

Population Monitoring of *Phacelia verna*: A Federal Candidate Species

Abstract

Population monitoring of *Phacelia verna* (Umpqua phacelia) was conducted over a five-year period between 1981 and 1985 to determine the effects of adjacent logging and road construction. Six plots were randomly selected along two transects in a single population. Counts of the number of individuals of *P. verna* in each plot were made twice during each growing season. Counts of other vascular plant species were made once during each growing season. Density (indiv/m²) of *P. verna* was found to vary significantly between plots but rarely between years. Similar results were found among associated species. Large fluctuations in seedling survival and capsule production were observed in *P. verna* throughout the study. These fluctuations did not correlate well with adjacent logging activity and are most likely explained by fluctuations in environmental parameters.

Introduction

Phacelia verna is a small annual in the Hydrophyllaceae (Waterleaf Family). White to light blue flowers are produced on a scorpioid cyme between April and June. Stems are up to 2.5 dm high, single or branched, and coarsely hairy. Leaves are alternate. More detailed descriptions can be found in Howell (1895), Abrams (1951), and Peck (1961).

Habitat requirements appear to be quite specific. All reported sightings have been on grass- and moss-covered balds or rock outcrops (Howell 1953; Oregon Natural Heritage Data Base unpublished data). Elevations of known sites range from 152 to 2011 m. Slopes are moderate, ranging up to 95% and the aspect usually is southerly from west to east. Balds where *P. verna* is found are wet in the spring when seeds germinate but begin to dry rapidly by the time of anthesis. The habitat becomes extremely dry and hot when capsules dehisce and begin disseminating seeds in late June or early July.

Distribution is restricted primarily to the Umpqua River drainage of Douglas and Coos Counties where a total of 63 sites are known. Sites are at times highly aggregated with as many as eight occurring in a single section. Two sites are known outside the Umpqua Valley, one just north of the Calapooya Divide in Lane County and another near King Mountain in Josephine County.

Phacelia verna is presently under review as a Candidate Species by the U.S. Fish and Wildlife Service (1985). The fact that there are relatively few populations, each having a limited distribution, combined with threats posed by intensive

forest management practices, indicate it is biologically appropriate for *P. verna* to be listed as threatened or endangered under the Endangered Species Act. Further field searches and an evaluation of the plants' susceptibility to threats must be made before a final decision can be reached. The purpose of this study was to evaluate the response of *P. verna* to adjacent logging activity and road construction, and to determine if protection measures implemented in the Timber Sale Plan were adequate. These measures included:

- (1) keeping yarder lines at least 200 feet and roads at least 100 feet away from the population;
- (2) rocking road surface to help control dust during loading and hauling operations;
- (3) prohibiting grass mulching of the road cut within 300 feet of the *P. verna* habitat;
- (4) prohibiting slash burning between 1 March and 15 July to insure seed set if the fire should escape; and
- (5) prohibiting herbicide application within 250 feet of the *P. verna* habitat.

Study Area

The study area is a typical sparsely vegetated bald located on the west slope of the Cascades in Douglas County (Sec. 27 NE1/4SW1/4, T. 25 S., R. 1 W., W.M.). The bald covers approximately 0.1 ha along the crest and upper slope of Williams Ridge at 975 m. Aspect of the bald is west with a 40-45 percent slope. The surrounding forest is a mixed conifer community consisting of *Pseudotsuga menziesii*, *Tsuga heterophylla*, and *Libocedrus decurrens* typical of the *Tsuga*

heterophylla zone as described by Franklin and Dyrness (1973). Most of the precipitation occurs in the winter months, with an average of 87% occurring October through April (McNabb *et al.* 1982, Froehlich *et al.* 1982). Snow can occur and accumulate between November and April. A thin soil over volcanic rock supports a community of moss, annuals, and scattered perennials. *Mimulus alsinoides*, *Collinsia parviflora*, *Trifolium variegatum*, *Gilia capitata*, and *Polygonum spergulariaeforme* are among the more frequently encountered annuals. The more common perennials include *Eriogonum compositum*, *Lomatium hallii*, and *Lupinus albifrons*.

Methods

Methods of monitoring were developed through consultation with the U.S. Fish and Wildlife Service (1980). Two transects were established across the bald with a total of six one m² plots randomly selected along the two transects. Population counts were made twice a year; once at the time of seedling establishment (22-27 April) and once at the time of peak flowering (13 May-1 June). A vegetation analysis was made at the time of peak flowering by identifying all species occurring in the six one m² plots and counting the number of individuals for each species. Litter accumulation was estimated at this time by determining the depth to bedrock using a metal spike graduated in centimeters that was permanently placed in each plot. Several photographs were taken at the time of peak flowering to document visually the condition of the habitat each season. The average number of capsules per plant for *P. verna* was estimated by counting capsules on 10% of the individuals in each plot once the plants reached fruit maturity (28 June-1 July). Plant identifications were made using Hitchcock and Cronquist (1973) and Peck (1961). Temperature was recorded using a model 5022 Weathertronics Hi Q hygromograph. Data was organized according to a crop year (October through September).

