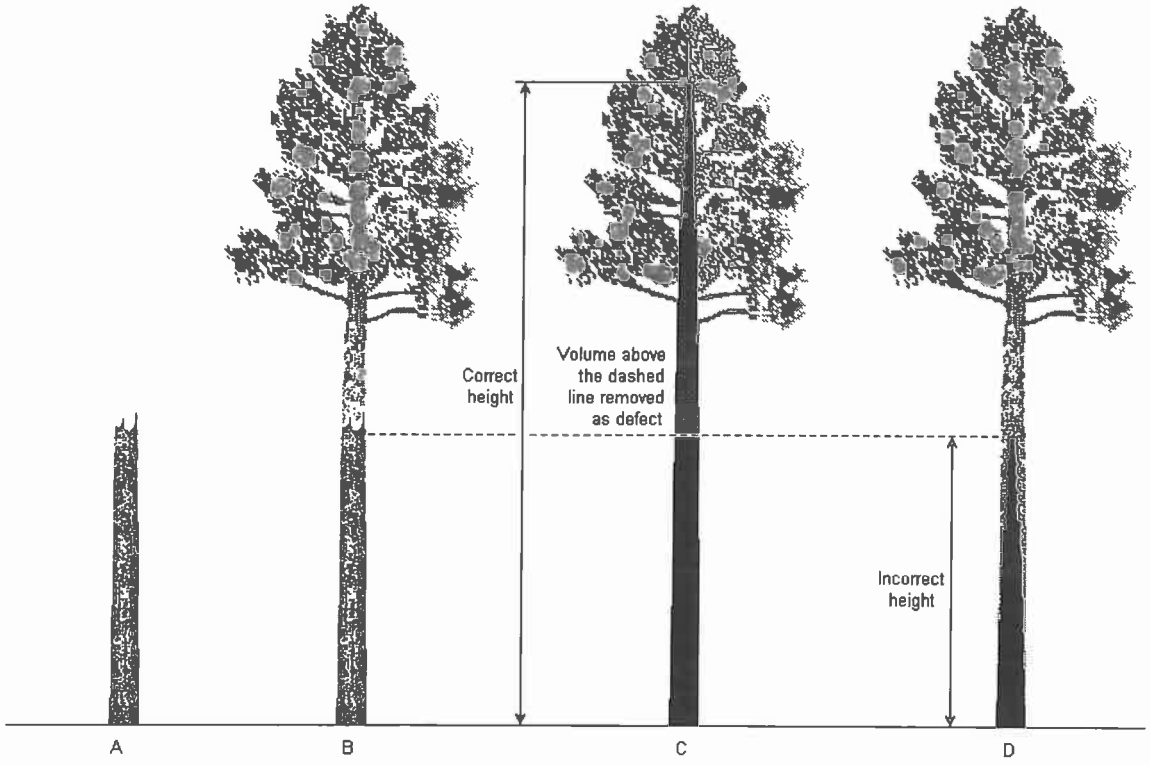


Figure 7.8 – Height measurement for a tree with missing top

Image C has a dark area representing the volume that will be calculated if the height is recorded correctly to an average height. The volume calculated to be above the breakage is obviously no longer there, so it would be deducted as defect. The volume calculated to be below the breakage point is pretty accurate. Image D shows the volume that would be calculated if the height is incorrectly recorded to the breakage point. The equations used to calculate the tree volume would assume that the typical minimum top diameter was reached at the breakage point instead of much higher on the tree, so the calculated tree taper would be too severe. It is easy to see that the calculated volume would be too low.

If the breakage occurs within the sawtimber portion of the tree, the sawtimber height is recorded to a point just below the damage due to the breakage. Sawtimber heights are *not* recorded to the minimum sawtimber diameter with an adjustment made using defect. The only exception is the case where the sawtimber height is the only height recorded for a tree.

7.9 Tree With Dead Top

In some cases the top of a tree dies but remains attached. It is not acceptable to simply measure the height to the point of topkill. The equations used to calculate the volume for the tree assume the height was measured to a particular top diameter. If the height was not measured to that diameter, then the volume calculations will be wrong (as discussed above in the section about a tree with a missing top). There are different ways to handle this situation, depending on the amount of growth the tree has put on since the time the top died.

If the top has recently died and the form of the dead top matches the rest of the tree fairly well (as shown in image A in figure 7.9), the height is measured as it would be for any other tree. The dead part may need to be removed from the calculated volume as defect, so a defect calculation may need to be done.

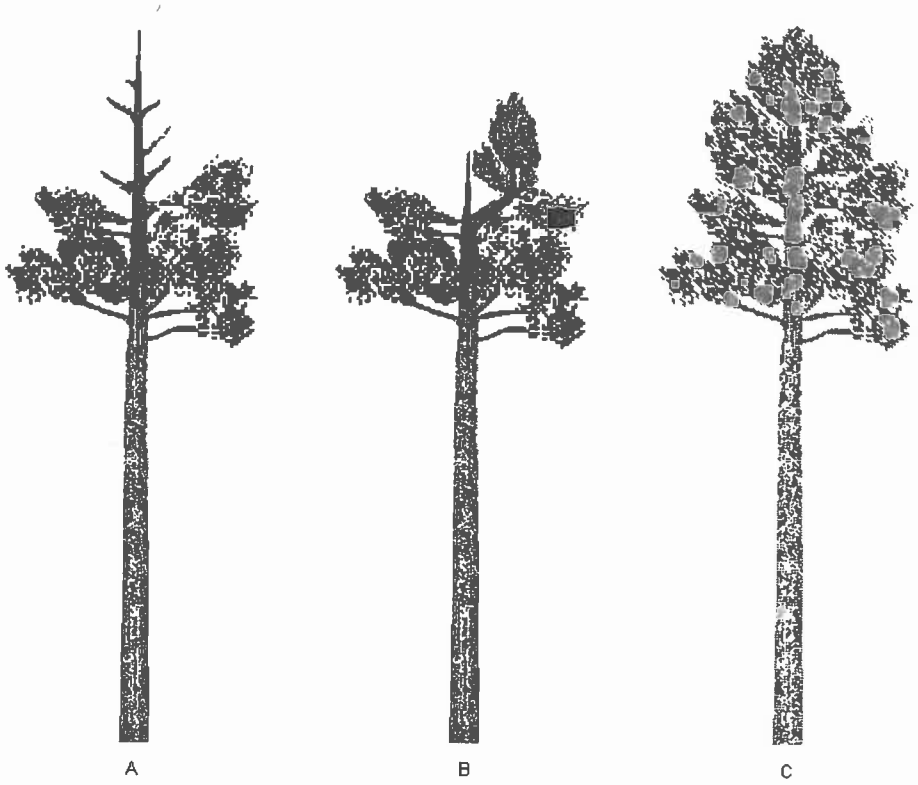


Figure 7.9 – Height measurement for a tree with a dead top

If the top died long ago, the form of the tree likely changes significantly at the point of topkill. It could be that the tree has continued to grow in diameter without additional height growth, or it could be that a secondary leader has taken over (image B in figure 7.9). In either case, the height of the tree is not be representative of the height the tree would have had if growing normally. When this occurs, several other trees of the same species and similar DBH and form are found, and their heights measured. The average height of those trees is recorded as the height of the tree with the dead top. Image C in figure 7.9 shows what the tree would have looked like if the top had not died,

and this is what the recorded height should reflect. The dead part of the stem may need to be removed from the calculated tree volume as defect, so a defect calculation may need to be done.

If the dead top begins within the sawtimber portion of the tree, the sawtimber height is recorded to the point of topkill. Sawtimber heights are *not* recorded to the minimum sawtimber diameter with an adjustment made using defect. The only exception is the case where the sawtimber height is the only height recorded for a tree.

8. DEFECT

Defect is defined as any irregularity or imperfection in a tree that reduces the quality and utilization potential of the wood. Common defects include, but are not limited to scars, rots, cracks, seams, breakage, conks, cankers, holes, forks, crook, sweep, burls, and dead limbs.

The volume of a product before defect is removed (sound wood plus unsound wood) is called *gross volume*. The remaining volume after defect has been removed (sound wood only) is called *net volume*.

Defect is one of the most difficult things for a cruiser to accurately measure. This is because the damage to the wood is usually determined by looking at the outside of the tree. It takes a good deal of practice to be able to reliably read the exterior signs of defect and accurately predict the extent of the damage to the wood.

In Region 9, defect is measured as the percentage of the volume of a particular product lost because of the irregularity or imperfection. For example, a sawtimber defect of 10% indicates that ten percent of the sawtimber volume in the tree is not sound, or in other words, 90 percent of the sawtimber volume is sound. The sawtimber defect does not apply to any other product, so if there is topwood volume above the sawtimber portion of the tree the sawtimber defect does not apply to the topwood.

There are two primary methods used in Region 9 for calculating the amount of defect. These are referred to as the length-deduction method and the pie-cut method.

8.1 Length-Deduction Method

The length-deduction method is usually reserved for defects that affect more than half the diameter of the tree stem. The assumption is that the defect can be removed through proper bucking. This method accounts for defect by estimating the length of a log that would be cut off due to the defect. The defect percentage is calculated as the volume lost in the defect section as a proportion of the gross volume of the entire product in the tree.

Figure 8.1a shows a tree with a 4-foot section that will be lost to defect. The defected section represents the entire lower half of the second 8-foot bolt. It is as if the second bolt has its length reduced by 4 feet.

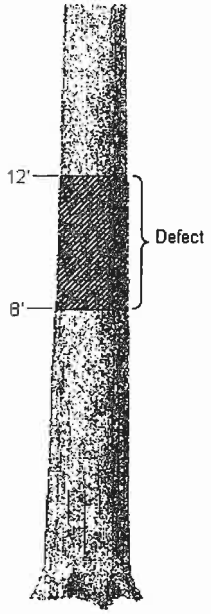


Figure 8.1a – Defect in the lower half of the second bolt

The proportion of volume in particular parts of a tree can be found in appendix F. For example, a tree containing 4 bolts has 17 percent of its volume in the lower half of the first bolt, 16 percent in the upper half of the first bolt, 14 percent in the lower half of the second bolt, and so on. If the tree in figure 8.1a contains 4 bolts, the defect would be recorded as 14 percent.

Of course, defect does not always fall at the end of a bolt, and is not always half a bolt in length. Because it is often difficult to determine the exact extent of a defect, length deductions should be made in increments of whole feet. For example, if a defect appears to be 1.5 feet in length, a length deduction of 2 feet is made.

If a defect is contained in more than one half a bolt, the values from appendix F are added together for all of the defected sections. For example, if the entire second bolt of a 4-bolt tree is defect, then the percentages for those two half-bolts are added together. The defect would be 12 percent plus 14 percent, and would be recorded as 26 percent.

Defect can also be less than half a bolt. Figure 8.1b shows a tree with a 2-foot long defect in the middle of the second bolt.

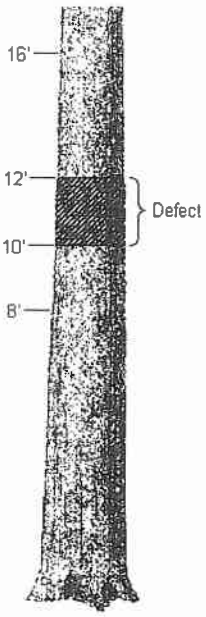


Figure 8.1b – Defect in the middle of a bolt

The defect occurs in the lower half of the second bolt. In this case, however, the defect is only half of the lower half-bolt (or in other words, one-fourth of the length of the second bolt). The volume in this defect is half the value found in appendix F. For example, if the tree in figure 8.1b contains 4 bolts, the defect would be recorded as 7 percent (half of the 14 percent from appendix F). If the volume percent for a half bolt is an odd number, assign the larger part to the lower section.

It is possible that a tree contains more than one area of defect. If that is the case, the volume percentages for all of the defect sections are added up, and the total is recorded. There is one potential problem, however. If the sound section between two defect sections is smaller than the minimum product length, that sound section becomes defected as well. Figure 8.1c shows a tree with two sections of defect close together.

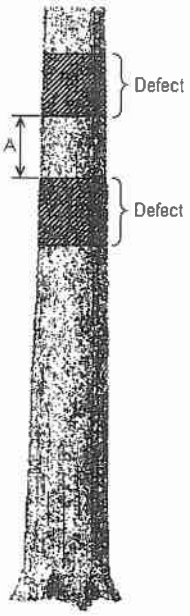


Figure 8.1c – Defect in two different areas

If length A in figure 8.1c is at least as long as the minimum product length, the two defect percentages are simply added together. If length A is shorter than the minimum product length, then that sound section is considered defect, and the percentage would be calculated from the bottom of the lower defect section to the top of the upper defect section.

If the defect occurs in the butt bolt or the uppermost bolt, the minimum product length may again need to be considered. Figure 8.1d shows a tree with defect in the butt bolt.

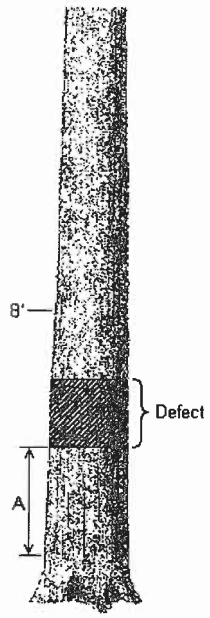


Figure 8.1d – Defect in the butt bolt

Length A is measured from the stump height to the bottom of the defect section. If length A is at least as long as the minimum product length, the defect is calculated for the defect section only. If length A is shorter than the minimum product length, the sound section below the defect section is also considered defect, and the defect percentage would be calculated from the stump to the top of the defect section.

Defect near the top of the uppermost bolt is handled similarly. If the sound section above the defect is at least as long as the minimum product length, defect is calculated for the defect section only. If the sound section above the defect is shorter than the minimum product length, the sound section is also considered defect, and the defect percentage would be calculated from the bottom of the defect section to the top of the uppermost bolt.

8.2 Pie-Cut Method

The pie-cut method is usually reserved for defects that do not affect the entire diameter of the tree stem, but may run for a significant length. The assumption behind this method is that the defect can be removed in the sawing process at the mill. This method accounts for defect by estimating the proportion of the cross-section of the stem affected by the defect (sort of like creating a pie chart with lines to either side of the defect) and then extending the wedge for the full length of the defect, creating a wedge-shaped defect segment. The defect percentage is calculated as the volume lost in the wedge-shaped defect segment as a proportion of the gross volume of the entire product in the tree. Figure 8.2 shows a tree with a scar and associated interior damage.

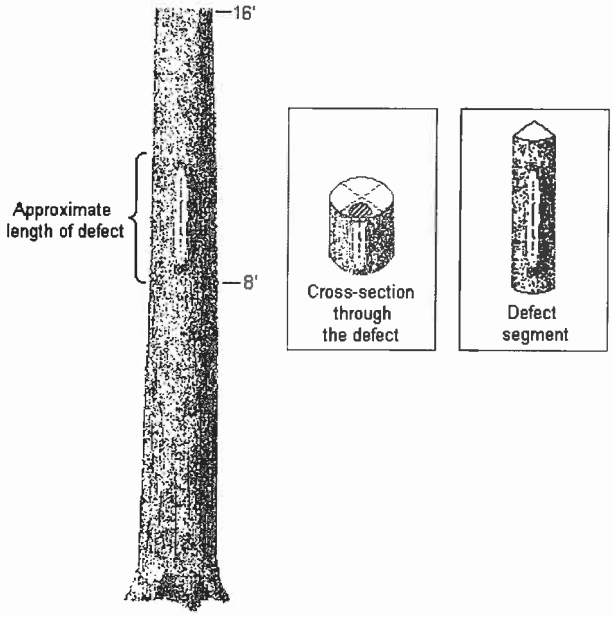


Figure 8.2 – Pie-cut defect

The estimated length of the interior damage is shown as affecting the lower half of the second bolt. From the cross-section in the left inset it can be seen that the damage is confined to about 1/4 of the stem. The defect segment (shown in the right inset) represents 1/4 the volume of the lower half of the second bolt. If this tree contains 3 bolts, the percentage of volume in the lower half of the second bolt is 17 percent (from appendix F). The defect is then 1/4 of 17 percent, or 4 percent.

9. OTHER TREE ATTRIBUTES

There are a few other attributes that are recorded for trees measured in a timber cruise.

9.1 Live/Dead

A tree is either alive or dead. The code for live is "L" and the code for dead is "D". This seems like a simple concept, but there are complicating factors. A tree that is currently alive may be very close to death from things like insect attack, disease, physical damage, fire, or many other factors. This type of tree may be dead before the sale actually occurs. A tree may also have a very small proportion of live crown left, and the tree stem may be mostly dead material.

The information recorded in a timber cruise is for the exact time that the cruise was performed. In other words, even if a live tree looks like it will soon be dead, it is recorded as a live tree.

9.2 Cut/Leave

A tree will either be cut or it will be left standing. The code for cut is "C" and the code for leave is "L". Again, this seems like a simple concept, and in most cases it is. In a unit that is cut-tree marked, all trees that will be cut are marked with tree marking paint. However, in units where the trees that are to be cut are designated by some type of description (for example, residual spacing), it may not be obvious which trees will actually be cut.

When cruising in units where cut trees are designated by description, the trees that the cruisers assume will be cut must be marked in some way (paint, flagging, etc.) so someone returning to that spot (for example, to check cruise) will know which trees were selected as cut trees and which were selected as leave trees. These may not be the trees that are actually cut during the harvest, but they must meet the specifications in the designation description, and should therefore be a good representation of the trees that are actually cut.

10. CRUISING METHODS

Timber cruising usually involves counting and measuring only a portion of the trees for which the volume is to be estimated. The system used to determine which trees are to be counted or measured is called the cruising method. There are many cruising methods used throughout the country. Only those typically used in Region 9 will be discussed here.

10.1 Cruising Concepts

Before the individual cruising methods can be discussed, a few underlying concepts must first be discussed.

10.1.1 – Counting and Measuring Trees that are to be included in the cruise calculations are either measure trees or count trees. Measure trees are those in which all of the required tree measurements are taken and recorded. Count trees are those that are simply counted (or tallied) without having measurements taken on them. Count trees are used to get an accurate count of the number of trees without taking the time to measure every one. Measure trees are also counted in the total tally, so the total number of trees that will be included in the cruise calculations is equal to the number of measure trees and count trees.

Some cruise methods use count trees and some do not. In those that do not, every tree that is to be included in the cruise calculations is measured.

The numbers of count trees must be tracked in some way. There are several methods commonly used. The simplest method involves keeping a written tally. The most common written tally is called a dot tally, where a mark (dot or line) is made every time a tree is tallied. The tallying of ten trees typically results in the formation of some kind of geometric pattern, so adding up the total tally is easier. Another method of keeping tallies involves mechanical tally meters, which have small wheels that display the tree count. A trigger mechanism is used to increase the count by one every time a tree is counted. There are also electronic tally meters. The cruise programs that are used on a portable data recorder (PDR) have an electronic tally meter built in.

