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Herbicide Tolerance of Lemhi Penstemon
(initially: Ute Ladies'-Tresses Orchid)

Peter Rice

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Abstract:

Lemhi penstemon (*Penstemon lemhiensis*) is a Sensitive plant species. Invasion by spotted knapweed (*Centaurea stoebe* synonym *maculosa*) is a major factor in its population decline. Fall treatments with clopyralid have confirmed that knapweed can be suppressed without decreasing abundance of this rare penstemon; although an apparent slight decrease in flowering occurred in the 1st year post-spray. Knapweed control was 95% in the first year after spraying. The total number of Lemhi penstemon in the baseline year sample and one year after spraying was essentially identical for both the no-spray controls and the sprayed plots. Mortality of marked Lemhi penstemon plants averaged 5% and was slightly greater in the no-spray plots. The flowering rate for Lemhi penstemon was much higher on all plots in the year after spraying, although this first year post-spray reproduction increase was slightly less for the sprayed plots. With the selected active ingredient, rate, and phenological timing there was also no ecologically significant first year post-spray herbicide effect on species richness, total cover of desirable forb species, annual or perennial grass abundance. Many vegetation managers are hesitant to employ herbicides for conservation of rare plants even when the habitat threat analyses indicate that weeds are a significant factor in the TES species declines. The results of this study should encourage managers to consider employing selective herbicides and application methods based on consideration of the biology and phenology of the target weed, the TES species, and other possibly competitive community components. We intend to assess the plots in the second year after spraying pending availability of funding,

Introduction:

The general goal of this project was to test the response of Threatened, Endangered, or Sensitive plants to herbicide suppression of invasive weeds that are degrading the habitat for listed TES species. The original herbicide tolerance test subject was a Ute ladies'-tresses orchid (*Spiranthes diluvialis*) population in the Diamond Fork drainage of southeast Utah. This appeared to be a feasible restoration project as we had full cooperation of the agencies, the NEPA was completed, and we had obtained a US Fish & Wildlife Service "take permit" authorizing us to implement the study plan. However since the initiation of the project in spring 2007 the abundance of Ute ladies'-tresses orchid has been further depressed in the Diamond Fork. There was slight recovery in 2009 but the orchid population remained below the level at which we could implement the experimental design and not put unacceptable stress on the small surviving population. Accordingly it was proposed to PIAP and agreed upon to conduct a study with a similar goal of restoration of a rare plant in habitat being degraded by weed invasion, but the desirable species was switched to Lemhi penstemon (*Penstemon lemhiensis*). Historic Lemhi penstemon sites on he Salmon-Challis National Forest in Idaho were not suitable for test plots as invasive weeds have come to fully dominate these areas and the Lemhi penstemon is now absent or exceedingly rare on those sites. The Bitterroot National Forest in Montana had been annually

monitoring two proximal weed infested Lemhi penstemon plots since 2001, and documented the steady increase of spotted knapweed and corresponding decline of the rare penstemon. The Bitterroot NF agreed to release these historic monitoring plots for the restoration study.

Background/Justification Statement:

Lemhi penstemon (*Penstemon lemhiensis*) is listed as species of Concern by the U.S. Fish and Wildlife Service. The U.S. Forest Service currently includes *P. lemhiensis* on its lists of Sensitive species for Region 1 and Region 4. The Idaho Bureau of Land Management lists Lemhi Penstemon as a State Sensitive species. The Montana Natural Heritage Program lists this penstemon as imperiled in Montana with a state rank of S2. It has been given the same listing in Idaho. As of 2009 Lemhi penstemon was still found on four U.S. National Forests (Salmon National Forest in Idaho; Beaverhead, Bitterroot and Deer Lodge National Forest in Montana), two BLM Districts (Salmon District in Idaho and Butte District in Montana) and on the National Park Big Hole Battlefield National Monument in Montana.

