

Jackson 1990; Thomas 1996; Hickey 2000). Thomas and Jackson (1990), however, indicated that exotic species of *Bromus* spp. can be controlled with a combination of management techniques. While such management is undoubtedly labor-intensive, and continued monitoring of this threat is warranted, there is no solid evidence to date that these exotic grasses have eliminated populations of *Lesquerella filiformis*, especially in areas that are regularly managed by techniques such as prescribed fire. Nonetheless, further research on the potential adverse impacts of brome grasses to Missouri bladderpod is clearly warranted.

The glade and other rocky habitats where *Lesquerella filiformis* is found were probably maintained historically by fires. The cessation or significant reduction in the number of fires occurring on glades in the last few centuries has enabled woody vegetation, such as red cedar, to encroach onto bladderpod habitat. The encroachment of such woody vegetation onto glades occupied by *Lesquerella filiformis* has been frequently listed as a threat to this species' continued existence (Hickey 1988; Thomas and Jackson 1990; Thomas 1996; The Nature Conservancy 2002). Recent research by MDC and TNC at the Rocky Barrens Conservation Area and Preserve in Greene County, MO, has provided strong evidence that this species responds well on glades that have been cleared of woody vegetation by the combination of cedar tree removal and the use of controlled fires (Figg and Davit 1997). Prescribed burns have been conducted on six sites under public ownership with positive results (Table 2). This management tool may be used at additional bladderpod sites.

Grazing and haying are potential threats to Missouri bladderpod populations under private ownership (U.S. Fish and Wildlife Service 1988). Overgrazing may impact small populations of the plant, but minor grazing actually enhances these populations (MDC 1997). Presently, there are no known incidents where haying has been a threat to existing Missouri bladderpod populations.

The poor, rocky, thin soils over bedrock make bladderpod habitat nonconductive to increases in agricultural development within the species' range in Missouri. Hickey (2000) reported that one population was destroyed by construction of a putting green on a golf course and another was destroyed as a result of residential construction. Thus, as discussed by Hickey (1988, 2000) and Thomas (1996), the species' habitat is threatened most

by urban/suburban expansion and development.

The Service, TNC, and all public land management agencies with extant sites on lands under their jurisdiction have been actively involved in various aspects of public outreach and education associated with Missouri bladderpod. These include developing landowner contact programs, producing educational brochures, and holding identification and ecology workshops on the species. In 1995, MDC published a new brochure for the Rocky Barrens Conservation Area that highlighted Missouri bladderpod. In the same year, MDC conducted an identification workshop for employees of the National Resources Conservation Service (NRCS) and the Williams Pipeline Company in Springfield, MO. This workshop was extremely productive as it led to the discovery of a previously unknown site of Missouri bladderpods along a powerline right-of-way in Greene County. In February 1997, MDC published an Endangered Species Guide Sheet for Missouri bladderpod and distributed it to private individuals and public agency employees through MDC, TNC, NRCS, and the University of Missouri Extension Service. The brochure provided information on identification, life history requirements, habitat, distribution, causes of historic decline, current threats to the species, and management guidelines that would contribute to bladderpod recovery.

Public outreach materials developed for Missouri bladderpod include a Best Management Practice Guide Sheet distributed by MDC (2000) that outlines suggested management practices for projects that could potentially impact the species identified by MDC during environmental reviews. A public information endangered species card was published by the Conservation Commission of the State of Missouri (1999). The species was also highlighted in two separate issues of MDC's *Missouri Conservationist* (June 1995 and February 1999) involving endangered species.

In 1992, MDC and the Service cooperated in a landowner contact program involving 25 private landowners with extant populations of *Lesquerella filiformis* in an approximately 5-square-mile area in Greene County, MO. The purpose of the program was to educate the landowners on the habitat needs of Missouri bladderpod and to suggest compatible land management techniques that would benefit the species. Over 80 percent of the people contacted responded favorably to the protection and management of the bladderpod and

its habitat (Amy Salveter, U.S. Fish and Wildlife Service, pers. comm. 2000).

Although great progress has been made toward the recovery of *Lesquerella filiformis*, the species is still threatened by urban/suburban expansion and development and encroachment of invasive woody plants and exotic pasture grasses. The recent discoveries in northeastern Arkansas indicate that additional surveys in southern Missouri and northern Arkansas are warranted. Additionally, population estimates at all extant sites in Missouri in one year have not been undertaken since observations made by Hickey (1988). Extended demographic analyses conducted by Thomas (1996), Kelrick (2001a, 2001b), and Smith (*in litt.* 2002) strongly suggest that a well-established long-term monitoring program is necessary to accurately detect population trends.

#### *B. Overutilization for Commercial, Recreational, Scientific, or Educational Purposes*

At the time of listing, overcollecting by botanists and flower garden enthusiasts was considered a threat to the species' continued existence. Although Steyermark (1963) indicated that Missouri bladderpod is a desirable addition to rock gardens, and the Service postulated that the species may be vulnerable to overcollection at the time of listing (52 FR 679, January 8, 1987), there is no evidence to date that such activities have taken place. Additionally, given the large number of currently known extant sites (61 in Missouri and 2 in Arkansas), adverse impacts from overcollecting by wildflower enthusiasts or botanical collectors is extremely unlikely, even during years when the number of flowering individuals is low. Overutilization is no longer believed to pose a distinct threat to this species.

#### *C. Disease or Predation*

Morgan (1983) studied one population of *Lesquerella filiformis* at Wilson's Creek National Battlefield in Greene County, MO, and determined that insect predation and fungal infection damaged seed set. Although there may be a concern for such impacts during low population levels, it is likely that Missouri bladderpod has adapted to such natural influences and the species is probably well buffered against these natural occurrences at more robust population levels. To date, there is no evidence that these agents are exotic to the species' habitat, or that naturally occurring incidents of disease or predation have contributed to a recent decline in any of the known extant populations.