Results

Precipitation was recorded each month throughout the study at the National Forest Service Steamboat Ranger Station 5.8 km southeast of the study site by the Douglas County Water Resources Survey (Table 1). Monthly precipitation

TABLE 1. Monthly precipitation for CY 1981-1985.

Month	Precipitation (cm)				
	1980-1	1981-2	1982-3	1983-4	1984-5
Oct	7.8	12.6	17.6	5.6	19.0
Nov	10.8	21.1	15.0	31.6	43.5
Dec	23.1	49.4	33.6	37.8	17.4
Jan	5.6	17.4	13.9	7.1	1.6
Feb	18.0	16.5	30.3	24.3	13.9
Mar	11.2	16.0	24.1	18.4	14.9
Apr	8.6	14.5	12.1	20.0	8.5
May	11.0	0.7	7.2	12.5	4.3
June	7.9	5.3	3.7	11.2	8.8
July	1.4	1.9	8.2	0.8	0.6
Aug	0.0	1.4	5.3	0.7	1.1
Sept	7.5	11.5	1.4	2.1	6.6
Total	112.9	168.3	172.4	172.1	140.2

ranged from 0 cm in August 1981 to 49.4 cm in December 1981. Total annual precipitation was lowest in crop year (CY) 1981 with 112.9 cm recorded. Only minor differences in annual precipitation were observed during the next three year period, ranging from 168.3 cm to 172.4 cm. A total of 140.2 cm of precipitation was recorded in CY 1985. Spring precipitation was lowest in CY 1982. Precipitation between April and June of that year was 20.5 cm, 12.2% of the annual amount. May was exceptionally dry with only 0.7 cm of precipitation. In comparison, at least 3.7 cm occurred in any single month during this period in the other three years of the study. Spring precipitation was highest during the spring of 1984. Precipitation between April and June was 43.7 cm which was 25.4% of the annual amount, over twice the amount observed in CY 1982.

Temperature measurements were recorded during the last three years of the study (Table 2). Mean low temperatures were less than 1° C between November and March for all years. Mean high temperatures did not exceed 15.4° C for the same period and monthly mean temperatures did not exceed 7.3° C. Mean temperatures progressively increased to a high in August 1983 and in July of 1984 and 1985 ranging from 17.1° C to 21.1° C. Extreme low temperatures occurred in December of CY 1983 and 1984 and in February of CY 1985. Temperatures fell to -7°, -18°, and -13° for these

TABLE 2. Monthly temperatures (°C) for CY 1983-1985.

Month	Mean High			Mean Low			Monthly Mean		
	1982-3	1983-4	1984-5	1982-3	1983-4	1984-5	1982-3	1983-4	1984-5
Oct	16.2	17.4	11.3	4.6	5.0	1.6	10.4	11.2	6.4
Nov	6.8	4.2	4.5	-1.4	-0.6	-1.0	2.7	1.8	1.8
Dec	4.5	1.0	5.1	-2.0	-3.7	-4.0	1.3	-1.4	0.6
Jan	*	10.3	15.4	*	-1.0	-0.9	*	4.7	7.3
Feb	*	7.6	5.6	*	-1.5	-3.4	*	3.1	1.1
Mar	7.4	10.2	6.6	0.4	0.7	-3.1	3.9	5.5	1.8
Apr	12.3	8.9	14.5	-0.5	-1.6	1.8	5.9	3.7	8.1
May	17.9	14.8	16.3	4.7	2.0	2.3	11.3	8.4	9.3
June	19.2	18.1	23.2	5.7	4.7	7.4	12.4	11.4	15.3
July	20.2	27.2	30.0	7.5	9.9	12.2	13.9	18.6	21.1
Aug	23.7	26.3	26.2	10.6	9.0	9.1	17.1	17.7	17.7
Sept	21.8	23.4	19.4	6.9	6.7	5.7	14.4	15.0	12.6

*Recording instrument removed because of deep snow and adverse weather conditions.

three consecutive years. Freezing or below temperatures occurred through May 15, 1983, June 10, 1984, and June 24, 1985. Extreme high temperatures occurred on May 28, 1983 (39° C), July 15, 1984 (35° C), and June 17, 1985 (37° C).