10.1.2 – Plot Monumentation Several of the cruising methods use some type of plot to sample the trees. Whenever plots are used, the plot center must be specified precisely enough so that it can be unquestionably determined whether any particular tree is in or out of the plot. This means that some type of stake or pin must be pushed into the ground to exactly mark plot center. The plot number must be recorded on the stake or pin (written on flagging or on a tag) or painted on the trees that are in the plot.

This location may need to be found again at a later time (for example, in a check cruise), so it must be made easy to find by using flagging, paint, or some other easily seen marking. The stake or pin is left at plot center, and is also marked so as to be easy to relocate.

All trees that are in a plot should be marked in some way using flagging, paint, or another mark that is easily visible from plot center. Any information painted on the measure trees in a plot will be applied on the side of the tree facing plot center. In this way, anyone standing at plot center should be able to easily determine which trees were in the plot, and which trees were measured.

10.1.3 – Stratification Stratification is the division of a set of things into groups of similar things. The large set of all of the things is called a population, and the groups of similar things are called sub-populations. For cruising, all of the trees for which the volume will be estimated make up a population. Those trees are stratified into sub-populations. For example, trees might be stratified by species and diameter. Trees from a particular set of species, and from a specific diameter range, might be grouped into one sub-population.

10.1.3.1 – Strata and Sample Groups Stratification is important in timber cruising, and it is important for the cruiser to understand how the trees are stratified. Two types of stratifications are used in cruising: strata and sample groups. Strata are usually used to separate the population by diameter range or cutting unit. Sample groups are usually used to separate the population by species and product. The combination of a stratum and a sample group defines a sub-population for the cruise.

Every measure tree in a cruise will have the stratum and sample group recorded. In addition, count trees are tallied by stratum/sample group combination.

10.1.4 – Cruising Method Categories There are two main categories of cruising methods: tree-based and area-based.

10.1.4.1 – Tree-Based Cruise Methods With tree-based methods, every single tree that is to be included in the volume estimate is visited by a cruiser and is counted. At that time the tree is marked in some way to ensure that no trees are missed and no tree is counted more than once. The proportion of the counted trees that are to be measured is specified in the cruise plan.

Tree-based cruising methods are primarily used with cut-tree marking, where each tree that is to be harvested in a timber sale is marked with timber marking paint. As the trees are marked with paint they are added to the count. If a tree-based method is used without cut-tree marking, the trees must be marked in some other manner. For example, each tree could be marked with chalk as it is counted

There are two tree-based cruising methods commonly used in Region 9: 100 percent and sample tree. Each is discussed in detail in the sections that follow.

10.1.4.2 – Area-Based Cruise Methods With area-based methods, some sort of plot system is used to determine which trees will be counted and measured. Depending on which method is used, either all of the trees on each plot are measured, or some proportion of the trees on the plots is measured. The plot design, number of plots, and plot spacing are specified in the cruise plan.

When using area-based methods, the center of each plot must be monumented as described in the section on plot monumentation. This is so that plot center is determined exactly and can be located again at a later time.

There are three area-based cruising methods commonly used in Region 9: fixed plot, point, and point count measure tree. Each is discussed in detail in the sections that follow.

10.2 100 Percent (100)

The 100 percent cruising method (abbreviated "100") involves measuring every single tree in the sub-population. Every tree is a measure tree, so there are no count trees in this method. Since every tree represents only itself, there is no volume expansion, and an accurate area estimate is not necessary in order to calculate the total volume with 100 percent cruising.

The 100 percent method is used primarily with very small areas, like landings or roads. It is also used with extremely valuable trees or with a sub-population of trees that are sparsely scattered throughout a large area.

10.3 Sample Tree (STR)

10.3.1 – Description The sample tree cruising method (abbreviated "STR") involves measuring a specified proportion of the trees in the sub-population. That proportion is translated into a sampling interval. For example, a sampling interval of 1:10 (read 1 in 10) would mean that one of every ten trees in the population would be measured. The remaining trees are simply tallied as count trees. An average volume per tree is calculated for the measured trees, and that volume per tree is then expanded by the total number of trees counted. Since volumes are calculated without needing to know the area, an accurate area estimate is not necessary in order to calculate the total volume with sample tree cruising.

With the sample tree method, every tree must be visited and marked in some way (for example, paint or chalk) so it is obvious which trees have already been counted and which have not. Because every tree must be marked, the sample tree method is most often used with cut-tree marking.

10.3.2 – Stratification Stratification is used extensively with sample tree cruising. Different primary products must be in different sub-populations. In addition, different combinations of strata and sample groups are usually used. Strata are often used to stratify by diameter, and sample groups are often used to further stratify by species. For example, strata might be defined for large sawtimber at least 20 inches DBH, small sawtimber less than 20 inches DBH, and pulpwood. An example of a sample group could be all oak species. One sub-population would then be all oaks that are sawtimber at least 20 inches DBH. A second would be all oaks that are sawtimber less than 20 inches DBH.

The different sub-populations must be tallied separately. Each can have its own sampling interval. For example, a large oak sawtimber sample group might have a sampling interval of 1:10 (one of every ten is measured), while a small oak sawtimber sample group might have an interval of 1:50. The sub-populations and the associated sampling intervals should be specified in the cruise plan. Once sampling has begun, the intervals should not be changed for a particular sub-population.

10.3.3 – Selection of Measure Trees Every tree in a sub-population should have an equal probability of being selected as a measure tree. For this reason, a random selection process is preferred. The best method is a computer program that randomly selects trees in the proportion needed and notifies the cruiser when a tree must be measured. A more systematic approach (for example, measuring every tenth tree if the interval is 1:10) is often more practical. The random approach is preferred, but the more systematic approach is acceptable. If a more systematic approach is used, the first measure tree of each sub-population should be selected randomly from within the sampling interval so that all of the first measure trees from all sub-populations are not all grouped at the point where the cruise began in the unit. For all intervals after the first, the sample trees may be selected systematically. Usually this means that, after the first interval, the first tree of every interval is measured.

The measure trees must be selected without bias. This means that it is not up to the cruiser to decide which trees to measure. When a measure tree is needed, the selection is made by the order in which the trees were tallied. A cruiser must never try to even out the measure trees by selecting trees based on species, size, or any other characteristic. Trees should certainly not be selected simply because they are easier to measure. Any bias in tree selection affects the final volume determination.

A simple example will be used to illustrate the process. Assume there is a sampling group for oak sawtimber with a sampling interval of 1:10. Even though it does not demonstrate random selection, a systematic selection process will be used where the first tree of every ten is measured. In this case, the first oak sawtimber tree is measured, regardless of which species of oak it is, or what size it is (as long as it is of sawtimber size). The next nine oak sawtimber trees are simply tallied. The eleventh would be measured, again regardless of which oak species it is or what size it is. Similarly the 21st, 31st, etc. would be measured. Notice that there is no attempt made to balance the species or sizes of the measure trees.

10.3.4 – Tree Counts Each cruiser may be asked to keep separate tallies for many different sub-populations, and record their own measurements for measure trees. Alternatively, a single cruiser can be designated as the tally person, whose sole job is to record the tallies of the other cruisers, call out when a tree must be measured, and record the measurements.

There are two different ways in which the tree counts can be recorded. The first is to record the sampling interval size as the count for every measure tree. For example, if the sampling interval is 1:25, then the measure tree records get a count of 25. The last measure tree in a unit gets whatever count has been tallied since the last measure tree. The other way to record the tree counts is to record zero (0) for the count of every measure tree, and then add a count tree record at the end with the total count for the sample group.

It is important to note that the tree counts are not really associated with the individual measure tree records, so the two count systems described above result in identical volumes. The only important tree count is the total count of all trees in the sample group. The cruising software simply calculates an average volume per tree for all of the measured trees, and then multiplies that volume by the total number of trees that were counted.

When a unit is finished, the counts usually are not exactly equal to the sampling interval. This is not a problem. Simply record the counts recorded up to that point. There is no need to force in another measure tree of each sample group. There is also no need to combine the counts from all of the cruisers. If the next unit is in the same stratum as the one just completed, the intervals should be picked up where they were left off in the last unit. For example, if the next unit is in the same stratum, the sampling interval for a sample group is 1:10, and the last unit ended with a count of 87, the first three trees of that sample group are counted (so the running total is 90) and the 91st tree (the fourth in the unit) of that sample group is measured.

10.4 Fixed Plot (FIX)

10.4.1 – Description The fixed plot cruising method (abbreviated "FIX") involves measuring all of the trees on plots of a fixed size scattered throughout the area of interest. The average volume per acre is calculated, and that volume per acre is multiplied by the total number of acres to get the total volume. Because the total volume estimate is based on area, an accurate estimate of the area of the units is required.

With the fixed plot method every tree on every plot is measured, so there are no count trees. Because of this, stratification is usually not used, with the exception that different primary products must always be in separate sample groups. For example, sawtimber trees might be in one sample group, and pulpwood trees in another.

A circular plot is the most common type of fixed plot. A stake is placed at the plot center and all trees within a specified horizontal distance of the plot center are in the plot, and must be measured (figure 10.4.1). This horizontal distance is known as the plot radius. Appendix A contains a table of several common fixed plot sizes and the plot radius associated with each.

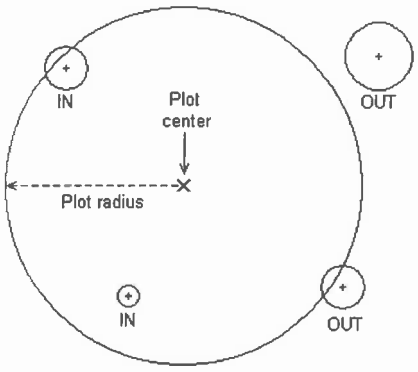


Figure 10.4.1 – Fixed plot

It is important to know whether the tape being used to measure the plot radius is graduated in inches or tenths of a foot. The values in appendix A are in tenths of a foot. If the tape being used to measure the plot radius is graduated in inches, use appendix C to convert inches to tenths of a foot.

10.4.2 – Determination of "In" Trees A tree is considered to be "in" if the horizontal distance from plot center to the center of the tree at breast height is less than or equal to the plot radius. This rule applies just as well to leaning or down trees. Any tree that is not obviously "in" or "out" must have its distance from plot center measured with a tape. The plot radii in Appendix A are measured to the center of the tree, not to the face. The easiest way to measure to the center of the tree is to run the tape past the tree so that it just touches the tree, and then measure the distance to the point of contact (figure 10.4.2a). An alternate method would be to measure distance to the face of the tree and add half the DBH, but that requires measuring DBH on every questionable tree.

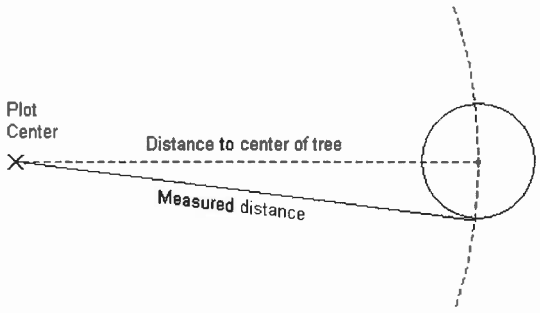


Figure 10.4.2a – Measuring distance to center of a tree

A situation can arise where a tape can't be stretched straight from plot center to a tree to determine whether it is "in" because a tree or other obstacle stands in the way. In this situation, the tape is stretched straight from the tree to a point as close to plot center as possible. The distance is measured at the point where plot center is perpendicular to the tape (figure 10.4.2b).

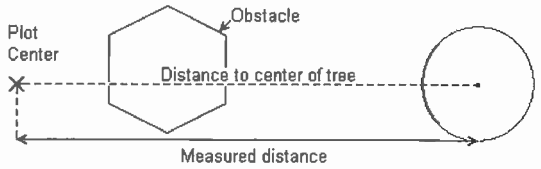


Figure 10.4.2b – Measuring to a tree around an obstacle

10.4.3 – Leaning or Down Trees Regardless of the orientation of the tree, the distance from plot center is measured to the center of the tree at breast height. The rules discussed in the sections on measurement of diameter at breast height are used to determine the location of breast height.

10.4.4 – Slope Correction It is important to note that the radius of a fixed plot is always measured as a horizontal distance. If the slope of the tape is 10 percent (5 degrees) or greater a slope correction must be applied. Appendix E contains a table of slope correction factors. The horizontal plot radius is multiplied by the correction factor corresponding to the slope to get the radius of the plot along that particular slope. The slope must be measured to each tree because the slope from plot center will change from tree to tree.

For horizontal distance measurements it can be a time saving shortcut to carry something to act as a plumb bob (like a heavy washer tied to a string). With a plumb bob, the end of the tape at plot center can be lifted to try to level the tape while ensuring the end of the tape remains exactly above plot center. If the tape can then be held horizontal, the horizontal distance to the tree is simply read from the tape. This should not be done unless a plumb bob is used.

10.4.5 – Null Plots Plots that have no trees on them are called "null plots". It is important to record information for these plots because otherwise the volume-per-acre values will be too high. To record a null plot, record the plot number and put a zero in for tree number. No other tree information is recorded. Some cruising software has a mechanism for automatically recording a null plot. For example, there may be a button or check box for null plots.

10.4.6 – Boundary Plots The fixed plot cruising method is designed to work where the entire plot falls within the boundary of a unit. When a plot center falls near the boundary of a unit, part of the plot could fall outside the boundary. This means that the part of the plot that is within the boundary does not represent the entire plot area. These types of plots are called "boundary plots". There are several methods for dealing with boundary plots.

10.4.6.1 – Half Plots The simplest method for dealing with boundary plots is also the most prone to bias. It is called the half plot method. Basically, an imaginary dividing line is drawn through the plot center in such a way that it does not cross the boundary. Only those trees whose center point is in the complete half plot are recorded. Since this represents only half a regular plot, every tree that is "in" is recorded twice.

This method is prone to bias in the selection of trees for the plots. There is very little probability that a tree at the very edge of a unit will ever be measured. This bias can be reduced somewhat by orienting the imaginary dividing line randomly while still assuring it doesn't cross the boundary. This method does work when the boundary is quite curved or irregularly shaped.

Figure 10.4.6.1 shows a half plot where only those trees to the left of the vertical line through the plot center are considered. The trees to the right of the vertical line (toward the boundary) are ignored. The small image to the right is shaded to show that exactly half of a normal plot is used.

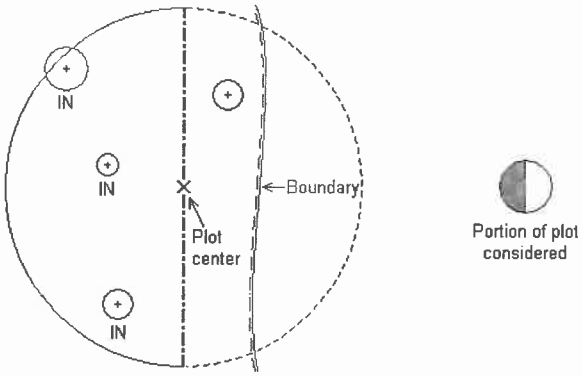


Figure 10.4.6.1 – Half plot

10.4.6.2 – Quarter Plots If a plot center falls near a corner or other area where even a half plot is not possible, the quarter plot method can be used. This method is basically the same as the half plot method except that only those trees whose center point is in the quarter plot are recorded (figure 10.4.6.2). Since this represents only a quarter of a plot, every tree that is "in" is recorded four times. The small image to the right is shaded to show that exactly one quarter of a normal plot is used.

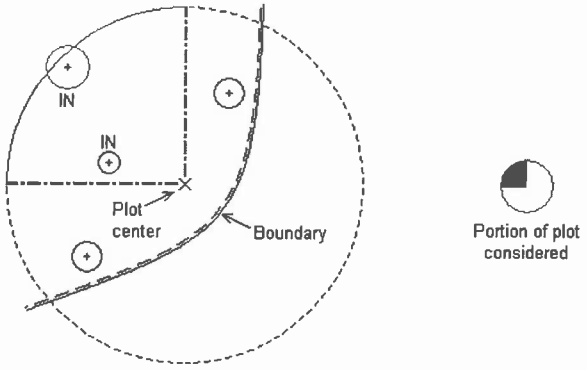


Figure 10.4.6.2 – Quarter plot

10.4.6.3 – Mirage Plots The idea behind mirage plots is to fill in for the part of the plot that is missing (due to the boundary) by using a second "mirage" plot. The mirage plot center is located outside the boundary the same distance that the original plot center is from the boundary (figure 10.4.6.3a). The "in" trees from both plots are selected only from those trees inside the boundary. In this way, some of the trees are recorded twice. Notice in figure 10.4.6.3a two of the trees are recorded twice since they are "in" for both the original plot and for the mirage plot.

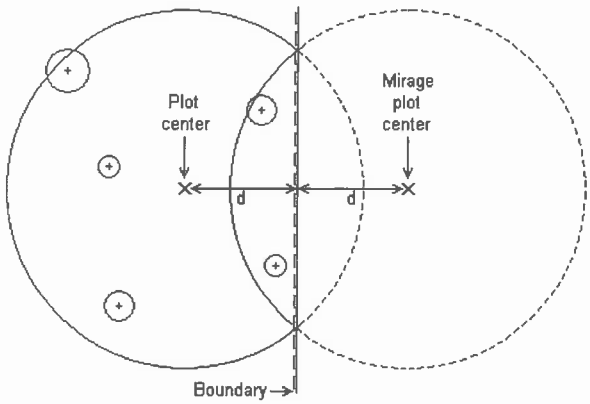


Figure 10.4.6.3a – Mirage plot

This process can be thought of as folding the original plot back on itself at the boundary. The trees that are in the folded over area are recorded a second time to fill in the blank part of the plot outside the boundary. Figure 10.4.6.3b shows how the area from the mirage plot looks just like the area missing from the original plot folded back onto the plot. It can be seen that these two parts together add up to a whole plot.

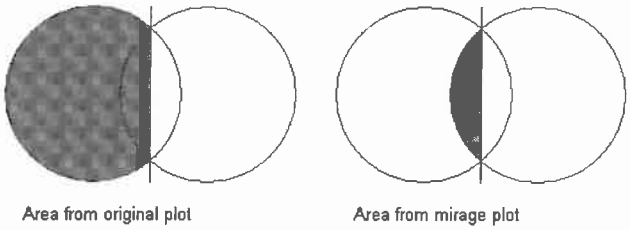


Figure 10.4.6.3b – Areas of original plot and mirage plot

There are several restrictions on the use of mirage plots. The boundary must be relatively straight. Mirage plots should not be used where the boundary is curved or irregularly shaped. The process for use in corners is complicated, so the use of mirage plots is discouraged there as well. In addition, someone must be able to actually stand at the mirage plot center, so the boundary can't be a cliff, the edge of a body of water, the boundary of inaccessible property, or any other place a person can't stand.

