Bradshaw's Desert-Parsley: Population Monitoring and Pollination Biology[1]

By Thomas N. Kaye

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Lomatium bradshawii (Bradshaw's desert-parsley) is unique. It is the only plant species in western Oregon listed by the US Fish and Wildlife Service as endangered. It is rare; only a handful of populations in remnant prairies and fence-rows are known, all in the Willamette Valley. And it is a challenge; conserving the species requires a thorough understanding of its biology. To preserve a species it is essential to know how it reproduces, what controls its population growth and decline and how to maintain an appropriate habitat (Harper, 1979; Massey and Whitson, 1980).

Thanks to the efforts of several researchers, a great deal of information on *L. bradshawii* is already known. In this article I report the results of my research on the pollination and population biology of *L. bradshawii* and review some work of others. Much of my work was conducted at a population in Buford Park east of Eugene near Mount Pisgah. This population met all the conditions necessary for the studies I conducted: It was easy to reach, occurred on public land, contained a large number of flowering plants, and botany students from nearby Lane Community College were able to participate in the study.

Monitoring the Buford Park Population

The population of *L. bradshawii* at Buford Park is at the eastern limit of the species' range, and is one of about a dozen populations known. When I first visited the site in the spring of 1990, it was obvious that the population was in jeopardy. I came to attend an on-site meeting of federal, state and county agency representatives with the purpose of evaluating the effect of cattle grazing on this sensitive plant and its habitat. *Lomatium bradshawii* plants had been trampled and eaten, the vegetation was grazed, and in some places, the soil was deeply churned by cow hooves. Cow flops punctuated the scene. The meeting's participants recommended that the area containing the population be fenced to exclude cattle, and thanks to a cooperative rancher, the fence was built a few months later.

Despite the negative impact of cattle that we observed, and that has been documented for other *Lomatium* species (e.g. Willoughby, 1987), grazing apparently had a role in maintaining the habitat for *L. bradshawii*. For hundreds or even thousands of years, Native Americans burned the prairies of the Willamette Valley, a practice that restricted the growth of woody vegetation and kept grasslands open. After settlement by Euro-Americans, fires were suppressed and trees and shrubs replaced large areas of native prairie (Johannessen et al., 1971). The cattle in Buford Park partially filled the role of fire by suppressing woody vegetation. Even with cows, however, large clumps of *Spiraea douglasii* grow in the wet-prairie habitat of *L. bradshawii*, and fire or manual cutting may be needed to maintain the open prairie the species seems to require. Connelly and Kauffman (1991) from Oregon State University have shown that *L. bradshawii* plants increase in size and seed production after their habitat is burned. Thus, fire may be the best tool to stimulate population growth *and* maintain the open prairie if the population declines.

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Spiraea encroaching into the wet desert-parsley habitat in the absence of fire choking out the prairie species.

Baseline information, updated annually, will help determine if and when the habitat at Buford Park should be burned or mowed. I decided to establish permanent transects for monitoring the *L. bradshawii* population to provide these data. With the help of Dr. Rhoda Love's botany class from Lane Community College, I established six transects in the population at Buford Park. At every meter along the transects, we mapped and measured each *L. bradshawii* plant in 20×50 cm plots. Some transects were placed in the open, while others were positioned near the expanding edge of *Spiraea* clumps to document the effect of shrub encroachment. Of course, after only one season of data collection, no trends can be reported. However, some patterns revealed by the structure of the population, especially when compared to other sites, are worth describing now. I sampled a population at Amazon Park in Eugene for detailed comparison with the Buford site.

