SECOND-YEAR RESULTS OF AN INVESTIGATION INTO THE LIFE HISTORY AND POPULATION DYNAMICS OF *CALOCHORTUS NITIDUS* DOUGL. (LILIACEAE)

by

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ABSTRACT

Detailed data on the morphology, life history, and reproductive biology of Calochortus nitidus, a Federal Candidate Plant Species, has been collected during two consecutive field seasons from permanent plots on the Nez Perce National Forest. These data suggest that about 25% of a population is reproductive in a given year. Nearly all of the buds produced in a given year are nipped, mostly by cattle, prior to fruit set. Reproductive success, as measured by the percentage of buds produced which develop into mature fruit, was about 5% during the first year and slightly greater than 10% in the second year. Herbivory by small mammals also appears to significantly lower the reproductive success of some populations; this is thought to be a local phenomenon of little detriment to the overall population.

Field observations over a three-year period suggest that the abundance of plants in individual populations may be maintained at current levels, or perhaps even enhanced, by a rest-rotation grazing system. It is recommended that a simple, multi-year experiment be conducted to determine the effects of exclusion from grazing, grazing on an annual basis, and grazing with a resting period every third year, on the species. These data will then be used to design and implement a Habitat Management Plan for the species on public lands administered by the US Forest Service.

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INTRODUCTION

This report presents the results of two years of investigations on the life history and population dynamics of Calochortus nitidus, a regional endemic plant which had a historic distribution throughout much of the Idaho portion of the Palouse Prairie. The species also occurred in the adjacent portions of the State of Washington where it is now considered extirpated. The species is now extirpated from large areas of its former range in Idaho as well (Caicco, 1988a,b).

For these reasons, Calochortus nitidus has been recommended to the U.S. Fish and Wildlife Service as a Category 1 candidate species for listing under the Endangered Species Act (Caicco, 1988b). Because sizable populations are extant on public lands, however, it was further recommended that a Habitat Management Plan be developed for the species in lieu of formal listing. The results of this study comprise the baseline data for developing such a plan.

STUDY SITES

Two study sites were established during the summer of 1988 in the Cold Springs Mountains on the Slate Creek Ranger District of the Nez Perce National Forest. The first site is at Cow Creek Saddle. The second site is within an elk exclosure at Joe Creek/Christie Creek Divide. Maps showing the specific locations of permanent plots are include in Appendix I.

METHODS

The field methodology followed was the same as that described by Caicco (1988a). Data was collected within quadrats established during 1988 at Cow Creek Saddle and within the elk exclosure at the Joe Creek-Christie Creek Divide (below Grave Point). The plots were read on July 3, 1989 and again on August 17, 1989. During the first visit few plants were in flower, although many were in bud. At this time, most young basal leaves had not yet dried and withered.

The following data were collected during each visit to the sites: i) the maximum above-ground length of the basal leaf; ii) the maximum width of the basal leaf; iii) the number of floral buds produced; iv) the number of fruits set; and, v) evidence of herbivory, specifically noting the location and nature of the loss or damage to the leaves, flowers, and fruits. These data are included in Appendix II. The data on leaf width and length are not discussed in this report.

RESULTS

Two consecutive years of data on the reproductive biology of Calochortus nitidus within four permanent transects are now available. Two-year results in four major categories will be presented for each of the four transects. These categories are: 1) the number of plants in each quadrat; 2) the number of reproductive plants in each quadrat; 3) the number of floral buds produced; and, 4) the number of fruits set. Because of their close proximity in an area of open grazing, Transects X001, X002, and X003 will be discussed together. Transect X004, located in an exclosure will be discussed separately.

Transect X001, X002, and X003

Number of plants

In 1988, there were a 52 plants of Calochortus identified within the ten quadrats of Transect X001; during 1989, the number more than doubled with a total of 109 plants (Figure 1a). More plants were seen in 1989 in all seven quadrats which had plants the previous year; no new plants appeared in the three quadrats which lacked plants in 1988. A similar increase in the total number of plants was seen in the two 1-m^2 quadrats of Transects X002 and X003, which increased in number of total plants from 23 to 45, and 25 to 36, respectively (Fig. 3a,b). The total number of plants in the three transects increased from 100 in 1988 to 190 in 1989.