The Habitat Conservation Assessment and Conservation Strategy for Lemhi penstemon is explicit in stating "Spotted knapweed is a direct threat to *P. lemhiensis* populations" (Elzinga 1997). In a field survey by Elzinga in 1994 all the sites inspected had spotted knapweed at least present. Spotted knapweed and Lemhi penstemon occupy the same bare soil microsites (Moseleyet al. 1990). The penstemon appears to compete for seed germination safe sites with knapweed. However knapweed has the advantage of post seed set fall germination while Lemhi penstemon does not germinate until the following spring (Elzinga 1997) . While flowering rates and subsequent seed production by Lemhi penstemon is rather low, spotted knapweed can produce up to 30,000 seed per square meter (Schirman 1981). Elzinga (1997) also reports observations of loss or severe declines of Lemhi penstemon in communities where knapweed infestations have increased. In the Resource Objectives for Protection Class A & B Populations of Lemhi penstemon Elzinga (1997) suggests that management response will be triggered by an increase in knapweed frequency of more than 20%; but Elzinga does caution that for populations that appear to be coexisting with knapweed the chemical may be a more serious threat than the knapweed. Elzinga specifically recommends herbicide trials for Lemhi penstemon with reference to clopyralid.

In a 2001 assessment of Montana populations, weed control research was identified as the third critical conservation research need particularly west of the Continental Divide (Heidel and Shelly 2001). Spotted knapweed is a widespread invasive plant in Lemhi penstemon habitat west of the Divide in Lemhi County, Idaho and Ravalli County, Montana (Bitterroot National Forest). Heidel and Shelly develop the fact that Lemhi penstemon has a positive response to fire but so does spotted knapweed. The potential for noxious weeds to expand after fires is very high in Lemhi penstemon occupied habitats on much of the Bitterroot National Forest, and such expansion may adversely affect the viability of many populations west of the Continental Divide (Heidel and Shelly 2001). Heidel and Shelly (2001) suggest that conditions on the Bitterroot National Forest after the 2000 wildfires warranted ongoing noxious weed monitoring at all currently un-infested Lemhi penstemon sites.

Eight years (2001-2009) of post-burn monitoring plot data for a Lemhi penstemon population in Robbins Gulch in Ravalli County indicated that while knapweed was increasing the Lemhi penstemon was in decline (Figures 1 & 2, Linda Pietarinen, Forest Botanist, Bitterroot National Forest).

