

**LONG-TERM VEGETATION TREND MONITORING
AT CRATERS OF THE MOON NATIONAL MONUMENT
YEAR 2000 REPORT**

Sue J. Majors

September 2000



Environmental Science and Research Foundation, Inc.
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TRANSECTS #3 (DOUGLAS FIR, GRASSY CONE), AND
#4 (CINDER GARDEN, DEVIL'S ORCHARD)

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LONG-TERM VEGETATION TREND MONITORING at Craters of the Moon National Monument Year 2000 Report

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Environmental Science and Research Foundation, Inc.

SUMMARY

Two long-term vegetation trend monitoring transects were read in June of 2000. The transects were: #3 (Douglas fir, Grassy cone), and #4 (Cinder garden, Devil's orchard). Significant changes in species composition occurred along each transect. Perennial forb species were more numerous in this survey than in previous ones. Despite these changes, the dominant species along each transect remained unchanged. Transect #3, Douglas fir (*Pseudotsuga menziesii* [PSME]¹) densities and trunk diameters increased, while limber pine (*Pinus flexilis* [PIFL]) densities decreased, and trunk diameters increased from previous surveys. Transect #4, limber pine densities increased, while trunk diameters slightly decreased from previous surveys. However, additional surveys are needed before any strong conclusions can be made about long-term trends in species composition or stand densities.

INTRODUCTION

The Long-term Vegetation Trend Monitoring Program, established in 1991 by Gerry Wright and Steve Bunting of the University of Idaho, Moscow, was developed as the vegetative component of the Craters of the Moon National Monument's (CMNM) Inventory and Monitoring (I & M) program. The frequency data obtained in this program over the years should provide managers with information regarding species composition and density and indicate any changes or trends that may be occurring in the selected vegetation types. The history of previous vegetation studies completed at CMNM can

be found in the report prepared by Sparhawk (1992).

METHODS

Eight permanent vegetation monitoring sites exist at CMNM. Each 100-meter transect is marked at each end by an orange and yellow metal fence post. Two of the eight sites are monitored each year on a rotating basis, resulting in each site being monitored every four years (Appendix 1). A complete description of the methods is reported by Sparhawk (1992).

In 1993, the Long-term Vegetation Trends Monitoring Study continued with the first

¹ Four letter codes follow standardized format of combining the first two letters of the genus and species as found in "Intermountain Range Plant Names and Symbols" USDA Forest Service General Technical Report INT-38.

scheduled reading of transect #3 (Douglas Fir, Grassy Cone). The 2000 survey was the third reading for this site. This survey was the second rotation for transect #4 (Cinder Garden, Devil's Orchard), five years after the initial reading. The location of the two transects are shown in Figure 1. The year 2000 survey was performed by M. Winter, and K. Holte, Environmental Science and Research Foundation Inc., and B. Colket, Craters of the Moon National Monument.

GRASSES, FORBS and WOODY SPECIES:

A 100-m tape measure was stretched between the posts at each end of the transect line and a 50 cm X 50 cm (0.25 m²) nested frequency frame was placed to the right of each meter mark on the tape, resulting in 100 readings (Sparhawk 1992). The frequency frame consisted of four nested frames of varying sizes, 10 cm X 10 cm, 25 cm X 25 cm, 25 cm X 50 cm and 50 cm X 50 cm (Figure 2). Every plant species (grasses, forbs and woody species) rooted in the area enclosed by the frame was assigned a number (1-4), corresponding to the nested frames in which the species first appeared. For example if a species was first observed in the 25 cm X 25 cm area it would be given a two; if it first occurred in the 50 cm X 50 cm area it would score a four (Sparhawk 1992).

TREES:

When trees occurred in the transect, the trees were identified by species, counted and diameter at breast height (dbh) measurements were taken 1.4 meters from

the base on the uphill side using a dbh tape for all live trees. In Douglas fir stands, data on every tree within 5 meters of either side of the transect line (resulting in a 10-meter wide transect) were collected. In limber pine stands, trees within 10 meters of the transect line (resulting in a 20-meter wide transect) were counted (Sparhawk 1992).