10.4.6.4 – Walkthrough Plots This method is the least biased in overall tree selection, but can cause sampling error to increase due to the way trees are selected on each individual plot. It is relatively easy to use. For any tree that is "in", measure the distance from the plot center to the tree, then measure that same distance beyond the tree. In other words, walk through the tree the same distance the tree is from plot center. If the ending point is outside the boundary the tree is recorded a second time (figure 10.4.6.4). Notice that it does not matter whether the walkthrough ending point is within the plot.

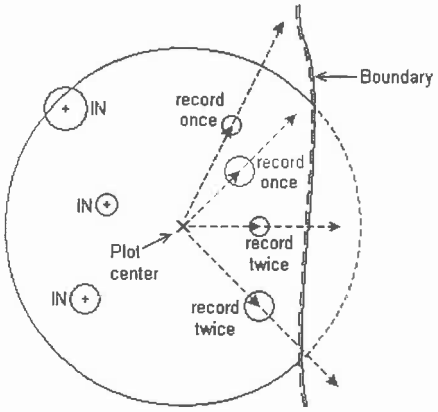


Figure 10.4.6.4 – Walkthrough plot

The walkthrough method works well with curved or irregular boundaries. It also works even if a person can't go beyond the boundary.

10.4.7 - Other Considerations Plot size should be selected so the average number of trees per plot is about 4 to 8. Plot size and spacing should be designated in the cruise plan. It is important that the plot size and spacing never change within a particular stratum. For example, if a stratum is started with a plot size of 1/10-acre and a spacing of 200 feet, those same specifications must be used for all units in that stratum. Even if there are very large units and very small units in the same stratum, the plot spacing does not change when moving from one unit to another within that stratum.

10.5 Point (PNT)

10.5.1 – Description The point cruising method (abbreviated "PNT") involves measuring all of the trees on variable radius (or BAF) points scattered throughout the area of interest. The average volume per acre is calculated, and that volume per acre is multiplied by the total number of acres to get the total volume. Because the total volume estimate is based on area, an accurate estimate of the area of the units is required.

With the point method every tree on every point is measured, so there are no count trees. Because of this, stratification is usually not used, with the exception that different primary products must always be in separate sample groups. For example, sawtimber trees might be in one sample group, and pulpwood trees in another.

10.5.2 – Determination of "In" Trees At each point, an angle gauge of some sort is used to determine which trees are "in". A stake is placed at point center and all angle measurements are made from that point. All trees with DBH greater than the angle projected by the angle gauge are "in" and must be measured (figure 10.5.2). Notice that larger trees will be "in" at a greater distance than smaller trees.

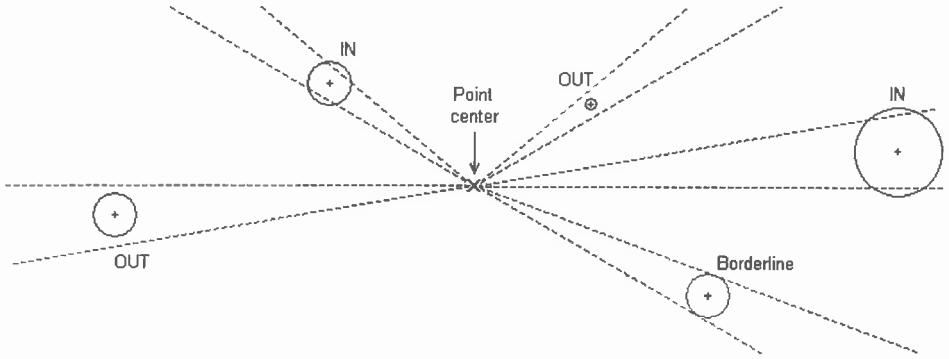


Figure 10.5.2 – Variable radius point

10.5.3 – Angle Gauges Different angle gauges work differently, but all allow the cruiser to visualize an angle projected out from point center. The angle represents a particular basal area factor (BAF). Every tree with a DBH greater than the projected angle represents that amount of basal area per acre for that point. For example, if there are 5 trees that are "in" when the angle represents 20 BAF, the point represents 100 square feet per acre (5 * 20). This is true regardless of the size of the trees. Smaller trees simply represent more trees per acre than larger trees.

There are two basic types of angle gauges. The first type uses refracted light to shift an image to the side. Cruising prisms are the most common instruments of this type. They are made of glass and ground at an angle to represent a particular BAF. The prism is held directly above the point center so the top edge appears to line up with breast height on the tree. If the shifted image of the tree at the top of the prism overlaps the unshifted image, the tree is "in". If the shifted image of the tree does not overlap the unshifted image, the tree is "out". If it is not obvious whether the images overlap, the tree is a "borderline" tree, and a limiting distance calculation must be done to determine whether it is "in". Figure 10.5.3a shows the use of the prism-type angle gauge.

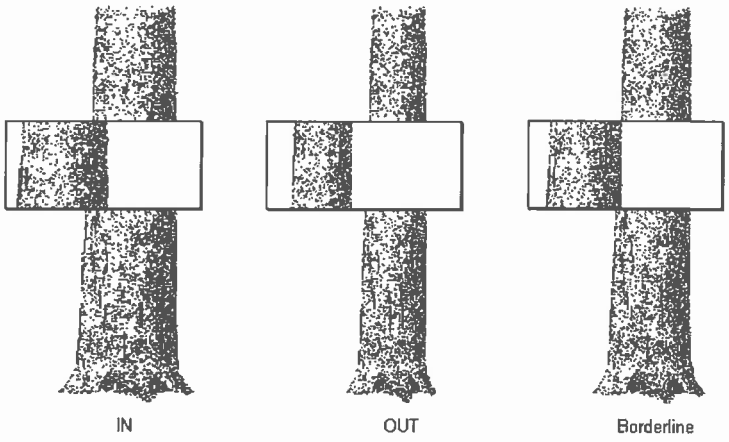


Figure 10.5.3a – Use of a cruising prism

The second type of angle gauge has a scale or sight so that the angle formed between the user's eye and the scale is appropriate to represent a particular BAF. Most of the cheaper metal or plastic angle gauges are of this type, but the relaskop and most electronic instruments are also of this type. The cruisers eye is held directly above the point center. If the width of a tree at breast height appears to be wider than the scale, it is "in". If the width of a tree at breast height appears to be narrower than the scale, it is "out". If a tree is close to the same width as the scale, it is a

"borderline" tree, and a limiting distance calculation must be done to determine whether it is "in". Figure 10.5.3b shows the use of a scale-type angle gauge. The black bar represents the width of the scale.

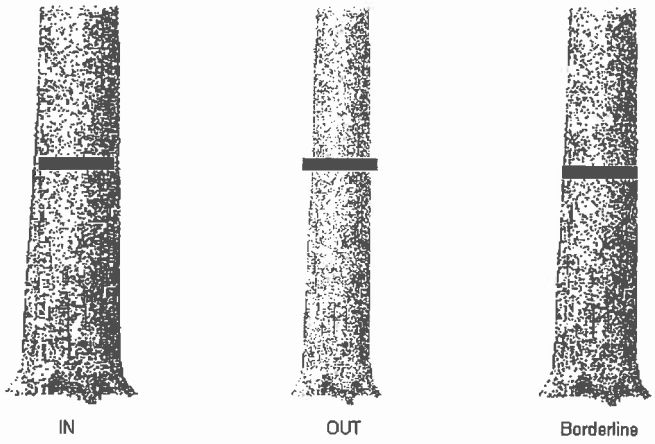


Figure 10.5.3b – Use of a scale-type angle gauge

There are different kinds of scales used in angle gauges. Some are see-through scales and some have a solid scale. Regardless of the kind of scale used, they all operate on the principal described above, where the diameter of the tree is compared to the width of the scale. Two different models are shown in figure 10.5.3c.

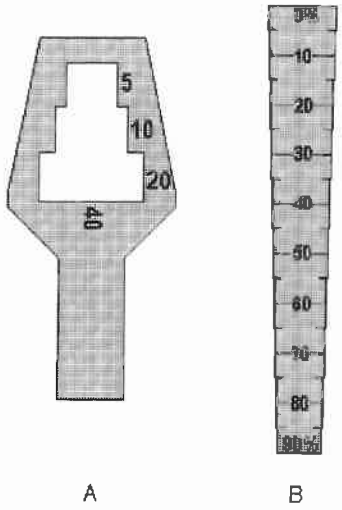


Figure 10.5.3c – Angle gauges

Model A in figure 10.5.3c is a see-through type with openings representing basal area factors of 5, 10, and 20 when held upright, and 40 when held sideways. The width of the opening acts as the scale. For example, if the diameter of the tree at breast height appears wider than the appropriate opening, the tree is "in". An attached chain maintains the proper distance from the eye to the instrument.

Model B is a solid type. The width of the instrument acts as the scale. The scale is read at the line corresponding to the slope from the eye to breast height on the tree. For example, if the slope from a cruiser's eye to breast height on

the tree is 30%, the scale labeled 30 is used. If the diameter of the tree at breast height appears wider than the appropriate scale, the tree is "in". An attached chain maintains the proper distance from the eye to the instrument. The chain has beads that are held to maintain the different lengths needed to represent different basal area factors.

Figure 10.5.3d shows the BAF scale in a relaskop. If the diameter of the tree at breast height appears wider than the appropriate scale, the tree is "in". Care must be taken to ensure the appropriate part of the scale is used for a particular basal area factor. The right half of the figure shows a close-up of the BAF scale, with the appropriate segments specified for basal area factors of 5, 10, 20, and 40.

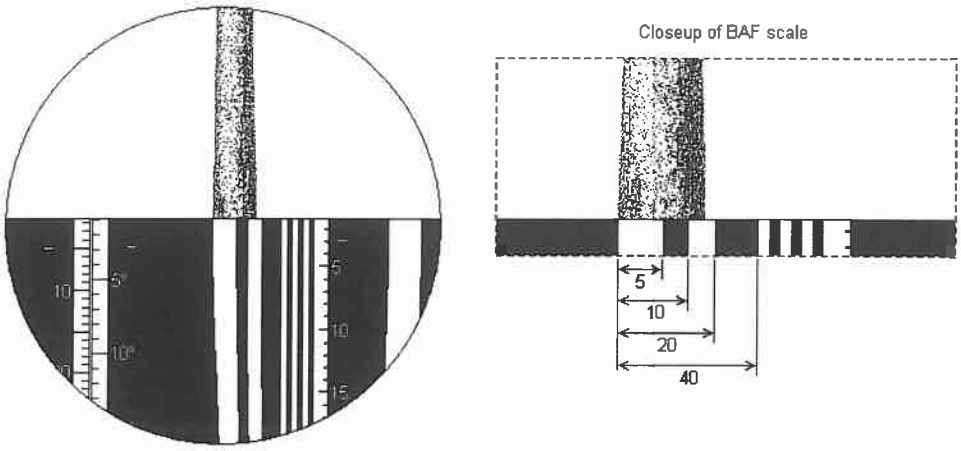


Figure 10.5.3d – BAF scale in a relaskop

10.5.4 – Limiting Distance Any tree with DBH close to the width of the angle projected by the angle gauge is considered a "borderline" tree, and a limiting distance calculation must be done to determine if the tree is "in" or "out". If the horizontal distance from the point center to the center of the tree at breast height is less than or equal to the limiting distance the tree is "in" and must be measured. Otherwise the tree is "out".

Appendix B contains a list of plot radius factors. The DBH of a borderline tree is multiplied by the appropriate plot radius factor to get a limiting distance.

Example:

BAF	20
Plot radius factor (from Appendix B)	1.944
Tree DBH	14.8 inches
Limiting distance	28.8 feet
Measured distance to the tree center	27.9 feet

The tree is "in" and must be measured.

Appendix G consists of tables that can be used in place of plot radius factors. Each table corresponds to a particular basal area factor. For a borderline tree, the whole inch part of the DBH is found at the left of the table, and the decimal part is found at the top. The value that falls directly to the right of the whole inch part, and directly below the decimal part is the limiting distance to the center of the tree.

Example:

BAF	10
Tree DBH	15.2 inches
Limiting distance (from Appendix G)	41.8 feet
Measured distance to the tree center	43.5 feet

The tree is "out" and need not be measured.

Limiting distance is always measured as a horizontal distance. If the slope of the tape is 10 percent (5 degrees) or greater a slope correction must be applied. Appendix E contains a table of slope correction factors. The horizontal limiting distance multiplied by the correction factor corresponding to the slope to get the limiting distance along that particular slope. The slope must be measured to each tree because the slope from point center will change from tree to tree.

It is important to know whether the tape being used to measure the plot radius is graduated in inches or tenths of a foot. The values in appendix A are in tenths of a foot. If the tape being used to measure the plot radius is graduated in inches, use appendix C to convert inches to tenths of a foot.

For horizontal distance measurements it can be a time saving shortcut to carry something to act as a plumb bob (like a heavy washer tied to a string). With a plumb bob, the end of the tape at point center can be lifted to try to level the tape while ensuring the end of the tape remains exactly above plot center. If the tape can then be held horizontal, the horizontal distance to the tree is simply read from the tape. This should not be done unless a plumb bob is used.

10.5.5 – Leaning Trees Angle gauges are always used by looking at the diameter of a tree at breast height. When a tree is leaning to the left or to the right, as viewed from point center, the angle gauge is tilted so it is oriented along the axis of the tree rather than vertically (figure 10.5.5). If the tree is leaning toward or away from point center, the angle gauge is held as it would be for a vertical tree.

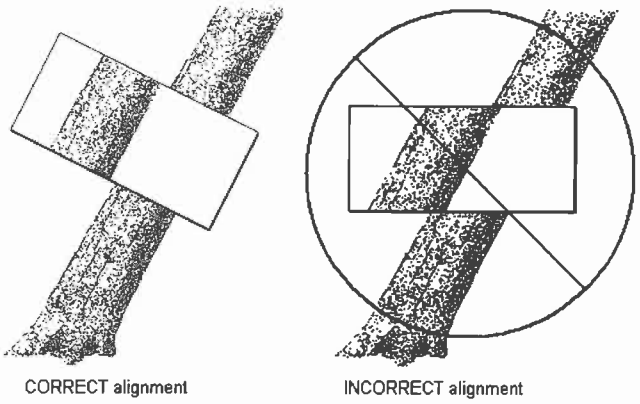


Figure 10.5.5 – Alignment of angle gauge for leaning trees

If a limiting distance calculation is required for a leaning tree, the distance from point center to the tree is measured to the center of the tree at breast height, just like it is for vertical trees.

10.5.6 – Obscured Trees It is possible that a tree or some other object obscures the view of a tree behind it. A cruiser must be careful to recognize this possibility, and check to see if there are any obscured trees that could be "in" trees. If there is an obscured tree that might be "in", the cruiser moves away from point center in a direction perpendicular to the direction to the tree just far enough to be able to clearly see the tree at breast height. The same rules then apply as for any other tree.

If a limiting distance calculation must be done, the tape is stretched straight from the tree to a point as close to plot center as possible. The distance is measured at the point where plot center is perpendicular to the tape (figure 10.5.6).

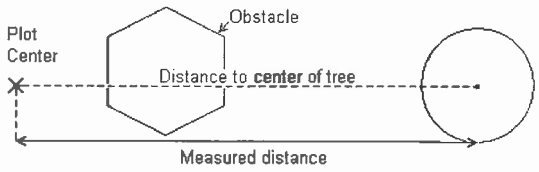


Figure 10.5.6 – Measuring to a tree around an obstacle

10.5.7 – Slope Correction The angle gauge in a relaskop and in some electronic instruments automatically adjusts to the slope at which the instrument is held. Other instruments are graduated for use on a variety of slopes. Many angle gauges, however, do not account for slope in any way. With instruments that do not account for slope, the angle gauge itself is rotated around the line of sight by an angle equal to the slope of the line of sight. The instrument will appear to be tilted to one side, and will not align with the axis of the tree, but the same rules for determining whether a tree is "in" or "out" are still used. The left half of figure 10.5.7 shows a prism rotated at an angle A because the slope to the tree was measured as A. The same angle would be used with any angle gauge that does not correct for slope. The right half of the figure shows a prism set on top of a clinometer so the rotation angle can be exactly matched to the slope angle.

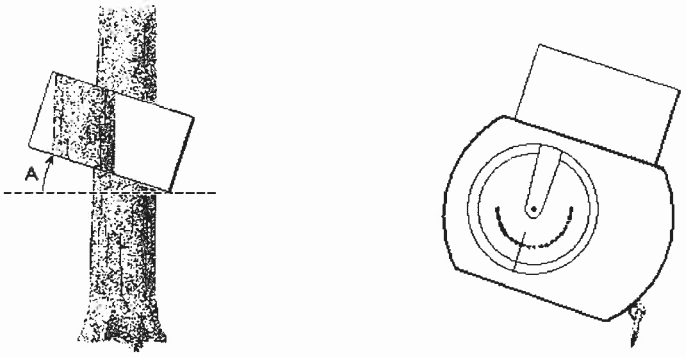


Figure 10.5.7 – Angle gauge used on sloping ground

10.5.8 – Null Points Points that have no trees on them are called "null points". It is important to record information for these points because otherwise the volume per acre values will be too high. To record a null point, record the point number and put a zero in for tree number. No other tree information is recorded. Some cruising software has a mechanism for automatically recording a null point. For example, there may be a button or check box for null points.

10.5.9 – Boundary Points The point cruising method is designed to work where trees from all directions and distances could potentially be "in". When a point center falls near the boundary of a unit, only those trees that are in the unit can be considered. This means that there are directions where trees from all distances can *not* be considered. These types of points are called "boundary points". There are several methods for dealing with boundary points.

10.5.9.1 – Half Points The simplest method for dealing with boundary points is also the most prone to bias. It is called the half point method. Basically, an imaginary dividing line is drawn through the point center in such a way that it does not cross the boundary. Only those trees whose center point is on the side of the line away from the boundary are considered. Since this represents only half a regular point, every tree that is "in" is recorded twice.

This method is prone to bias in the selection of trees for the points. There is very little probability that a tree at the very edge of a unit will ever be measured. This bias can be reduced somewhat by orienting the imaginary dividing

line randomly while still assuring it doesn't cross the boundary. This method does work when the boundary is quite curved or irregularly shaped.

Figure 10.5.9.1 shows a half point where only those trees to the left of the vertical line through the point center are considered. The trees to the right of the vertical line (toward the boundary) are ignored.