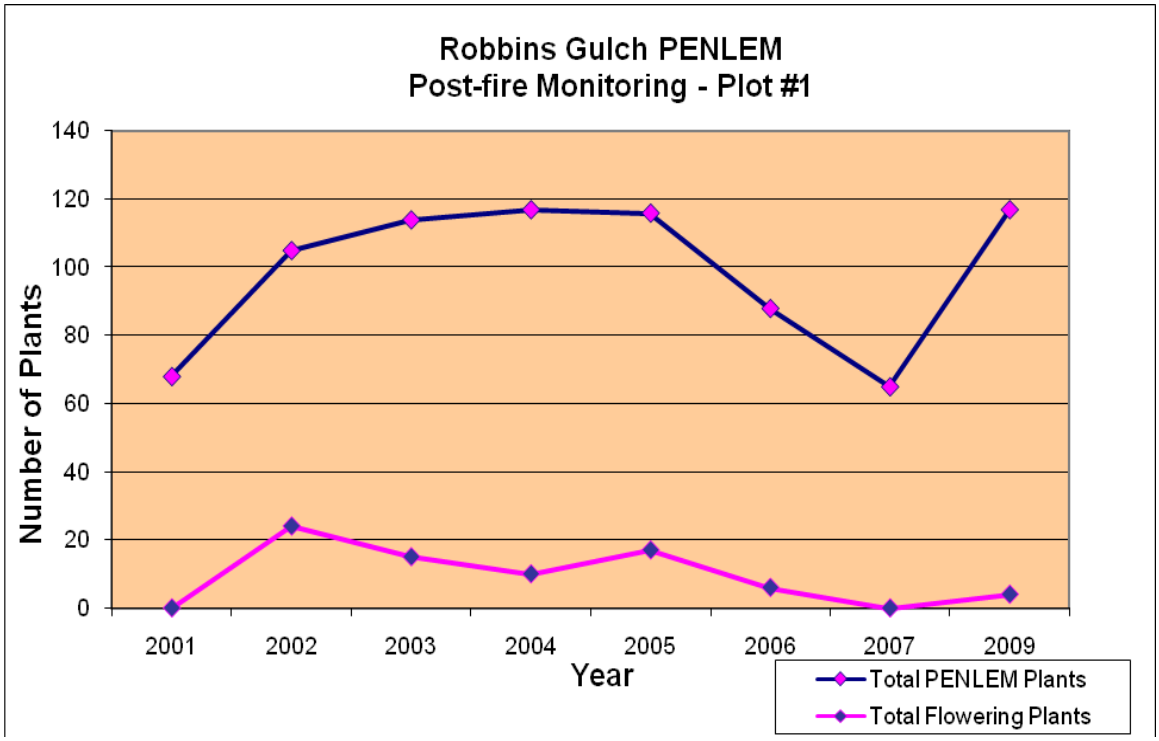

Figure 1

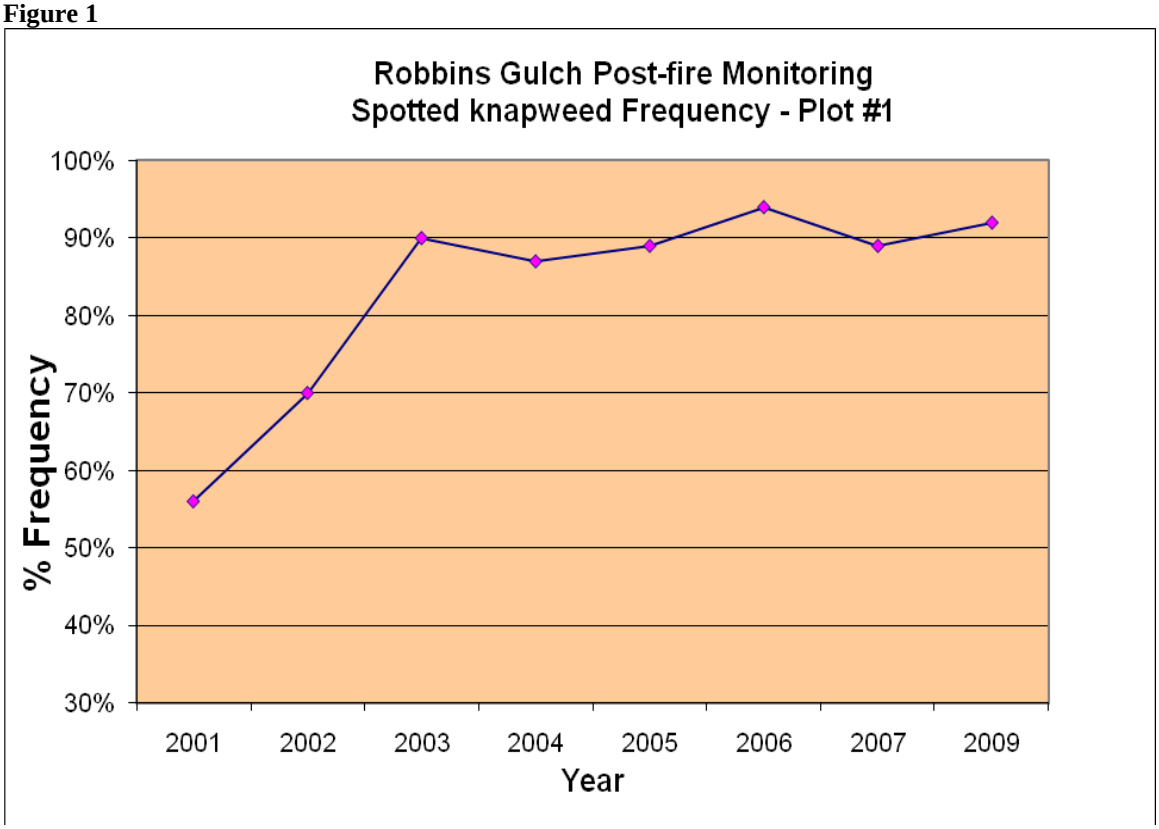

Figure 1. Lemhi penstemon density and spotted knapweed frequency plot #1 from Robbins Gulch, Darby Ranger District, Bitterroot National Forest, Montana (L. Pietarinen data).

