Methods-

A. Boulder Hills
    a. Site information
        1. Located on BLM land
        2. The habitat is a big sage/bluebunch wheatgrass plant community with Douglas fir encroaching.
        3. Dalmatian toadflax is present at varing densities throught the area. Density I greatest on disturbances from mining. Density is low in the intact plant community
    b. Plot establishment and information
        1. Four permanent replicates were established in the Boulder hills area in 2004.
        2. The elevation of the reps ranged from 3,618ft to 6,259ft and the slope range from 10 to 30%. Aspect varied among reps.
        3. Each rep was devided into four 14 by 14 foot whole-plots
        4. Herbicide application
            1. Each of the four plots received one of the four herbicide treatments; 1qt/acre picloram, 1 oz/acre metsulfuron, a combination of picloram and metsulfuron in the same concentration and a control.
            2. The order of the treatments was randomly chosen in each rep.
        5. Each of the four plots was divided in half and insecticide was applied on a randomly chosen half to control for *Mecinus* insect impact on toadflax. It was randomly chosen which half would receive the insecticide.
            1. Insecticide was applied three times in 2005; 6/21, 7/12, and 8/5. dates in 2005 to prevent the biocontol from establishing in the biocontrole free sites.
        6. In each of the herbicide by biocontrol treatments a 1 m^2 plot and a 1 m^2 hervivory exclosures were established to provided prermanent monitoring locations for *L. dalmatica* density and cover as well as ground cover of other plant species, bare ground and litter. The locations were randomly chosen
    c. Biocontrol: *Mecinus janthinus*
        1. Approximately 75 adult insects were initially released on a high density toadflax plpulation next to each of the four reps on 6/14/04. Another 50 insects per rep were release on 6/1/05.
        2. Establishment and/or evidence of insect feeding on toadflax were found on all but the second rep in May, Hune, and July 2005 indicating establishment and survival of the insect.
    d. Plant community sampling began on6/15/05.
        1. We recorded density of mature and immature *L. dalmatica* growing in the monitoring plots. Mature *L. dalmatica* was considered any stems that were flowering or had buds, all others were considered immature.
        2. Within the plots we also estimated percent cover of the *L. dalmatica* as well as all plant species found, including forbs, grasses and shrubs. We also estimamated the percent bare ground, litter and rock. We did record the percent of other non-native invasive plants but this only occurred at two reps.
        3. The average amount of damage to the *L. dalmatica* by *M. janthinus* was recorded as 0 (no damage), 1 (a few leaves), 2 (some leaves), 3 (seveal leaves), 4 (severe damage)
        4. When possible the previous years *L. dalmatica* stems were collected within the monitoring plots.
        5. We also clipped one plant per treatment at each rep growing outside of the monitoring plots. Leaf area of clipped plants was scanned and the plants were dried and weighed.

B. Elkhorns.
    a. Site information
        1. Located on BLM land
        2. The habitat is a big sage/bluebunch wheatgrass plant community.

3. Dalmatian toadflax ws present at high densities throughout the area.
4. Lat, long coord or other descipt of location.

b. Plot establishment and information
   1. Two sites adjacent to each other
   2. Sites established in ???
   3. elev, aspect, slope?
   4. why this site chosen (elk mgmt and burn I think)
   5. The area was divided into two sites one burned and one was left unburned.
      1. Burn information.
   6. Each site had four reps with different herbicide and treatments.
      1. Both sites received ??g/ac metsulfuron, ??g/ac picloram and a control.
      2. The unburn site had two application timings;… and the burn site had three timings.
      3. the herbicide was applied…..
      4. The order of the treatments was randomly chosen.
   7. In each of the herbicide by timing treatments a 1 m^2 plot established to provided permanent monitoring locations for *L. dalmatica* density and cover as well as ground cover of other growth forms, bare ground and litter. The locations were randomly placed near the center of the plots.

c. *Mecinus janthinus*
   1. Insects were added …

d. We began data collection on August 11th.
   1. We colleced data for *L. dalmatica* density and percent cover, percent cover for other growth forms, bare ground and litter and average damage to *L. dalmatica* caused by the *M. janthinus.*
   2. All the method used where the same as those followed at he Boulder hills site.

