

sites, and irregular monitoring has occurred at numerous other sites. Thomas (1998) and Boetsch (*in litt.* 2002) reported changes in population status of *Lesquerella filiformis* between 1988 and 2003 on National Park Service (NPS) property at Bloody Hill Glade, Wilson's Creek National Battlefield, and observed that the population varied from 0 to 303,446 plants, with an average annual population of 58,862 plants (Table 1). The MDC monitored 21 permanent plots within 1 population at the Rocky Barrens Conservation Area between 1992 and 2003 and noted that the number of individual plants varied from 2 to 3,584 (Tim Smith, MDC, *in litt.* 2003, Table 1). Monitoring of a population at Cave Springs Outcrop Glade in Dade County in 1980, 1984, 1988, 1990, and 1993 yielded 500, 545, 50, 0, and 0 plants, respectively (MDC 2002a). To date, the maximum population estimate at the Izard County, AR site has been "tens of thousands of plants," in 1997, while in 1999 only a few plants were found at the same site (Theo Witsell, *in litt.* 2002). Irregular monitoring (a minimum of 4 years of data between 1993 and 1999) at seven Nature Conservancy registry sites yielded similar fluctuations in population numbers as described elsewhere, with estimates ranging from 0 to 47 plants at the smallest population and 3 to 3,448 plants at the largest (Susanne Greenlee, TNC, *in litt.* 1999; MDC 2002a).

TABLE 1. ANNUAL POPULATION ESTIMATES OF MISSOURI BLADDERPOD ON BLOODY HILL GLADE (WILSON'S CREEK NATIONAL BATTLEFIELD) AND IN 21 PLOTS AT ROCKY BARRENS CONSERVATION AREA, GREENE COUNTY, MO, 1988–2003 (FROM THOMAS 1998; TIM SMITH, *in litt.* 2003; JOHN BOETSCH, *in litt.* 2002; MIKE DEBACKER, *in litt.* 2003).

Year	Estimated Population Size (number of plants)	
	Bloody Hill Glade	Rocky Barrens Conservation Area (21 plots)
1988	58,351
1989	31,911
1990	10,154
1991	303,446
1992	24,611	110
1993	0	1,211
1994	0	200
1995	18,514	2,295
1996	88,166	224
1997	33,873	3,584
1998	30,475	1,283

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Year	Estimated Population Size (number of plants)	
	Bloody Hill Glade	Rocky Barrens Conservation Area (21 plots)
1999	66,650	320
2000	72,623	143
2001	145,604	2
2002	2,401	713
2003	50,701	2,438
Average	58,593	1,0441

¹ Average within 21 permanent plots—total population size at this site is much larger.

An examination of the status of most extant sites following the procedures established by Hickey (1988) was conducted in the spring of 2000. Hickey visited 52 extant sites between April and May and noted that: (1) Populations of the species were found in the same terrace or rock shelf as they were in 1988–1990, and (2) some sites exhibited lower numbers than in 1988–1990, apparently attributable to the drought conditions, an increase in cedar density or encroachment of other woody vegetation, or competition from exotic species of brome grasses (*Bromus spp.*). Population density at some locations increased apparently because of tree removal and maintained grazing (Hickey 2000). Continued long-term monitoring of some larger sites in Missouri and the site in Izard County, AR, is also planned.

In years when germination, overwinter survival, seedling establishment, and plant growth are ideal, *Lesquerella filiformis* populations can be so large as to make rangewide population estimates extremely difficult. Despite the difficulty, estimates made by Hickey (1988) at 55 sites in Missouri yielded approximately 400,000 plants. Had rangewide estimates been taken in 1991 when 303,446 plants were estimated at Bloody Hill Glade, Wilson's Creek National Battlefield (Table 1, Thomas 1998), the population that year likely would have exceeded 500,000 plants. However, given the extreme annual fluctuations in

population size, only long-term monitoring efforts patterned similarly to the protocol developed for the Wilson's Creek National Battlefield (Kelrick 2001a, 2001b) can accurately reflect the true population status and trend of this species and effectively evaluate the efficacy of management regimes on bladderpod habitat (Thomas 1998).

The current 63 extant sites have the following Nature Conservancy Natural Community rankings: (1) 11 (10 in Missouri and 1 in Arkansas) are graded A (*i.e.*, are relatively stable and undisturbed natural communities with a high diversity of conservative species); (2) 18 (all in Missouri) are graded B (*i.e.*, late successional or lightly disturbed communities, or recently lightly disturbed or moderately disturbed in the past but now recovered, and the biological diversity has not been greatly reduced); (3) 1 in Arkansas is graded AB (*i.e.*, intermediate between A and B); (4) 17 in Missouri are graded C (*i.e.*, midsuccessional, moderately to heavily disturbed communities, or moderate recent disturbance or heavy past disturbance with decreased recent disturbance); and (5) 16 in Missouri are graded D (*i.e.*, early successional or severely disturbed communities where the structure and composition of the community has been severely altered with few characteristic native species present) (MDC 2002a; Theo Witsell, *in litt.* 2002).

Threats identified by the Service at the time of listing (52 FR 679, January 8, 1987) were: (1) Vulnerability of small populations to overcollecting and human disturbance, (2) lack of research on proper management techniques necessary to maintain and promote populations of the species, (3) potential impacts of annual maintenance activities to populations located on highway rights-of-way, (4) seed destruction by insects and fungal infections, and (5) inadequate protection or management on public and private property necessary for the species' continued existence. Subsequently, the Service (1988) documented the presence of exotic plant species, such as *Bromus tectorum* (a cheat grass), in bladderpod habitat as a significant threat, and this was further supported by observations by Hickey (1988, 2000) and Thomas (1996, 1998). Additionally, Hickey (1988, 2000) and Thomas (1996) identified development, especially land-use changes resulting from urban expansion, as a major threat to the species, and Hickey (1988) noted an increase in grazing pressure at some of the sites discovered during a four-county survey.