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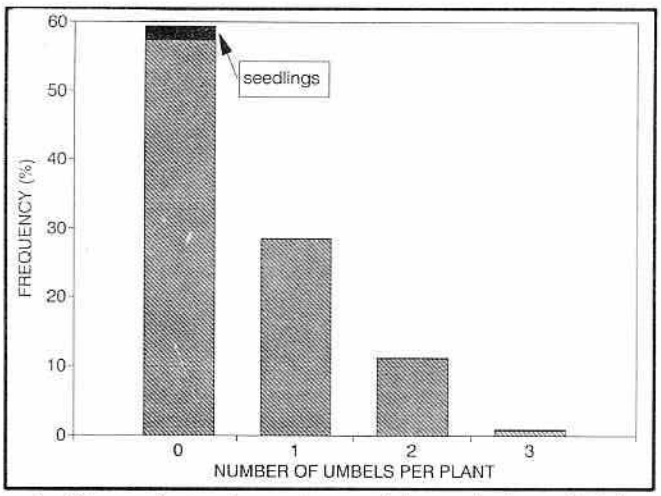
Annual monitoring is necessary to determine if the population at Buford Park is declining because of shrub invasion. An enthusiastic botany class from Lane Community College helped with the 1991 sample.

Plant Size and Population Structure

The population at Buford Park was very dense, averaging 52 plants/m² with a maximum of 230 plants/m². This density was higher than any previously reported for *L. bradshawii*, including all the sites sampled by Connelly and Kauffman in 1988-1990, and the Amazon Park population. Also, the plants at Buford Park were relatively small, averaging only 16 cm tall with three leaves. Plants at other sites were generally taller with more than three leaves. My curiosity was piqued by NPSO member Tom Pringle who suggested to me that the fruits of *L. bradshawii* looked bigger at Amazon Park than at Buford. When I sampled the plants at Amazon Park I found that, in a population with a density of only 4 plants/m², the average plant produced 75 seeds on two umbels (flower clusters). But Buford plants matured an average of only 8 seeds on 1.2 umbels! Pringle was right; fruits from Amazon Park were nearly twice the length and weight of the Buford fruits. The small stature and low seed production of the Buford plants may have been related to high population density at that site. As density increased, leaf length, umbel number and plant height decreased significantly. One hypothesis to explain this pattern is that conditions for seedling establishment at Buford Park may be good, but soil nutrients may be limiting, thus leading to a high density of small plants. The situation may be reversed at Amazon Park, with plentiful nutrients and poor conditions for seedlings.



Seedlings made up only two percent of the population at Buford Park. Most individuals were non-reproductive.

Seedlings of *L. bradshawii*, however, were not very abundant at Buford Park in 1991. Only 2% of the individuals mapped had the cotyledon leaves indicative of first-year plants. Reproductive plants made up about 40% of the population, while the remainder were non-flowering. Small plants tended to be seedlings or non-reproductive, while large plants usually produced flowers. In general, the Buford population was skewed toward small and non-reproductive plants, a structure similar to that reported by Connelly and Kauffman.

Pollination Biology

Lomatium bradshawii does not reproduce vegetatively (e.g., by runners or basal sprouts). Instead, it relies on seed production, and therefore pollination, for population maintenance. At first glance, the pollination biology of *L. bradshawii* appears simple. The flowers are presented in a flat-topped umbel that most insects, large or small, can visit and pollinate. Upon closer inspection, the breeding system is more complicated. *L. bradshawii* has two kinds of flowers, male (stamens only) and hermaphroditic (stamens and pistil). Only the latter type can produce fruits and seeds. As in most species of *Lomatium*, the hermaphroditic flowers are protogynous; i.e., the stigmas become receptive and exerted before the anthers shed their pollen. In addition, the first umbel on a given plant will have a majority of male flowers, while later umbels will have a higher proportion of hermaphroditic flowers (Schlessman, 1978, 1980).