Number of reproductive plants

The number of reproductive plants (those which produced at least one floral bud) within Transect X001 during the summer of 1988 was eight (Fig. 1b). Transects X002 and X003 had six and ten reproductive plants respectively (Fig. 3a). The total of 24 reproductive plants in these three transects represented 24% of the total number of individuals within them.

In 1989, the number of reproductive plants in Transect X001 increased by four to twelve (Fig 1b). The number of reproductive plants in Transects X001 and X002 increased to 16 and 12, respectively (Fig. 3b). These 40 plants represent about 21% of the total number of individuals within the transects.

Number of floral buds

A doubling in number from 12 to 24 between 1988 and 1989 was seen in the number of floral buds formed by plants in Transect X001 (Fig. 2a). The number of floral buds formed within the two 1-m^2 quadrats of Transects X002 and X003 also showed an increase from 13 to 37 and 15 to 25 buds, respectively (Fig. 3a,b).

Figure 1. a) total number of plants by quadrat in Transect X001 during 1988 and 1989; b) number of reproductive plants by quadrat in Transect X001 during the same years.

Figure 2. a) number of floral buds by quadrat in Transect X001 during 1988 and 1989; b) number of fruits set by quadrat in Transect X001 during the same years.

Figure 3. a) number of plants, reproductive plants, floral buds, and fruits set in Transects X002, X003, and X004 during 1988; b) data for the same categories during 1989.

Number of fruits set

The total number of fruits set by reproductive plants in the quadrats of Transect X001 increased from one in 1988 to six in 1989. No fruits were produced in Transects X002 or X003. The two fruits set in 1988 represented about 5% of the floral buds formed by plants within the three transects. In 1989, nine fruits were produced in the three transects, that is, about 10% of the total number of floral buds produced.

Transect X004

A general increase in total numbers in two of the four categories between 1988 and 1989 was seen in the 1-m^2 quadrat which comprises Transect X004 (Figure 3a,b). The total number of plants increased from 26 to 40. Nine of these plants were reproductive in each year. The fifteen floral buds present on these plants in 1988 produced ten fruit, a success rate of 67%. In 1989, however, only 12 buds were formed and they produced only one fruit. This is a reduction in this measure of reproductive success to slightly greater than 8%.

Other Field Observations

The area outside of the elk exclosure, which had been heavily grazed in 1987 and 1988 was only lightly grazed by livestock during the summer of 1989. In many areas in which there was no aboveground evidence of Calochortus in prior years, hundreds of individuals were present in 1989. This was also observed at Grave Peak, where in previous years only a few scattered individuals were present; during 1989, in the absence of significant cattle grazing, numerous individuals were seen.

In addition to the monitoring of Calochortus nitidus in the permanent transects, survey work was conducted along the ridge north of Pittsburg Saddle and on the Clearwater Ranger District of the Nez Perce National Forest. North of Pittsburg Saddle, I surveyed the ridge from Mottman Saddle to Big Canyon Saddle. A moderate-size population of Calochortus nitidus occurs along the south- and west-facing slopes south of Big Canyon Saddle (Map 3, Appendix I). There were no apparent threats to the population.

On the Clearwater Ranger District, I visited several of the populations reported by Brixen during the summer of 1988 (Caicco, 1988a). Brixen estimated the population size as either light, moderate, or dense. Based on my observations during the 1989 field season, these categories are roughly equivalent to those employed in my 1987 report. I discovered two new populations in the vicinity of those found by Brixen (Map 4, Appendix I). I also extended my survey south to the Pinnacle Ridge area, but found only two small patches of Calochortus in this area (Map 5, Appendix I), which is heavily grazed by livestock.

DISCUSSION

Much of the apparent increase in total numbers of individuals may be artificial. The summer of 1988 was a dry year in which the first visit to the site was made while most plants were in full bloom. Many smaller basal leaves had already dried and withered, resulting in an underestimate of the number of plants present.

Nevertheless, a general increase in reproductive success was be seen in the Transects X001, X002, and X003 between 1988 and 1989. In 1988, 100 plants were present in these three transects. Of these 100 plants, a total of 26 were reproductive. These 26 plants formed 40 floral buds, which succeeded in producing only one fruit. In 1989, a total of 190 plants were observed, of which 40 were reproductive. These 40 plants formed 86 floral buds, which produced nine fruits. The overall success in fruit production by floral buds increased, therefore, from less than three percent in 1988 to over 10% in 1989.