Numbers of *P. verna* varied significantly throughout the study. Average plot densities dropped from 66.0 individuals per m² in CY 1981 to 1.8 in CY 1982 (Figure 1). The population rebounded in CY 1983 to 68.0 individuals per m² and then fell again to near 1982 levels in CY 1984 and CY 1985. Comparisons of mean plot densities using a two tailed t test revealed that mean plot density was significantly less in CY 1982 as compared to CY 1981 and CY 1983 but was statistically equivalent to CY 1984 and CY 1985 ($p=0.05$). Variation between plots was high all five years.

Similar results were observed among associated species (Table 3). Species fluctuated widely between years but variation between plots was high enough that these fluctuations were rarely significant. Several annuals (*Lotus micranthus*, *Mimulus alsinoides*, and *Montia perfoliata*) and one biennial (*Erysimum asperum*) were not observed in any plots during CY 1982 but were observed in all other years. One perennial, (*Castilleja pruinosa*) observed in CY 1981 was not observed in subsequent years. The only significant variation occurred between CY 1981 and CY 1982 for *Collinsia parviflora*, between CY 1982 and CY 1984 for *Montia perfoliata* and between

CY 1982 and CY 1985 for *Polygonum spergulariaeforme*. In all cases, CY 1982 was significantly less ($p=0.05$).

Very little variation was observed in other measured components. Percent non-vascular cover remained essentially unchanged (Table 4). Changes in litter accumulation were negligible.

Large fluctuations in seedling survival and capsule production were observed throughout the study. Mortality was 84% in CY 1982 (Table 5). Mortality dropped to zero or near zero in the last three years of the study. Capsule production decreased from 8.4 per plant in CY 1981 to 4.9 in CY 1982 and 3.9 in CY 1983. A sharp rise to 7.2 in CY 1984 and 6.0 in CY 1985 returned capsule production to near 1981 levels.

Discussion

Results have shown that density of vascular plant components of the bald community fluctuate substantially between plots but rarely between years. Only three out of sixteen associated species (*Montia perfoliata*, *Polygonum spergulariaeforme*, and *Collinsia parviflora*) showed any significant variation between years and in each case 1982 was lower than all other years. Similarly population levels of *P. verna* were lower in 1982 as compared to 1981 and 1983.

These fluctuations have not correlated very well with logging activity. Road construction began in November 1982 and continued intermittently throughout the following winter and