C. Statistical analysis

Results

A. Boulder

Table 1
P vales of percent cover across all four reps.

LSD = 2.09		**% toadflax cover**	**% forb cover**	**% grass cover**
Factor	**DF**	**p-value**	**p-value**	**p-value**
Picloram	1	0.1161	0.0331	0.0092
Metsulfuron	1	0.7989	0.0077	0.8889
picloram * metsulfuron	1	0.6123	0.4907	0.0471

Table 2
Means of percent cover by main effects

		% toadflax cover		**% forb cover**		**% grass cover**	
Treatment	**Level**	**Mean**	**S. D**	**mean**	**S. D**	**mean**	**S. D**
Picloram	0	7.934	10.66	19.84	10.96	33.91	10.31
	1	4.63	5.87	15.47	7.66	41.1	10.53
metsulfuron	0	6.031	7.69	20.63	9.57	37.34	9.91
	1	6.53	9.73	14.69	8.88	37.66	12.11

Table 3
Means of percent cover by mixed effects

Picloram * metsulforon	**% toadflax cover**		**% forb cover**		**% grass cover**	
Level	**Mean**	**S. D**	**mean**	**S. D**	**mean**	**S. D**
0pic * 0met	8.19	9.82	23.44	10.44	36.25	9.04
0pic*1met	7.68	11.76	16.25	10.57	31.56	11.36

1pic*0met	3.86	3.96	17.81	7.95	38.34	10.91
1pic*1met	5.34	7.37	13.13	6.80	43.75	9.75

1. Percent cover
    a. Percent cover of the D. toadflax was not significantly affected by the herbicide treatments (table 1).
    b. Piciloram and metsulfuron had a significant affect on the percent cover of forbs (table 1). The mean percent forb cover of the picloram and metsulfuron plots was greater than the in control plots (table 2).
    c. Piciloram had a significant affect on the percent cover of grass (table 1), cover was lower in plots treated with picloram compared to the control (table 2)
    d. There was also a significant interaction effect on percent grass cover between picloram and metsulfon (table 1), percent cover was higher in plots treated with both herbicides compared to those treated only with picloram (table 3).

Table 4
P values of toadflax density across all four reps

LSD = 2.09		**Total toadflax density**	**Mature toadflax density**	**Immature toadflax density**
Factor	**DF**	**p-value**	**p-value**	**p-value**
Picloram	1	0.1039	0.1345	.0994
Metsulfuron	1	0.6457	0.5835	.6760
picloram * metsulfuron	1	0.9211	.9881	.8887

Table 5
Means of D. toadflax main effects

		Total toadflax density		**Mature toadflax density**		**Immature toadflax density**	
Treatment	**Level**	**mean**	**S. D**	**Mean**	**S. D**	**mean**	**S. D**
Piciloram	**0**	30.88	35.90	7.525	12.11	23.63	26.16
	1	17.56	17.87	3.91	6.44	13.66	12.77
metsulfuron	**0**	22.47	25.22	5.00	7.98	17.47	18.95
	1	25.97	32.52	6.16	11.38	19.81	23.17

Table 6
Means of D. toadflax mixed effects

Piciloram * metsulforon	**Total toadflax density**		**Mature toadflax density**		**Immature toadflax density**	
Level	**Mean**	**S. D**	**mean**	**S. D**	**mean**	**S. D**
0pic * 0met	28.75	31.01	6.69	9.80	22.06	23.23
0pic*1met	33.00	41.14	7.81	14.37	25.19	29.43
1pic*0met	16.19	16.37	3.31	5.42	12.88	12.43
1pic*1met	18.94	19.67	4.50	7.45	14.44	13.47

