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WESTERN SPRUCE BUDWORM SUPPRESSION AND EVALUATION PROJECT USING CARBARYL

1980

Progress Report No. 4

by

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ABSTRACT

In 1977, carbaryl was aerially applied to a building western spruce budworm, Choristoneura occidentalis Free., outbreak in an isolated mountain range in New Mexico. Sampling results for 1980 show that, although budworm densities increased slightly in the treated area, population levels continued to remain low for the third year following treatment. In a comparable check area, larval densities continued to increase and were significantly higher than densities in the treated area. The average density of egg masses per meter square of foliage indicates that larval densities will increase in both the treated and untreated areas in 1980.

Since 1980 data show that budworm populations are beginning to increase in the treated area, egg mass densities and defoliation will be sampled again in 1981 in order to determine the level of increase.

I. INTRODUCTION

In 1977, a suppression project was conducted to evaluate the prolonged effects of an insecticide treatment on a building western spruce budworm, Choristoneura occidentalis Free., outbreak to determine if a "population reduction strategy" was a viable alternative. Sevin® 4 oil was aerially applied to 37,450 acres of forested land in an isolated mountain range on the Santa Fe National Forest and the Jemez Pueblo Indian Reservation. The objectives of the project were to: (1) suppress the budworm population to such a low level that mating becomes less likely, parasites and predators become more significant in regulating the population, and density-independent factors, such as weather, keep the budworm population below an economically damaging level; (2) evaluate the effectiveness of suppression for a 2-year period in the treated area and a comparable untreated check area (37,398 acres); and (3) evaluate and compare annual defoliation and tree damages in the treated and untreated areas.

The application phase of the project was successfully completed in 1977 (Parker et al. 1978).[1/] Criteria established to show treatment success were: (1) reducing the budworm larval density by an average of 90 percent and (2) obtaining an egg mass density of less than 1.5 new egg masses per meter square of foliage. The 1976-77 budworm generation was reduced by an average of 93.1 percent, compared with a 44.5 percent reduction in the untreated area. The adjusted budworm mortality, using Abbott's formula, was 87.5 percent. One larva per 100 buds of Douglas-fir remained 14 days following treatment. The average density of new egg masses was 1.6 per square meter in the treated area, and 9.9 per square meter in the untreated area. Although an average of 84.1 percent of the budworm larvae were in the fifth and sixth instars and 0.3 percent were pupae at the time of treatment, defoliation was considerably lower than that recorded in the untreated area: treatment area--26.5 percent for Douglas-fir and 37.0 percent for white fir; untreated area--40.8 percent for Douglas-fir and 61.3 percent for white fir.

Sampling for larval densities, egg mass, and defoliation on the plots was done in 1978 and 1979 to determine whether suppression

1/ Parker, Douglas L., Robert E. Acciavatti, and Eugene D. Lessard. 1978. Western spruce budworm suppression and evaluation project using carbaryl. Progress Rep. No. 1, USDA Forest Serv., Southwestern Reg., Albuquerque, NM. R-3 78-11. 136 pp.

effects continued. Larval and egg mass densities and defoliation all remained at low levels for both years in the treated areas, and increased in the check area.[2, 3]

This report presents the results of sampling done in 1980. Raw data for larval and egg mass densities and defoliation are provided in the Appendix.

II. METHODS

A. Entomological Phases

1. Sampling Locations

The treated and untreated areas were divided into six subunits in 1977 (Fig. 1). In each subunit, 25 permanent plots (3-tree cluster) were established, as uniformly as possible, throughout each subunit along roads and trails. Each plot was assigned a unique number. Data were collected on these permanent plots from 1977 to 1979. In 1980, 12 of the original 25 permanent plots in each subunit were used for data collection.

2. Timing of Larval Sampling

For between-year-comparison of late-instar larval densities, sampling had to be done at about the same developmental point in the yearly cycle of the budworm. As a result, budworm larval development had to be closely monitored.

Larval development sampling was initiated in late May on all development clusters. Data were collected on three, 2-tree clusters in each subunit. Trees sampled for budworm development were not the same as those used to estimate late-instar larval densities, but clusters were located near sampling points. Development sampling continued intermittently until buds began to swell. Then, development sampling was done every other day until 90 percent of current bud caps dropped or 90 percent of the larvae were in the third and fourth instars. At this time, daily sampling was done until at least 20 percent of the larvae were in the fifth and sixth instars.

2/ Parker, Douglas L., Eugene D. Lessard, and Iral Ragenovich. 1979. Western spruce budworm suppression and evaluation project using carbaryl. Progress Rep. No. 2, USDA Forest Serv., Southwestern Reg., Albuquerque, NM. R-3 79-8. 109 pp.

3/ Parker, Douglas L., and Iral R. Ragenovich. 1980. Western spruce budworm suppression and evaluation project using carbaryl. Progress Rep. No. 3, USDA Forest Serv., Southwestern Reg., Albuquerque, NM. R-3 80-1. 56 pp.

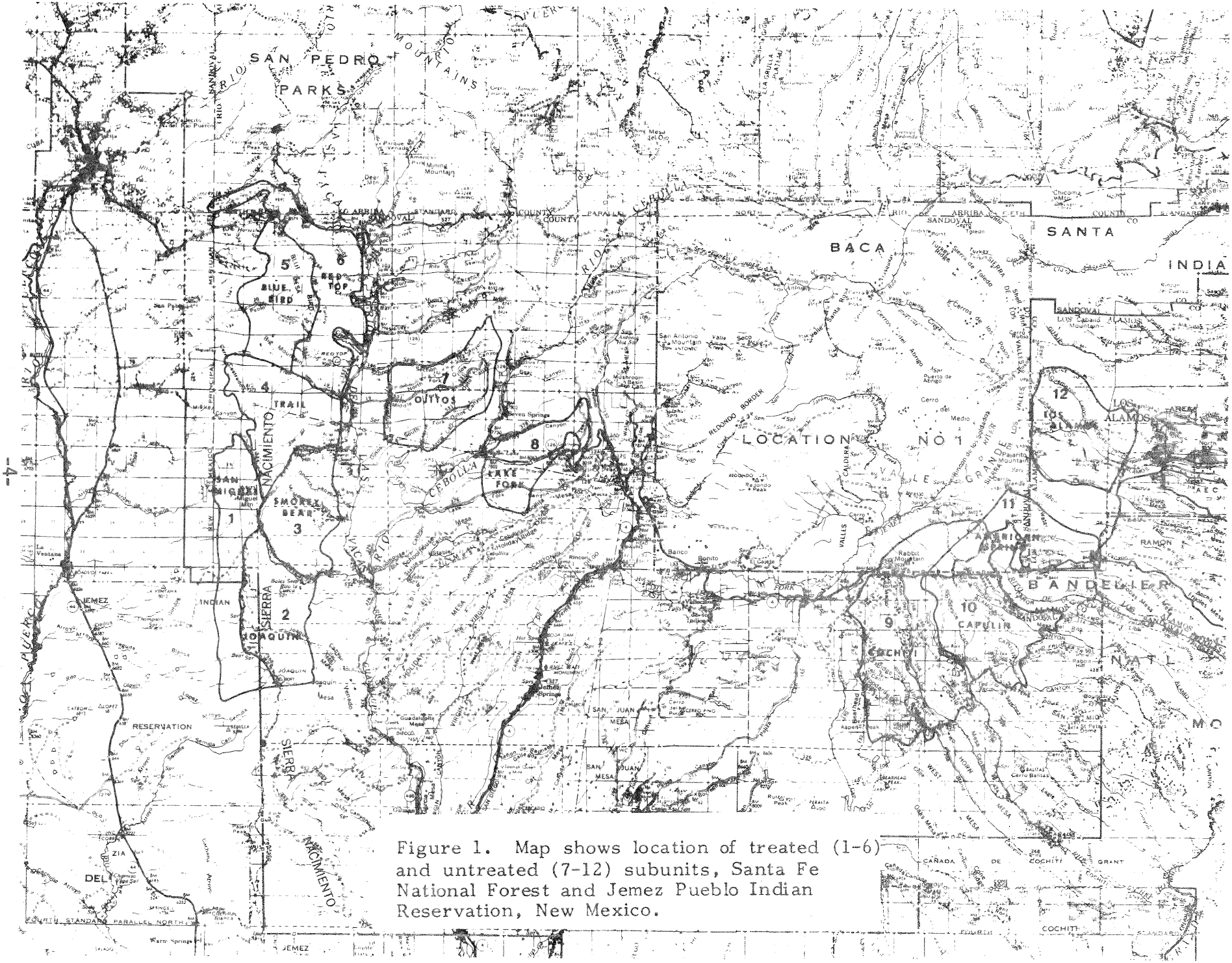

Figure 1. Map shows location of treated (1-6) and untreated (7-12) subunits, Santa Fe National Forest and Jemez Pueblo Indian Reservation, New Mexico.