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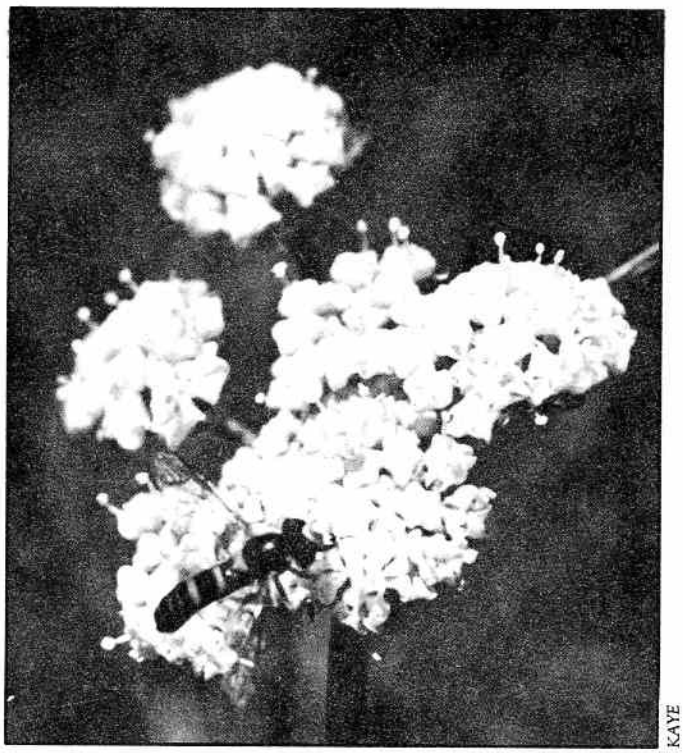
In Bradshaw's desert-parsley only perfect flowers produce fruits. A swallow-tail butterfly caterpillar at Buford Park.

In his Master's thesis on the biology of *L. bradshawii*, Kagan (1980) showed that reproductive plants produced one or two (rarely three) umbels per season. The umbel is usually all male, and the second has at least some hermaphroditic flowers. Each phase of sexuality in *L. bradshawii* appears to be sequential. I observed that, on umbels with hermaphroditic flowers the hermaphrodites were usually on the outer umbellets, *and* on the outer edge of the outer umbellets. The outer umbellets and the outer flowers were always the first to bloom, resulting in protogyny. Although some self-pollination may occur (and *Lomatium* species are usually self-compatible), the probability of cross-pollination by insects is increased because male and hermaphroditic flowers within a single plant mature at different times. Pollination biologists consider this type of breeding system to be the result of natural selection for outcrossing, and thus gene flow, to offset the deleterious effects of inbreeding. Unfortunately, efforts thus far by Kagan and myself to test for self-pollination in *L. bradshawii* have failed for various reasons, and it is still unknown whether hermaphroditic flowers can set seed in the absence of insects.

Insect Visitors

Species that rely on insects for pollination are vulnerable to the loss of their pollinators, for without them, they are unable to produce seeds and new individuals. For example, an orchid species pollinated by a single species of long-tongued moth could die out if the moth became extinct. Although *L. bradshawii* may be capable of some self-pollination, the breeding system described above suggests that insect-mediated cross-pollination is the rule. Therefore, the fate of *L. bradshawii* may depend, at least in part, on the survival of its pollinators. The Willamette Valley is an intensely agricultural area. Every year a huge acreage, including many fence-rows and road-sides, is sprayed with insecticides and herbicides. Local destruction of pollinating insects and their nesting habitat is cause for concern. Does *L. bradshawii* depend on insect pollinators that could be damaged by this spraying? Researchers have suggested that rare plant populations should be surrounded by a no-spray zone with a three-mile radius to protect vital pollinators (Tepedino, 1990). However, very little is known about the pollintor(s) of *L. bradshawii*. Information on their identity and abundance may be crucial to the recovery of this endangered species.