REFERENCE PHOTOGRAPHS:

A 1.5 meter pole marked in alternating black and white decimeter bands was placed one meter from the transect pole. A sign indicating the transect location, date and time was placed on the post and a photograph taken with a 50 mm lens on a 35 mm camera, using ASA 64 slide film (Sparhawk 1992).

DATA ANALYSIS:

Analysis consisted of calculating the sum frequency for each species or group of species. This was done by counting the number of times that a species occurred in one of the four nested frequency areas. Because there were 100 plots, this number represents a percentage of plots in which this species occurred (Sparhawk 1992).

Sum frequency values were used to compare similar readings from past surveys. Because values followed a binomial distribution it was possible to calculate a confidence interval for each value. Significant differences were determined by comparing confidence intervals. If two values had confidence intervals that did not overlap, they were considered significantly different (Sparhawk 1992). A modified 95%

confidence interval table for frequency values observed for 100 plots (Snedecor 1956) was used to determine significant differences. In addition, chi-square analysis was used to determine if significant changes in overall species composition had occurred between surveys (Ludwig and Reynolds 1988).

Saplings (<2 inches dbh) and dead trees were used in determining the total number of trees per hectare but were withheld from the mean diameter at breast height (dbh) and basal areas.

RESULTS

TRANSECT #3 - DOUGLAS FIR, GRASSY CONE

In the year 2000, this transect contained 26 species, including three grass species, 19 forb species and four woody species (Table 1). Six forb species were recorded that had not been found in previous surveys. Nine forb and four woody species recorded in other surveys were not found in 2000.

Perennial grasses and perennial forbs had the highest sum frequency along the transect (Table 2). Bluebunch wheatgrass (*Agropyron spicatum* [AGSP]) was the most abundant grass species. The dominant forb was the perennial tapertip hawksbeard (*Crepis acuminata* [CRAC]). Douglas fir (*Pseudotsuga menziesii* [PSME]) was the most frequently encountered woody species.

Chi-square analysis indicated significant ($P = 0.10$) changes in species composition had occurred since this transect was last

read. Sum frequency values also indicated differences between years. Significant changes were observed in six species found in transect #3 between the 1993, 1997, and 2000 surveys (Table 3). Bluebunch wheatgrass, pinegrass (*Calamagrostis rubescens* [CARU]), bluegrass species (*Poa* spp. [POA]), and Douglas fir (*Pseudotsuga menziesii* [PSME]) all increased significantly in frequency. Slenderleaf colomia (*Collomia linearis* [COLI]), and blue-eyed Mary (*Collinsia parviflora* [COPA2]) both significantly decreased ($P = 0.10$) in frequency from 1993 to 2000.

Douglas fir and limber pine (*Pinus flexilis* [PIFL]) were the only two tree species found in the transect, with Douglas fir being the more numerous (Table 4).

Tree densities and basal areas increased over the past seven years for Douglas fir (Table 5). Limber pine densities decreased while basal areas increased since the last survey was conducted. Mean tree diameters increased from 1993 to 2000 for both Douglas fir and limber pine (Table 5).

TRANSECT #4 - CINDER GARDEN, DEVIL'S ORCHARD

Seventeen species were recorded along this transect in the year 2000: three grass species, 10 forb species and four woody species (Table 1). This was a decrease of three forb and one shrub species compared to 1995 records (Table 6). No grass species were recorded during the previous survey.

Perennial grasses and annual forbs had the highest sum frequencies along the transect (Table 6). Stipa species (*Stipa* spp.

[STIPA]) were the most frequent grasses. The annual dwarf monkeyflower (*Mimulus nanus* [MINA]) was the most frequent forb. Based on sum frequency values antelope bitterbrush (*Purshia tridentata* [PUTR]) was the most abundant woody species.

