

TIMBER MANAGEMENT PLAN

Parashant

I. INTRODUCTION

A. Purpose and Objectives

The intent of this document is to develop a timber management plan for the Parashant forest. The primary objective of this plan is to recommend silvicultural prescriptions which will allow the forest to attain maximum health, growth and vigor, while enhancing other resource values. Timber prescriptions, where appropriate, will place the majority of the forest under an uneven-aged system of management.

B. Area

The forest lies on the south end of the Shivwits Resource Area approximately 80 miles south of St. George, Utah. Access to the area is via the BLM's Quail Hill Road and Mohave County's Roads #5 and #103, all dirt roads. The Colorado River and the Grand Canyon restrict access from the south. During inclement weather, the road systems could become impassable.

The forest is divided into two compartments, The East and West Parashant drainages. The East Parashant is broken by eighty acres of State lands in section 2 and 160 acres of private land in section 24. As a result of the Gubler-Frye land exchange, the West Parashant is entirely Public Lands.

C. Description of the Area

1. Physiography

The forest is located in the southern portion of the Shivwits Plateau. The timbered lands lie mostly in stringers within the headwaters of Parashant Wash. On it's way to the Colorado River, the Parashant Wash runs north to poverty Mountain before turning southeast towards the Colorado.

The Parashant forest is quite unique in that it lies well below the "text-book" minimum elevation of 6500 feet. By locating itself within the drainages, the ponderosa pine is more moisture efficient while enjoying a longer growing season. The north slopes of Mt. Dellenbaugh and Castle

Peak are higher in elevation but are devoid of ponderosa pine.

2. Climate

The Parashant forest experiences the semi-annual droughts typical of the Southwest. Precipitation ranges from 16" to 20" in the form of violent thunderstorms in the summer and the more gentle frontal systems in the winter. A large portion of the winter moisture is in the form of snow. Local phenological data on the ponderosa pine is not available. The mean annual air temperature averages about 45-47°F. The frost-free period ranges from about 110 to 150 days. A Remote Automated Weather Station (RAWS) is located on Yellow John Mountain.

3. Soils

The soils on the Parashant forest are usually deep and well-drained alluvium from basalt, sandstone, limestone and shale formations. They have a high moisture holding capacity, permeability is slow and except for the Boquillas-Colbran Complex in the East Parashant, runoff is moderate and the erosion hazard is slight.

4. History

a. Prehistoric

Native-American occupation of the Parashant dates from at least 10,000 B.C. through the Archaic, Anasazi and Paiute Cultures up until the relocation to the reservations in the early 1890's. Paiute and Anasazi use of the area was heavy. Sites located within the Parashant have been confined to small, linear field houses and lithic and ceramic scatters.

b. Historic

The history of the area dates back to the mid-nineteenth century where it is suspected that the Dunne party met it's fate near the north base of Castle Peak in 1869. Ten years later the Canaan Company established a dairy ranch at Oak Grove. By 1908, the Parashant forest was a part of the Dixie National Forest and remained so until President Wilson opened the area to entry in May of 1916. A 1911 Forest Service inventory estimated a timber volume of 22 million board feet on the

Parashant Division.

Personal communication with Reid Mathis revealed that approximately 9MMbf had been harvested from the former private lands on the Parashant. All timber, public and private, was sawn by small, portable sawmills and removed as lumber or as mine timbers. The small sawmill at the head of Green Spring Canyon was destroyed by fire in the early '60s.

The District sold two timber sales in the Parashant in the 1950's, approximately 800Mbf on the East Parashant in 1950 and 300Mbf on the West Parashant in 1955. The scars from sales remain, especially in the East Parashant where poor practices have left little or no regeneration. both logging

II. FOREST RESOURCES

A. Non-productive Forest Land

Non-productive forest lands are defined as those areas not capable of producing 20 cubic feet of forest trees per acre per year. Several areas within the forest have been identified as not capable of producing the required 20 cubic feet due to steep, rocky slopes or adverse soils.

B. Forest Land

Forest lands are now or are capable of being at least ten percent stocked by forest trees and are not currently developed for non-forest use. Pinyon pine and juniper are considered forest trees.

C. Productive Forest Land

Productive forest lands are capable of yielding at least 20 cubic feet of wood per acre per year of any tree species.

D. Commercial Forest Land

Commercial forest land is capable of yielding at least 20 cubic feet of wood per acre per year of a commercial tree species.