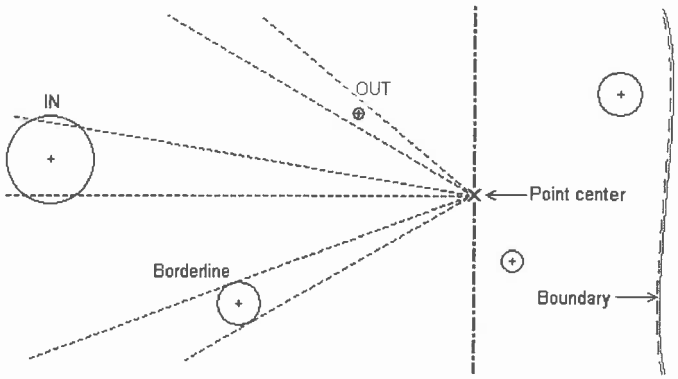


Figure 10.5.9.1 – Half point

10.5.9.2 – Quarter Points If a point center falls near a corner or other area where even a half point is not possible, the quarter point method can be used. This method is basically the same as the half point method except that two imaginary lines extending at a right angle from the point center in such a way that they do not cross the boundary. The only trees that are considered are in the area between two imaginary lines (figure 10.5.9.2). Since this represents only a quarter of a point, every tree that is "in" is recorded four times.

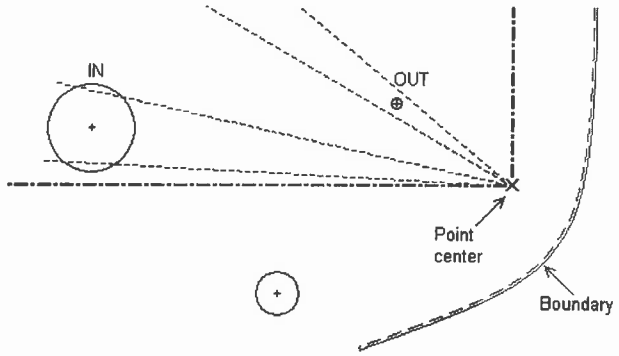


Figure 10.5.9.2 – Quarter point

10.5.9.3 – Mirage Points The idea behind mirage points is to fill in for the part of the point that is missing (due to the boundary) by using a second "mirage" point. The mirage point center is located outside the boundary the same distance that the original point center is from the boundary (figure 10.5.9.3). The "in" trees from both point centers are selected only from those trees inside the boundary. In this way, some of the trees are recorded twice. Notice in figure 10.5.9.3 one of the trees is recorded twice since it is "in" for both the original point center and for the mirage point center.

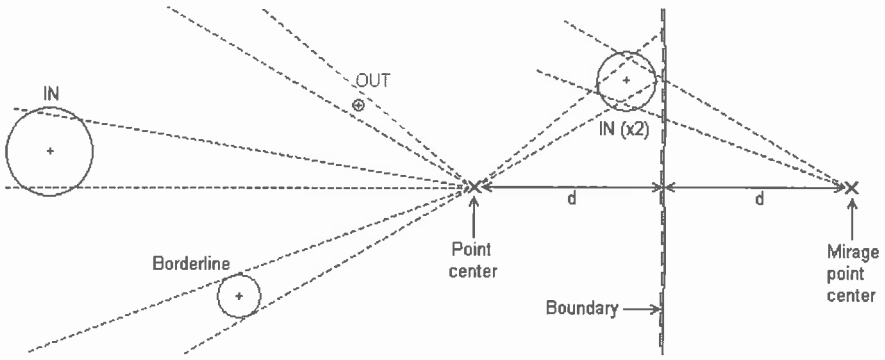


Figure 10.5.9.3 – Mirage point

There are several restrictions on the use of mirage points. The boundary must be relatively straight. Mirage points should not be used where the boundary is curved or irregularly shaped. The process for use in corners is complicated, so the use of mirage points is discouraged there as well. In addition, someone must be able to actually stand at the mirage point center, so the boundary can't be a cliff, the edge of a body of water, the boundary of inaccessible property, or any other place a person can't stand.

10.5.9.4 – Walkthrough Points This method is the least biased in overall tree selection, but can cause sampling error to increase due to the way trees are selected on each individual sample point. It is relatively easy to use. For any tree that is "in", measure the distance from the point center to the tree, then measure that same distance beyond the tree. In other words, walk through the tree the same distance the tree is from point center. If the ending point is outside the boundary the tree is recorded a second time (figure 10.5.9.4).

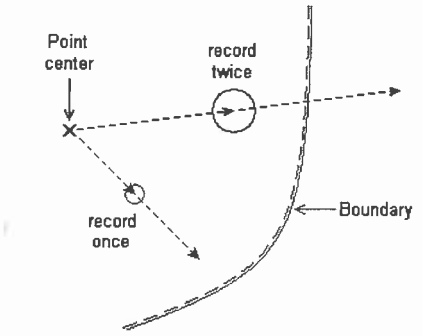


Figure 10.5.9.4 – Walkthrough point

The walkthrough method works well with curved or irregular boundaries. It also works even if a person can't go beyond the boundary.

10.5.10 - Other Considerations The basal area factor should be selected so the average number of trees per point is about 4 to 8. BAF and spacing should be designated in the cruise plan. It is important that the BAF and spacing never change within a particular stratum. For example, if a stratum is started with a BAF of 10 and a spacing of 200 feet, those same specifications must be used for all units in that stratum. Even if there are very large units and very small units in the same stratum, the point spacing does not change when moving from one unit to another within that stratum.

10.6 Point Count Measure (PCM)

10.6.1 – Description The point count measure tree cruising method (abbreviated "PCM" or "PCMTRE") is exactly like the point cruising method except that not all of the trees on every point are measured. All of the trees on every point are counted, but there are rules that determine which of these trees must be measured. The average volume per acre is calculated, and that volume per acre is multiplied by the total number of acres to get the total volume. Because the total volume estimate is based on area, an accurate estimate of the area of the units is required.

With the point count measure tree method sample groups are usually used to define sub-populations (for example, to group species that will be sold for a single price). Tree counts are recorded by sample group, not by individual species (unless a particular species is in a sample group by itself). Some of the trees in each sample group will be measured. Trees with different primary products must always be in different sample groups.

10.6.2 – Selection of Measure Trees Measure trees must be selected in an unbiased way. This means that every "in" tree has an equal probability of being selected as a measure tree. There are several methods commonly used to select measure trees.

The preferred method of selecting measure trees is to measure all of the trees on some proportion of the points, and simply count the trees on the other points. The "measure plots" are treated exactly as they would be with the point cruising method (PNT). On the "count plots", as the trees are determined "in" they are simply tallied in the appropriate sample group and recorded as count-tree records. The frequency of measure plots to count plots should be specified in the cruise plan.

Another unbiased method of selecting measure trees is similar to that used in the sample tree (STR) method. Each sample group is assigned a sampling interval so that a specified proportion of the trees in the sample group are measured. For example, if a sample group is assigned a sampling interval of 1:10, then one of every ten trees tallied in that sample group is measured. The selected tree may be any species or size contained in the sample group. Some points may have more than one tree of a particular sample group measured, and some points may have none. Care must be taken when recording the tree counts. If there is a single tree from a particular sample group the count of trees from that sample group is included on the measure-tree record. If no trees from a particular sample group are measured, the count of trees from that sample group is included on a count-tree record. If more than one tree from a particular sample group is measured, the count of trees from that sample group must be split between the measure-tree records. A measure-tree record should never have a count of zero with the point count measure tree method.

A third, but less desirable method of selecting measure trees is to measure one tree of every sample group on every point. This is not an unbiased way to select measure trees because all trees do not have the same probability of being selected. The measure trees are usually selected in some systematic fashion. For example, it could be decided that for each sample group, the first "in" tree clockwise of north is measured. The tree counts for each sample group are included on the one measure-tree record for that sample group. It is important to note that measuring one tree from each sample group is not the same as measuring one tree of each species (unless each sample group represents a single species).

10.6.8 – Null Points Points that have no trees on them are called "null points". It is important to record information for these points because otherwise the volume per acre values will be too high. To record a null point, record the point number and put a zero in for tree number. No other tree information is recorded. Some cruising software has a mechanism for automatically recording a null point. For example, there may be a button or check box for null points.

10.6.9 - Other Considerations The sample groups should be defined in the cruise plan. The basal area factor (BAF) and spacing should also be designated in the cruise plan. The BAF should be selected so the average number of trees per point (count trees and measure trees) is about 4 to 8. It is important that the BAF and spacing never change within a particular stratum. For example, if a stratum is started with a BAF of 10 and a spacing of 200 feet, those same specifications must be used for all units in that stratum. Even if there are very large units and very small units in the same stratum, the point spacing does not change when moving from one unit to another within that stratum.

11. TIMBER MARKING PAINT

Marking timber and cruising timber are two entirely different things, however these two things are usually done in conjunction with one another. In fact, they are often done at the same time.

There are several reasons for applying paint to trees. Some examples are the designation of cutting unit boundaries, reserve area boundaries, cut trees, leave trees, plot trees, measure trees, etc. There are specific restrictions and protocols associated with each paint use.

11.1 Tracer Paint

Forest Service timber marking paint containing the registered tracer is the only type of paint that may be used to designate trees for removal, measurement, tallying, and so forth, and to designate the boundaries.

11.1.1 – Formulation Forest Service timber marking paint is specially formulated for the Forest Service. It has to meet very strict production specifications. It also contains a special tracer element that is registered to the Forest Service. This tracer may not be used for any other purpose, or in any other paint.

The tracer element allows for testing to determine whether the paint on a tree is actually Forest Service paint. This is *not* a radioactive tracer. Test kits are used to test for the presence of the tracer, and a chemical reaction causing a color change indicates the tracer is present.

There are two main forms in which the paint may be ordered: bulk and aerosol. Bulk paint is used with hand-operated paint guns or with pressurized sprayers. Aerosol paint comes in pressurized cans containing a spray nozzle. The aerosol propellant is simply pressurized carbon dioxide.

There are also several different formulations of the paint. Each formulation was designed for specific conditions. For example, one formulation may perform better in extremely cold conditions, and one may perform better in wet conditions.

11.1.2 – Paint Security Timber marking paint security measures are discussed in the Timber Cruising Handbook (FSH 2409.12 Chapter 70). All of the paint security measures discussed below are based on the information contained there.

Forest Service timber marking paint is not sold to anyone outside of the Forest Service. Because this paint is the only paint that may be used to designate trees for harvest, it is very important that we have tight security surrounding its storage and use. If it fell into the wrong hands it could be used to do things like mark additional trees during a harvest, and the Forest Service would have a difficult time determining which trees were illegally marked.

Timber marking paint must be stored in an approved, secure, safe paint storage facility specifically designed for this purpose. This facility must be kept locked with a non-Forest Service lock. Only those people designated as Paint Custodians with a signed designation letter from the District Ranger may check paint into and out of the paint storage facility. There is a very specific procedure that Paint Custodians use to account for every container of paint that leaves or is returned to the facility.

Timber marking paint containers may not be checked out of the paint storage facility for extended periods of time. All containers (full, partially full, and empty) must be returned to the Paint Custodian at the storage facility so that an inventory of the paint can be done.

11.1.2.1 – Transporting Paint Timber marking paint placed in vehicles must be in securely locked storage boxes out of public view. The lock must not be a Forest Service lock. If possible, the paint should not be transported in the passenger compartment of the vehicle. If paint must be transported in the passenger compartment, it must be placed in a sturdy, vapor-proof container.

11.1.2.2 – Paint Container Disposal Paint Custodians are the *only* people allowed to dispose of timber marking paint containers. An inventory must be reconciled whenever containers are destroyed. No other person is to dispose of these containers.

11.2 Paint Colors

The Forest Service has a national paint color scheme that all regions, forests, and districts must follow. The national scheme was adopted to create uniformity in timber sale contract administration. A particular color of paint may only be used for the particular purposes specified in the Timber Cruising Handbook (FSH 2409.12 Chapter 70). Table 11.2 is adapted from that chapter.

Table 11.2 – National paint scheme for timber-related activities

Item	Paint Color
Cut Trees	Blue Yellow Green
Leave Trees	Orange
Cultural Resources	White
Wildlife Reservation	White
Cutting Unit Boundary	Orange Pink (soon)
Cancel Prior Work	Black

One paint color with a standardized use that does not appear above is red. Red paint is used to designate property lines. Since property lines are not always associated with timber-related activities, tracer paint is not required. In fact, red tracer paint is no longer produced for the Forest Service.

11.3 Paint Application

There are two primary reasons paint is applied to trees for timber-related activities. The first is to designate which trees are to be removed in a harvest, and the second is to record information on measured trees.

11.3.1 – Designations The primary methods for designating trees for harvest include marking individual trees that are to be cut (cut trees) or left standing (leave trees), and marking the boundaries around an area that is to be harvested.

When a unit is designated as a "cut tree unit" the trees must be designated with paint in order to be harvested. One of the three colors specified for cut trees must be used. Trees that have not been designated as cut trees must be left standing.

When a unit is designated as a "leave tree unit" the trees must be designated with paint in order to be left standing. Leave trees are marked with orange paint, and reserve trees (for wildlife or cultural resources) are marked with white paint. Trees not designated as leave trees or reserve trees are to be harvested.

There are times when no trees are designated as cut trees or leave trees even though there will be a harvest. Examples would be units designated for clearcut, or units with a prescription known as "designation by description" where the specified residual stand condition determines which trees will be harvested.

In almost all cases, the boundaries of a cutting unit must be marked with paint. The only exception is in an area where a border feature is so obvious that mistakes will not be made when cutting trees. A color specified for cutting unit boundaries must be used. Boundary trees are not cut during the harvest.

11.3.2 – Applying Paint for Designation Regardless whether a tree is a cut tree, leave tree, or boundary tree, the paint marks that are made on the tree are similar. Some type of eye-level mark is made, and a stump mark is made.

11.3.2.1 – Eye Level Mark The eye-level mark is the primary mark that will be seen by those operating in the sale area. As such, it must be prominent and easy to see from a distance. It must also contain an appropriate amount of paint to last for a significant time in the elements. Any moss, lichens, snow, or very loose bark should be removed before the paint is applied. Whenever possible, paint should be applied so that it falls into crevices and rough parts of the tree bark in addition to wider, flatter areas.

Some forests or districts have special marks designated for specific purposes. For example, boundary trees might have a series of diagonal slashes or dots. Sawtimber cut trees might have two horizontal stripes where pulpwood cut trees might have a single horizontal stripe. These are just a few examples, and are certainly not required.

11.3.2.2 – Stump Mark All trees painted to designate some type of activity *must* have a stump mark. This includes trees painted to designate them as cut trees, leave trees, wildlife trees, or boundary trees for cutting units, cultural resources, or wildlife reserves.

The stump mark is made at the base of the tree. It is left behind even after a tree has been harvested. It shows the designation the tree received, and whether it was supposed to have been cut. The stump mark must survive not only the harvest of the tree, but also any other sale activities, like being run over by heavy equipment or having logs skidded over the stump. Because of the potential for the stump mark being obliterated, placement of the paint is very important. Whenever possible, the stump mark should be placed on the downhill side of the stump in a recess between root swellings. It must be lower than the standard stump height, and should extend slightly onto the ground. Any moss, snow, loose bark, or excessive duff should be removed before the paint is applied.

Stump marks may become important law enforcement tools. They can be used as evidence of illegal harvest of trees. Following a harvest in a cut tree unit, every stump must have a stump mark of the paint color used to designate the cut trees. Following a harvest in a leave tree unit, no stump should have a stump mark of the paint color used for any leave trees.

11.3.2.3 – Canceling Prior Work There is no way to remove paint that has been applied to a tree. Therefore, whenever the designation of a tree with marking paint on it is to change, the old paint is covered with black paint. The black paint must completely cover the old paint. Both the eye-level mark and the stump mark must be completely covered.

Black Forest Service timber marking paint with the registered tracer is the only paint that may be used for cancellation of prior work. It does not matter that black may not match the bark color very well. Different colors of paint should never be mixed for any reason, so mixing colors to try to match bark color should never be done.

11.3.3 – Applying Paint to Measure Trees Trees that are measured during a timber cruise have information painted onto them with Forest Service timber marking paint. This is done primarily so a check cruiser can check the measurements recorded for the tree, so the information must uniquely identify that tree among all of the tree records in the cruise information for the sale. The specific information painted on the tree and the configuration of that information may vary slightly from forest to forest, but there are several requirements.

The tree number, as recorded on the cruise card or in the portable data recorder, must be painted on the tree. Any other information needed to find that tree record among all tree records in the sale is also required. For example, if tree numbers are restarted at 1 on every cruise card, then the cruise card number must also be painted on the tree.

The initials or designated cruiser ID of the cruiser making the measurements is also usually painted on the tree. The check cruiser must be able to find the recorded information for that specific tree in the cruise data just from the information painted on the tree, and must be able to determine which cruiser measured the tree.

Actual tree measurements like DBH or height do *not* need to be painted on the tree. Those measurements are recorded in the cruise data, and the check cruiser will have access to that information when doing the check cruise.

The painted information alone does not designate a tree as a cut tree or a leave tree. If a measure tree is to be designated, it must get the appropriate eye-level mark and stump mark as well, made with the correct color of paint. If all of the measure trees are also cut trees (as would be the case with a sample tree cruise method), then the paint color used to mark the cut trees could also be used to paint the measure tree information. If leave trees are also being measured (as might be the case with area based cruises), the paint color used to record the tree information for the leave trees must not be a cut tree color for that unit. If the cut trees are not being designated with paint (as would be the case in a clearcut), then any paint color that will not cause confusion could be used.

11.3.4 – Applying Paint to Plot Trees If paint is used to designate measure trees on fixed plots or sample points, the same information painted on them as described above. However, any information painted on the measure trees in a fixed plot or a sample point will be applied on the side of the tree facing plot center. In this way, anyone standing at plot center should be able to easily determine which trees were in the plot, and which trees were measured.

Count trees in a plot or sample point may also be designated in some way so a check cruiser can identify which trees were considered to be in the plot. If paint is used for this purpose the markings must not be the same as those used on measure trees. Use of flagging is a good alternative to paint for indicating which trees are in a plot or sample point.

11.3.5 – Safety Forest Service timber marking paint is a very safe paint formulation. With any paint, however, there are inherent safety issues. Every person who will be working with timber marking paint should read through the Job Hazard Analysis prepared by the San Dimas Technology Development Center. A copy of this document should be kept in the paint storage facility. It is also available for download from the San Dimas web site. The items that follow should be thought of as supplements to some of the personal safety issues addressed in that document. They are *not* intended as a replacement for the Job Hazard Analysis.

All containers, loaded paint guns, and backpack containers must be properly sealed so that paint does not leak from them. Paint that comes in contact with the skin should be immediately wiped off with a clean cotton cloth or hand wipe. Clothing that becomes saturated with paint should be changed as soon as possible.

If the nozzle of the paint gun is too close to the tree when sprayed, backspatter may occur. Different equipment works differently, but markers should stand as far from the tree as possible while still producing acceptable markings. Wind may cause paint mist to drift, so spraying directly into the wind should be avoided. Spraying in the direction of another person close enough to be hit by paint or mist should also be avoided.