Chi-square analysis indicated species composition differed significantly ($P = 0.01$) between the 1995 and 2000 surveys. Two species significantly increased in frequency between the 1995 and 2000 surveys (Table 7). One was the perennial grass stipa, and the other was the annual forb Torrey's cryptantha (*Cryptantha torreyana* [CRTO]). The annual forb Borage (*borage spp.* [BORA]) and the perennial forb scorpion weed (*Phacelia hastata* [PHHA]) both declined significantly between surveys. The only tree species present in the transect was limber pine.

There was approximately a 75% increase in the number of limber pines/hectare between the 1996 and 2000 surveys (Table 8). The mean trunk diameter decreased slightly but the basal area increased.

DISCUSSION

TRANSECT #3 - DOUGLAS FIR, GRASSY CONE

The significant sum frequency changes observed did not represent a change in the dominant vegetation. Over the past six years, the dominant understory species have been bluebunch wheatgrass, blue-eyed Mary, tapertip hawksbeard, and mountain snowberry. The abundant overstory species continues to be Douglas fir.

Douglas fir continued to be the most abundant tree species and increased in abundance by nearly 800%. This increase in abundance was the appearance of 180 saplings (<2 inches in diameter) while only two trees were found dead. The mean dbh also increased suggesting a healthy stand of Douglas fir. Although Douglas fir has thrived over the past seven years, limber pine abundance has declined with increases in mean dbh and basal area. The decline in abundance of limber pine could be the result of sampling error, since no mention was made of dead limber pine trees in previous surveys. It is possible that trees along the edge of the transect lines, counted in the first survey, may have been omitted in subsequent surveys.

Overall, the understory vegetation community appears stable. Although, a species shift was observed among the less common species, dominant species from previous years were still dominant.

TRANSECT #4 - CINDER CONE, DEVIL'S ORCHARD

The vegetation composition along transect #4 has changed since 1995. Most of the significant changes observed were due to perennial grass species. Cummings (1995) reported that during the 1995 survey a *Poa* spp. was most abundant with a 54% frequency, but in 2000 *Stipa* spp. was the most common grass species. Since both species are perennial it is assumed that there was either some identification error or that there was a disturbance that changed the grass composition. The forb composition appears to be changing from annuals to

perennials becoming most dominant. The relative abundance of perennials has more than doubled while the abundance of annuals has declined by 21%.

Limber pine densities increased by 75% since 1996. Mean dbh decreased slightly while basal area increased by 39%. Although an increase in density coinciding with a decrease in dbh suggests healthy regeneration, >61% of the trees were found to contain the parasite mistletoe (*Arceuthobium spp.*).

RECOMMENDATIONS

Species compositions differed between surveys at a given site, making it difficult to determine trend changes. One possible way to monitor trend is to group the vegetation into four categories representing life form, i.e. perennial and annual grasses, perennial and annual forbs, shrubs, and trees. The sum frequency values from this grouping could be used to compare trend changes since it would not be as strongly influenced by changes in species composition within a given group. For example, if the frequency of perennial grasses significantly decreased over time and annual forbs increased, than an obvious change has occurred. The combination of using both the life form grouping and the traditional species composition would allow more flexibility in observing vegetation changes over time. We recommend that this be incorporated into the methods section for future surveys on all transects.

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Table 1. Year 2000 Species List for Vegetation Trends Monitoring Transects # 3 (Douglas Fir, Grassy Cone), and #4 (Cinder Garden, Devil's Orchard), at Craters of the Moon National Monument, Arco, Idaho.