E. Timber Types

A total of 3850 acres were identified in the 1978-79 extensive forest inventory and the inventory following the 1988 Gubler-Frye land exchange and were classified as productive forest lands. The acreage and type breakdown on these lands are as follows:

Timber Type	Acreage
PP1-/PP2=	321
PP1-/PP2-	355
PP1-/PP3	29
PP1-/PP3=	24
PP1-/PP3-	51
PP1=	71
PP1-	148
PP2=/PP3=	985
PP2=/PP3-	63
PP2-/PP3-	23
PP2=	24
PP2=	549
PP2-	248
Scattered PP	958
	3850 Acres

All productive and commercial stands have been mapped and typed according to age classes and densities. A representative type classification (PP1-/PP2=) is interpreted as ponderosa pine (PP) with a mature to over-mature (1) overstory and a 0-33 percent crown closure (-). The understory consists of ponderosa pine (PP) with young sawtimber (2) and a 34-66% (=) crown closure.

<u>Age Classes</u>	<u>Crown Closure</u>
1. Mature and over-mature sawtimber	- 0-33%
2. Young sawtimber	= 34-66%
3. Poles and smaller	67-100%

The results of the 1979 and 1989 forest inventories are described in Tables 1 and 2.

TABLE 1														
UNIT	ACRES	STEMS /A	AVE DBH	AVE HT	MERCH DBH	VOL /A	TOT VOL MERCH	REC	BA/ A	R I	ANN IN CU FT	CU VOL PER /A	AGE	S I
EAST 1	13	66	11.1	40	13.1	4206	54678	.95	54	0.8	24.9	1349	75	60
EAST 2	12	105	14.0	44	14.8	10117	121404	.95	115	0.7	55.4	120	67	70
EAST 3	65	35	11.0	28	14.0	2068	134420	.90	24	0.7	7.3	616	64	50
EAST 4	24	108	15.0	60	15.0	13215	317160	.95	126	0.8	64.3	4142	79	70
EAST 5	10	41	14.3	51	15.0	4384	43840	.95	49	1.0	28.8	1397	74	70
EAST 6	165	187	10.8	40	12.5	8508	1403820	.95	129	0.5	70.9	3010	67	70
EAST 7	29	268	7.8	32	12.9	7402	214658	.93	109	0.9	75.3	2651	61	60
EAST 8	34	88	9.6	36	12.0	2857	97138	.98	50	0.6	23.1	1039	64	60
EAST 9	24	50	10.8	31	15.5	4403	105672	.85	58	0.8	14.7	1379	96	50
EAST 10	100	204	9.8	37	12.7	8073	807300	.94	125	0.7	61.6	2846	67	65
EAST 11	23	32	8.9	27	12.3	802	18446	.95	16	1.1	10.5	274	48	60
EAST 12	78	164	9.6	44	13.1	8515	664170	.93	101	0.6	46.5	2969	75	70
EAST 13	32	107	11.1	47	15.9	9247	295904	.96	93	0.5	30.8	2945	80	70
EAST 14	44	104	8.5	31	13.6	5146	226424	.96	55	0.8	27.3	1627	68	70
EAST 15	35	35	13.0	45	14.4	2987	104545	.95	36	0.9	28.6	964	80	60
EAST 16	42	31	13.5	41	15.8	3221	153282	.94	38	0.8	20.0	984	85	60
EAST 17	18	55	13.6	43	14.5	3034	54612	.95	60	0.8	38.6	1503	75	70
EAST 18	47	162	10.0	40	13.0	6705	315135	.95	104	0.7	74.1	2531	75	70
EAST 19	72	110	9.1	29	12.7	3246	233712	.95	60	0.7	37.1	1206	70	60
EAST 20	56	82	11.3	36	13.4	4772	267232	.95	65	0.8	43.7	1470	80	75
EAST 21	72	97	9.9	34	14.3	5210	375120	.95	68	0.8	46.4	1690	80	70
TOTALS	995	123	10.6	38	13.8	6039	6008672	.94	83	0.7	45.2	1845	72	65