3. Evaluation of Project Effectiveness

The lasting effectiveness of insecticide treatment was determined by (1) measuring budworm larval and egg mass densities in 1980 and (2) comparing them with similar data collected in 1977, 1978, and 1979.

a. Sampling Design for Larvae

Larval sampling began when 20 percent of the larvae were in the fifth and sixth instars (prespray sample). Larval density data were obtained on 12 plots per subunit. Three trees were sampled per plot. Sample trees were codominant Douglas-fir, 30 to 50 feet in height, and relatively open-grown with full crowns. Sample branches were cut from opposite sides of the midcrown of trees with a pole pruner and attached collecting bag. Larval densities were expressed as larvae per 100 live buds to give equal weight to each branch sampled. Cluster means were computed by averaging the larval density on each sample branch per tree, and then averaging the 3-tree means.

b. Sampling Design for Egg Masses

In late July, two branches (70 cm in length) were cut from opposite sides of sample trees on permanent plots. The length and width of each branch was used to calculate foliated branch area.

Foliage from all branches was examined under ultraviolet light for egg masses. Needles bearing egg masses were classed as from current year's foliage, or a previous year, and kept separate in labeled pill boxes. New and old egg masses were separated under a stereomicroscope. All egg masses on current year's foliage were classed as new, and their characteristics formed the basis for aging those egg masses found on the previous year's foliage.

c. Analysis of Population Reduction

Estimates of two types of population density per plot were computed for each sampling period. Larval densities were expressed as the number of late-instar larvae per 100 live buds. Egg mass density was expressed as number of new masses per square meter (1,550 sq. in.) of foliage. Subunit and treatment level means and standard errors were computed.

(1) Subscripts:

i = treatments	1 = spray	2 = check
j = subunit	j = 1, 6	
k = cluster	k = 1, 25	
l = tree	l = 1, 3	
m = branch	m = 1, 4 for larval density	
	m = 1, 2 for egg density	

(2) Cluster Level:

Prespray population

$$pre_{ijk} = \frac{\sum_{l=1}^{3} \sum_{m=1}^{2} \frac{budworm_{ijklm}}{buds_{ijklm}}}{6} \quad (100)$$

In 1980, there were 144 cluster level values for each variable (2 treatments X 6 subunits X 12 clusters = 144).

(3) Subunit Level Calculations of Means and Standard Errors. Means and standard errors were calculated for each of the three variables at the subunit level. The formulas follow, using X_{ijk} as an example for one of the variables.

$$X_{ij} = \sum_{k=1}^{n} \frac{X_{ijk}}{n}$$

, where X_{ij} is the mean for the j^{th} subunit in the i^{th} treatment.

$$S.E.\ x_{ij} = \sqrt{\frac{\sum_{k=1}^{n} X_{ijk}^2 - \frac{\left(\sum_{j=1}^{n} X_{ijk}\right)^2}{n}}{(n-1)}},$$

where S.E. x_{ij} is the standard error of the mean x_{ij}.

(4) Treatment Level Calculations of Means and Standard Errors. Assumptions made for each of the subunits are independent of each other and are self-weighting.

$$X_i = \sum_{j=1}^{6} X_{ij/6}$$ where X_i is the mean for the i^{th} treatment.

$$S.E.\ x_i = \sum_{j=1}^{6} S.E.\ x_{ij}^2$$

All data were pooled for the same population and treated as one sample in order to show whether or not the residual population in the treated population remained at a low level, i.e., 2-5 budworm per 100 buds.

B. Tree Damage Appraisal Phases

1. Evaluating Defoliation

Defoliation on Douglas-fir was sampled on 12 clusters in each subunit. On all clusters, three codominant Douglas-fir, 30 to 50 feet tall, with relatively open-grown crowns, were sampled.

Sample branches consisted of four apical branches, 70 cm in length, taken from four quadrants at midcrown of each sample tree. From each of these branch samples, 25 new shoots were examined for current defoliation using the left side of one branch and the right side of another, and so on. Each new shoot was individually examined for defoliation and assigned an index value as follows:

6-class

Defoliation class %	Index value	Midpoint value %
0	0	0
1-25	1	12.5
26-50	2	37.5
51-75	3	62.5
76-99	4	87.5
100	5	100

Defoliation estimates were analyzed on a "per cluster" basis.

The following formulas were used to determine the percent defoliation on a "per cluster" basis.

$$\text{Percent defoliation} = \frac{n_1\ (12.5) + n_2\ (37.5) + n_3\ (62.5) + n_4\ (87.5) + n_5\ (100)}{N}$$

where n_1 = number of twiglets with index value 1
n_2 = number of twiglets with index value 2
n_3 = number of twiglets with index value 3
n_4 = number of twiglets with index value 4
n_5 = number of twiglets with index value 5
N = total number of twiglets examined per plot = 300

2. Tree Mortality and Top-kill

Tree damage data on seedlings and saplings were collected at five locations in each of the treated and untreated subunits, for a total of 60 sample locations. At each location, a cluster of five permanent 1/100-acre fixed radius plots were sampled. Permanent 1/100-acre plots established in 1977 were used as the center plot, and four additional plots were located 100 feet from the center of the permanent plot in cardinal directions. Trees were recorded by species and condition (live, top-killed, dead). Trees with a diameter at breast height (d.b.h.) of less than 0.5 inches or less than 4.5 feet in height were considered as seedlings. Trees considered as saplings were 0.5 to 4.9 inches d.b.h. Trees less than 1 foot tall were not recorded. Pine and spruce trees also were recorded on each plot. Data were analyzed using the PEST computer program.[4/]

3. Growth Loss

Increment cores were taken from three Douglas-fir and one ponderosa pine at each plot. Two cores, 90° apart, were taken from each tree. Trees used for increment cores were selected for similarity in height, diameter, and crown class to the sample trees, but did not include any of the sample trees. Cores were put in plastic straws and labeled.

III. RESULTS

A. Entomological Phases

1. Larval Densities

Following treatment, the larval density per 100 buds of new foliage on Douglas-fir remained at a low level from 1977 to 1980. An average of 14.9 larvae was recorded during the 1977 prespray sample; about one larvae per 100 buds remained 14 days following treatment; and the prespray density decreased to 0.9 in 1978, 0.6 in 1979, and increased slightly to 1.16 in 1980 (Table 1).

4/ Acciavatti, R. E. and B. W. Geils. 1977. A user's guide to "PEST": A computer program for summarizing forest insect and disease damage surveys. USDA Forest Serv., Southwestern Reg., Albuquerque, NM. R-3 77-16. 45 pp.

Table 1. Western spruce budworm larvae and pupae per 100 buds on Douglas-fir for treated (1-6) and untreated check (7-12) subunits, Santa Fe National Forest and Jemez Pueblo Indian Reservation lands, New Mexico.