Species Code	Scientific name	Common Name	Transect #3	Transect #4
GRASSES				
AGSP ¹	<i>Agropyron spicatum</i>	bluebunch wheatgrass	X	X
CARU ¹	<i>Calamagrostis rubescens</i>	pinegrass	X	
POA ¹	<i>Poa</i> spp.	bluegrass species	X	
STCO3 ¹	<i>Stipa comata</i>	needle and thread grass		X ⁴
STIPA ¹	<i>Stipa</i> spp.	Stipa species		X ⁴
FORBS				
AGGL ¹	<i>Agoseris glauca</i>	pale agoseris	X	
ANMI ¹	<i>Antennaria microphylla</i>	rosy pussytoes	X	
ARNICA ¹	<i>Arnica</i> species	arnica species	X	
ASCA ¹	<i>Astragalus canadensis</i>	Canada milkvetch		
BASA ¹	<i>Balsamorhiza sagittata</i>	arrowleaf balsamroot	X	
BORA ²	<i>Borage</i> spp.	borage species		X
CHDO ¹	<i>Chaenactis douglasii</i>	Douglas chaenactis		X
COPA2 ²	<i>Collinsia parviflora</i>	blue-eyed Mary	X	
COLI ²	<i>Collomia linearis</i>	slenderleaf collomia	X	
CRAC ¹	<i>Crepis acuminata</i>	tapertip hawksbeard	X	
CRTO ²	<i>Cryptantha torreyana</i>	Torrey's cryptantha	X	X
EPILO ¹	<i>Epilobium</i> spp.	Epilobium species		
EROV ¹	<i>Eriogonum ovalifolium</i>	dwarf buckwheat		X
ERUM ¹	<i>Eriogonum umbellatum</i>	sulfur buckwheat		X
FORB ¹	Unknown forb spp.	Unknown forb species	X	
FRAT ¹	<i>Fritillaria atropurpurea</i>	leopard-lily	X	
GAster ¹	<i>Gaster</i> spp.	Gaster species	X ⁴	
LIPA ¹	<i>Lithosperma parviflora</i>	woodland star	X ⁴	
LIRU ¹	<i>Lithosperma ruderales</i>	wayside gromwell	X ⁴	
LOMAT ¹	<i>Lomatium</i> spp.	lomatium species	X	
MINA ²	<i>Mimulus nanus</i>	dwarf monkeyflower		X
MISU ²	<i>Mimulus sukdorfii</i>	monkeyflower		X ⁴
PHHA ¹	<i>Phacelia hastata</i>	scorpion weed		X
PHHE ¹	<i>Phacelia heterophylla</i>	varileaf phacelia		X
PHLO ¹	<i>Phlox longifolia</i>	longleaf phlox	X ⁴	
PORTU ¹	<i>Portulaca</i> spp.	Portulaca species		X ⁴
POGL ¹	<i>Potentilla glandulosa</i>	gland cinquefoil	X ⁴	

TABLE 1 CONT.

Species Code	Scientific name	Common Name	Transect #3	Transect #4
RAGL ¹	<i>Ranunculus glaberrimus</i>	sagebrush buttercup	X ⁴	
SECA ¹	<i>Senecio canus</i>	woolly groundsel	X	
VINU ¹	<i>Viola nuttallii</i>	Nuttall violet	X	
WOODY SPECIES				
CHNA ¹	<i>Chrysothamnus nauseosus</i>	rubber rabbitbrush		X
LEPU ¹	<i>Leptodactylon pungens</i>	prickly phlox		X
PUTR ¹	<i>Purshia tridentata</i>	antelope bitterbrush		X
PRVI ¹	<i>Prunus virginiana</i>	chokecherry	X	
PSME ¹	<i>Pseudotsuga menziesii</i>	Douglas fir	X	
RIBES ¹	<i>Ribes spp.</i>	currant species		X
ROWO ¹	<i>Rosa woodsii</i>	Wood's rose	X	
SYOR ¹	<i>Symphoricarpos oreophilus</i>	mountain snowberry	X	

1 Indicates perennial species

2 Indicates an annual species.

3 Indicates a non-native species.

4 Indicates first time species has been recorded in survey.

Table 2. Year 2000 Plant Species Frequency Data for 100 Plots in the Vegetation Monitoring Transect # 3 (Douglas Fir, Grassy Cone) at Craters of the Moon National Monument, Arco, Idaho.