A different picture emerges, however, from Transect X004, located within the elk exclosure. Although total numbers increased from 26 to 40 plants between 1988 and 1989, the number of reproductive individuals remained stable at nine. This is a relative decrease from about 33% to 23% The number of floral buds set by the nine plants decreased slightly from 15 to 12. The major difference between the years, however, can be seen in the number of fruit set which decreased from ten in 1988 to only one in 1989.

Caicco (1988a) suggested that cattle grazing was the most likely factor in the apparent low degree of reproductive success exhibited by the 1988 quadrat data. Although nipping of floral buds by cattle is the major factor in reducing reproductive success in areas open to grazing, deer may also be nipping buds.

Neither cattle nor deer grazing can explain the sharp drop in fruit production observed inside the elk exclosure during 1989. Of the 12 floral buds produced, five appeared to abort (some perhaps due to herbivory) five disappeared between visits, and one was still present when last observed (Appendix II). The twelfth bud disappeared along with the plant which produced it. The soil around this plant had been freshly churned. It appeared as if by the plant had been pulled underground by a small burrowing mammal (pocket gopher?). Basal leaf herbivory by small mammals had been noted in previous years (Caicco, 1988a), although no taking of fruits had been observed.

The habitat in which the Calochortus is found within the elk exclosure is dissimilar to that in which the other transects were placed. The soils are deeper, the vegetation is more dense and lush, the species assemblage differs, and the local environment

is much more mesic. The elk exclosure site appears to provide optimal conditions in this area for the growth of robust plants of Calochortus with large, succulent leaves. The deeper soils may also provide better habitat for what seems to be another major herbivore of the broad-fruited mariposa, the pocket gopher.

My observations suggest that Calochortus herbivory by small mammals is a localized phenomenon, whose impact is negligible on at the population level. It appears to be most common on deeper soils, while large populations of Calochortus are most common on rockier soil. As shown by the 1989 quadrat data for Transect X004, however, the local impacts on reproduction can be great.

The fact that large numbers of Calochortus were observed in areas which in previous years had only a few individuals is interesting. As noted above, the plants were in areas which in previous years had been heavily grazed, but in which no significant livestock grazing took place during the summer of 1989. This suggests that a rotational grazing system might be effective in maintaining, or perhaps even enhancing, the existing population levels of Calochortus nitidus on public lands.

SUMMARY

Calochortus nitidus appears to have a relatively low rate of reproductive success when growing in areas open to grazing by domestic livestock. Although trampling of plants has been observed, the most important factor detrimental to the reproductive success of individual plants is the nipping of floral buds prior to fruit set. The highest percentage of successful fruit set (based on floral buds formed) in grazed
situations is about 10%.

Although the short-term effects of this reduction in reproduction may be negligible, the long-term effects are unknown. Based on field observations over several years, it seems probable that continual heavy grazing by cattle can reduce Calochortus population numbers to very low levels and, in some cases, result in local extirpation.

Total numbers of Calochortus nitidus, as well as reproductive success, appeared to improve between 1988 and 1989 in transects open to grazing by livestock. The increase in total numbers in part reflects an underestimate during the first year of this study. At best, however, the percentage of floral buds which produce fruits under the current grazing management appears to be low, a maximum of about 10%. This is in a population in which only about 25% of the plants are reproductive in a given year. The effects of this lowered reproductive success on overall population numbers are not known.

A sharp decrease in fruit production also occurred in 1989 within the elk exclosure and appears to be attributable to herbivory by small mammals and, perhaps to a lesser degree, by insects. This appears to be localized herbivory, probably of little significance to the overall population.

Some areas in which Calochortus was previously seen in extremely low numbers supported large populations of the species during 1989. This phenomenon is attributable to the lack of significant grazing by cattle during the 1989 field season, and suggests that a rotational grazing system might be effective in maintaining, or perhaps even enhancing, the existing population levels of Calochortus nitidus on public lands.

RECOMMENDATIONS

Despite two years of detailed data collection, many questions remain to be answered about the population dynamics of Calochortus nitidus. Perhaps more relevant to land managers, however, is the question of how to manage the habitat of the species in order to maintain, or enhance, the existing population levels of the species. Field observations during 1989 suggest that a rotational grazing system may be the best management tool available toward this goal.