Long sleeve shirts, long pants, boots, and gloves are recommended to minimize skin contact with the paint. Hardhats and eye protection help to protect the head and face. Exposed skin can be protected with a barrier cream.

Whenever possible, vinyl gloves and eye protection should be worn when cleaning paint equipment. Exposed skin should be cleaned with soap and water. Whenever possible, equipment should be cleaned outdoors.

12. THE CRUISE PLAN

A cruise plan must be prepared for every timber sale. It contains all of the information necessary to cruise the timber. It may be prepared by an advanced cruiser, a pre-sale forester, or someone else who understands the cruising requirements.

A cruise should never be started without a copy of the cruise plan. This is necessary to ensure that the cruisers are using the correct cruise methods, population definitions, timber designations, and so on.

12.1 Cruise Plan Contents

The Timber Cruising Handbook (FSH 2409-12, Chapter 40, Section 41) contains the requirements for a cruise plan. That information is listed in greater detail below.

12.1.1 – Definition of the Sample Populations

a. Stratum and sample group codes
b. Species and products included
c. Tree sizes included, if applicable (for example, 11-15.9 inches, 16 inches and greater)
d. Cutting units included in the different populations

12.1.2 - Sampling Methods and Intensity

a. Sale error standards based on estimated sale value
b. Cruise methods used for the different populations
c. Tree-based cruise sampling intervals (for example, 1:20, 1:50) by population
d. Area-based cruise plot sizes (acres or BAF) and spacing

12.1.3 – Product Merchantability and Utilization Specifications

a. Minimum DBH by product
b. Product lengths (for example, 8-foot logs, 100-inch logs)
c. Minimum top diameter (for example, 4 inches top DOB, 10.6 inches top DOB)
d. Secondary products included for topwood
e. Utilization cull percentages, if applicable
f. Other utilization specifications (for example, grade 3 log, straightness requirement)

12.1.4 – Cutting Unit Map Info

a. Acreage, and the method used to determine it (for example, GPS, traverse)
b. Location of plots, if applicable
c. Location of any reserve areas or special marking areas

12.1.5 – Silvicultural Marking Guides

a. Method of timber designation (for example, cut tree marking, leave tree marking, clearcut, designation by description)
b. Description, if using designation by description
c. Paint color(s) to be used
d. Other silvicultural or marking instructions

13. FIELD NAVIGATION

In order to cruise effectively, a timber cruiser must know how to use navigation tools in the field. This set of tools includes things like a compass, maps, and aerial photos. It can also include electronic equipment like Global Positioning System (GPS) units.

13.1 Compass Use

A traditional compass is a fairly simple instrument. It contains a magnetized needle mounted on a pivot point, and a scale that is graduated to read angles. The magnetized needle will align itself with the magnetic field of the earth, and will point toward the north pole. This is not the traditional north pole, but rather the magnetic north pole. The two north poles are not in the same location on the earth. In fact, the magnetic north pole moves slightly from year to year. Figure 13.1 shows the location of the magnetic north pole relative to the true north pole in the year 2004.

Figure 13.1 – Earth's north poles

13.1.1 – Magnetic Declination Because a compass points at the magnetic north pole, it does not point to true north unless you are in an area where the two happen to line up. From any particular spot on the earth, the angle between magnetic north and true north is called the magnetic declination.

In the United States, the line where the two north poles line up runs through western Wisconsin and eastern Missouri. As you move west of this line, a compass needle will point east of true north. This is called east declination. As you move east of this line, a compass needle will point west of true north. This is called west declination. Figure 13.1.1a shows the approximate angles of declination across Region 9 in the year 2004. The national forests are shaded in black.

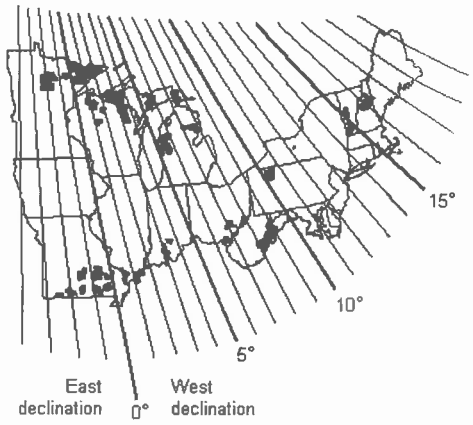


Figure 13.1.1a – Magnetic declination in the year 2004

Parts of the Superior National Forest in Minnesota and the Mark Twain National Forest in Missouri have declinations of zero. The White Mountain National Forest in New Hampshire has a declination of around 16 degrees west. This means that a compass needle on the White Mountain will point about 16 degrees west of true north. There are a number of sources where the actual magnetic declination for an area can be found. One such source is a United States Geological Survey (USGS) topographic map. The declination is shown with a series of arrows pointing out the different directions of north. Figure 13.1.1b shows two declination arrows from two different USGS maps. MN indicates magnetic north, GN indicates grid north (the alignment of the grid lines on the map), and TN indicates true north. True north may also be designated with just a star.

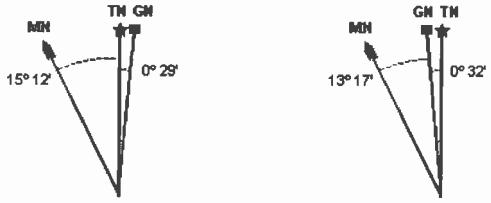


Figure 13.1.1b – Examples of map declination arrows

The magnetic declination is the angle between true north and magnetic north. The apostrophe symbol is used to represent minutes. (There are sixty minutes in a degree.) In the left image in figure 13.1.1b the magnetic declination can be read directly as 15 degrees 12 minutes west. In the right image magnetic north and grid north are on the same side of true north, so the magnetic declination is the sum of the two angles or 13 degrees 49 minutes west. This is nearly 14 degrees west.

13.1.2 – Compass Declination Due to magnetic declination an uncorrected compass will not point to true north (unless the magnetic declination is zero). It will instead point toward the magnetic north pole, as shown in figure 13.1.2a. Notice that, when the compass is correctly aligned with the needle, the N on the round bezel points to magnetic north instead of true north.

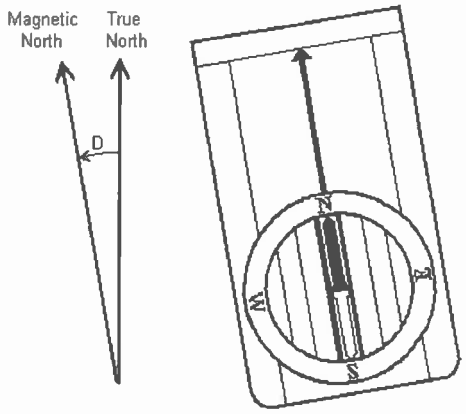


Figure 13.1.2a – Compass without the declination set

In order to deal with this problem, compasses are designed with a mechanism for setting the compass declination to match the magnetic declination in the area. The declination is set in different ways on different compass models, so the documentation that came with the compass should be referred to. Figure 13.1.2b shows a compass with the declination set correctly. Notice that, when the compass is correctly aligned with the needle, the N on the round bezel now points to true north.

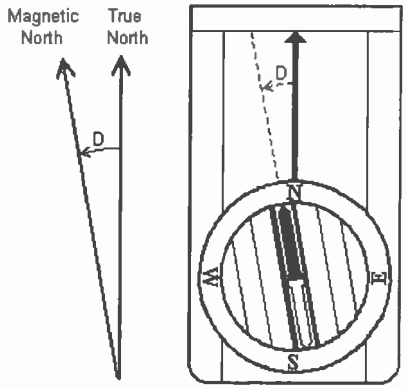


Figure 13.1.2b – Compass with declination set correctly

If the declination of a compass is not correctly set, the readings obtained from that compass will be incorrect in all directions. Compasses without a mechanism for setting the compass declination should not be used unless the magnetic declination is nearly zero.

13.1.3 – Compass Navigation A traditional compass has two main parts: a base that is used to determine the direction of travel, and a housing for the needle. The needle housing can be rotated on the base, and has a bezel (or rim) marked with graduations in degrees. North is defined as 0 degrees, and the values increase in a clockwise fashion so that east is 90 degrees, south is 180 degrees, and west is 270 degrees. The direction indicated by one of these degree readings is referred to as the azimuth.

To use a traditional compass for navigation, the bezel is turned until the desired azimuth is aligned with the directional arrow on the base. The compass is then held level to allow the needle to rotate freely and align itself.

The compass is then rotated until the needle comes into alignment with the markings in the housing. The directional arrow then points in the direction of the specified azimuth.

The compass should be held as close to the line of sight as possible while still allowing the needle position to be checked. A distant target object is selected in the direction specified by the directional arrow on the compass. Once a target object is selected, the compass can be lowered and travel toward the object can begin.

Some compasses have a mirror that can be positioned so the compass face can be seen while looking directly at the target object. Figure 13.1.3 shows two types of compass. The one on the left must be held below eye level so both the compass face and the target object can be seen. The one on the right has a mirror that is adjusted so the user can see the compass face when looking through the small notch sight above the mirror. The dashed lines show the line of sight and the direction of travel once a target object has been selected.

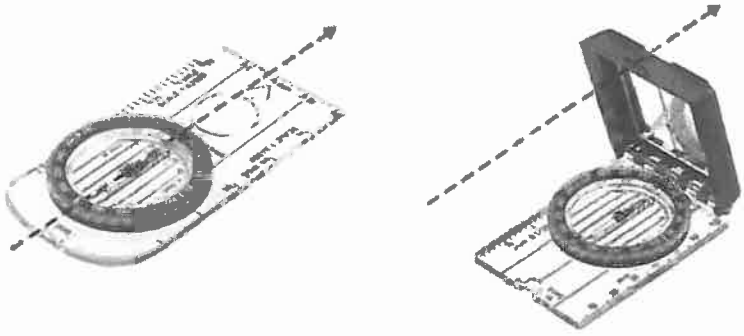


Figure 13.1.3 – Sighting with different types of compass

13.1.4 – **Avoiding Potential Problems** Because a compass works with a magnetic needle, anything that affects a magnetic field can cause incorrect readings with a compass. This means that anything made with steel or iron must be kept away from a compass when it is in use. This includes clipboards, mechanical pencils, belt buckles, steel tapes, metal stakes, and many other things. It also includes things that could be near a cruiser, like a wire fence, a vehicle, or even rocks with high iron content.

13.2 Pacing

It is not always practical or necessary to measure very long distances with a tape. For example, when moving from one plot center to another it is probably not be necessary to know the exact distance to the nearest foot. When a precise distance measurement is not necessary, long distances can be estimated with pacing.

Pacing involves counting the number of steps taken from one point to another, and then converting that into an actual distance. In order to estimate distances accurately, cruisers must have some knowledge of their own pacing.

A pace is the same as two steps (one with each foot), and must be consistent in length when used for measuring distances. At a minimum, a cruiser should know the number of paces required to move 66 feet (one chain) and 100 feet. Most long distances will be multiples of one or the other of these.

In order to determine the number of paces in a particular distance, that distance should be measured out in typical terrain. Wearing the same type of clothing that will be worn in the field (boots, long pants, etc.) the measured distance is traversed and the number of paces counted. It is important the length of each pace is as consistent as possible. The same distance should be traversed repeatedly until a consistent number of paces are counted. This number should be memorized for use in the field.

When pacing is to be used in the field, use the memorized number of paces for the most convenient distance. For example, if the required distance is 4 chains, use the number of paces for 66 feet (one chain) multiplied by 4. If the requested distance is 350 feet it is probably easier to use the number of paces for 100 feet multiplied by 3.5.

It is important for a cruiser to periodically check to see that their pace has not changed.

13.3 Topographic Maps

Maps are typically flat documents that represent ground that is not flat. Maps can represent the topography of the ground through the use of topographic lines. These are thin lines that are drawn on a map to show all of the points where the elevation is the same. The topographic lines show the general contours of the ground, and can be used to determine the approximate elevation of any point on the map.

Figure 13.3 shows two views of the same ground. The top view is looking at the landscape from a particular reference point. The bottom view is the topographic map representing the same area.

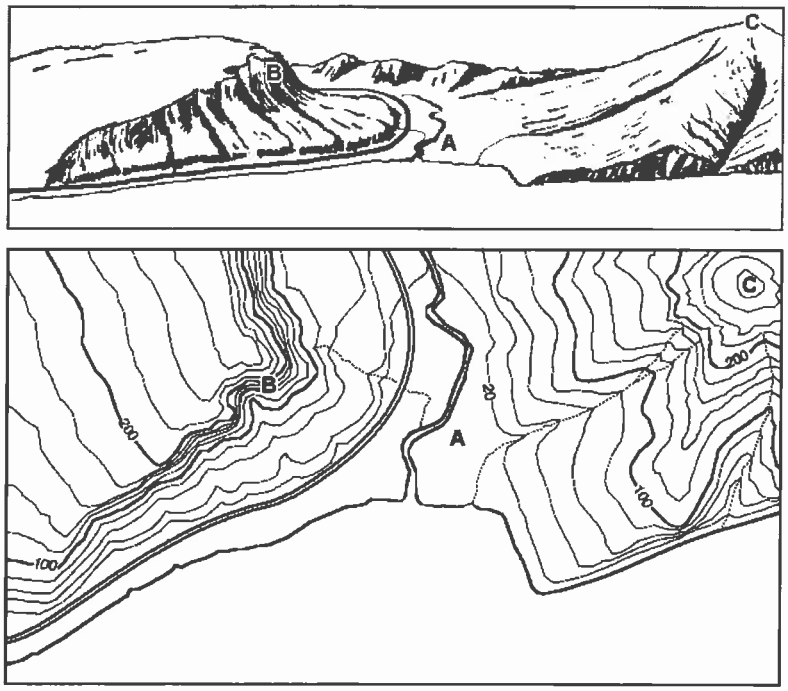


Figure 13.3 – Topographic representation of an area

The light squiggly lines are topographic lines representing areas of equal elevation. For example, all of the points along the heavy line labeled "100" are 100 feet above sea level. In flatter areas (like that labeled A) the topographic lines are farther apart. In steeper areas (like that labeled B), the lines are closer together. Peaks (like that labeled C) have rings of topographic lines around them, but depressions may also have rings. Small creeks are often shown as dashed lines (like that to the right of A). The lines running through creek beds and valleys appear to point uphill as they cross the valley bottom.

13.4 Map Scale

Maps are scaled down representations of a particular piece of ground. In other words, a particular distance on the map represents a larger actual distance on the ground. For example, one inch on a map might represent one mile on the ground. The relationship between the map distance and the real distance is called the map scale.

In order to be useful for cruising, distances on a map need to be converted to actual distances on the ground. The map scale will allow this to be done. The map scale is printed on most maps. A common type of map is a digital orthophoto quadrangle (also known as an ortho quad or DOQ) produced by the United States Geological Survey (USGS). The map scale for an ortho quad is either 1:12,000 or 1:24,000. A scale of 1:24,000 means that one inch on the map represents 24,000 inches on the ground. The ground distance is converted to feet by dividing by 12 (since there are 12 inches in a foot), so a scale of 1:24,000 means one inch on the map represents 2000 feet on the ground.

Distances between any two points on a map can be converted to the actual distance between those points on the ground. Convert the map scale to number of feet of actual distance per inch on the map by dividing by 12 (since there are 12 inches in a foot). Then simply multiply the map distance by the converted map scale.

Example:

Map scale	1:12,000
Converted map scale	1 inch = 12,000 / 12 = 1,000 feet
Map distance	3.25 inches
Actual distance	3.25 * 1,000= 3,250 feet

13.5 Aerial Photographs

Aerial photographs are taken from aircraft, usually looking straight down toward the ground. Series of photos are taken from different flights across the area. The photos in a particular flight line overlap, so an area of ground should appear in more than one photo.

13.5.1 – **Photo Scale** The distance from an aircraft to the ground changes due to altitude change and ground topography. This means the photo scale changes from one aerial photo to another. In addition, objects in the center of an aerial photo are closer to the camera than are objects near the edge of the photo (figure 13.5.1). The scale of a single photo, therefore, is not constant for all parts of the photo. Due to the distortion near the edges of an aerial photo, it is best if the only part used for calculating distances is a circle in the middle of the photo with a diameter about half the diameter of the photo.

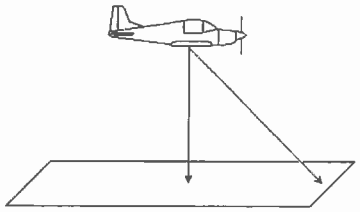


Figure 13.5.1 – Distance to ground relative to angle from camera

In order to determine actual distances from an aerial photo, it is necessary to calculate the photo scale. This is done by finding two items that are easily seen near the center of the photo. These items must be exactly identifiable on the ground, at least several hundred feet apart, and should be at approximately the same elevation. The distance between the objects on the photo is measured in inches, and the distance between the actual objects on the ground is measured in feet. The actual distance is divided by the photo distance to determine the actual ground distance

represented by one inch in the center part of the photo. The photo scale for that part of the photo is found by multiplying by 12 to convert everything to inches.

Example:

Photo distance	1.5 inches
Actual distance	480 feet
Actual distance per inch	480 feet / 1.5 inches = 320 feet per inch
Photo scale	320 * 12 = 3840 (photo scale is 1:3,840)

It is important to remember that photo scale changes within an aerial photo. The calculated photo scale is appropriate only in the general area of the photo where the measurements were done.

13.5.2 – Photo Orientation Aerial photos very rarely align exactly with compass bearings. The actual alignment of a photo can be found in a similar method to finding the photo scale. Two items are found near the center of the photo that are exactly identifiable on the ground and at least several hundred feet apart. One of the objects must be able to be seen while standing at the other. A perfectly straight line is drawn between the two items right on the photo. The azimuth between the actual objects is measured with a compass. That azimuth is recorded near the line that was drawn on the photo. An arrowhead should be added to the line to indicate which direction the azimuth represents.

In order to get bearings from the photo it needs to be aligned correctly. A compass set to the azimuth recorded on the photo. The photo is placed on the ground or other flat, immovable, non-metallic object. The edge of the compass is aligned with the line that was drawn on the photo, and then the photo and compass together are rotated until the compass is oriented correctly. The photo is then fixed in that alignment. Readings between other objects in the photo can then be read by aligning the edge of the compass with the objects, rotating the needle housing until it is aligned with the needle, and then reading the azimuth.

13.5.3 – Stereo Views Two adjacent photos from the same flight line are centered on different locations, but the images overlap. This allows for a stereo (three-dimensional) view of the overlap area. The process is basically the same as looking at a real object with two eyes, where the slightly different view from each eye allows the brain to see the object as three-dimensional. In much the same way, each photo can represent the view from one eye.