Species	10X10 cm	25X25 cm	25X50 cm	50X50 cm	SUM
GRASSES					
AGSP	39	19	11	5	74
CARU	3	4	2	2	11
POA	1	4	0	1	6
PERENNIAL GRASS	43	27	13	8	91
ANNUAL GRASS	0	0	0	0	0
FORBS					
CRAC	4	8	10	11	33
COPA	1	6	4	9	20
CRTO	6	1	7	5	19
VINU	2	2	6	9	19
RAGL	3	2	3	3	11
SECA	0	2	3	8	8
BASA	1	1	0	5	7
PHLO	0	2	4	0	6
FORB	0	1	2	1	4
AGGL	2	1	0	0	3
FRAT	0	0	1	2	3
POGL	1	1	0	0	2
ANMI	0	1	0	0	1
ARNICA	0	0	0	1	1
COLI	0	1	0	0	1
GAster	0	0	0	1	1
LIPA	0	0	1	0	1
LIRU	0	0	0	1	1
LOMA	0	0	1	0	1
MOSS	0	0	0	1	1
PERENNIAL FORB	13	20	29	36	98
ANNUAL FORB	7	8	11	14	40
WOODY SPECIES					
PSME	16	14	15	9	54
SYOR	8	6	13	10	37
PRVI	1	2	3	6	12
WOODY SPECIES	25	22	31	25	103

Table 3. Comparative Sum Frequencies for All Species Found during Years 1993, 1997, and 2000 on the Vegetation Monitoring Program's Transect #3 (Douglas Fir, Grassy Cone) Craters of the Moon National Monument, Arco, Idaho.

GRASSES	1993	1997	2000
AGSP	22	35 ¹	74 ¹
CARU	1	0	11 ¹
POA	0	1	6 ¹
PERENNIAL GRASS	23	36	91
ANNUAL GRASS	0	0	0
FORBS			
AGGL	0	0	3
AGRE	0	2	0
ANMI	2	2	1
AMAL	2	0	0
ARNICA	0	0	1
BASA	12	7	7
COLI	4	13 ¹	1 ¹
COPA2	30	35	20 ¹
CRAC	25	29	33
CRTO/CRYPTAN ²	19	19	19
EROV	0	1	0
FRAT	1	0	3
GAster	0	0	1
HEUN	3	0	0
LIPA	0	0	1
LIRU	0	0	1
LOMA/LOMAT	7	1 ¹	1
MOSS	0	0	1
MUSTARD	0	2	0
NIAT	8	0 ¹	0
ORNE	3	0	0
POGL/POAR/POTEN ²	4	3	2
PHHA	0	1	0
PHLO	0	0	6 ¹
RAGL	0	0	11 ¹
SECA	1	8 ¹	8
SOLID	3	0	0
VINU/VIOLA ²	8	11	19
PERENNIAL FORB	63	65	98
ANNUAL FORB	63	69	40
WOODY SPECIES			
AMAL	3	0	0
CHVI	0	1	0
PIFL	0	1	0
PRVI	4	6	12
PSME	16	11	54 ¹
RIBES	1	1	0
SYOR	31	40	37
WOODY SPECIES	55	60	103

¹ Indicates significant change from the previous monitoring period using the 95% Confidence Intervals frequency observed for 100 plots (Snedecor 1956).

² Indicates two species that may have been confused for one another during different surveys.

Table 4. Tree Density, Mean Diameter and Basal Area for Tree Species Found in the 10 m x 100 m (Douglas Fir) and the 5m X 100m (Limber pine) Transect for Transect #3 (Douglas Fir, Grassy Cone) in the Year 2000 Long-term Vegetation Monitoring Program at Craters of the Moon National Monument, Arco, Idaho.

Species	#trees/hectare	Mean $\pm$ SD dia.	Basal area
Douglas Fir	4,940	7.87 $\pm$ 5.29 cm	259.89 m ² /hectare
Limber pine	50	11.2 $\pm$ 4.98 cm	8.53 m ² /hectare

Table 5. Comparative Results of Tree Density, Mean Diameter at Breast Height (dbh) and Basal Area Trees Found in the 5m X100m Transect for Transect #3 (Douglas Fir, Grassy Cone) in 1993, and 2000 at Craters of the Moon National Monument, Arco, Idaho.