	Budworm Larvae and Pupae Per 100 Buds of Douglas-fir									
	1977 Pre-spray[a/]		1977 Post-spray		1978 Pre-spray[a/]		1979 Pre-spray[a/]		1980[b/] Pre-spray[a/]	
Treated Subunits	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1 San Miguel	20.5	2.5	1.7	0.4	1.3	0.4	0.3	0.1	0.5	0.2
2 Joaquin	11.9	2.1	0.7	0.2	0.4	0.1	0.5	0.2	1.6	0.4
3 Smokey Bear	11.7	1.7	1.1	0.3	0.4	0.1	1.0	0.3	1.4	0.7
4 Trail	17.9	2.2	1.0	0.2	1.2	0.4	0.7	0.2	0.7	0.2
5 Blue Bird	18.2	2.8	1.1	0.4	1.5	0.7	0.1	0.1	1.2	0.8
6 Red Top	9.0	1.1	0.6	0.2	0.6	0.2	0.9	0.2	1.5	0.4
Average	14.9		1.0		0.9		0.6		1.2	
Untreated Subunits										
7 Ojitos	2.7	0.4	0.8	0.2	2.0	0.4	1.4	0.3	5.2	1.3
8 Lake Fork	9.5	1.8	5.8	1.0	10.7	2.0	11.8	1.9	11.3	3.1
9 Cochiti	8.7	1.5	4.6	0.8	11.8	1.7	11.2	1.3	22.2	4.1
10 Capulin	17.7	3.0	7.8	1.2	11.5	1.4	10.6	1.5	20.7	2.9
11 American Springs	12.6	2.1	8.3	1.5	10.8	1.3	9.2	1.1	24.4	3.6
12 Los Alamos	14.3	2.2	8.1	1.2	5.5	0.8	9.7	1.7	21.2	5.2
Average	12.4		6.9		8.7		9.0		17.5	

a/ Pre-spray samples taken when 20 percent of the larvae was in the fifth and sixth instars, and before 5 percent pupated.
b/ 1980 pre-spray samples were based on data collected on 12 plots per subunit; 1977-79 pre-spray data were based on 25 plots per subunit.

In the untreated area, the infestation decreased from 12.4 larvae per 100 buds of Douglas-fir to 8.7 larvae in 1978. A slight increase in the larval density to 8.9 was noted in 1979, and a substantial increase in larvae density to 17.5 was recorded in 1980 (Table 1). Overall, the average density of larvae in the untreated area was significantly higher than in the treated area for all 4 years that samples were taken (Fig. 2).

2. Egg Mass Densities

The density of egg masses is another population index that indicates that suppression of the budworm population was achieved from 1977 to 1980.

Table 2 shows the average egg mass densities on the treated and untreated subunits. In the treatment area, the average density of egg masses per square meter of foliage decreased from 1.7 in 1977 to 0.4 in 1978 and increased slightly to 0.6 in 1979. Egg mass density increased to 4.9 in 1980. The average density of egg masses per meter square of foliage in the untreated areas was: 1977, 9.9; 1978, 10.1; 1979, 15.9; and 1980, 18.0. The increase in the average density of egg masses continued in the untreated area in 1980 (Fig. 3). This increase in the density of eggs indicates that defoliation will be heavier in the untreated area in 1981. The infestation in the treated area will begin to show increasing defoliation in 1981.

B. Tree Damage Appraisal Phase

1. Defoliation

A comparison of defoliation between the treated and untreated areas shows that foliage protection was achieved in the treatment area (Table 3, Fig. 4) in 1980. Average defoliation in the treated area increased from 2.5 percent in 1979 to 9.6 percent in 1980. Although there was an increase in defoliation, it still remains at a low level. Average percent defoliation in the check area increased from 26.7 percent in 1979 to 54.7 percent in 1980.

2. Tree Mortality and Top-kill

Analysis of the data collected on the 1/100-acre fixed plots shows that there is no significant difference between the treated and untreated areas in the percent of Douglas-fir and true fir seedlings and saplings recorded as top-killed or dead. This would indicate that seedlings and saplings have not been severely damaged through the fifth year of this infestation.

3. Growth Loss

Increment cores were taken from host and nonhost trees in each plot. Cores have not yet been analyzed. Data from the cores will be used to establish the history and effects of previous outbreaks and to establish a data base for the current infestation.

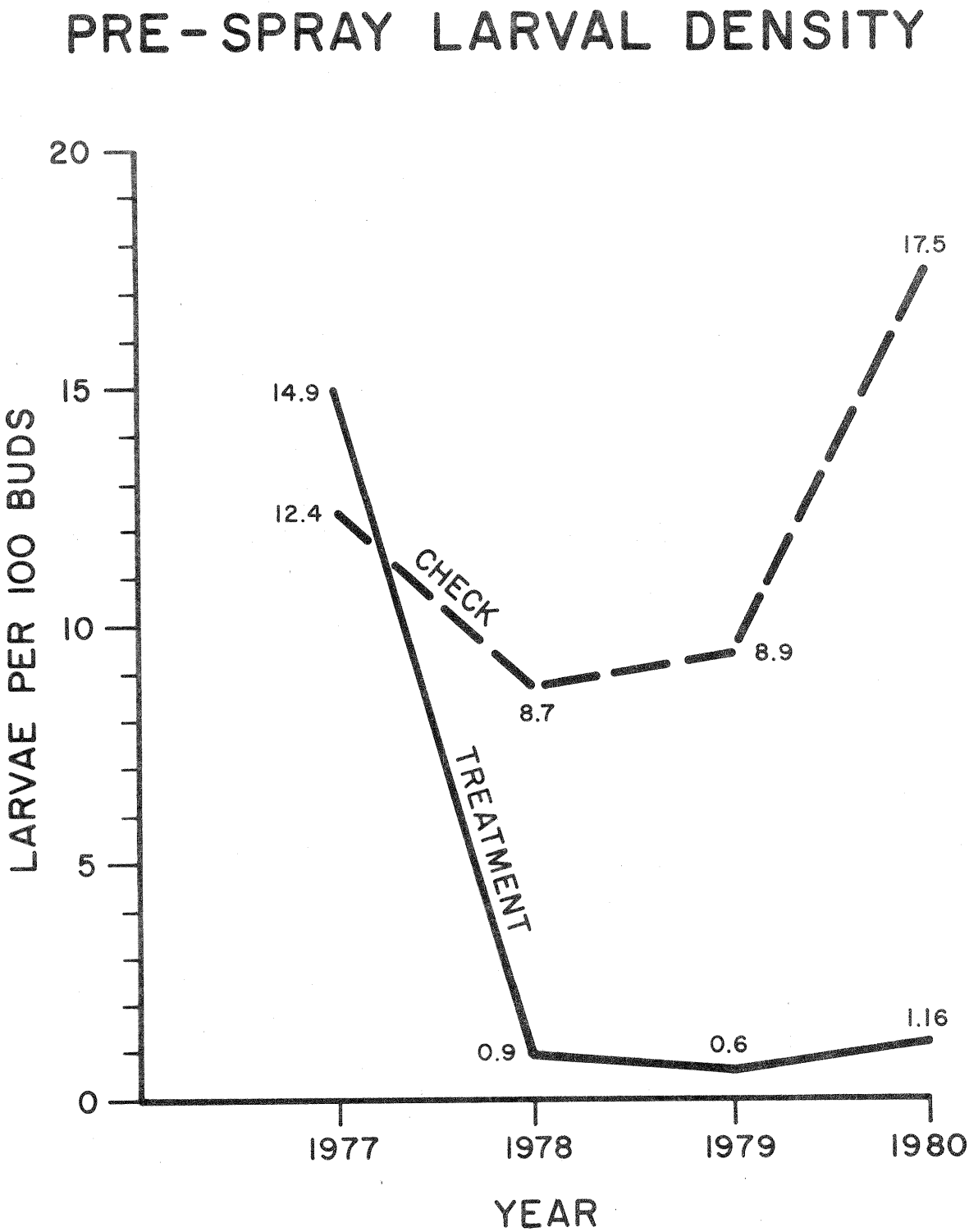

Figure 2.--Comparison of average number of western spruce budworm larvae in treated and untreated check areas, Santa Fe National Forest and Jemez Pueblo Indian Reservation, New Mexico.

Table 2. Western spruce budworm egg mass densities on treated (1-6) and untreated check (7-12) subunits, Santa Fe National Forest and Jemez Pueblo Indian Reservation lands, New Mexico.