A special viewing instrument called a stereoscope allows each of a person's eyes to focus on a different photo. This is accomplished through lenses, and sometimes mirrors.

In order to use a stereoscope, two adjacent photos from the same flight line are laid out flat so that the edges with the common area are touching or slightly overlapped. An obvious item is found in the overlap area of both photos. The stereoscope is placed over the photos, and the eyepieces are lined up with the user's eyes. The photos are then moved until the image of the selected object in both eyes exactly lines up. At that point is should appear three dimensional. Minor adjustments might be necessary to get the rest of the overlap area to appear three-dimensional.

Viewing aerial photos with a stereoscope makes it easy to see topographical features. The ability to see ridges, valleys, slopes, and many other features can help in locating items shown in the photos.

13.5.4 – Photo Care Aerial photos are fairly expensive, and are easily damaged. If the actual photos are to be taken to the field, they should be kept in protective covers. There are clear plastic covers with waterproof closures specifically made for this purpose.

An alternative to taking the actual photos is to have reproductions made. These must be high quality reproductions, and should not be distorted in any way. These too must be protected in the field.

13.5.5 – Digital Orthophotos There is a process by which aerial photos are electronically scanned and geometrically corrected on a computer to remove much of the distortion found in the original photos. These are known as digital orthophotos.

The photo scale on a digital orthophoto is approximately the same anywhere in the photo. This means that practical use is not limited to the center part of the photo. The photo scale of a digital orthophoto is known, and may be printed on the photo itself. Digital ortho photo quadrangles (also known as ortho quads or DOQs) are made up of many digital orthophotos that have been correctly aligned and matched at the edges. The scale is printed at the bottom of all USGS ortho quads.

APPENDICES

Appendix A – Plot Radii for Fixed Plots

Limiting distance (horizontal distance in feet from plot center to the center of the tree).

Plot Size (Acre)	Plot Radius* (Feet)
1	117.8
1/2	83.3
1/3	68.0
1/4	58.9
1/5	52.7
1/10	37.2
1/20	26.3
1/25	23.5
1/50	16.7
1/100	11.8
1/300	6.8
1/500	5.3
1/1000	3.7

*Plot radius is $\sqrt{(PlotSize * 43560)/\pi}$

Appendix B – Plot Radius Factors for BAF Points

For limiting distance (in feet from point center to the center of the tree), multiply tree DBH (in inches) by the appropriate plot radius factor.

BAF	Plot Radius Factor*
5	3.889
10	2.750
15	2.245
20	1.944
25	1.739
30	1.588
37.5	1.420
40	1.375
50	1.230
60	1.123
70	1.039
80	0.972

*Plot radius factor is $8.696/\sqrt{BAF}$

Appendix C - Inches To Tenths Of A Foot

Inches	Feet
1	0.1
2	0.2
3	0.3
4	0.3
5	0.4
6	0.5
7	0.6
8	0.7
9	0.8
10	0.8
11	0.9

Appendix D – Minimum merchantable height needed per number of 8' bolts

Number of 8' Bolts	Minimum Merch. Ht.
1	8' 6"
2	12' 6"
3	21' 0"
4	29' 0"
5	37' 6"
6	45' 6"
7	54' 0"
8	62' 0"
9	70' 6"
10	78' 6"

Number of 8' Bolts	Minimum Merch. Ht.
11	87' 0"
12	95' 0"
13	103' 6"
14	111' 6"
15	120' 0"
16	128' 0"
17	136' 6"
18	144' 6"
19	155' 0"
20	161' 0"

Appendix E - Slope or lean correction factors

For slope distances, multiply the horizontal distance by the correction factor for the appropriate slope angle. (Slope angles are measured from horizontal).
For leaning heights, multiply the vertical height by the correction factor for the appropriate lean angle. (Lean angles are measured from vertical).

Degrees Slope or Lean	Percent Slope or Lean	Correction Factor*
0 - 4°	0 - 9%	1.00
5 - 9°	10 - 17%	1.01
10 - 12°	18 - 22%	1.02
13 - 14°	23 - 26%	1.03
15 - 16°	27 - 30%	1.04
17 - 18°	31 - 33%	1.05
19 - 20°	34 - 36%	1.06
21°	37 - 39%	1.07
22°	40 - 42%	1.08
23 - 24°	43 - 44%	1.09
25°	45 - 47%	1.10
26°	48 - 49%	1.11
27°	50 - 51%	1.12
28°	52 - 53%	1.13
29°	54 - 55%	1.14
30°	56 - 57%	1.15
	58 - 59%	1.16
31°	60 - 61%	1.17
32°	62 - 63%	1.18
33°	64 - 65%	1.19
	66 - 67%	1.20

Degrees Slope or Lean	Percent Slope or Lean	Correction Factor*
34°	68 - 69%	1.21
35°	70%	1.22
	71 - 72%	1.23
36°	73 - 74%	1.24
37°	75%	1.25
	76 - 77%	1.26
38°	78 - 79%	1.27
	80%	1.28
39°	81 - 82%	1.29
	83%	1.30
40°	84 - 85%	1.31
	86%	1.32
41°	87 - 88%	1.33
	89%	1.34
42°	90 - 91%	1.35
	92%	1.36
43°	93 - 94%	1.37
	95%	1.38
44°	96 - 97%	1.39
	98%	1.40
45°	99 - 100%	1.41

*Correction factor for any slope or lean measured in degrees is $1 / Cosine(SlopeDegrees)$

*Correction factor for any slope or lean measured in percent is $\sqrt{1+(SlopePercent/100)^2}$

Appendix F - Volume Distribution Within a Tree

Percent										Bolt
84 - 88 80 - 84									1 - 100 2 - 100	10
68 - 72 64 - 68								2 - 100 2 - 100	2 - 100 2 - 100	9
60 - 64 56 - 60							2 - 100 3 - 100	3 - 100 3 - 90	3 - 90 3 - 90	8
52 - 56 48 - 52						3 - 100 3 - 100	4 - 100 4 - 90	4 - 90 4 - 90	4 - 90 4 - 80	7
44 - 48 40 - 44					5 - 100 5 - 90	4 - 90 5 - 90	4 - 90 5 - 80	4 - 80 5 - 80	4 - 80 5 - 80	6
36 - 40 32 - 36				7 - 100 7 - 90	6 - 90 7 - 80	6 - 80 7 - 80	6 - 80 6 - 70	5 - 70 6 - 70	5 - 70 6 - 70	5
28 - 32 24 - 28			9 - 100 10 - 90	8 - 90 9 - 80	7 - 80 8 - 70	7 - 70 7 - 60	6 - 70 7 - 60	6 - 60 7 - 60	6 - 60 6 - 50	4
20 - 24 16 - 20		13 - 100 14 - 90	11 - 80 11 - 70	9 - 70 10 - 60	9 - 60 9 - 50	8 - 60 9 - 50	8 - 50 8 - 50	7 - 50 8 - 40	7 - 50 7 - 40	3
12 - 16 8 - 12	21 - 100 23 - 80	15 - 70 17 - 60	12 - 60 14 - 50	11 - 50 12 - 40	9 - 40 11 - 30	9 - 40 10 - 30	8 - 40 9 - 30	8 - 30 8 - 30	8 - 30 8 - 30	2
4 - 8 0 - 4	39 - 100 61 - 60	26 - 60 30 - 30	19 - 40 22 - 20	16 - 30 17 - 20	13 - 30 14 - 10	12 - 20 12 - 10	11 - 20 11 - 10	10 - 20 10 - 10	9 - 20 9 - 10	8 - 20 9 - 10	1
# Bolts	1	2	3	4	5	6	7	8	9	10	
Min. Ht.	8' 6"	12' 6"	21' 0"	29' 0"	37' 6"	45' 6"	54' 0"	62' 0"	70' 6"	78' 6"	

Cumulative % Volume (Rounded)
Actual % Volume by 4' Bolts

Appendix G – Limiting Distances for BAF Points

Horizontal distance in feet from plot center to the center of a tree of the specified DBH. The whole-number part of the DBH is read from the left column, and the decimal part is read from the top row. The number from that row and column is the limiting distance for a tree of that DBH when using the specified BAF.

Basal Area Factor 5 – Limiting Distances for BAF Points

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.0	0.4	0.8	1.2	1.6	1.9	2.3	2.7	3.1	3.5
1	3.9	4.3	4.7	5.1	5.4	5.8	6.2	6.6	7.0	7.4
2	7.8	8.2	8.6	8.9	9.3	9.7	10.1	10.5	10.9	11.3
3	11.7	12.1	12.4	12.8	13.2	13.6	14.0	14.4	14.8	15.2
4	15.6	15.9	16.3	16.7	17.1	17.5	17.9	18.3	18.7	19.1
5	19.4	19.8	20.2	20.6	21.0	21.4	21.8	22.2	22.6	22.9
6	23.3	23.7	24.1	24.5	24.9	25.3	25.7	26.1	26.4	26.8
7	27.2	27.6	28.0	28.4	28.8	29.2	29.6	29.9	30.3	30.7
8	31.1	31.5	31.9	32.3	32.7	33.1	33.4	33.8	34.2	34.6
9	35.0	35.4	35.8	36.2	36.6	36.9	37.3	37.7	38.1	38.5
10	38.9	39.3	39.7	40.1	40.4	40.8	41.2	41.6	42.0	42.4
11	42.8	43.2	43.6	43.9	44.3	44.7	45.1	45.5	45.9	46.3
12	46.7	47.1	47.4	47.8	48.2	48.6	49.0	49.4	49.8	50.2
13	50.6	50.9	51.3	51.7	52.1	52.5	52.9	53.3	53.7	54.1
14	54.4	54.8	55.2	55.6	56.0	56.4	56.8	57.2	57.6	57.9
15	58.3	58.7	59.1	59.5	59.9	60.3	60.7	61.1	61.4	61.8
16	62.2	62.6	63.0	63.4	63.8	64.2	64.6	64.9	65.3	65.7
17	66.1	66.5	66.9	67.3	67.7	68.1	68.4	68.8	69.2	69.6
18	70.0	70.4	70.8	71.2	71.6	71.9	72.3	72.7	73.1	73.5
19	73.9	74.3	74.7	75.1	75.4	75.8	76.2	76.6	77.0	77.4
20	77.8	78.2	78.6	78.9	79.3	79.7	80.1	80.5	80.9	81.3
21	81.7	82.1	82.4	82.8	83.2	83.6	84.0	84.4	84.8	85.2
22	85.6	85.9	86.3	86.7	87.1	87.5	87.9	88.3	88.7	89.1
23	89.4	89.8	90.2	90.6	91.0	91.4	91.8	92.2	92.6	92.9
24	93.3	93.7	94.1	94.5	94.9	95.3	95.7	96.1	96.4	96.8
25	97.2	97.6	98.0	98.4	98.8	99.2	99.6	99.9	100.3	100.7
26	101.1	101.5	101.9	102.3	102.7	103.1	103.4	103.8	104.2	104.6
27	105.0	105.4	105.8	106.2	106.6	106.9	107.3	107.7	108.1	108.5
28	108.9	109.3	109.7	110.1	110.4	110.8	111.2	111.6	112.0	112.4
29	112.8	113.2	113.6	113.9	114.3	114.7	115.1	115.5	115.9	116.3
30	116.7	117.1	117.4	117.8	118.2	118.6	119.0	119.4	119.8	120.2
31	120.6	120.9	121.3	121.7	122.1	122.5	122.9	123.3	123.7	124.1
32	124.4	124.8	125.2	125.6	126.0	126.4	126.8	127.2	127.6	127.9
33	128.3	128.7	129.1	129.5	129.9	130.3	130.7	131.1	131.4	131.8
34	132.2	132.6	133.0	133.4	133.8	134.2	134.6	134.9	135.3	135.7
35	136.1	136.5	136.9	137.3	137.7	138.1	138.4	138.8	139.2	139.6
36	140.0	140.4	140.8	141.2	141.6	141.9	142.3	142.7	143.1	143.5
37	143.9	144.3	144.7	145.1	145.4	145.8	146.2	146.6	147.0	147.4
38	147.8	148.2	148.6	148.9	149.3	149.7	150.1	150.5	150.9	151.3
39	151.7	152.1	152.4	152.8	153.2	153.6	154.0	154.4	154.8	155.2
40	155.6	155.9	156.3	156.7	157.1	157.5	157.9	158.3	158.7	159.1
41	159.4	159.8	160.2	160.6	161.0	161.4	161.8	162.2	162.6	162.9
42	163.3	163.7	164.1	164.5	164.9	165.3	165.7	166.1	166.4	166.8
43	167.2	167.6	168.0	168.4	168.8	169.2	169.6	169.9	170.3	170.7
44	171.1	171.5	171.9	172.3	172.7	173.1	173.4	173.8	174.2	174.6
45	175.0	175.4	175.8	176.2	176.6	176.9	177.3	177.7	178.1	178.5
46	178.9	179.3	179.7	180.1	180.4	180.8	181.2	181.6	182.0	182.4
47	182.8	183.2	183.6	183.9	184.3	184.7	185.1	185.5	185.9	186.3
48	186.7	187.1	187.4	187.8	188.2	188.6	189.0	189.4	189.8	190.2
49	190.6	190.9	191.3	191.7	192.1	192.5	192.9	193.3	193.7	194.1
50	194.4	194.8	195.2	195.6	196.0	196.4	196.8	197.2	197.6	197.9

Basal Area Factor 10 – Limiting Distances for BAF Points

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.0	0.3	0.5	0.8	1.1	1.4	1.6	1.9	2.2	2.5
1	2.7	3.0	3.3	3.6	3.8	4.1	4.4	4.7	4.9	5.2
2	5.5	5.8	6.0	6.3	6.6	6.9	7.1	7.4	7.7	8.0
3	8.2	8.5	8.8	9.1	9.3	9.6	9.9	10.2	10.4	10.7
4	11.0	11.3	11.5	11.8	12.1	12.4	12.6	12.9	13.2	13.5
5	13.7	14.0	14.3	14.6	14.8	15.1	15.4	15.7	15.9	16.2
6	16.5	16.8	17.0	17.3	17.6	17.9	18.1	18.4	18.7	19.0
7	19.2	19.5	19.8	20.1	20.3	20.6	20.9	21.2	21.4	21.7
8	22.0	22.3	22.5	22.8	23.1	23.4	23.6	23.9	24.2	24.5
9	24.7	25.0	25.3	25.6	25.8	26.1	26.4	26.7	26.9	27.2
10	27.5	27.8	28.0	28.3	28.6	28.9	29.1	29.4	29.7	30.0
11	30.2	30.5	30.8	31.1	31.3	31.6	31.9	32.2	32.4	32.7
12	33.0	33.3	33.5	33.8	34.1	34.4	34.6	34.9	35.2	35.5
13	35.7	36.0	36.3	36.6	36.8	37.1	37.4	37.7	37.9	38.2
14	38.5	38.8	39.0	39.3	39.6	39.9	40.1	40.4	40.7	41.0
15	41.2	41.5	41.8	42.1	42.3	42.6	42.9	43.2	43.4	43.7
16	44.0	44.3	44.5	44.8	45.1	45.4	45.6	45.9	46.2	46.5
17	46.7	47.0	47.3	47.6	47.8	48.1	48.4	48.7	48.9	49.2
18	49.5	49.8	50.0	50.3	50.6	50.9	51.1	51.4	51.7	52.0
19	52.2	52.5	52.8	53.1	53.3	53.6	53.9	54.2	54.4	54.7
20	55.0	55.3	55.5	55.8	56.1	56.4	56.6	56.9	57.2	57.5
21	57.7	58.0	58.3	58.6	58.8	59.1	59.4	59.7	59.9	60.2
22	60.5	60.8	61.0	61.3	61.6	61.9	62.1	62.4	62.7	63.0
23	63.2	63.5	63.8	64.1	64.3	64.6	64.9	65.2	65.4	65.7
24	66.0	66.3	66.5	66.8	67.1	67.4	67.6	67.9	68.2	68.5
25	68.7	69.0	69.3	69.6	69.8	70.1	70.4	70.7	70.9	71.2
26	71.5	71.8	72.0	72.3	72.6	72.9	73.1	73.4	73.7	74.0
27	74.2	74.5	74.8	75.1	75.3	75.6	75.9	76.2	76.4	76.7
28	77.0	77.3	77.5	77.8	78.1	78.4	78.6	78.9	79.2	79.5
29	79.7	80.0	80.3	80.6	80.8	81.1	81.4	81.7	81.9	82.2
30	82.5	82.8	83.0	83.3	83.6	83.9	84.1	84.4	84.7	85.0
31	85.2	85.5	85.8	86.1	86.3	86.6	86.9	87.2	87.4	87.7
32	88.0	88.3	88.5	88.8	89.1	89.4	89.6	89.9	90.2	90.5
33	90.7	91.0	91.3	91.6	91.8	92.1	92.4	92.7	92.9	93.2
34	93.5	93.8	94.0	94.3	94.6	94.9	95.1	95.4	95.7	96.0
35	96.2	96.5	96.8	97.1	97.3	97.6	97.9	98.2	98.4	98.7
36	99.0	99.3	99.5	99.8	100.1	100.4	100.6	100.9	101.2	101.5
37	101.7	102.0	102.3	102.6	102.8	103.1	103.4	103.7	103.9	104.2
38	104.5	104.8	105.0	105.3	105.6	105.9	106.1	106.4	106.7	107.0
39	107.2	107.5	107.8	108.1	108.3	108.6	108.9	109.2	109.4	109.7
40	110.0	110.3	110.5	110.8	111.1	111.4	111.6	111.9	112.2	112.5
41	112.7	113.0	113.3	113.6	113.8	114.1	114.4	114.7	114.9	115.2
42	115.5	115.8	116.0	116.3	116.6	116.9	117.1	117.4	117.7	118.0
43	118.2	118.5	118.8	119.1	119.3	119.6	119.9	120.2	120.4	120.7
44	121.0	121.3	121.5	121.8	122.1	122.4	122.6	122.9	123.2	123.5
45	123.7	124.0	124.3	124.6	124.8	125.1	125.4	125.7	125.9	126.2
46	126.5	126.8	127.0	127.3	127.6	127.9	128.1	128.4	128.7	129.0
47	129.2	129.5	129.8	130.1	130.3	130.6	130.9	131.2	131.4	131.7
48	132.0	132.3	132.5	132.8	133.1	133.4	133.6	133.9	134.2	134.5
49	134.7	135.0	135.3	135.6	135.8	136.1	136.4	136.7	136.9	137.2
50	137.5	137.8	138.0	138.3	138.6	138.9	139.1	139.4	139.7	140.0