Douglas Fir	1993	2000
trees/hectare	620	4,940
Mean dbh (in)	2.6	7.87
Basal area (m ² /hectare)	13.64	259.89
Limber pine		
trees/hectare	70	50
Mean dbh (in)	3.6	11.2
Basal area (m ² /hectare)	2.97	8.53

Table 6. Year 2000 Plant Species Frequency Data for 100 Plots in the Vegetation Monitoring Program's Transect # 4 (Cinder Garden, Devil's Orchard) Craters of the Moon National Monument, Arco, Idaho.

Species	10X10 cm	25X25 cm	25X50 cm	50X50 cm	SUM
GRASSES					
STIPA	12	18	16	16	62
STOC	0	2	0	0	2
AGSP	0	1	0	0	1
POA	0	0	0	1	1
U.K. GRASS	0	0	1	4	5
PERENNIAL GRASS	12	21	17	21	71
ANNUAL GRASS	0	0	0	0	0
FORBS					
MINA	50	12	11	5	78
CRTO	21	17	19	10	67
EPILOBIUM	15	14	12	16	57
PORT	13	8	3	3	27
EROV	2	2	2	5	11
PHHE	1	4	0	6	11
PORTULACA	2	2	2	5	11
MISU	3	2	1	2	8
PHHA	0	4	2	1	7
BORAGE	1	2	1	2	6
CHDO	1	1	0	1	3
ERUM	0	1	1	0	2
MINA	0	1	0	0	1
FORB	0	1	0	0	1
PERENNIAL FORB	18	23	17	23	81
ANNUAL FORB	75	35	31	23	163
WOODY SPECIES					
PUTR	6	5	6	10	27
CHNA	1	3	5	2	11
LEPU	4	2	2	2	10
PIFL	0	0	0	2	2
WOODY SPECIES	11	10	13	16	50

Table 7. Comparative Sum Frequencies for All Species Found during Years 1995 and 2000 on the Vegetation Monitoring Program's Transect # 4 (Cinder Garden, Devil's Garden) Craters of the Moon National Monument, Arco, Idaho.

GRASSES	1995	2000
AGSP	0	1
POA	0	1
STIPA	0	62 ¹
STOC	0	2
PERENNIAL GRASS	0	70
ANNUAL GRASS	0	0
FORBS		
ASCA	7 ¹	0
BORA/BORAGE ²	48	6 ¹
CHDO	1	3
CRT0	3	67 ¹
EPILOBIUM	0	57 ¹
EROV	14	11
ERUM	0	2
GAYO	53	0 ¹
MIGU	43	0 ¹
MINA	69	78
MINA	0	1
MISU	0	8 ¹
PHHA	18	7 ¹
PHHE	0	11 ¹
PORTULACA	0	11 ¹
PORT	0	27 ¹
FORB (UNKNOWN)	13	1 ¹
PERENNIAL FORB	40	81
ANNUAL FORB	216	170
WOODY SPECIES		
CHNA	16	11
LEPU	0	10
PIFL	0	2
PUTR	16	27 ¹
TECA	6	0 ¹
WOODY SPECIES	38	50