	Egg Masses Per M^2 of Foliage							
	1977		1978		1979		1980	
Treated Subunits	Mean	S.E.	Mean	S.E.	Mean	S.E.	Mean	S.E.
1 San Miguel	4.2	1.1	0.9	0.3	0.7	0.3	3.4	1.1
2 Joaquin	1.4	0.5	0.0	0.0	0.2	0.1	6.4	1.8
3 Smokey Bear	0.2	0.1	0.2	0.1	0.4	0.2	3.5	0.7
4 Trail	1.9	0.6	0.6	0.2	1.2	0.4	7.6	4.0
5 Blue Bird	1.2	0.4	0.4	0.2	0.8	0.3	5.7	4.7
6 Red Top	1.0	0.3	0.5	0.2	0.6	0.3	2.8	0.7
Average	1.7		0.4		0.6		4.9	
Untreated Subunits								
7 Ojitos	1.0	0.3	1.0	0.3	1.5	0.6	14.9	6.0
8 Lake Fork	7.5	1.7	11.2	2.6	17.9	3.7	39.6	11.0
9 Cochiti	11.6	2.9	12.4	2.5	21.0	5.2	69.7	9.0
10 Capulin	14.4	2.5	12.5	1.9	19.2	3.3	51.7	9.2
11 American Springs	7.4	1.1	11.1	1.7	15.0	2.8	60.1	8.9
12 Los Alamos	17.5	2.6	12.5	1.9	20.6	3.2	51.9	6.6
Average	9.9		10.1		15.9		18.0	

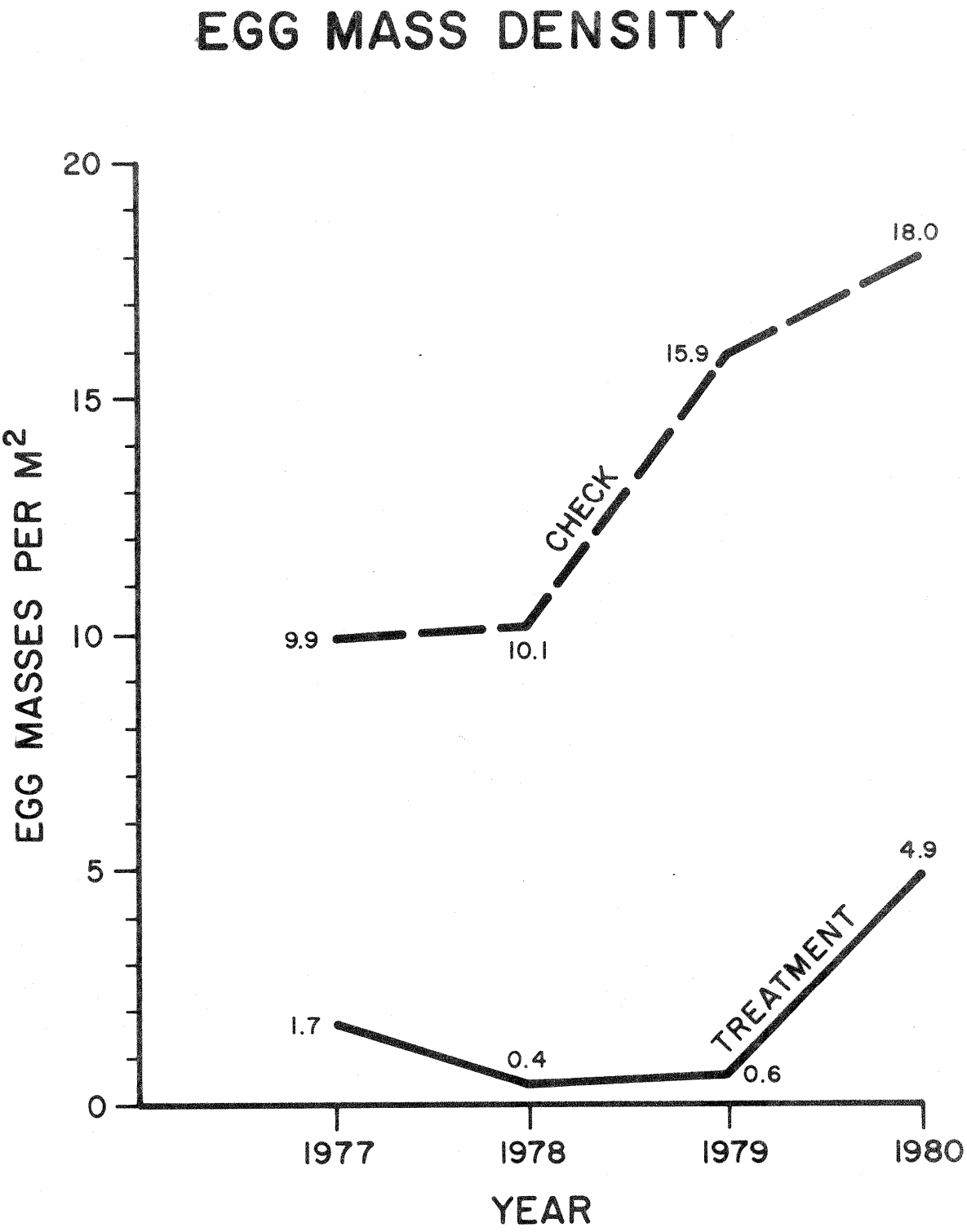

Figure 3.--Comparison of average number of western spruce budworm egg masses in treated and untreated check areas, Santa Fe National Forest and Jemez Pueblo Indian Reservation, New Mexico.

Table 3. Percent defoliation for treated (1-6) and untreated (7-12) subunits, Santa Fe National Forest and Jemez Pueblo Indian Reservation lands, New Mexico.

Treated Subunits	Percent Defoliation					
	1977		1978		1979	1980
	WF[a/]	DF[b/]	WF	DF	DF	DF
1 San Miguel	--	41.6	--	4.5	3.7	9.2
2 Joaquin	28.6	19.9	3.1	1.5	2.0	7.1
3 Smokey Bear	24.8	18.0	5.2	1.1	1.0	7.6
4 Trail	53.1	37.0	7.2	5.4	2.2	12.5
5 Blue Bird	41.8	25.8	5.7	2.7	3.0	13.6
6 Red Top	--	16.6	--	2.0	3.2	8.1
Average	37.0	26.5	5.3	2.9	2.5	9.6
Untreated Subunits						
7 Ojitos	--	14.1	--	9.4	6.8	24.4
8 Lake Fork	62.2	51.1	58.1	40.9	34.1	48.4
9 Cochiti	52.8	37.2	46.8	35.3	29.4	55.4
10 Capulin	63.6	51.2	38.7	29.0	28.3	65.7
11 American Springs	66.4	34.2	46.3	29.1	31.6	73.5
12 Los Alamos	--	56.7	--	23.8	29.9	60.9
Average	61.3	40.8	47.5	27.9	26.7	54.7

a/ WF = White fir
b/ DF = Douglas-fir

IV. SUMMARY

Results of the 1980 data show that treatment of an infestation early in the outbreak cycle can keep the population at low levels for up to 4 years. The data indicate that populations are beginning to increase in the treated area. This may be due to the movement of moths from adjacent untreated area, rather than to a buildup of the resident population. If this is the case, management implications are that application of a pesticide over the entire infestation, early in the outbreak cycle, could effectively control that population for the duration of the outbreak.

V. FUTURE PLANS

Plans are being made to continue to evaluate the effects of the treatment and determine the trend of the infestation in 1981. Egg mass densities, defoliation, and tree damage sampling will be done on both the treated and untreated subunits on the same permanent plots used in the 1980 fieldwork. An annual progress report will be issued for the 1981 fieldwork.