TABLE 2														
UNIT	ACRES	STEMS /A	AVE DBH	AVE HT	MERCH DBH	VOL /A	TOT VOL MERCH	REC	BA/ A	R I	ANN IN CU FT	CU VOL PER /A	AGE	S I
WEST 1	51	13	20.0	51	28.2	5421	276471	.73	39	0.6	7.3	1842	160	70
WEST 2	882	6	11.8	37	13.8	378	333396	.95	5	0.9	2.8	120	70	65
WEST 3	76	3	12.0	29	13.0	112	8512	.98	2	1.0	1.1	36	70	50
WEST 4	75	92	14.0	44	15.5	6915	518625	.87	87	0.7	45.5	2260	68	60
WEST 5	111	26	14.0	35	13.9	1512	167832	.82	29	0.7	9.1	539	70	55
WEST 6	31	70	9.3	37	13.0	3958	122698	.84	56	0.6	21.3	1129	80	60
WEST 7	13	8	8.0	21	10.0	253	3289	.98	4	1.0	2.1	50	43	60
WEST 8	910	167	10.6	42	14.0	12089	11000990	.94	131	0.7	78.6	3705	75	80
WEST 9	61	17	11.0	36	12.6	680	41480	.98	11	.08	6.0	232	56	60
WEST 10	32	26	10.0	26	13.3	648	20736	.96	14	1.0	6.8	231	55	60
WEST 11	63	111	12.0	44	15.1	10396	688968	.95	106	0.8	56.0	3021	70	70
WEST 12	15	63	12.8	37	13.9	3808	57120	.98	60	0.7	34.0	1258	60	70

WEST 13	31	48	12.5	35	12.9	2848	88288	.98	43	0.9	27.0	499	60	70
WEST 14	72	23	12.5	44	13.3	1620	116640	.98	21	0.7	8.8	502	80	80
WEST 15	28	133	10.9	38	13.2	8041	225148	.98	99	0.5	55.3	1229	75	80
WEST 16	14	52	13.3	36	16.1	5908	82712	.85	62	0.6	17.3	1452	90	70
WEST 17	131	65	13.8	65	15.5	8164	1069484	.95	76	0.6	40.0	2249	85	70
WEST 18	179	68	11.9	43	13.5	4652	832708	.90	60	0.5	55.3	1590	75	80
WEST 19	55	100	11.3	40	14.1	6848	376640	.96	85	0.7	54.9	2173	85	70
WEST 20	25	39	15.6	46	15.6	4963	124075	.95	55	0.7	31.6	1395	100	50
TOTALS	2855	75	11.8	41	14.2	5659	16155812	.93	63	0.8	37.3	1720	74	71

F. Damaging Agents

Southwestern ponderosa pine can be damaged or destroyed by many agents throughout its life. It is most vulnerable during early life. As the tree reaches maturity, the number of injurious agents decrease, but the damage becomes greater in terms of volume loss. On the Parashant forest, the following agents are most destructive:

a. Weather

Heavy wet snows cause some bending and breakage in young dense stands. The smaller, more spindly trees are damaged by snow, while lightning attacks the larger trees. Isolated trees or trees with their tops higher than the general crown canopy are prime candidates for lightning strikes. Trees, young or old, that have been struck hard enough to split the bole or loosen the bark, seldom survive.

b. Fire

Fire damage occurs mainly in the younger age classes. Older trees are quite resistant, but hot ground or crown fires will destroy entire stands. Heavy ground fuels will produce enough heat to kill standing timber.

c. Livestock

Cattle can be quite damaging to ponderosa pine seedlings and saplings. They rarely pay attention to where they are stepping and can crush or deform a young seedling. A cow with a tick problem will straddle a 4-8 foot sapling to scratch its belly, bending or breaking off the stem.

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d. Disease

Dwarf mistletoe, *Arceuthobium vaginatum* ssp. *cryptopodum*, infects trees of all age classes and may kill trees up to pole size within a few years of infection. Older trees are killed more slowly from the top until all branches are dead. It has a serious impact on pine seed production. Dwarf mistletoe has not yet been detected in the Parashant forest.

e. Insects

The mountain pine beetle, *Dendroctonus ponderosae*, is endemic in any ponderosa pine forest. It normally kills only the old, weakened and decadent trees but, during epidemic conditions, may also kill younger trees. Sanitation cuttings in mature and over-mature stands and thinnings in overpopulated stands will reduce the chances of epidemic.

III. SILVICULTURAL PRACTICES

A. Pre-commercial Thinning

Pre-commercial thinnings are the first entry into the young, managed stand. The thinning is from below, concentrating on the intermediate and suppressed crown classes. The smaller age classes, 10 inches in diameter and below are discriminated against. Spacing is usually 15 feet, even if some of the larger diameter classes are affected. Where a market exists, the thinned trees may be sold for poles or fuelwood. Tables 3 and 4 present the number of trees per acre by 4" diameter classes. The exception is the 10" class which is the lowest limit of merchantability. East 7, with 192 stems/acre below 10" in diameter, is the only area that is in need of a pre-commercial thinning.