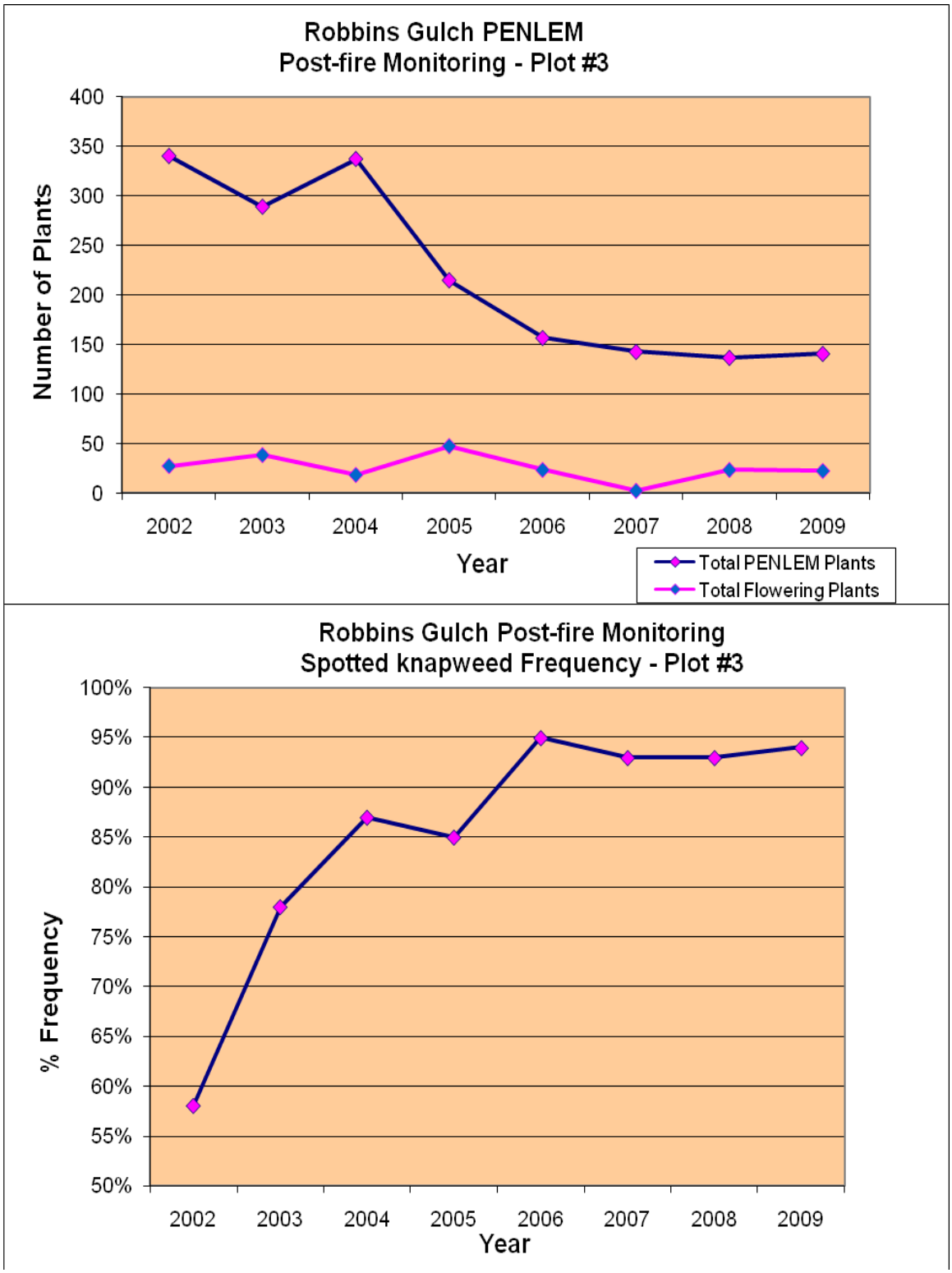

Figure 2. Lemhi penstemon density and spotted knapweed frequency plot #3 from Robbins Gulch, Darby Ranger District, Bitterroot National Forest, Montana (L. Pietarinen data).

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Spotted knapweed is highly susceptible to clopyralid treatments (Rice et al. 1997). Clopyralid is the most selective of the herbicides that are efficacious on knapweed when evaluated as first and second year post-spray responses (Rice et al. 1997; Rice 2008) . *Penstemon procerus* and *Penstemon wilcoxii* did not significantly (p=.674 and p=.322 respectively) decrease

or increase in a previous whole community assessment of knapweed sprayed with picloram and clopyralid in western Montana bunchgrass communities (Rice and Toney 1996), although the power of that trial for individual non-target forbs of low abundance was limited. A more recent clopyralid non-target forb study conducted in Colorado indicated that clopyralid with both spring and fall timing had minimal impact on a *Penstemon sp.* (Mary Halstvedt & George Beck personal communication).