VI. APPENDIX

A. Larval Density Data - 1980

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME SAN MIGUEL SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
1	1	.00	.00	.00	.00
1	25	.00	.00	.00	.00
1	4	.00	.00	.00	.00
1	37	.30	.00	.00	.30
1	13	.19	.00	.00	.19
1	43	2.05	.00	.00	2.05
1	73	.51	.00	.00	.51
1	55	.99	.00	.00	.99
1	46	.27	.00	.00	.27
1	70	.93	.00	.00	.93
1	64	.57	.00	.00	.57
1	22	.46	.00	.00	.46
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		.523	.000	.000	.523
STANDARD ERRORS		.169	.000	.000	.169
VARIANCE		.3	.0	.0	.3

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME JOAQUIN SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
2	94	.62	.00	.00	.62
2	124	.56	.00	.00	.56
2	106	3.82	.00	.00	3.82
2	76	1.40	.00	.00	1.40
2	127	1.01	.00	.00	1.01
2	133	.94	.00	.00	.94
2	148	4.32	.00	.00	4.32
2	91	1.66	.00	.00	1.66
2	145	2.31	.00	.00	2.31
2	121	.79	.00	.00	.79
2	118	.23	.00	.00	.23
2	88	1.44	.00	.00	1.44
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		1.590	.000	.000	1.590
STANDARD ERRORS		.372	.000	.000	.372
VARIANCE		1.7	.0	.0	1.7

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME SMOKEY BEAR SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
3	184	.63	.00	.00	.63
3	214	.19	.00	.00	.19
3	175	.00	.00	.00	.00
3	151	.00	.00	.00	.00
3	172	.00	.00	.00	.00
3	199	.00	.00	.00	.00
3	223	.00	.00	.00	.00
3	217	.25	.00	.00	.25
3	193	5.35	.00	.00	5.35
3	208	1.41	.00	.00	1.41
3	202	6.93	.00	.00	6.93
3	220	2.56	.00	.00	2.56
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		1.444	.000	.000	1.444
STANDARD ERRORS		.678	.000	.000	.678
VARIANCE		5.5	.0	.0	5.5

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME TRAIL SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
4	286	.22	.00	.00	.22
4	277	1.74	.00	.00	1.74
4	226	2.53	.00	.00	2.53
4	250	.96	.00	.00	.96
4	289	.00	.00	.00	.00
4	232	.00	.00	.00	.00
4	229	1.04	.00	.00	1.04
4	238	.00	.00	.00	.00
4	271	.00	.00	.00	.00
4	256	.38	.00	.00	.38
4	244	.77	.00	.00	.77
4	262	.38	.00	.00	.38
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		.669	.000	.000	.669
STANDARD ERRORS		.231	.000	.000	.231
VARIANCE		.6	.0	.0	.6

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME BLUE BIRD SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
5	361	10.38	.00	.00	10.38
5	334	.20	.00	.00	.20
5	304	.52	.00	.00	.52
5	340	.40	.00	.00	.40
5	373	.60	.00	.00	.60
5	328	.49	.00	.00	.49
5	325	1.80	.00	.00	1.80
5	331	.29	.00	.00	.29
5	322	.31	.00	.00	.31
5	310	.00	.00	.00	.00
5	313	.00	.00	.00	.00
5	349	.00	.00	.00	.00
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		1.249	.000	.000	1.249
STANDARD ERRORS		.842	.000	.000	.842
VARIANCE		8.5	.0	.0	8.5

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME RED TOP SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
6	385	1.19	.00	.00	1.19
6	400	.36	.00	.00	.36
6	388	1.64	.00	.00	1.64
6	439	1.28	.00	.00	1.28
6	394	3.43	.00	.00	3.43
6	415	2.83	.00	.00	2.83
6	382	4.08	.00	.00	4.08
6	421	.00	.00	.00	.00
6	412	.41	.00	.00	.41
6	397	.00	.00	.00	.00
6	391	1.07	.00	.00	1.07
6	436	1.72	.00	.00	1.72
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		1.502	.000	.000	1.502
STANDARD ERRORS		.385	.000	.000	.385
VARIANCE		1.8	.0	.0	1.8

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME OJITOS SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
7	505	2.68	.00	.00	2.68
7	460	12.15	.00	.00	12.15
7	472	5.37	.00	.00	5.37
7	451	1.35	.00	.00	1.35
7	469	7.52	.00	.00	7.52
7	499	4.04	.00	.00	4.04
7	511	.68	.00	.00	.68
7	502	1.68	.00	.00	1.68
7	454	10.67	.00	.00	10.67
7	493	2.05	.00	.00	2.05
7	517	1.25	.00	.00	1.25
7	523	13.46	.00	.00	13.46
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		5.242	.000	.000	5.242
STANDARD ERRORS		1.327	.000	.000	1.327
VARIANCE		21.1	.0	.0	21.1

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME LAKE FORK SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
8	598	29.39	.00	.00	29.39
8	592	21.76	.00	.00	21.76
8	526	.83	.00	.00	.83
8	529	2.12	.00	.00	2.12
8	538	.46	.00	.00	.46
8	541	.96	.00	.00	.96
8	547	16.93	.00	.00	16.93
8	553	10.22	.00	.00	10.22
8	562	24.16	.00	.00	24.16
8	568	20.70	.00	.00	20.70
8	574	.84	.00	.00	.84
8	586	7.67	.00	.00	7.67
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		11.339	.000	.000	11.339
STANDARD ERRORS		3.095	.000	.000	3.095
VARIANCE		114.9	.0	.0	114.9

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME COCHITI SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
9	601	2.78	.00	.00	2.78
9	610	12.49	.00	.00	12.49
9	661	16.69	.00	.00	16.69
9	616	1.40	.00	.00	1.40
9	664	18.74	.00	.00	18.74
9	652	43.58	.00	.00	43.58
9	631	36.66	.00	.00	36.66
9	625	22.64	.00	.00	22.64
9	658	39.63	.00	.00	39.63
9	634	29.79	.00	.00	29.79
9	604	8.04	.00	.00	8.04
9	655	34.43	.00	.00	34.43
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		22.239	.000	.000	22.239
STANDARD ERRORS		4.196	.000	.000	4.196
VARIANCE		211.3	.0	.0	211.3

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME CAPULIN SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
10	676	35.40	.00	.00	35.40
10	697	16.80	.00	.00	16.80
10	703	18.35	.00	.00	18.35
10	706	18.97	.00	.00	18.97
10	709	18.90	.00	.00	18.90
10	715	28.06	.00	.00	28.06
10	730	25.71	.00	.00	25.71
10	733	18.76	.00	.00	18.76
10	739	3.98	.00	.00	3.98
10	727	9.38	.00	.00	9.38
10	682	14.84	.00	.00	14.84
10	718	39.12	.00	.00	39.12
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		20.689	.000	.000	20.689
STANDARD ERRORS		2.896	.000	.000	2.896
VARIANCE		100.7	.0	.0	100.7

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME AMERICAN SPRINGS SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
11	784	5.83	.00	.00	5.83
11	760	14.23	.00	.00	14.23
11	781	3.30	.00	.00	3.30
11	772	16.71	.00	.00	16.71
11	808	19.52	.00	.00	19.52
11	769	34.58	.00	.00	34.58
11	793	40.71	.00	.00	40.71
11	751	39.55	.00	.00	39.55
11	787	32.26	.00	.00	32.26
11	802	32.64	.00	.00	32.64
11	763	25.64	.00	.00	25.64
11	817	27.62	.00	.00	27.62
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		24.384	.000	.000	24.384
STANDARD ERRORS		3.607	.000	.000	3.607
VARIANCE		156.1	.0	.0	156.1

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

REGION 3

CLUSTER LEVEL MEANS -- BUDWORM PER 100 BUDS

UNIT NAME LOS ALAMOS SURVEY PERIOD 1980 PRE SPRAY

UNIT	CLUSTER	LARVAE	PUPAE	CASES	TOTAL
12	835	1.22	.00	.00	1.22
12	838	14.51	.00	.00	14.51
12	847	27.93	.00	.00	27.93
12	850	32.59	.00	.00	32.59
12	856	12.67	.00	.00	12.67
12	865	17.69	.00	.00	17.69
12	868	64.18	.00	.00	64.18
12	880	2.76	.00	.00	2.76
12	886	.48	.00	.00	.48
12	892	16.38	.00	.00	16.38
12	844	35.11	.00	.00	35.11
12	859	28.74	.00	.00	28.74
NUMBER OF CLUSTERS		12.			
BLOCK MEANS		21.188	.000	.000	21.188
STANDARD ERRORS		5.219	.000	.000	5.219
VARIANCE		326.8	.0	.0	326.8