Basal Area Factor 20 – Limiting Distances for BAF Points

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.0	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8
1	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3	3.5	3.7
2	3.9	4.1	4.3	4.5	4.7	4.9	5.1	5.3	5.4	5.6
3	5.8	6.0	6.2	6.4	6.6	6.8	7.0	7.2	7.4	7.6
4	7.8	8.0	8.2	8.4	8.6	8.8	8.9	9.1	9.3	9.5
5	9.7	9.9	10.1	10.3	10.5	10.7	10.9	11.1	11.3	11.5
6	11.7	11.9	12.1	12.3	12.4	12.6	12.8	13.0	13.2	13.4
7	13.6	13.8	14.0	14.2	14.4	14.6	14.8	15.0	15.2	15.4
8	15.6	15.8	15.9	16.1	16.3	16.5	16.7	16.9	17.1	17.3
9	17.5	17.7	17.9	18.1	18.3	18.5	18.7	18.9	19.1	19.3
10	19.4	19.6	19.8	20.0	20.2	20.4	20.6	20.8	21.0	21.2
11	21.4	21.6	21.8	22.0	22.2	22.4	22.6	22.8	22.9	23.1
12	23.3	23.5	23.7	23.9	24.1	24.3	24.5	24.7	24.9	25.1
13	25.3	25.5	25.7	25.9	26.1	26.3	26.4	26.6	26.8	27.0
14	27.2	27.4	27.6	27.8	28.0	28.2	28.4	28.6	28.8	29.0
15	29.2	29.4	29.6	29.8	29.9	30.1	30.3	30.5	30.7	30.9
16	31.1	31.3	31.5	31.7	31.9	32.1	32.3	32.5	32.7	32.9
17	33.1	33.3	33.4	33.6	33.8	34.0	34.2	34.4	34.6	34.8
18	35.0	35.2	35.4	35.6	35.8	36.0	36.2	36.4	36.6	36.8
19	36.9	37.1	37.3	37.5	37.7	37.9	38.1	38.3	38.5	38.7
20	38.9	39.1	39.3	39.5	39.7	39.9	40.1	40.3	40.4	40.6
21	40.8	41.0	41.2	41.4	41.6	41.8	42.0	42.2	42.4	42.6
22	42.8	43.0	43.2	43.4	43.6	43.8	43.9	44.1	44.3	44.5
23	44.7	44.9	45.1	45.3	45.5	45.7	45.9	46.1	46.3	46.5
24	46.7	46.9	47.1	47.3	47.4	47.6	47.8	48.0	48.2	48.4
25	48.6	48.8	49.0	49.2	49.4	49.6	49.8	50.0	50.2	50.4
26	50.6	50.8	50.9	51.1	51.3	51.5	51.7	51.9	52.1	52.3
27	52.5	52.7	52.9	53.1	53.3	53.5	53.7	53.9	54.1	54.3
28	54.4	54.6	54.8	55.0	55.2	55.4	55.6	55.8	56.0	56.2
29	56.4	56.6	56.8	57.0	57.2	57.4	57.6	57.8	57.9	58.1
30	58.3	58.5	58.7	58.9	59.1	59.3	59.5	59.7	59.9	60.1
31	60.3	60.5	60.7	60.9	61.1	61.3	61.4	61.6	61.8	62.0
32	62.2	62.4	62.6	62.8	63.0	63.2	63.4	63.6	63.8	64.0
33	64.2	64.4	64.6	64.8	64.9	65.1	65.3	65.5	65.7	65.9
34	66.1	66.3	66.5	66.7	66.9	67.1	67.3	67.5	67.7	67.9
35	68.1	68.3	68.4	68.6	68.8	69.0	69.2	69.4	69.6	69.8
36	70.0	70.2	70.4	70.6	70.8	71.0	71.2	71.4	71.6	71.8
37	71.9	72.1	72.3	72.5	72.7	72.9	73.1	73.3	73.5	73.7
38	73.9	74.1	74.3	74.5	74.7	74.9	75.1	75.3	75.4	75.6
39	75.8	76.0	76.2	76.4	76.6	76.8	77.0	77.2	77.4	77.6
40	77.8	78.0	78.2	78.4	78.6	78.8	78.9	79.1	79.3	79.5
41	79.7	79.9	80.1	80.3	80.5	80.7	80.9	81.1	81.3	81.5
42	81.7	81.9	82.1	82.3	82.4	82.6	82.8	83.0	83.2	83.4
43	83.6	83.8	84.0	84.2	84.4	84.6	84.8	85.0	85.2	85.4
44	85.6	85.8	85.9	86.1	86.3	86.5	86.7	86.9	87.1	87.3
45	87.5	87.7	87.9	88.1	88.3	88.5	88.7	88.9	89.1	89.3
46	89.4	89.6	89.8	90.0	90.2	90.4	90.6	90.8	91.0	91.2
47	91.4	91.6	91.8	92.0	92.2	92.4	92.6	92.8	92.9	93.1
48	93.3	93.5	93.7	93.9	94.1	94.3	94.5	94.7	94.9	95.1
49	95.3	95.5	95.7	95.9	96.1	96.3	96.4	96.6	96.8	97.0
50	97.2	97.4	97.6	97.8	98.0	98.2	98.4	98.6	98.8	99.0

Basal Area Factor 37.5 – Limiting Distances for BAF Points

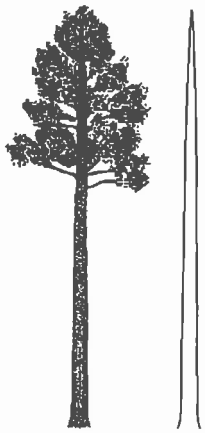
	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.0	0.1	0.3	0.4	0.6	0.7	0.9	1.0	1.1	1.3
1	1.4	1.6	1.7	1.8	2.0	2.1	2.3	2.4	2.6	2.7
2	2.8	3.0	3.1	3.3	3.4	3.6	3.7	3.8	4.0	4.1
3	4.3	4.4	4.5	4.7	4.8	5.0	5.1	5.3	5.4	5.5
4	5.7	5.8	6.0	6.1	6.2	6.4	6.5	6.7	6.8	7.0
5	7.1	7.2	7.4	7.5	7.7	7.8	8.0	8.1	8.2	8.4
6	8.5	8.7	8.8	8.9	9.1	9.2	9.4	9.5	9.7	9.8
7	9.9	10.1	10.2	10.4	10.5	10.7	10.8	10.9	11.1	11.2
8	11.4	11.5	11.6	11.8	11.9	12.1	12.2	12.4	12.5	12.6
9	12.8	12.9	13.1	13.2	13.3	13.5	13.6	13.8	13.9	14.1
10	14.2	14.3	14.5	14.6	14.8	14.9	15.1	15.2	15.3	15.5
11	15.6	15.8	15.9	16.0	16.2	16.3	16.5	16.6	16.8	16.9
12	17.0	17.2	17.3	17.5	17.6	17.8	17.9	18.0	18.2	18.3
13	18.5	18.6	18.7	18.9	19.0	19.2	19.3	19.5	19.6	19.7
14	19.9	20.0	20.2	20.3	20.4	20.6	20.7	20.9	21.0	21.2
15	21.3	21.4	21.6	21.7	21.9	22.0	22.2	22.3	22.4	22.6
16	22.7	22.9	23.0	23.1	23.3	23.4	23.6	23.7	23.9	24.0
17	24.1	24.3	24.4	24.6	24.7	24.9	25.0	25.1	25.3	25.4
18	25.6	25.7	25.8	26.0	26.1	26.3	26.4	26.6	26.7	26.8
19	27.0	27.1	27.3	27.4	27.5	27.7	27.8	28.0	28.1	28.3
20	28.4	28.5	28.7	28.8	29.0	29.1	29.3	29.4	29.5	29.7
21	29.8	30.0	30.1	30.2	30.4	30.5	30.7	30.8	31.0	31.1
22	31.2	31.4	31.5	31.7	31.8	32.0	32.1	32.2	32.4	32.5
23	32.7	32.8	32.9	33.1	33.2	33.4	33.5	33.7	33.8	33.9
24	34.1	34.2	34.4	34.5	34.6	34.8	34.9	35.1	35.2	35.4
25	35.5	35.6	35.8	35.9	36.1	36.2	36.4	36.5	36.6	36.8
26	36.9	37.1	37.2	37.3	37.5	37.6	37.8	37.9	38.1	38.2
27	38.3	38.5	38.6	38.8	38.9	39.1	39.2	39.3	39.5	39.6
28	39.8	39.9	40.0	40.2	40.3	40.5	40.6	40.8	40.9	41.0
29	41.2	41.3	41.5	41.6	41.7	41.9	42.0	42.2	42.3	42.5
30	42.6	42.7	42.9	43.0	43.2	43.3	43.5	43.6	43.7	43.9
31	44.0	44.2	44.3	44.4	44.6	44.7	44.9	45.0	45.2	45.3
32	45.4	45.6	45.7	45.9	46.0	46.2	46.3	46.4	46.6	46.7
33	46.9	47.0	47.1	47.3	47.4	47.6	47.7	47.9	48.0	48.1
34	48.3	48.4	48.6	48.7	48.8	49.0	49.1	49.3	49.4	49.6
35	49.7	49.8	50.0	50.1	50.3	50.4	50.6	50.7	50.8	51.0
36	51.1	51.3	51.4	51.5	51.7	51.8	52.0	52.1	52.3	52.4
37	52.5	52.7	52.8	53.0	53.1	53.3	53.4	53.5	53.7	53.8
38	54.0	54.1	54.2	54.4	54.5	54.7	54.8	55.0	55.1	55.2
39	55.4	55.5	55.7	55.8	56.0	56.1	56.2	56.4	56.5	56.7
40	56.8	56.9	57.1	57.2	57.4	57.5	57.7	57.8	57.9	58.1
41	58.2	58.4	58.5	58.6	58.8	58.9	59.1	59.2	59.4	59.5
42	59.6	59.8	59.9	60.1	60.2	60.4	60.5	60.6	60.8	60.9
43	61.1	61.2	61.3	61.5	61.6	61.8	61.9	62.1	62.2	62.3
44	62.5	62.6	62.8	62.9	63.1	63.2	63.3	63.5	63.6	63.8
45	63.9	64.0	64.2	64.3	64.5	64.6	64.8	64.9	65.0	65.2
46	65.3	65.5	65.6	65.7	65.9	66.0	66.2	66.3	66.5	66.6
47	66.7	66.9	67.0	67.2	67.3	67.5	67.6	67.7	67.9	68.0
48	68.2	68.3	68.4	68.6	68.7	68.9	69.0	69.2	69.3	69.4
49	69.6	69.7	69.9	70.0	70.2	70.3	70.4	70.6	70.7	70.9
50	71.0	71.1	71.3	71.4	71.6	71.7	71.9	72.0	72.1	72.3

Basal Area Factor 40 – Limiting Distances for BAF Points

	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
0	0.0	0.1	0.3	0.4	0.5	0.7	0.8	1.0	1.1	1.2
1	1.4	1.5	1.6	1.8	1.9	2.1	2.2	2.3	2.5	2.6
2	2.7	2.9	3.0	3.2	3.3	3.4	3.6	3.7	3.8	4.0
3	4.1	4.3	4.4	4.5	4.7	4.8	4.9	5.1	5.2	5.4
4	5.5	5.6	5.8	5.9	6.0	6.2	6.3	6.5	6.6	6.7
5	6.9	7.0	7.1	7.3	7.4	7.6	7.7	7.8	8.0	8.1
6	8.2	8.4	8.5	8.7	8.8	8.9	9.1	9.2	9.3	9.5
7	9.6	9.8	9.9	10.0	10.2	10.3	10.4	10.6	10.7	10.9
8	11.0	11.1	11.3	11.4	11.5	11.7	11.8	12.0	12.1	12.2
9	12.4	12.5	12.6	12.8	12.9	13.1	13.2	13.3	13.5	13.6
10	13.7	13.9	14.0	14.2	14.3	14.4	14.6	14.7	14.8	15.0
11	15.1	15.3	15.4	15.5	15.7	15.8	15.9	16.1	16.2	16.4
12	16.5	16.6	16.8	16.9	17.0	17.2	17.3	17.5	17.6	17.7
13	17.9	18.0	18.1	18.3	18.4	18.6	18.7	18.8	19.0	19.1
14	19.2	19.4	19.5	19.7	19.8	19.9	20.1	20.2	20.3	20.5
15	20.6	20.8	20.9	21.0	21.2	21.3	21.4	21.6	21.7	21.9
16	22.0	22.1	22.3	22.4	22.5	22.7	22.8	23.0	23.1	23.2
17	23.4	23.5	23.6	23.8	23.9	24.1	24.2	24.3	24.5	24.6
18	24.7	24.9	25.0	25.2	25.3	25.4	25.6	25.7	25.8	26.0
19	26.1	26.3	26.4	26.5	26.7	26.8	26.9	27.1	27.2	27.4
20	27.5	27.6	27.8	27.9	28.0	28.2	28.3	28.5	28.6	28.7
21	28.9	29.0	29.1	29.3	29.4	29.6	29.7	29.8	30.0	30.1
22	30.2	30.4	30.5	30.7	30.8	30.9	31.1	31.2	31.3	31.5
23	31.6	31.8	31.9	32.0	32.2	32.3	32.4	32.6	32.7	32.9
24	33.0	33.1	33.3	33.4	33.5	33.7	33.8	34.0	34.1	34.2
25	34.4	34.5	34.6	34.8	34.9	35.1	35.2	35.3	35.5	35.6
26	35.7	35.9	36.0	36.2	36.3	36.4	36.6	36.7	36.8	37.0
27	37.1	37.3	37.4	37.5	37.7	37.8	37.9	38.1	38.2	38.4
28	38.5	38.6	38.8	38.9	39.0	39.2	39.3	39.5	39.6	39.7
29	39.9	40.0	40.1	40.3	40.4	40.6	40.7	40.8	41.0	41.1
30	41.2	41.4	41.5	41.7	41.8	41.9	42.1	42.2	42.3	42.5
31	42.6	42.8	42.9	43.0	43.2	43.3	43.4	43.6	43.7	43.9
32	44.0	44.1	44.3	44.4	44.5	44.7	44.8	45.0	45.1	45.2
33	45.4	45.5	45.6	45.8	45.9	46.1	46.2	46.3	46.5	46.6
34	46.7	46.9	47.0	47.2	47.3	47.4	47.6	47.7	47.8	48.0
35	48.1	48.3	48.4	48.5	48.7	48.8	48.9	49.1	49.2	49.4
36	49.5	49.6	49.8	49.9	50.0	50.2	50.3	50.5	50.6	50.7
37	50.9	51.0	51.1	51.3	51.4	51.6	51.7	51.8	52.0	52.1
38	52.2	52.4	52.5	52.7	52.8	52.9	53.1	53.2	53.3	53.5
39	53.6	53.8	53.9	54.0	54.2	54.3	54.4	54.6	54.7	54.9
40	55.0	55.1	55.3	55.4	55.5	55.7	55.8	56.0	56.1	56.2
41	56.4	56.5	56.6	56.8	56.9	57.1	57.2	57.3	57.5	57.6
42	57.7	57.9	58.0	58.2	58.3	58.4	58.6	58.7	58.8	59.0
43	59.1	59.3	59.4	59.5	59.7	59.8	59.9	60.1	60.2	60.4
44	60.5	60.6	60.8	60.9	61.0	61.2	61.3	61.5	61.6	61.7
45	61.9	62.0	62.1	62.3	62.4	62.6	62.7	62.8	63.0	63.1
46	63.2	63.4	63.5	63.7	63.8	63.9	64.1	64.2	64.3	64.5
47	64.6	64.8	64.9	65.0	65.2	65.3	65.4	65.6	65.7	65.9
48	66.0	66.1	66.3	66.4	66.5	66.7	66.8	67.0	67.1	67.2
49	67.4	67.5	67.6	67.8	67.9	68.1	68.2	68.3	68.5	68.6
50	68.7	68.9	69.0	69.2	69.3	69.4	69.6	69.7	69.8	70.0

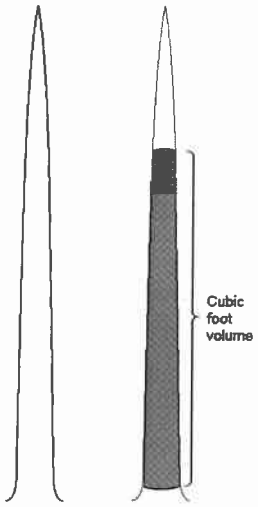
Taper Model Explained

The new timber volume estimation system for the Eastern Region is called a taper model (or stem profile model) because it uses a 3-dimensional tapered shell to represent the tree stem. Each species or group of species has its own coefficients used to define the taper. Hundreds of thousands of actual tree measurements from throughout the region were used in the development of the coefficients.



The entire tapered shell for the correct species is proportionally stretched wider or narrower (to fit the tree DBH), and taller or shorter (to match the tree height) to represent the entire tree stem. It can then be used to calculate volumes. Of course, it represents the "average" tree of that species, DBH, and height.

The gross volume of merchantable wood is calculated as the volume inside the shell from the stump up to the specified minimum diameter.



The minimum diameter for merchantable products can be changed as necessary, and the calculated volumes will change accordingly. For example, volume could be calculated to a two-inch top diameter.

Quick Guide to New Cruising Practices

HEIGHTS

- All heights are measured in feet from the ground....the high side of the stump.

  The cruise software accounts for the stump height when calculating tree volumes. SO, YOU DO NOT NEED TO DEDUCT THESE STUMP HEIGHTS FROM YOUR HEIGHT MEASUREMENT. [The equations use 6" for pulpwood trees and 12" for sawtimber trees.]

- On all sawtimber trees, record the sawtimber height in feet.

  Warning -once we move to the new volume equations, recording a sawtimber height of 0 (or blank) for a sawtimber tree will cause the cruise software to calculate a sawtimber height based on tree taper. If a tree was called sawtimber but it turns out to have no sawtimber volume, then record a recoverable product defect of 100% (discussed in the Defect section below). All merchantable volume will then be pulpwood.

- On all trees, record the height to a 4" top or record total height to the very tip. At least one of these two heights *must* be recorded for every tree.

  For conifers and possibly other species with fairly uniform taper, you can measure the height to the very tip of the tree. For all other species (including most hardwoods) measure the height to the 4-inch diameter. Be sure to record one of these heights for all trees, and record it in the correct column.

  On the Ottawa National Forest:

  1. **Conifers – measure total height (to the tip) in feet and the cruise program will calculate the 4" cut-off.**
  2. **Hardwoods (includes Aspen) – measure the height in feet to the 4" top.**
  3. **Sawtimber – cut-off point or "stoppers" will follow our regular practices. Measure sawtimber height in feet. Secondary product height will be measured as described in item 1 or 2 depending on the species.**
  4. **Default dib's are already built into our equations;**
     pulpwood = 4.0"
     sawtimber = 9.6" (hardwood)
     = 7.6" (mixed conifers, pine)

- On trees with a broken, dead, or deformed top, **record the height to the point where the 4" top or the tip would have been if the tree were still growing normally**, then record defect to account for the missing volume.