We had planned to install restoration test sites on the Salmon-Challis National Forest (Idaho), but 2010 inspection of registered Lemhi penstemon sites on that Forest revealed that spotted knapweed now completely dominated those historic sites and the penstemon had declined to trace levels or could not be found on some sites. The Salmon-Challis rare plant specialist was then not willing to risk habitat restoration testing with herbicides; and the penstemon numbers were so now low and scattered a test would have presented considerable experimental design challenges.

Linda Pietarinen, a now retired Bitterroot NF botanist, had installed the two Robbins Gulch Lemhi penstemon monitoring plots in 2001 and employed an annual sampling protocol through 2009. The Bitterroot National Forest agreed to allow us to use the Robbins Gulch plots for testing for maintenance and restoration of Lemhi penstemon habitat employing clopyralid to suppress the spotted knapweed dominating the site.

Herbicide treatment and research approach:

In the summer of 2010 the two original Robbins Gulch Lemhi penstemon monitoring plots were relocated by this investigator (P. Rice) and resampled with the Pietarinen protocol established in 2001, plus additional sampling to quantify the entire plant community, and installation of markers to track individual Lemhi penstemon plants over time. Two additional monitoring plots were installed in 2010 and sampled by the same protocols. Two of the four plots were sprayed with clopyralid (Transline at 2/3 pt/ac) on 23 October 2010 with a CO_2 regulated backpack research sprayer. Conditions were ideal for the treatment. The spotted knapweed was actively growing in the fall greenup stage. The Lemhi penstemon was still green but had stopped growing.

The original 2001 protocol counts seven different life stages of all Lemhi penstemon plants in 450 meters of 2 meter wide belt transects per plot. Ninety nested rooted frequency microplots per plot are read for spotted knapweed. Then in 2010 the two new 30 x 30 meter plots that were established in Robbins Gulch were also sampled by the historic protocol. In addition to repeating the historic sampling for Lemhi penstemon and spotted knapweed, a full plant community assessment (all species) was done on all four Robbins Gulch plots using microplot canopy cover methods (45 1 meter square microplots per plot). A rebar grid was install so that tapes can be used to relocate transects and microplots at the same sampling point each year. Thirty Lemhi penstemon plants in each of the four plots were marked with vinyl stake chasers in 2010 to allow assessment of the spray tolerance of individual marked plants.

The rarity and heterogeneous distribution of TES species places treatment plot replication constraints on experimental designs that include inference testing. We compensate for this in-situ limitation by having large plots (30 x 30 meters) and intensive sub-sampling. The various counts of Lemhi penstemon are analyzed by chi square. The clopyralid effect on spotted knapweed was so strong as to not require inference testing

Results through fall 2011 (first year after spraying):

The four plots were resampled in mid-August 2011, ten months after spraying. As expected, the clopyralid treatment was highly efficacious on the spotted knapweed (Table 1).

Table1. Fall applied Transline (clopyralid) at 2/3 pt/ac provided 95% control of spotted knapweed canopy cover in the 1st year after treatment.

	2010 - June	2011- August
	Pre-Spray Mean % Canopy Cover	Post-Spray Mean % Canopy Cover
Sprayed Plots 1+4	6.0	0.4
No-Spray Plots 2+3	3.5	7.8
		95.3% Control

The total number of individual Lemhi penstemon plants was not altered by the clopyralid treatment (Tables 2).

Table 2. Lemhi penstemon total counts before (2010) spraying and in the first year after spraying (2011) were essentially identical.

	2010	2011
	Pre-Spray Count	Post-Spray Count
Sprayed Plots 1+4	156	165
No-Spray Plots 2+3	206	202

In the pre-spray year (2010) the proportion of individual Lemhi penstemon plants that produced flowers did not differ between the no spray plot total count and the total count for plots to be sprayed in the fall (Chi square 0.107, d.f. 1, p=0.743) (Table 3). The proportion of individual Lemhi penstemon plants that produced flowers in 2011, the first year after spraying, increased markedly on all four plots compared to the 2010 pre-spray year. The overall increase in post-spray 2011 reproduction was slightly less for the sprayed plot total count (Chi-square 4.101, d.f. 1, p=0.043).