Table 3									
Stems/acre by DBH Class (East)									
Area	.1-4.9	5-8.9	9-11.9	12-15.9	16-19.9	20-23.9	24-27.9	28-31.9	32+
1	8	16	8	23	8	2			1
2	15	34	17	15	20	3			1
3	8	18	5	2					2

4		11	13	42	29	11	2		
5		3	5	16	11	6			
6	4	52	43	66	12	3	1		
7	63	129	42	18	13			3	
8	7	31	22	22	6			3	
9	3	13	14	11	3			6	
10	22	61	36	69	13	2	1		
11	4	13	5	8	1				
12	16	65	35	28	15	2	2	1	
13	12	41	15	10	12	12	5		
14	25	43	11	15	5	4			1
15	3	2	5	12	10	3			
16	4	2	2	14	6	1	1		1
17	2	5	10	18	15	5			
18	28	38	22	58	13	2			
19	18	40	17	25	8	2			
20	5	17	12	33	12	3			
21	25	21	9	25	10	6	1		

Table 4									
Stems/acre by DBH Class (West)									
Area	.1-4.9	5-8.9	9-11.9	12-15.9	16-19.9	20-23.9	24-27.9	28-31.9	32+
1	3	1	1	2	1			1	5
2		1	1	3	1				
3			1	2					
4	15	19	8	26	16	3	4		1

5	1	5	5	9	5	1			1
6	19	13	14	19	3		1		1
7	3	2			3				
8	23	44	16	33	15	1			1
9	3	3	2	7	2				
10	4	12	3	5	2				
11	12	25	15	24	21	13		1	
12	2	8	6	29	18				
13		3	10	25	8	2			
14	1	2	5	10	3	1	1		
15	6	41	25	39	16	5			
16		18	10	12		2	10		
17	5	6	6	18	21	8	1		
18	6	8	12	28	11	2	1		
19	10	24	19	23	13	11			
20			5	16	8	6	4		

B. Commercial Thinning

Commercial thinnings also concentrate on the intermediate and suppressed crown classes, however the cutting is in diameter classes $>10"$ and the thinned trees can be sold for sawlogs. The number of entries into the stand will be dependant upon site quality. All genetically inferior trees (including old growth) will be removed. Each thinning will be designed to provide the remaining trees with sufficient space to realize their maximum growth potential.

In stands designed for uneven-aged management, all age classes are represented. In southwest ponderosa pine, even-aged stands are a serial stage while uneven-aged stands are at climax. Managing at the climax stage is much simpler and involves less risk. The poorer sites are well managed in this manner. The number of commercial entries are dependant on site quality. All age classes will be cut to densities determined by prior

management decisions. Regeneration will be passive.

A commercial timber stand improvement contract will contain many stipulations designed to protect the area. The purchaser must conform to an approved plan. The Area Manager may, at any time, suspend operations for violations of the contract or the approved plan. For major violations the Area Manager may attach the purchaser's performance bond.

The area may be treated by horse, bulldozer, rubber-tired skidders, or mobile yarder-loaders. Operations will be restricted to slopes of less than 40%. Some spur roads will be required to facilitate the removal operations. Since most of the area has previously been exposed to some degree of harvesting, many spur roads still exist. Pioneering of new spur roads will be kept to a minimum while old, existing spur roads will be re-activated. Upon completion of operations, all non-essential roads will be ripped, water-barred and seeded to grass.

C. Sanitation Cutting

A sanitation cut is the thinning or removal of unwanted tree species that are in competition with the ponderosa pine. Pinyon and juniper are the on-site competitors on the Parashant forest. Poor logging practices in the past have severely curtailed ponderosa pine regeneration and growth while benefiting other species such as pinyon and juniper. Concentrating woodland product sales in these areas would greatly assist nature in recovering from the scars of past mistakes.



D. Salvage Cutting

A salvage cut is the removal of dead or dying ponderosa pine. It is imperative that any substantial areas of sudden mortality due to fire, drought, etc. be quickly removed in order to prevent build-ups of bark beetles in the residual stands. Dead blackjack pine decay quite rapidly and anyone working under or near these snags is in danger from falling tops or branches (widow-makers). It would, therefore, be prudent to retain only the larger snags for the cavity-nesters, raptors, et al.