My recommendation is that the Nez Perce National Forest, in coordination with the USFS Region 1 ecology staff and the U.S. Fish and Wildlife Service develop a Habitat Management Plan for Calochortus nitidus. In order to do so, one basic question must be answered - what is the long-term response of the broad-fruit mariposa to differing grazing regimes. I suggest that a minimum of three grazing regimes be tested - no grazing, open grazing on a annual basis, and open grazing with a rest period every third year.

In order to examine this problem, one permanent exclosure, and one temporary exclosure, each 100-m^2 (roughly equal to 1/5 of an acre, or 33 ft^2) in area, should be established in an area subject to annual grazing by domestic livestock. A third 100-m^2 area would be marked to serve as the annual grazing treatment. These macroplots should be located adjacent to one another in an area of relatively homogeneous vegetation, readily accessible by motor vehicle (for example, the vicinity of Cow Creek Saddle).

The temporary exclosure should be installed during the first year prior to the time cattle arrive in the area, (prior to mid-June), and should remain in place until the plants have dispersed their seed. It would then be removed for the next two grazing seasons. Within each of the three areas, information need only be kept on three parameters: 1) the number of reproductive individuals (a loop of colored plastic flagging should be place

loosely around each reproductive plant); 2) the number of floral buds produced; and, 3) the number of fruits set. These three parameters are easily observed and recorded. I estimate that the collection of these data would require only a few hours of time on two or three separate days during the period between late-June and early-August.

The data collection should be repeated at three-year intervals (that is, each year that the temporary exclosure is erected). At the end of the third year of data collection (the seventh year of the experiment - see Appendix IV), the data should be analyzed for significant differences attributable to the three treatments. At that time, if the results show that population levels of the mariposa respond favorably to a particular treatment, a Habitat Management Plan can be developed which will implement that treatment wherever population levels of the species appear to be in decline. If it seems necessary, the experiment can be extended over an additional period of time.

REFERENCES CITED

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Caicco, S.L. 1987. Field investigations of selected sensitive plant species on the Nez Perce National Forest, Idaho. Report submitted under Cooperative Challenge Grant Project. Idaho Natural Heritage Program, Idaho Department of Fish and Game, Boise. 42 pp., plus appendices.

APPENDIX I

MAPS

APPENDIX II

DATA FROM PERMANENT PLOTS

APPENDIX III

DIAGRAMS SHOWING LOCATIONS OF INDIVIDUAL PLANTS WITHIN PERMANENT PLOTS

Each diagram shows the location of individuals within a single square meter quadrat. Circled numbers indicate plants which were first observed in 1989. A diagonal slash indicates the absence in 1989 of a plant observed in 1988. The corners and center of the quadrat are indicated by a "+". The positions of quadrats located along the 50-meter transect are also indicated, where appropriate. Refer to Appendix II.

APPENDIX IV

HABITAT MANAGEMENT PLAN WORK SCHEDULE

The following work schedule is the suggested framework for a multi-year study to determine the effects of several grazing regimes on the reproductive success of Calochortus nitidus.

1990

June

Establish three 10-m X 10-m macroplots within a relatively homogeneous population of Calochortus nitidus. One macroplot should be enclosed by a permanent fence built to exclude cattle and deer. A second macroplot should be temporary, but capable of excluding cattle and deer. The corners of the third macroplot should be marked with rebar stakes, but remain open to grazing.

late June-early July

Prior to the time cattle are present in the area, all reproductive plants within the three macroplots should be marked with a loose basal loop of colored flagging. The flags should be numbered sequentially to facilitate counting. The total number of reproductive plants and the total number of buds or flowers they produce should be tallied and recorded.

late July-early August

The total number of fruits produced within each of the three macroplots should be tallied and recorded.

September

The temporary exclosure should be removed.

1991 Check on integrity of permanent exclosure.

1992 Check on integrity of permanent exclosure.

1993

June

Establish temporary exclosure.

During 1993 field season, complete same tasks described under late June-early July, late July-early August, and September of 1990 according to the same schedule.

1994 Check on integrity of permanent exclosure.

1995 Check on integrity of permanent exclosure.

1996

June

Establish temporary exclosure.

During 1996 field season, complete same tasks described under late June-early July, late July-early August, and September of 1990 according to the same schedule.

Analyze data and prepare Habitat Management Plan based on the results. Extend monitoring if deemed necessary.