B. Egg Mass Density Data - 1980

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 1

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
1	.155	.000	.0	.0	.0	.0	.0	.0	.0	.0
4	.143	.000	2.4	.0	.3	.0	.0	.0	.0	.0
13	.066	.000	2.3	.0	.2	.0	.0	.0	.0	.0
22	.156	.000	2.2	.0	.3	.0	.0	.0	.0	.0
25	.111	.000	.0	.0	.0	.0	.0	.0	.0	.0
37	.115	.000	11.7	.0	1.2	.0	.0	.0	.0	.0
43	.151	.000	10.2	.0	1.5	.0	.0	.0	.0	.0
46	.128	.000	1.2	.0	.2	.0	.0	.0	.0	.0
55	.137	.000	.0	.0	.0	.0	.0	.0	.0	.0
64	.103	.000	1.8	.0	.2	.0	.0	.0	.0	.0
70	.096	.000	5.2	.0	.5	.0	.0	.0	.0	.0
75	.084	.000	4.1	.0	.3	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.120	.000	3.4	.0	.4	.0	.0	.0	.0	.0
S.E.	.008	.000	1.1	.0	.1	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 2

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
76	.158	.000	4.0	.0	.7	.0	.0	.0	.0	.0
88	.161	.000	6.1	.0	1.0	.0	.0	.0	.0	.0
91	.152	.000	.9	.0	.2	.0	.0	.0	.0	.0
94	.145	.000	2.3	.0	.3	.0	.0	.0	.0	.0
106	.104	.000	8.5	.0	1.0	.0	.0	.0	.0	.0
118	.177	.000	1.0	.0	.2	.0	.0	.0	.0	.0
121	.113	.000	2.3	.0	.3	.0	.0	.0	.0	.0
124	.115	.000	2.2	.0	.3	.0	.0	.0	.0	.0
127	.120	.000	12.5	.0	1.5	.0	.0	.0	.0	.0
133	.120	.000	3.9	.0	.5	.0	.0	.0	.0	.0
145	.125	.000	9.9	.0	1.3	.0	.0	.0	.0	.0
148	.153	.000	22.9	.0	4.0	.0	.0	.2	.0	.0
CLUSTERS	12.								0.	
MEAN	.137	.000	6.4	.0	.9	.0	.0	.0	.0	.0
S.E.	.007	.000	1.8	.0	.3	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 3

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
151	.106	.000	5.0	.0	.5	.0	.0	.0	.0	.0
172	.105	.000	.0	.0	.0	.0	.0	.0	.0	.0
175	.100	.000	4.1	.0	.3	.0	.0	.0	.0	.0
184	.113	.000	5.5	.0	.7	.0	.0	.0	.0	.0
193	.118	.000	5.3	.0	.7	.0	.0	.0	.0	.0
199	.144	.000	4.0	.0	.7	.0	.0	.0	.0	.0
202	.141	.000	.0	.0	.0	.0	.0	.0	.0	.0
208	.123	.000	1.3	.0	.2	.0	.0	.0	.0	.0
214	.182	.000	5.5	.0	1.0	.0	.0	.0	.0	.0
217	.157	.000	1.3	.0	.2	.0	.0	.0	.0	.0
220	.158	.000	2.2	.0	.3	.0	.0	.2	.0	.0
223	.169	.000	7.7	.0	1.0	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.135	.000	3.5	.0	.5	.0	.0	.0	.0	.0
S.E.	.008	.000	.7	.0	.1	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 4

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	NUMBER OLD	NUMBER ROWS	LENGTH
226	.136	.000	5.0	.0	.7	.0	.0	.0	.0	.0
229	.096	.000	7.0	.0	.5	.0	.0	.0	.0	.0
232	.141	.000	6.4	.0	.8	.0	.0	.0	.0	.0
238	.093	.000	.0	.0	.0	.0	.0	.0	.0	.0
244	.108	.000	2.7	.0	.3	.0	.0	.0	.0	.0
250	.113	.000	.0	.0	.0	.0	.0	.0	.0	.0
256	.141	.000	6.4	.0	.8	.0	.0	.0	.0	.0
262	.127	.000	4.1	.0	.5	.0	.0	.0	.0	.0
271	.126	.000	7.5	.0	1.0	.0	.0	.0	.0	.0
277	.137	.000	50.9	.0	7.0	.0	.0	.0	.0	.0
286	.124	.000	1.3	.0	.2	.0	.0	.0	.0	.0
289	.120	.000	.0	.0	.0	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.122	.000	7.6	.0	1.0	.0	.0	.0	.0	.0
S.E.	.005	.000	4.0	.0	.6	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 5

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	NUMBER OLD	NUMBER ROWS	NUMBER LENGTH
304	.101	.000	1.6	.0	.2	.0	.0	.0	.0	.0
310	.105	.000	1.2	.0	.2	.0	.0	.0	.0	.0
313	.093	.000	.0	.0	.0	.0	.0	.0	.0	.0
322	.129	.000	.0	.0	.0	.0	.0	.0	.0	.0
325	.109	.000	3.5	.0	.3	.0	.0	.0	.0	.0
328	.000	.003	.2	47.6	.2	.0	.0	.0	.0	.0
331	.119	.000	1.5	.0	.2	.0	.0	.0	.0	.0
334	.114	.000	.0	.0	.0	.0	.0	.0	.0	.0
340	.114	.000	.0	.0	.0	.0	.0	.0	.0	.0
349	.120	.000	2.6	.0	.3	.0	.0	.0	.0	.0
361	.102	.000	57.1	.0	5.8	.0	.0	.2	.0	.0
373	.129	.000	1.0	.0	.2	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.103	.000	5.7	4.0	.6	.0	.0	.0	.0	.0
S.E.	.010	.000	4.7	4.0	.5	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 6

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
382	.108	.000	5.1	.0	.5	.0	.0	.0	.0	.0
385	.128	.000	.0	.0	.0	.0	.0	.0	.0	.0
388	.085	.000	8.1	.0	.7	.0	.0	.0	.0	.0
391	.153	.000	3.4	.0	.5	.0	.0	.0	.0	.0
394	.111	.000	.0	.0	.0	.0	.0	.0	.0	.0
400	.117	.000	2.6	.0	.2	.0	.0	.0	.0	.0
412	.107	.000	2.9	.0	.3	.0	.0	.0	.0	.0
415	.130	.000	4.7	.0	.7	.0	.0	.0	.0	.0
421	.104	.000	4.2	.0	.3	.0	.0	.0	.0	.0
436	.127	.000	.0	.0	.0	.0	.0	.0	.0	.0
439	.073	.000	2.5	.0	.2	.0	.0	.0	.0	.0
448	.108	.000	.0	.0	.0	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.113	.000	2.8	.0	.3	.0	.0	.0	.0	.0
S.E.	.006	.000	.7	.0	.1	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 5 HOST 1 FOREST 10 UNIT 7

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
451	.175	.000	4.0	.0	.7	.0	.0	.0	.0	.0
454	.128	.000	48.7	.0	6.3	.0	.0	.0	.0	.0
460	.113	.000	66.6	.0	7.0	.0	.0	.2	.0	.0
469	.156	.000	16.6	.0	2.5	.0	.0	.0	.0	.0
472	.142	.000	12.1	.0	1.8	.0	.0	.0	.0	.0
493	.106	.000	7.9	.0	.8	.0	.0	.0	.0	.0
499	.142	.000	3.4	.0	.3	.0	.0	.0	.0	.0
502	.163	.000	4.2	.0	.8	.0	.0	.0	.0	.0
505	.176	.000	2.9	.0	.5	.0	.0	.0	.0	.0
511	.118	.000	2.2	.0	.3	.0	.0	.0	.0	.0
517	.082	.000	1.6	.0	.2	.0	.0	.0	.0	.0
523	.100	.000	8.5	.0	.8	.0	.0	.2	.0	.0
CLUSTERS	12.								0.	
MEAN	.134	.000	14.9	.0	1.8	.0	.0	.0	.0	.0
S.E.	.009	.000	6.0	.0	.7	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 8