E. Regeneration

In order to provide good natural regeneration, ponderosa pine requires:

1. A large supply of seed
2. On a well prepared seed bed
3. Free of competing vegetation
4. A low population of seed eating pests
5. Sufficient moisture for early seed germination (June rains)
6. A stand basal area between 14 and 50 square feet per acre
7. Protection from browsing animals

The difficulty in the southwest has been to get these requirements to coincide. Adequate June rains in this area are not common. Good cone crops occur on the average of every four years. A sound management plan can provide for all but the fifth requirement.

Artificial regeneration would require:

1. On site cone collection
2. Shipment to a forest nursery
3. Two years in the nursery for containerized or bare root stock
4. Reshipment and storage

5. Site preparation (scalping)
6. Planting
7. Construction of a fence to protect the area from browsing animals

Bureau policy dictates that an area have adequate regeneration (minimum of 400 stems per acre) within five years following harvesting. With proper site preparation and protection, an area should regenerate within the time limit. Lush stands of second growth in West 8 are a result of past logging operations and are indications of what can be expected through intensive management. The 1950 BLM timber sale in East Parashant is an indication of what can be expected through improper management. Artificial regeneration is too expensive to be considered except as a last resort.

An understory of *Artemesia tridentata* provides a very good natural seed bed for ponderosa pine reproduction. The soil at the base of the plant is loose and more moist than the interspaces and needed shade is provided during the critical first years.

F. Prescribed Burning

Once an understory has been established, prescribed burning is a recognized effective forest management tool to reduce potentially high intensity fires. When fire is totally excluded from an area, debris of all types will accumulate. If allowed to continue, this situation can be most detrimental should a project fire develop.

Through evolution, ponderosa pine was assured preservation by developing a resistance to fire. Periodic lightening caused fires occurring in the past, prior to total exclusion as we know it today, maintained low fuel levels. Thus, when fires occurred during extreme conditions, the results were not as significant as would be the situation now due to current build-ups. The stagnated condition in many of the stands would not have developed had nature's selection method been allowed to proceed. Stands would have been thinned and fire would have pruned dead branches from these trees while they were still in the pole or sapling stage.

Recognizing the natural build-up of slash, a prescribed burning schedule should be established. Treatment should be on a systematic basis, both from the standpoint of the area treated and the periodic recurrence of the treatment. Recurring treatments on any one area should be conducted at six to ten year intervals. Natural barriers such as roads, trails, ridges, etc. should be used in establishing burning units. In situations where natural

barriers are lacking, artificial barriers may be constructed.

The benefits derived from a prescribed burning program can be seen in the reduction of fuels, lessening the potential for wildfires, grass species would increase due to the diminished solid needle cover and wildlife would benefit from the succulent growth of rejuvenated browse species. Once the fire hazard has been reduced, modified fire suppression tactics should be used on lightning caused fires in lieu of prescribed burning. Under favorable conditions, natural fires would be allowed to burn to natural or artificial barriers.

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Table 5							
History of Past Treatments (East)							
Area	Date Inv.	Section	Elev.	Aspect	Past treatmt	Date	Acres
1	10/78	22	6140	SE			
2	10/78	22	6140	West			
3	11/78	22	6190	West			
4	9/78	23	6140	SE			
5	9/78	23	6200	West	Logged	11/50	All
6	5/89	23	6180	West	Logged	11/50	All
7	5/79	23	6160	West			
8	5/79	23	6180	West	Logged	11/50	All
9	5/79	23	6160	East	Logged	11/50	All
10	5/79	14	6150	East	Logged	11/50	All
11	5/79	14	6150	East	Logged	11/50	All
12	5/79	14	6140	North	Logged	10/50	All
13	10/78	11	6000	North			
14	5/79	2	5900	North			
15	8/89	13	6240	East	Exch. burned	1980	All
16	8/89	24	6200	West	Exch. burned	1980	All
17	8/89	24	6200	SE	Exch. burned	1980	All
18	9/89	24	6160	West	Exch.	1988	All
19	9/89	25	6200	North	Exch.	1988	All
20	6/90	25	6180	West	Exch.	1988	All
21	6/90	26	6200	East	Exch.	1988	All