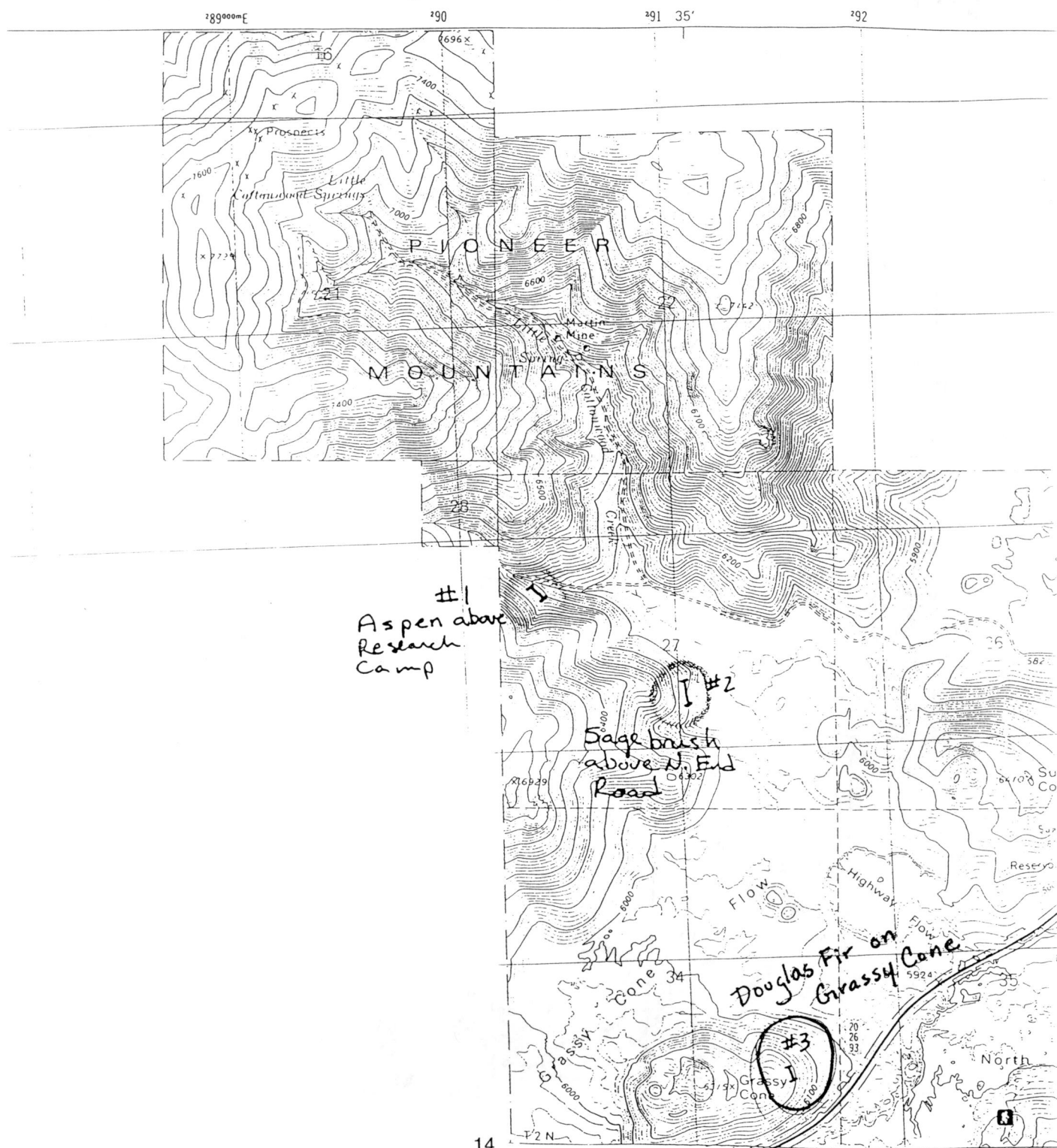
¹ Indicates significant change from the previous monitoring period using the 95% Confidence Intervals for frequency observed for 100 plots.

² Indicates two species that may have been confused for one another during different surveys.

Table 8. Comparative Results of Tree Density, Mean Diameter at Breast Height (dbh) and Basal Area of Trees Found in the 10m X 100m Transect for Transect #4 (Cinder Garden, Devil's Orchard) of the Vegetation Monitoring Program for 1996, and 2000 at Craters of the Moon National Monument, Arco, Idaho.

Limber pine	1996	2000
trees/hectare	120	210
Mean dbh (in)	9.79	9.06
Basal area (m ² /hectare)	29.85	41.43

Map Locations of The Craters of The Moon National Monument's Long-term Vegetation Monitoring Transects #3, and #4.