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	NUMBER OLD	NUMBER ROWS	NUMBER LENGTH
526	.149	.000	6.1	.0	.8	.0	.0	.0	.0	.0
529	.129	.000	16.8	.0	2.3	.0	.0	.0	.0	.0
538	.131	.000	3.8	.0	.5	.0	.0	.0	.0	.0
541	.097	.000	7.9	.0	.8	.0	.0	.0	.0	.0
547	.149	.000	40.2	.0	5.8	.0	.0	.0	.0	.0
553	.104	.000	75.5	.0	6.8	.0	.0	.0	.0	.0
562	.155	.000	11.5	.0	1.7	.0	.0	.0	.0	.0
568	.125	.000	66.4	.0	8.3	.0	.0	.2	.0	.0
574	.145	.000	.0	.0	.0	.0	.0	.0	.0	.0
586	.115	.000	64.7	.0	7.3	.0	.0	.5	.0	.0
592	.126	.000	107.3	.0	13.3	.0	.0	.2	.0	.0
598	.149	.000	74.4	.0	10.5	.0	.0	.2	.0	.0
CLUSTERS	12.								0.	
MEAN	.131	.000	39.6	.0	4.9	.0	.0	.1	.0	.0
S.E.	.005	.000	10.6	.0	1.3	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 9

CLUSTER	BRANCH AREA (L*W)/2	GRID	EGG MASS / M**2 (L*W)/2	GRID	NUMBER	EGG MASS PER BRANCH GOOD	BAD	OLD	NUMBER ROWS	LENGTH
601	.080	.000	82.8	.0	6.0	.0	.0	.0	.0	.0
604	.125	.000	10.4	.0	1.3	.0	.0	.0	.0	.0
610	.128	.000	68.1	.0	10.0	.0	.0	.2	.0	.0
616	.115	.000	46.1	.0	5.7	.0	.0	.2	.0	.0
625	.139	.000	92.1	.0	12.0	.0	.0	.0	.0	.0
631	.086	.000	74.4	.0	7.0	.0	.0	.0	.0	.0
634	.117	.000	81.8	.0	9.2	.0	.0	.0	.0	.0
652	.106	.000	80.8	.0	7.8	.0	.0	.0	.0	.0
655	.136	.000	21.6	.0	3.0	.0	.0	.0	.0	.0
658	.142	.000	110.5	.0	15.8	.0	.0	.0	.0	.0
661	.163	.000	58.7	.0	9.7	.0	.0	.5	.0	.0
664	.098	.000	109.1	.0	10.0	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.120	.000	69.7	.0	8.1	.0	.0	.1	.0	.0
S.E.	.007	.000	9.0	.0	1.1	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 10

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	NUMBER OLD	NUMBER ROWS	NUMBER LENGTH
676	.135	.000	36.2	.0	5.0	.0	.0	.0	.0	.0
682	.114	.000	34.5	.0	4.0	.0	.0	.0	.0	.0
697	.106	.000	12.5	.0	1.3	.0	.0	.0	.0	.0
703	.117	.000	74.6	.0	8.2	.0	.0	.0	.0	.0
706	.117	.000	90.0	.0	11.2	.0	.0	.0	.0	.0
709	.112	.000	82.3	.0	9.3	.0	.0	.5	.0	.0
715	.131	.000	44.7	.0	5.8	.0	.0	.0	.0	.0
718	.122	.000	47.5	.0	5.0	.0	.0	.0	.0	.0
727	.104	.000	113.3	.0	12.5	.0	.0	.0	.0	.0
730	.134	.000	32.3	.0	4.0	.0	.0	.2	.0	.0
733	.113	.000	43.2	.0	4.7	.0	.0	.2	.0	.0
739	.089	.000	9.7	.0	.8	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.116	.000	51.7	.0	6.0	.0	.0	.1	.0	.0
S.E.	.004	.000	9.2	.0	1.0	.0	.0	.0	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 11

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	NUMBER OLD	NUMBER ROWS	LENGTH
751	.168	.000	49.2	.0	7.7	.0	.0	.0	.0	.0
760	.131	.000	68.5	.0	8.8	.0	.0	.0	.0	.0
763	.170	.000	58.5	.0	11.2	.0	.0	.0	.0	.0
769	.116	.000	51.3	.0	5.8	.0	.0	.0	.0	.0
772	.124	.000	69.3	.0	8.7	.0	.0	.0	.0	.0
781	.090	.000	14.6	.0	1.2	.0	.0	.0	.0	.0
784	.155	.000	22.1	.0	3.3	.0	.0	.0	.0	.0
787	.124	.000	113.3	.0	13.3	.0	.0	.0	.0	.0
793	.164	.000	20.6	.0	3.5	.0	.0	.0	.0	.0
802	.112	.000	69.8	.0	8.0	.0	.0	1.0	.0	.0
808	.104	.000	96.0	.0	9.3	.0	.0	.2	.0	.0
817	.102	.000	88.3	.0	9.3	.0	.0	.0	.0	.0
CLUSTERS	12.								0.	
MEAN	.130	.000	60.1	.0	7.5	.0	.0	.1	.0	.0
S.E.	.008	.000	8.9	.0	1.0	.0	.0	.1	.0	.0

WESTERN SPRUCE BUDWORM EGG MASS - DEFOLIATION
SURVEY SYSTEM

TABLE 1: EGG MASS ESTIMATES - CLUSTER LEVEL MEANS

YEAR 1980 REGION 3 HOST 1 FOREST 10 UNIT 12

CLUSTER	BRANCH AREA (L*W)/2	BRANCH AREA GRID	EGG MASS / M**2 (L*W)/2	EGG MASS / M**2 GRID	EGG MASS PER BRANCH NUMBER	EGG MASS PER BRANCH GOOD	EGG MASS PER BRANCH BAD	EGG MASS PER BRANCH OLD	NUMBER ROWS	LENGTH
835	.111	.000	53.3	.0	6.0	.0	.0	.0	.0	.0
838	.075	.000	88.3	.0	7.0	.0	.0	.2	.0	.0
844	.129	.000	78.7	.0	9.8	.0	.0	.2	.0	.0
847	.148	.000	38.7	.0	5.8	.0	.0	.2	.0	.0
850	.131	.000	67.9	.0	8.7	.0	.0	.0	.0	.0
856	.128	.000	65.0	.0	7.8	.0	.0	2.0	.0	.0
859	.136	.000	52.5	.0	6.2	.0	.0	.0	.0	.0
865	.192	.000	21.4	.0	4.0	.0	.0	.2	.0	.0
868	.104	.000	62.4	.0	6.7	.0	.0	.2	.0	.0
880	.143	.000	9.1	.0	1.3	.0	.0	.2	.0	.0
886	.107	.000	40.2	.0	4.2	.0	.0	.0	.0	.0
891	.159	.000	45.5	.0	9.3	.0	.0	.3	.0	.0
CLUSTERS	12.								0.	
MEAN	.130	.000	51.9	.0	6.4	.0	.0	.3	.0	.0
S.E.	.009	.000	6.6	.0	.7	.0	.0	.2	.0	.0

C. Defoliation Estimates - 1980

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME SAN MIGUEL HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
1	1	25.9	13.4	2.0
1	4	37.8	25.3	18.2
1	13	25.7	13.2	2.1
1	22	26.2	13.7	2.6
1	25	26.0	13.5	2.3
1	37	32.2	19.7	10.6
1	43	31.7	19.2	10.3
1	46	28.1	15.6	4.9
1	55	30.6	18.1	8.1
1	64	50.4	37.9	34.2
1	70	29.9	17.4	7.9
1	73	29.1	16.6	6.7
NUMBER OF CLUSTERS	12.			
MEAN		31.1	18.6	9.2
STANDARD ERROR		2.0	2.0	2.7
VARIANCE		49.2	49.2	84.6