DEFECT

- Defect calculations are still recorded as the percent of the volume of the product.

  Sawtimber defect is for the sawtimber portion only. Non-saw defect is for the non-saw portion only. Non-saw defect does not affect the sawtimber portion of the tree at all.

- Trees still need to be mentally divided into logs for defect calculation.

Use the same tables and calculations you have been using all along. The tables are typically calibrated for both logs and feet.

- Record *Recoverable Product* percent for material that is defect from the standpoint of sawtimber, but which could be recovered as pulpwood volume. This is recorded only for sawtimber trees.

  An example is a sawtimber tree with a bad spiral seem affecting an entire log. Even though that log might not be sawtimber, the volume could be recovered as pulpwood (assuming it meets pulpwood specs).

  Sawtimber defect is the total percentage of the gross sawtimber volume that does not meet the specifications for sawtimber. Recoverable product is the percentage of the gross sawtimber volume that can be recovered as another product. For example, if 20% of the sawtimber volume of a tree is recoverable as pulpwood, and 10% is not recoverable, then the sawtimber defect is recorded as 30% and the recoverable product is recorded as 20%.

MEASURING TREE HEIGHTS IN FEET

Use of the FSCruiser and CruiseProcessing software requires tree heights to be recorded in feet rather than number of 8-foot logs. This document is designed to explain how the different height measurements are used to calculate the volume of the trees.

There are three different height measurements that can be recorded with the FSCruiser software. The measurement we traditionally call sawtimber height will be referred to as *Primary Product Height*. The measurement we call pulpwood height or (incorrectly) total height will be referred to as *Secondary Product Height*. In addition to these to there is a new height measured to the very tip of the tree, and it will be referred to as *Total Height*. The volumes may be calculated differently depending on the combination of values provided.

EXISTING VOLUME EQUATIONS

Initially we will continue to use the same volume equations that were used in the old NatCrs software. The only difference is the CruiseProcessing software converts the heights from feet to logs before beginning the calculations. After that conversion the volumes are calculated as they have been all along.

A height entered as the Primary Product Height is converted to sawtimber height in logs. A height entered as the Secondary Product Height is converted to pulpwood height in logs. Secondary Product Height should always be recorded to the point where the stem is 4 inches in diameter. If the tree is not merchantable all the way to that point, then the part above the merchantable section is removed as defect.

Total Height

For conifers and other species with a single main stem with uniform taper, Total Height can now be measured instead of pulpwood height. That height is reduced to represent pulpwood height, and is then converted to logs.

Either Total Height or Secondary Product Height must now be recorded for *all* trees. Recording neither of these will result in a warning message and no volume being calculated for the tree. Even if no topwood volume will be calculated, sawtimber trees still need either a secondary product height or total height recorded.

Defect

Defect is calculated as it had been before the switch to measuring heights in feet. The tree is still visually divided into logs for the defect calculations. The tables used for defect calculation are usually calibrated for both logs and feet. There is one additional type of defect called *Recoverable Primary Product*, which is material that is defect from the standpoint of sawtimber, but which could be recovered as pulpwood volume. An example is a sawtimber tree with a bad spiral seem affecting an entire log. Even though that log might not be sawtimber, if it meets the specifications for pulpwood it can be recorded as Recoverable Primary Product.

The total percent of gross sawtimber material that does not meet sawtimber specs is recorded as saw defect (just like we always did). Recoverable Product is the percent of gross sawtimber material that is recoverable as pulpwood. This is included in the saw defect.

Here is an example. If 20% of the gross sawtimber volume is junk, and 40% of the gross sawtimber volume is recoverable as pulpwood, then record the sawtimber defect as 60% and recoverable product as 40%.

NEW TAPER MODEL EQUATIONS

Until we switch to the new volume equations, the changes described above are the only ones of importance. Eventually we will be mandated by the Regional Forester to begin using the new taper model volume equations. At that time there will be a few concepts related to height measurement that will need to be understood.

In addition to understanding how the three height measurements are used, it is important to understand the two top diameters that can be specified for volume calculation. What we call sawtimber DIB will be referred to as *Primary Product Top DIB*, and what we call pulp DIB will be referred to as *Secondary Product Top DIB*.

Secondary Product Height Or Total Height Must Be Specified

An upper stem height is needed in order to define the taper of the tree. This means that either Secondary Product Height or Total Height is required to be recorded for all trees. Recording neither of these will result in a warning message and no volume being calculated for the tree. Even if no topwood volume will be calculated, sawtimber trees still need either a secondary product height or total height recorded.

Total Height Specified

If a Total Height is provided, it is used to determine tree taper. Any other heights are used only for volume calculation.

If *Secondary Product Height is not recorded* or is zero, then the Secondary Product Top DIB specified in the CruiseProcessing program is used to determine where the non-sawtimber volume ends. The non-sawtimber volume is calculated to that point.

If *Total Height and Secondary Product Height are both recorded*, then the Total Height is used to determine the taper of the tree, and the non-sawtimber volume is calculated up to the Secondary Product Height. The stem diameter is calculated at that point.

For sawtimber trees, if *Total Height and Primary Product Height are both recorded*, then the sawtimber volume is calculated up to the Primary Product Height. The stem diameter is calculated at that point.

For sawtimber trees, if *Primary Product Height is not recorded* or is zero, then the height is calculated to the point where the stem diameter equals the Primary Product Top DIB specified in the CruiseProcessing program, and the sawtimber volume is calculated to that point.

WARNING: If a tree is recorded as a sawtimber tree but it has no sawtimber volume, the Primary Product Height should *not* be recorded as zero or left blank. Instead, either record this height as 1 or record the height based on diameter and record 100% Recoverable Primary Product. The CruiseProcessing program interprets a zero or blank Primary Product Height as a request to calculate sawtimber volume based solely on taper. As described above, the program will estimate the sawtimber volume.

No Total Height, But Secondary Height Specified

If Total Height is not recorded or is zero, then Secondary Product Height is used to determine tree taper.

When Total Height is not recorded, the Secondary Product Height is assumed to have been measured to the point where the stem diameter is 4 inches. For volume calculation, the height is calculated to the point where the stem diameter equals the Secondary Product Top DIB, and the non-sawtimber volume is calculated to that point.

For sawtimber trees, if Total Height is zero or blank, and *Secondary Product Height and Primary Product Height are both recorded*, then the sawtimber volume is calculated up to the Primary Product Height. The stem diameter is calculated at that point.

For sawtimber trees, if the Primary Product Height is zero or blank, then the height is calculated to the point where the stem diameter equals the Primary Product Top DIB specified in the CruiseProcessing program, and the sawtimber volume is calculated to that point.

Top DIB Values

The Secondary Product Top DIB specified in the CruiseProcessing program will always be used in the calculation of non-sawtimber volumes. This is true regardless of which heights are provided. If the specified Secondary Product Top DIB value is zero or blank, then the default value of 4 inches will be used.

The Primary Product Top DIB specified in the CruiseProcessing program is usually ignored. *It will only be used if the Primary Product Height is zero or blank.* The CruiseProcessing program interprets zero or blank Primary Product Height as a request to calculate sawtimber volume based solely on taper. As described above, the program will estimate the sawtimber volume. If the specified Primary Product Top DIB value is zero or blank, then the default value for that forest and species will be used.

Defect

Again, defect is calculated as it had been before the switch to measuring heights in feet. Recoverable Primary Product is again available for material that is defect from the standpoint of sawtimber, but which could be recovered as pulpwood volume.

MEASURING TREE HEIGHTS

When measuring heights for a timber cruise, there are situations where merchantability stops before the typical top diameter is reached. This document outlines the rules for dealing with these situations.

Top Height Measurement

The top height measurement is an important one because it determines the overall taper for the tree. The volume equations used to calculate the tree volume assume the diameter is 4 inches at the point where the top height is measured.

The left image in figure 1 shows a tree with the stem represented in solid black. The top of the merchantable stem is well below the 4-inch top. The correct way to deal with this situation is to record the height to the point where the stem is 4 inches in diameter (even though this is above the merchantable top) and then include defect to remove the volume for the portion above the merchantable top. The middle image in figure 1 illustrates the correct measurement of height. The solid blue portion represents the net volume, and the slashed blue portion represents the volume removed as defect. Notice the blue portions match the shape of the black portions beneath, so the shape of the stem is represented correctly.

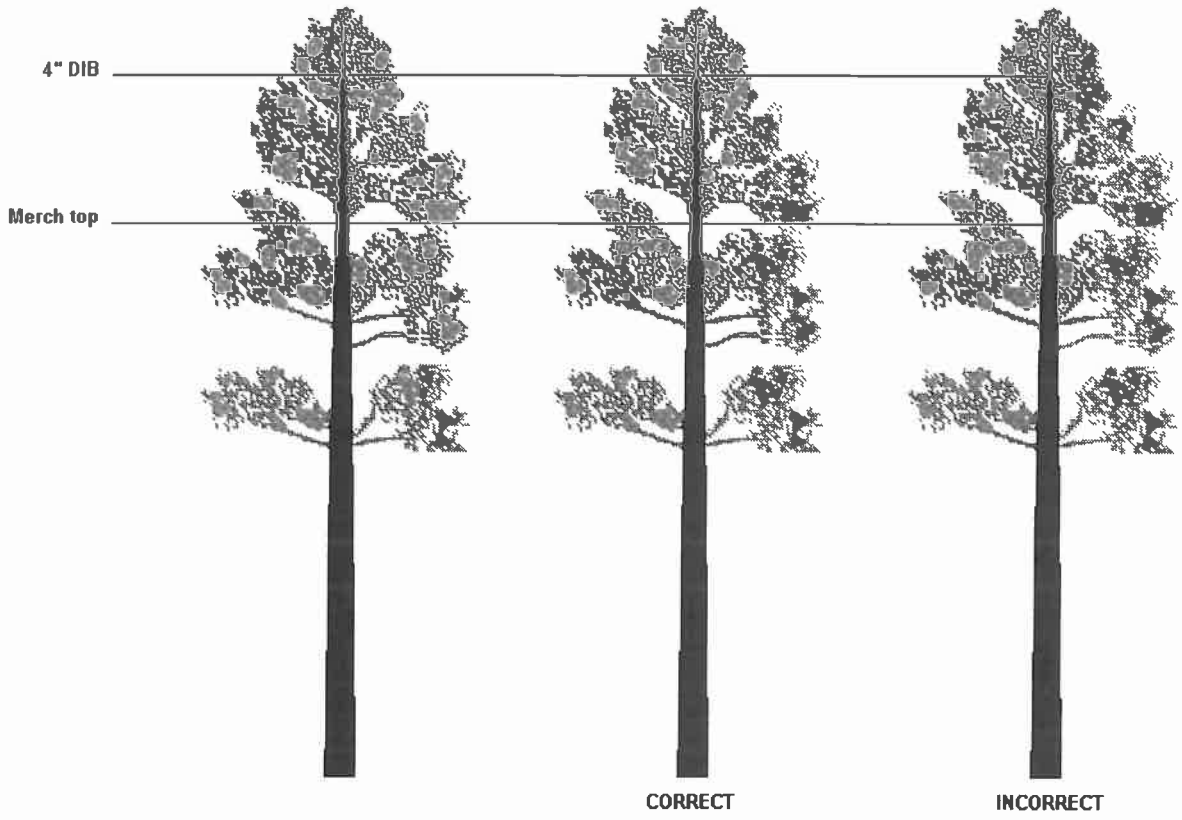


Figure 1 - Measurement of top height.

The right image in figure 1 illustrates an incorrect measurment of the top height. Height was incorrectly measured to the point where merchantability ends. Since the volume equations assume the top DIB is 4 inches at the height specified, the tree will appear to taper too quickly, and the calculated volume will be too small. Notice the blue portion tapers much more quickly than the the black portion beneath, so the shape of the stem is not represented correctly. This affects not only the pulpwood volume, but also any sawtimber volume in the tree.

Sawtimber Height Measurement

The measurement of sawtimber height is a different matter entirely. The most important thing to remember is that volume removed as defect from the sawtimber part of the tree does not get put in with the topwood volume. Defected volume is simply lost. Sawtimber heights are therefore recorded to the point where the sawtimber part of the tree ends, even if this is at a point below the typical sawtimber top DIB.

The left image in figure 2 shows a tree with the stem represented in solid black. The top of the sawtimber portion is well below the 7.6-inch top. The correct way to deal with this situation is to record the sawtimber height to the point where the sawtimber portion ends. The middle image in figure 2 illustrates the correct measurement of the sawtimber height. The solid red portion represents the sawtimber volume, and the solid blue portion represents the topwood. With our current volume equations the calculated volume is less than the actual volume because the top diameter is assumed to be 7.6 inches when it is actually larger.

The new volume equations will deal with this situation better because the diameter at the top of the sawtimber portion will be calculated based on the tree taper. The solid red portion will then better match the black portion beneath.

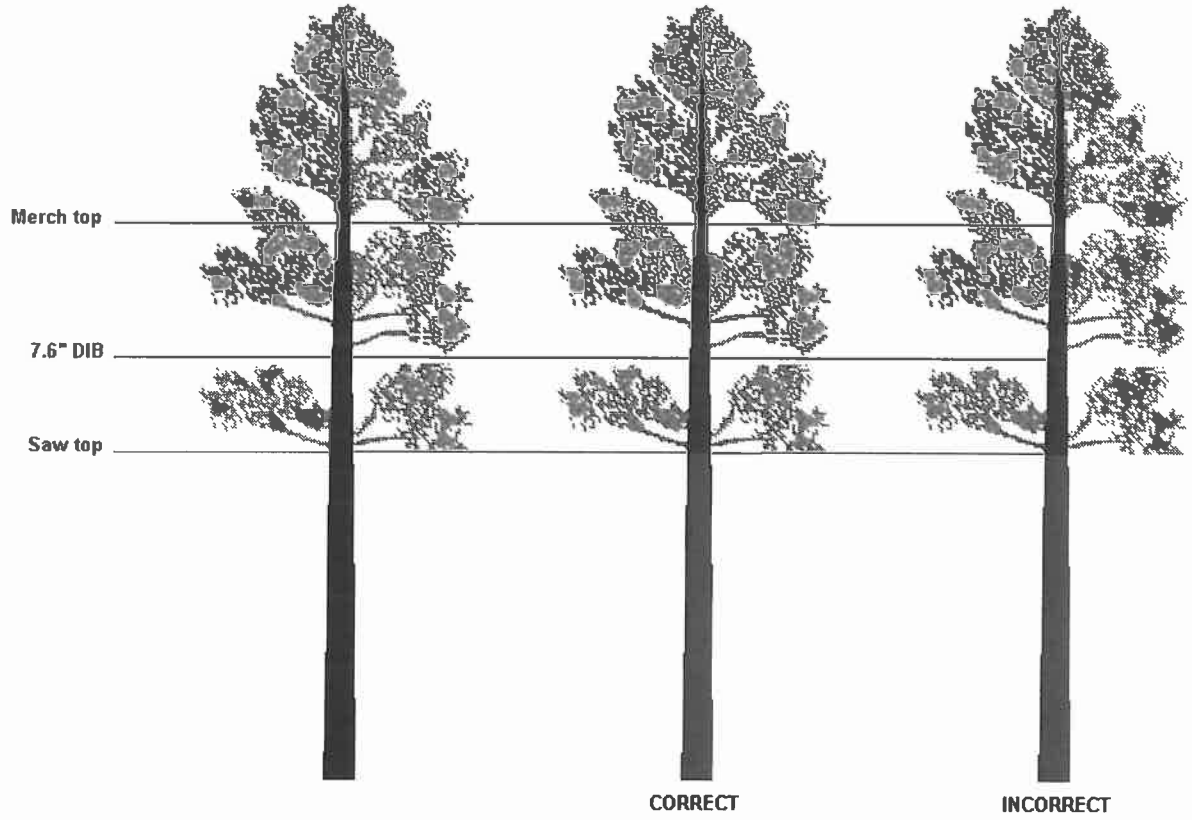


Figure 2 - Measurement of sawtimber height

The right image in figure 2 illustrates an incorrect measurment of the sawtimber height. Height was incorrectly measured to the 7.6-inch top, and then defect was applied to the portion above the top of the sawtimber portion. The solid red portion represents the sawtimber volume, and the solid blue portion represents the topwood. The defected portion shown in slashed red would be lost, and would not be recovered as topwood. The taper of the tree is correct, but there is a chunk of volume missing.

PERCENT												BOLT
93 - 97										1 100	12 96'	
89 - 93										1 100		
85 - 89									1 100	1 100	11 88'	
81 - 85									1 100	2 100		
77 - 81	Cumulative % Volume (Rounded)							1 100	2 100	2 100	10 80'	
73 - 77	Actual % Volume by 4' Bolts							2 100	2 100	2 100		
69 - 73							2 100	2 100	2 100	2 90	9 72'	
65 - 69							2 100	2 100	2 90	2 90		
61 - 65						2 100	3 100	3 90	3 90	3 90	8 64'	
57 - 61						3 100	3 90	3 90	3 90	3 80		
53 - 57					3 100	4 100	4 90	4 90	3 80	3 80	7 56'	
49 - 53					3 100	4 90	4 90	4 80	4 80	4 80		
45 - 49				5 100	4 90	4 90	4 80	4 80	4 80	4 70	6 48'	
41 - 45				5 90	5 90	5 80	5 80	5 80	4 70	4 70		
37 - 41			7 100	6 90	6 80	6 80	5 70	5 70	5 70	4 60	5 40'	
33 - 37			7 90	7 80	7 80	6 70	6 70	6 70	6 70	5 60		
29 - 33		9 100	8 90	7 80	7 70	6 70	6 60	6 60	6 60	6 50	4 32'	
25 - 29		10 90	9 80	8 70	7 60	7 60	7 60	6 50	6 50	6 50		
21 - 25	13 100	11 80	9 70	9 60	8 60	8 50	7 50	7 50	7 50	6 40	3 24'	
17 - 21	14 90	11 70	10 60	9 50	9 50	8 50	8 40	7 40	7 40	7 40		
13 - 17	21 100	15 70	12 60	11 50	9 40	9 40	8 40	8 30	8 30	8 30	7 30	2 16'
9 - 13	23 80	17 60	14 50	12 40	11 30	10 30	9 30	8 30	8 30	8 30	8 20	
5 - 9	39 100	26 60	19 40	16 30	13 30	12 20	11 20	10 20	9 20	8 20	8 20	8 20	1 8'
1 - 5	61 60	30 30	22 20	17 20	14 10	12 10	11 10	10 10	9 100	9 10	8 10	8 10	
# BOLTS	1	2	3	4	5	6	7	8	9	10	11	12	
Min. Ht.	9' 6"	13' 6"	22' 0"	30' 0"	38' 6"	46' 6"	55' 0"	63' 0"	71' 6"	79' 6"	88' 0"	96' 0"	