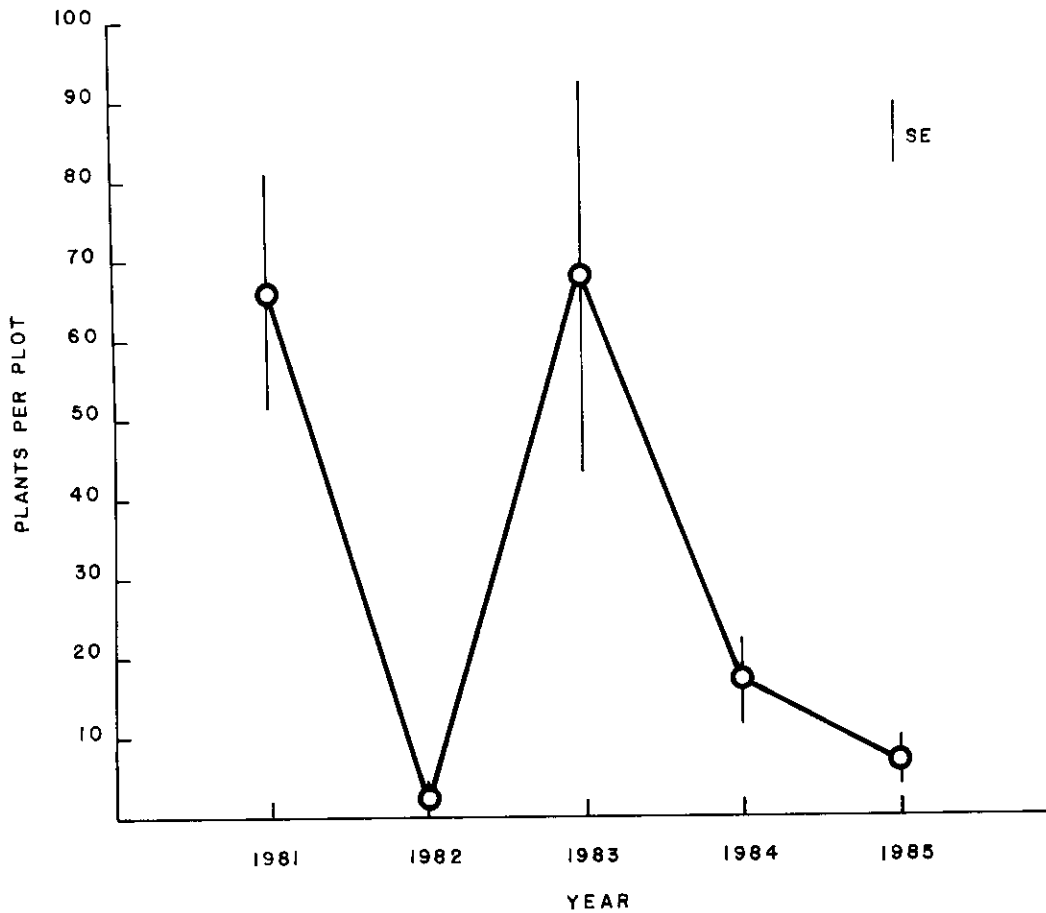


Figure 1. Mean plot densities of *Phacelia verna* 1981-1985

spring. Logging on one of two adjacent units began in August and was completed in November 1983. The second unit was logged between May and September 1984. Some of the most intensive logging adjacent to the study area occurred immediately prior to and during the growing season that produced the greatest number of *P. verna* which was significantly more than the previous year when no logging occurred. These observations seem to indicate that the protection measures implemented in the timber sale plan were effective. This is further supported by photos of the habitat which show no disturbance or visible change of any sort over the course of the study. Delayed impact however, is possible.

Monitoring will have to be continued to determine if the relatively low population levels observed in 1984 and 1985 persist.

Fluctuations in community structure are most likely explained by fluctuations in environmental parameters, in particular, precipitation and temperature. This would seem to explain the low population levels of *P. verna* in 1982. A cold late spring with snow remaining on the ground well into April (field notes) followed by unusually dry conditions in May (Table 1) very likely contributed to the low germination and high mortality observed that year (Table 5). The rebound of *P. verna* in 1983 provides evidence of substantial seed storage in the soil.

TABLE 3. Average plot densities (indiv/plot) at time of peak flowering 1981-1985.

Species	Plot Density				
	1981	1982	1983	1984	1985
<i>Arenaria stricta</i>	0.0	0.3	0.0	6.0	0.5
<i>Berberis nervosa</i>	0.2	0.2	0.2	0.2	0.3
<i>Castilleja pruinosa</i>	0.2	0.0	0.0	0.0	0.0
<i>Collinsia parviflora</i>	15.2	0.7	34.7	64.8	13.7
<i>Epilobium minutum</i>	41.2	4.5	5.0	23.3	3.7
<i>Eriogonum compositum</i>	7.7	11.5	14.0	11.8	13.7
<i>Erysimum asperum</i>	0.8	0.0	0.3	0.2	0.2
<i>Gilia capitata</i>	19.8	0.5	16.7	4.7	7.7
<i>Lomatium hallii</i>	6.2	5.2	3.0	19.2	10.5
<i>Lotus micranthus</i>	7.0	0.0	2.0	1.2	0.7
<i>Lupinus albifrons</i>	1.8	0.3	0.2	0.3	0.3
<i>Microsteris gracilis</i>	35.5	0.8	10.8	12.7	6.7
<i>Mimulus alsinoides</i>	5.3	0.0	4.8	14.2	8.3
<i>Montia perfoliata</i>	32.0	0.0	10.5	23.5	2.5
<i>Phacelia verna</i>	66.0	1.8	68.0	17.0	7.3
<i>Polygonum spergulariaeforme</i>	28.2	1.3	14.3	23.5	23.8
<i>Trifolium variegatum</i>	5.8	3.3	6.0	2.5	7.0

TABLE 4. Vegetation analysis at time of peak flowering 1981-1985.

Component	Component Value				
	1981	1982	1983	1984	1985
% Grass Cover	3.2	1.0	1.3	1.5	1.3
% Non Vascular Cover	86.0	86.0	85.5	90.5	93.8
Litter Accumulation (cm)	3.9	3.6	4.0	4.8	4.4

TABLE 5. *Phacelia verna* seedling mortality 1981-1985.

Year	Ave. Number per plot		Mortality	
	Seedling	Peak Flowering	Individuals	Percent
1981	—	66.0	—	—
1982	11.5	1.8	9.7	84
1983	69.8	68.0	1.8	3
1984	17.0	17.0	0.0	0
1985	7.5	7.3	0.2	3

Dependency of *P. verna* on precipitation alone is not supported by the data collected to date. Regression of *P. verna* density against precipitation for the months of April through June, April through May, and May alone and against percent of annual precipitation for the month of May did not show any significant relationship for all years of the study ($p=0.05$).

Further research and monitoring needs to be conducted before the ecology of *P. verna* can be clearly understood. In particular, the response of *P. verna* to fluctuations in environmental parameters needs to be more thoroughly exam-

ined. Data on seed viability, germination requirements, and in situ substrate seed densities needs to be obtained.

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