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME JOAQUIN HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
2	76	25.2	12.7	1.1
2	88	37.2	24.7	17.0
2	91	31.7	19.2	10.7
2	94	26.7	14.2	3.0
2	106	35.7	23.2	15.2
2	118	25.9	13.4	2.0
2	121	25.1	12.6	.5
2	124	25.0	12.5	.4
2	127	28.7	16.2	7.8
2	133	25.9	13.4	1.8
2	145	33.1	20.6	12.7
2	148	33.1	20.6	13.0
NUMBER OF CLUSTERS	12.			
MEAN		29.5	17.0	7.1
STANDARD ERROR		1.3	1.3	1.8
VARIANCE		20.1	20.1	39.9

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME SMOKEY BEAR HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
3	151	25.3	12.8	1.2
3	172	28.2	15.7	4.6
3	175	32.6	20.1	11.6
3	184	26.1	13.6	2.7
3	193	44.1	31.6	25.4
3	199	32.1	19.6	10.1
3	202	28.1	15.6	4.7
3	208	27.8	15.3	4.3
3	214	34.2	21.7	13.8
3	217	27.7	15.2	4.5
3	220	28.6	16.1	5.4
3	223	26.2	13.7	2.3
NUMBER OF CLUSTERS	12.			
MEAN		30.1	17.6	7.6
STANDARD ERROR		1.5	1.5	2.0
VARIANCE		27.0	27.0	46.8

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME TRAIL HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
4	226	31.4	18.9	10.0
4	229	47.8	35.3	33.1
4	232	35.2	22.7	16.0
4	238	27.5	15.0	3.9
4	244	41.8	29.3	22.2
4	250	30.2	17.7	8.0
4	256	27.2	14.7	4.0
4	262	28.9	16.4	6.6
4	271	25.7	13.2	2.0
4	277	54.0	41.5	37.6
4	286	27.8	15.3	4.1
4	289	26.9	14.4	2.6
NUMBER OF CLUSTERS	12.			
MEAN		33.7	21.2	12.5
STANDARD ERROR		2.7	2.7	3.5
VARIANCE		85.9	85.9	149.6

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME BLUE BIRD HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
5	304	26.9	14.4	5.7
5	310	25.6	13.1	2.1
5	313	28.6	16.1	7.5
5	322	30.6	18.1	11.1
5	325	26.0	13.5	4.4
5	328	26.2	13.7	3.0
5	331	46.2	33.7	28.1
5	334	28.6	16.1	7.0
5	340	30.7	18.2	10.5
5	349	29.1	16.6	6.4
5	361	82.7	70.2	72.0
5	373	26.2	13.7	4.7
NUMBER OF CLUSTERS	12.			
MEAN		33.9	21.4	13.6
STANDARD ERROR		4.7	4.7	5.7
VARIANCE		266.3	266.3	385.8

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME RED TOP HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
6	382	27.2	14.7	4.2
6	385	27.2	14.7	4.6
6	388	33.9	21.4	12.6
6	391	31.2	18.7	10.3
6	394	33.2	20.7	11.9
6	400	28.2	15.7	5.6
6	412	27.0	14.5	4.8
6	415	39.7	27.2	20.8
6	421	32.0	19.5	13.7
6	436	25.7	13.2	1.3
6	439	26.9	14.4	3.6
6	448	27.1	14.6	3.3
NUMBER OF CLUSTERS	12.			
MEAN		29.9	17.4	8.1
STANDARD ERROR		1.2	1.2	1.7
VARIANCE		17.2	17.2	33.2

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME OJITOS HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
7	451	31.7	19.2	11.0
7	454	50.8	38.3	34.9
7	460	74.6	62.1	61.7
7	469	47.3	34.8	31.2
7	472	60.6	48.1	50.2
7	493	32.6	20.1	13.0
7	499	28.2	15.7	6.1
7	502	33.3	20.8	14.8
7	505	27.2	14.7	5.1
7	511	25.2	12.7	1.4
7	517	26.8	14.3	3.2
7	523	72.2	59.7	60.2
NUMBER OF CLUSTERS	12.			
MEAN		42.6	30.1	24.4
STANDARD ERROR		5.2	5.2	6.5
VARIANCE		328.0	328.0	508.1

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME LAKE FORK HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
8	526	31.5	19.0	14.2
8	529	38.3	25.8	20.0
8	538	32.6	20.1	11.4
8	541	29.6	17.1	11.7
8	547	77.1	64.6	62.3
8	553	66.7	54.2	54.8
8	562	78.8	66.3	67.0
8	568	95.7	83.2	88.4
8	574	47.2	34.7	30.9
8	586	83.3	70.8	72.9
8	592	74.7	62.2	64.4
8	598	90.7	78.2	82.5
NUMBER OF CLUSTERS	12.			
MEAN		62.2	49.7	48.4
STANDARD ERROR		7.1	7.1	8.3
VARIANCE		612.2	612.2	836.2

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME COCHITI HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
9	601	51.7	39.2	36.5
9	604	34.9	22.4	15.0
9	610	56.9	44.4	41.8
9	616	35.6	23.1	16.1
9	625	78.1	65.6	67.7
9	631	93.8	81.3	86.0
9	634	72.2	59.7	59.0
9	652	98.1	85.6	91.3
9	655	90.7	78.2	81.5
9	658	70.8	58.3	57.5
9	661	81.3	68.8	67.8
9	664	60.7	48.2	44.6
NUMBER OF CLUSTERS	12.			
MEAN		68.7	56.2	55.4
STANDARD ERROR		6.1	6.1	7.3
VARIANCE		451.7	451.7	642.2

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME CAPULIN HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
10	676	99.2	86.7	96.8
10	682	77.7	65.2	67.1
10	697	77.1	64.6	67.4
10	703	79.5	67.0	67.0
10	706	90.7	78.2	79.9
10	709	99.5	87.0	97.6
10	715	89.7	77.2	79.5
10	718	89.3	76.8	78.8
10	727	68.4	55.9	54.0
10	730	80.0	67.5	68.2
10	733	47.8	35.3	30.5
10	739	26.1	13.6	2.1
NUMBER OF CLUSTERS	12.			
MEAN		77.1	64.6	65.7
STANDARD ERROR		6.2	6.2	7.8
VARIANCE		457.6	457.6	725.6

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME AMERICAN SPRINGS HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
11	751	87.2	74.7	77.0
11	760	96.4	83.9	89.9
11	763	93.0	80.5	85.7
11	787	95.4	82.9	87.3
11	793	88.8	76.3	79.9
11	769	87.2	74.7	79.5
11	772	91.5	79.0	83.3
11	781	34.1	21.6	13.7
11	784	44.7	32.2	26.6
11	802	86.6	74.1	79.5
11	808	98.0	85.5	91.2
11	817	95.9	83.4	88.7
NUMBER OF CLUSTERS	12.			
MEAN		83.2	70.7	73.5
STANDARD ERROR		6.1	6.1	7.4
VARIANCE		440.2	440.2	649.7

WESTERN SPRUCE BUDWORM EVALUATION PROJECT

CLUSTER LEVEL MEANS - DEFOLIATION ESTIMATES

UNIT NAME LOS ALAMOS HOST DOUGLAS FIR YEAR 1980

UNIT	CLUSTER	DEFOLIATION ESTIMATES 4-CLASS	4-CLASS ADJ	6-CLASS
12	835	39.3	26.8	21.9
12	838	57.2	44.7	42.5
12	844	77.6	65.1	65.1
12	847	93.3	80.8	85.2
12	850	83.5	71.0	71.8
12	856	89.3	76.8	79.2
12	859	92.0	79.5	84.2
12	865	92.9	80.4	83.2
12	868	88.8	76.3	81.2
12	880	33.4	20.9	14.2
12	886	63.1	50.6	49.2
12	892	65.7	53.2	52.5
NUMBER OF CLUSTERS	12.			
MEAN		73.0	60.5	60.9
STANDARD ERROR		6.1	6.1	7.2
VARIANCE		447.4	447.4	614.3