Table 6							
History of Past Treatments (West)							
Area	Date Inv.	Section	Elev.	Aspect	Past. Treatmt	Date	Acres
1	8/78	5	5900	NW			
2	8/78	18	5960	NE			
3	8/78	20	5920	NE			
4	8/78	20	5920	NE			
5	8/78	20	5960	NW			
6	1/81	30	6000	NW			
7	7/78	32	5960	SE			
8	8/78	32	5960	North	Logged	5/55	All
9	8/78	32	5960	NE	Logged	5/55	All
10	7/78	32	5960	SE	Logged	5/55	All
11	9/78	32	5980	West	Logged	5/55	All
12	9/88	20	5900	NW	Exch. burned	1980	All
13	9/88	20	5900	North	Exch. burned	1980	All
14	9/88	28	5900	West	Exch. burned	1980	All
15	9/88	28	5920	NW			
16	11/88	30	6000	East	Burned	1965	All
17	11/88	30	5900	NW			
18	3/89	33	5940	West	Exch. burned	1980	All
19	7/89	5	5960	South	Exch.	1988	All
20	7/89	5	6000	SW	Exch. burned	1980	All

SUMMARY

The Arizona Strip Resource Management Plan challenges us to maintain a healthy, viable and biologically diverse forest ecosystem for the enhancement of all resource values. A forest management plan is called for. This Parashant Timber Management Plan will become a part of the overall forest management plan to be included with the HMP, AMP, CRMP, etc..

The even-aged, young mature stands in the Parashant Forest are in their final serial stage slowly proceeding to the uneven-aged climax stage. Variations in soils, aspect, slope, moisture availability and the hand of man have given a heterogeneous, bio-diverse character to the forest.

The health and vigor of many of the stands is in decline. As we look to the future we must face the results of decades of well-intentioned mismanagement. Throughout the West, the last decade has been dry. In many of these Parashant stands, two to ten trees are growing where only one can thrive. When far too many trees are competing with each other for moisture and nutrients, we are entering a crisis situation. Moisture stressed trees become easy prey to the insects and diseases that are endemic in any stand. With an increase in mortality added to the already high fuel loadings, the forest is a powder keg ready to explode if dry weather, high winds and ignition coincide. The question is not whether these stands will explode, but when. All members of the biological community of this planet must function within specific parameters set by natural laws. Any attempt to extend beyond these parameters could be very harsh and devastating.

In most stands, the future forest is in place if we can retain the existing canopy. We must thin and treat the canopy so the trees can get the moisture and nutrients needed to regain their health. This is critical if the forest plan foresees an "old growth" management strategy. The emergence of an old growth system is dependant on having a far lower tree population. We have an 80-year start if we can just protect these trees from an epidemic or wildfire. The long term element is thinning and improving the forest so it is more drought and damage resistant into the next century.

APPENDIX

Parashant Operations Inventory 1980-82

The Parashant operations inventory was similar to SVIM in that homogeneous areas within the forest were selected to reduce variability. The small size of the forest and inadequate funding ruled out the standard five or ten-point inventory methods suggested by the BLM manual. Instead, a 1/5 acre, fixed radius plot method was used resulting in a 1-2 percent sample.

Field measurements included DBH in 2" classes, merchantable height, total height, ten-year radial and one-year height increments, site index and an estimate of defect. Programs were devised on the TI-59 programmable calculator for the following formulae:

Merchantable Volume-Schribner Decimal C Log Rule

$$V = (.79 \times D^2) - (2 \times D) - 4$$

Where:

V = 16' log volume

D = Scaling diameter

Merchantable top diameter was set at 5" or 40 percent of the scaling diameter of the first 16' log, whichever was greater.

The taper of the tree above the first log was established through the determination of the diameter of each log above the butt log (the diameter of the butt log having been determined by multiplying the form class by the DBHob) through the use of the formula:

$$D = \frac{L}{.9L + 1.1} + 0.5$$

In this formula, D is a decimal fraction representing the ratio of the scaling diameter at any point on the tree to the scaling diameter of the first log, e.g., if the scaling diameter of the first log is 40" and the scaling diameter of the third log is 30" divided by 40" or 75%. The value L is the ratio of the number of logs (or lineal distance) between the top of the butt log and the merchantable top, e.g., in a 5 log tree the L for the third log would be .5 since there are 2 logs above it's scaling diameter (to the merch top) and 2 logs below (to the top of the butt log).

$$Basal\ Area = \Pi \times R^2$$

and

$$Cubic\ Volume = (\pi \times R^2) \times .5L$$