Table 3. Flowering success of Lemhi penstemon in the year (2010) before spraying and in the first year (2011) after clopyralid treatment.

Plot	% Reproductive Pre-spray (2010)	% Reproductive Post-Spray (2011)	Sprayed
2	10.8%	36.0%	no
3	5.8%	24.2%	no
1	4.1%	8.9%	yes
4	11.2%	31.2%	yes

Thirty Lemhi penstemon plants that had been marked in each plot in 2010 were examined for survival and reclassified as to life stage in 2011. Marked plant survival was not affected by spraying (Table 4).

Table 4. First year post-spray (2012) mortality of specific individual Lemhi penstemon plants marked in 2010 (pre-spray).

	2011 (First Year After Spraying)	
	Number Died	Number Surviving
Sprayed Plots 1+4	2	58
No-Spray Plots 2+3	4	56

Species richness declined in the first year post-spray from that observed in the pre-spray year (Table 5), but the decline was similar for sprayed and no-spray plots (Chi square 0.706, d.f. 3, p=.872).

Table 5. Species richness.

Plot	Species Richness Pre-spray (2010)	Species Richness Post-Spray (2011)	Change	Sprayed
2	60	42	-18	no
3	68	53	-15	no
1	55	43	-12	yes
4	60	50	-10	yes

Annual grass (cheatgrass and Japanese brome) canopy cover changed very little from 2010 to 2011 (Table 6). Perennial grass canopy cover increased almost three-fold but there was no herbicide treatment effect.

Table 6. Annual and perennial grasses % canopy cover pre-spray in 2010 and post-spray in 2011.

Lifeform	Plot	Pre-spray (2010)	Post-Spray (2011)	Change	Sprayed
Annual Grasses	2 + 3	0.4	0.4	0	no
“	1 + 4	1.4	2.3	+0.9	yes
Perennial Grasses	2 + 3	5.5	15.9	+10.4	no
“	1 + 4	5.3	13.3	+8.0	yes

Total canopy cover of desirable forbs also increased from 2010 to 2011 (Table 7). If there was an herbicide effect it was small and ecologically insignificant.

Table 7. Total non-weedy forb % canopy cover pre-spray in 2010 and post-spray in 2011.

Plot	Pre-spray (2010)	Post-Spray (2011)	Change	Sprayed
2 + 3	19.4	30.5	+11.1	no
1 + 4	24.7	32.2	+7.5	yes

Reference list:

Elzinga, C. 1997. Habitat conservation assessment and conservation strategy for *Penstemon lemhiensis* (Lemhi Penstemon) Unpublished report to the U.S. Forest Service and Bureau of Management. 49 pp.+ app.

Heidel, Bonnie; Shelly, Stephen J. 2001. The effects of fire on Lemhi penstemon (Penstemon lemhiensis) final monitoring report 1995 - 2000. Report to the Beaverhead-Deerlodge National Forest and the Dillon Field Office - Bureau of Land Management. Helena, MY: Montana Natural Heritage Program. Agreement 00-CS-11010200-016; Agreement 1422E930A960015, Task Order No. 23. 19p

Moseley, R. K.; Mancuso, M.; Hilty J.1990. Field investigation and status survey of *Penstemon lemhiensis* in Idaho. Unpublished report. Boise ID: Idaho Department of Fish and Game, Conservation Data Center. 17p

Rice, P. M. 2008. Longer term community impact & benefits of aminopyralid treatments 2008 PIAP Progress Report for R1/4-34. 14p

Rice, Peter M.; Toney, J. C. 1996. Plant population responses to broadcast herbicide applications for spotted knapweed control. Down to Earth. 51(2): 14-19.

Rice, Peter M.; Toney, J. C.; Bedunah, Donald J.; Carlson, Clinton E. 1997. Plant community diversity and growth form responses to herbicide applications for control of *Centaurea maculosa*. Journal of Applied Ecology. 34: 1397-1412.

Schirman, R. 1981. Seed production and spring seedling establishment of diffuse and spotted knapweed34(1): 45-47.