In 1990 and 1991 I visited four populations of *L. bradshawii* to observe and collect insect pollinators for identification and examination of pollen load. These populations, Buford Park and Amazon Park in Lane County, and Finley National Wildlife Refuge and Jackson-Frazier wetland near Corvallis in Benton County, were chosen to represent the geographic range of the species. I worked during various weather conditions (sunny to rainy) and times of day. *Lomatium bradshawii* blooms in early spring, usually in April, before many insect species are active. Even so, I encountered a large variety of bees, flies and other insect visitors to the plants. In all, I collected 93 specimens representing 25 species from flowers of *L. bradshawii* (Table 1). Two extremely small species of flies did not carry pollen and were unlikely pollinators. Also, ants observed on umbels at the Jackson-Frazier population did not carry pollen, seldom moved among plants and were probably ineffective pollinators. However, ten species (bees, flies, wasps and beetles) carried pollen on their bodies or legs, demonstrating their potential ability to cross-pollinate *L. bradshawii*, and most insects frequently moved from one plant to another. At least one bee, in the genus *Andrena*, may be the same as that observed by Kagan in 1980. Hover-flies (family Syrphidae) were prominent among the flies observed in 1991.



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A hover fly (Syrphidae, *Sphaerophoria* sp.) *visits Bradshaw's desert-parsley.*

One important pattern was that the relative abundance of bees and flies changed from 1990 to 1991. The 1990 collections were dominated by solitary bees, but flies outnumbered all other insects in 1991. Weather conditions may have been more suitable for bees (i.e. warmer) in 1990, and flies may have been better able to tolerate the cooler April of 1991. In addition, only three insect species were seen at more than one site. No single insect species dominated the pollinator fauna of *L. bradshawii* in two years of observations. Instead, a high diversity of insects visited the flowers, and many of these appeared capable of affecting cross pollination. Apparently, *L. bradshawii* is not vulnerable to population swings of any one insect species.

Conservation

The successful maintenance and recovery of *L. bradshawii* depends on an adequate understanding of the species' biology. Protecting the habitat of the species from develop-

ment is of foremost concern, but the dynamic nature of its interactions with the environment, plant succession, fire and insect pollinators require that we do more. Only a small part of the "story" of this species has been told in these pages. It is hoped that the combined knowledge of many researchers working on various aspects of the biology of *L. bradshawii* will allow us to protect it in perpetuity. Sooner or later the Buford Park population will require some rigorous management, such as burning to control shrub invasion. We now have the baseline information to help decide when that action should be taken. The complex breeding system of the species indicates that insects may be crucial to cross-pollination and seed production. Fortunately, floral visitors appear to be diverse and widely capable of pollinating the flowers. In the long-run, protecting the nesting sites of pollinators may be a necessary component of the species' conservation.

TABLE 1. Insect visitors to *Lomatium bradshawii* flowers at four sites in the Willamette Valley in 1990 and 1991. Numbers indicate how many specimens of each taxon were collected. The family is given when the genus is unknown.

	Buford 1990	Buford 1991	Finley 1990	Finley 1991	JF 1991	Amazon 1991
Solitary Bees						
Andrena sp. 1*	7					
Andrena sp. 2*	1					
Ceratina sp.			5			
Halictidae sp.					1	
Lasioglossum sp.			1		1	
Melanostoma sp.*				1		
Tenthredinidae sp.*				1		
Wasps						
Ichneumonidae sp.*				1		
Flies						
Anthomyiidae sp.		1		5	1	
Calophoridae	1					
Cheilosia sp.		1				
Empididae sp. 1		3			5	6
Empididae sp. 2**				3		
*Mesograpta marginata**	1					
Paragus sp.*					18	
Rhagio sp.						1
Sphaerophoria sp.*					5	
Xylota sp.*	1					
Misc. Diptera**	1					
Caddisflies						
Trichoptera sp.						2
Beetles						
Bruchus brachiodis						1
Dalopius sp.						1
Diabrotica undecimpunctata				1		
*Lebia moesta**					5	
Ants						
*Formica fusca**					1	
Total specimens	12	5	6	12	47	11
Total species	6	3	2	6	7	5
Bees/Flies/Other	66/33/0	0/100/0	100/0/0	17/67/8	4/63/11	0/64/36

*specimens carried pollen.
**individuals very small and unlikely to transfer pollen among umbels.

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