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## A model for managing an endangered species in Sandhills rangeland

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**Key words :** blowout penstemon , endangered species , rangeland

**Introduction** Blowout penstemon (*Penstemon haydenii* S . Wats .) is an endangered perennial plant species native to the Sandhills region of Nebraska , USA . Populations of blowout penstemon have reached adequate numbers to consider reclassifying its status to threaten as outlined in the Recovery Plan (Fritz et al . , 1992) . Its habitat is disturbed areas of blowing sand in Nebraska rangeland . The survival of blowout penstemon depends on its ability to prosper in current conditions and on our ability to manage for minimum viable population levels . The impact of cattle grazing on this plant will be a key factor in effectively managing its populations . These impacts will be added to a Lefkovich stage-structured model in later studies to determine its potential for self-sufficiency .

**Materials and methods** The number of plants remaining and flowering stalks which appear following grazing determine plant survival and productivity . Fifteen pairs of plants were chosen at random from each of two sites in the spring of 2006 . These plants were marked , the stalks were counted and measured , and the number of floral whorls was counted . Flowering stalks were counted again in the autumn after seed set . In order to simulate grazing , all flowering stalks and vegetative material was clipped to within 10 cm . of the ground from half the plants after bloom in mid June . The experiment was repeated on the same 60 plants in 2007 .

**Results and discussion** None of the clipped plants produced new flowering stalks in the same year after clipping . There was no significant difference in plant mortality between the clipped and unclipped treatments in the first year . For those plants which remained alive , there was no significant difference between treatments , in the mean change in number of flowering stalks from one year to the next ( mean clipped = -0 .70 flowering stalks , control = +0 .35 stalks ;  $P = 0 .2705$  ) . Clipped stalks had significantly shorter flowering stalks (28 .08 cm ,  $P = 0 .0494$ ) in the second year than control plants (31 .43 cm ,  $P = 0 .0494$ ) . The number of floral whorls in the clipped group (7 whorls) was significantly fewer than the number of floral whorls in the control group (9 whorls ,  $P = 0 .0037$ ) in 2007 . In the autumn following clipping , there was a significant increase in vegetative shoots among the clipped groups at both locations ( mean difference 5 .8 stalks per plant ,  $P < 0 .0001$  ) . In the spring of 2006 , there was no significant difference in the number of vegetative shoots of clipped plants versus control plants . The mean number of vegetative stalks on clipped plants (6 .7) in the autumn of 2006 was significantly greater ( mean dif . = 5 .8 ,  $P = < 0 .0001$  ) than that of the control plants (0 .9 vegetative stalks per plant) . The number of vegetative stalks was not significantly different in the following spring (2007) .

**Conclusions** Grazing does not appear to significantly affect the survival of adult blowout penstemon plants after one year . It does cause a loss of production for the year of grazing as well as a reduction in the potential for seed production in the following year , as it produces smaller flowering stalks with fewer floral whorls . These effects in the short-term can be included in the stage-structured model as management events affecting seed production . Grazing events would decrease seed bank potential but not adult plant survival in the model . One recommendation would be to allow animals to graze after seed set , in order to prevent reductions in production potential . If the hoof action of grazing animals can open these blowouts to sand movement , allowing for seedling establishment (Stubbendieck et al . , 1989) , grazing late in the season could actually benefit the survival of the blowout penstemon .

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