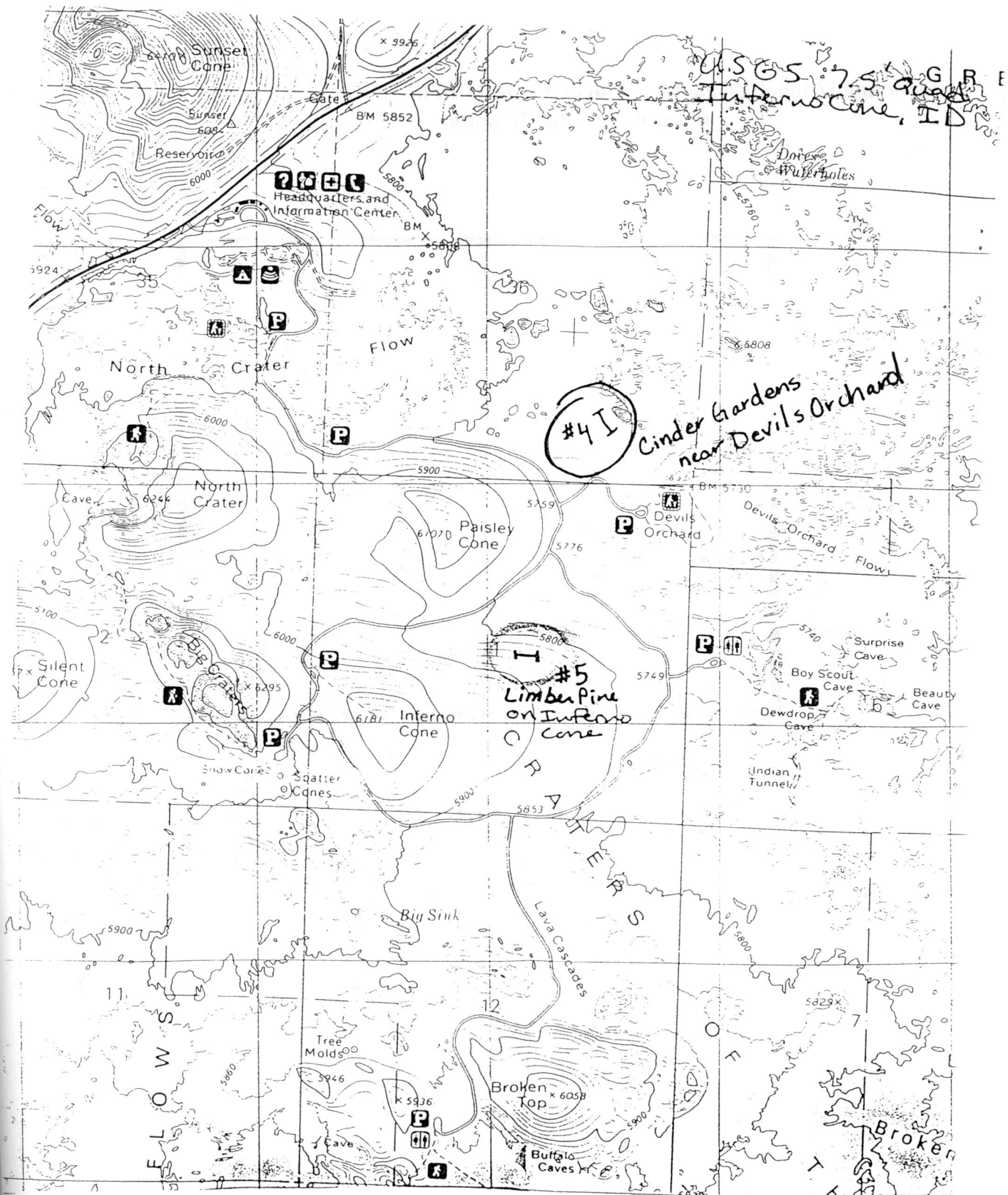


Figure 2.

Illustration of Frequency Frame Used in The Craters of The Moon National Monument's Long-term Vegetation Monitoring Program