2. Density
    a. Total D. toadflax density and mature D. toadflax density were not significantly affected by the herbicide treatments (table 4).
    b. Picloram did have a significant effect on the density of the immature D. toadflax (table 4). Density of the immature D toadflax plants was lower in plots treated with the picloram compared to the control plots(table 5).
3. Biocontol damage
    a. ……..(not yet established enough to impact)

B. Elkhorns

Figure 1

Percent Ground cover by type at the burned and unburned site

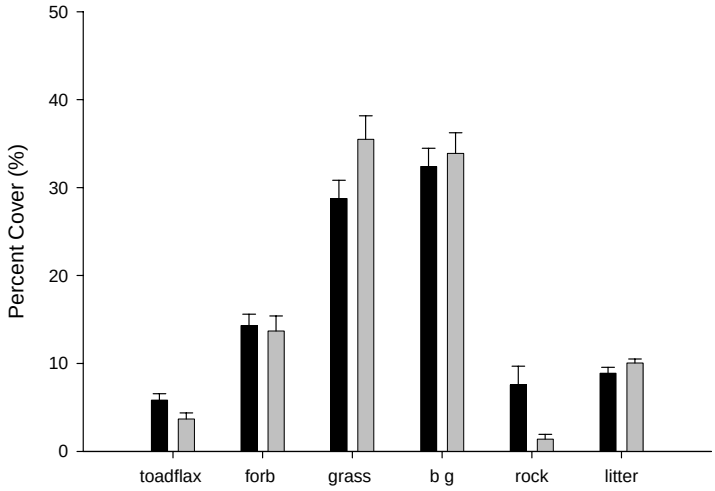

Table 7

P values of percent covers between the burned and unburned sites

Variable	Df	p-value
Toadflax cover	45.598	0.0424
Forb cover	37.928	0.7733
Grass cover	39.073	0.0529
Bare ground cover	42.509	0.6312
Rock	30.403	0.0081
Litter	44.62	0.1689

Table 8

P values of percent cover by herbicide treatment for the burned and unburned site

		Unburned		Burned	
Variable	**Factor**	**Df**	**p-value**	**Df**	**p-value**
Toadflax percent cover	Herbicide	2	0.58224	2	0.03410
	time of application	1	0.00870	2	0.72080
	Herbicide* time	1	0.18598	2	0.50530
Forb percent cover	Herbicide	2	0.26570	2	0.16100
	time of application	1	0.44150	2	0.25240
	herbicide* time	1	0.97040	2	0.66860
Grass percent cover	Herbicide	2	0.11750	2	0.00002
	time of application	1	0.48500	2	0.00581
	herbicide* time	1	0.81420	2	0.01390
Bare ground percent cover	Herbicide	2	0.39280	2	0.14266
	time of application	1	0.27450	2	0.44414
	herbicide* time	1	0.43310	2	0.46129
Litter percent cover	Herbicide	2	0.53287	2	0.99700
	time of application	1	0.05404	2	0.67920
	herbicide* time	1	0.00884	2	0.82350

Table 9

Means of percent cover at the unburned site for significant variables

		Toadflax % cover		Litter % cover	
Main Effects	**Time**	**mean**	**S.E.**	**Mean**	**S.E.**
	Control	3.25	1.70	10.00	0.97
	Fall	2.00	0.27	10.88	0.49

	Spring	5.63	1.3	9.25	0.81
Mixed effects	**Herbicide * time of application**				
	Control			10.00	0.81
	picloram * fall			12.50	1.44
	metsulfuron * fall			9.25	0.75
	picloram * spring			8.50	0.87
	metsulfuron * spring			10.00	0.00

Table 10
Means of percent cover at the burned site for significant variables

		Toadflax % cover		**Grass % cover**	
Main Effects	**Herbicide**	**mean**	**S.E.**	**Mean**	**S.E.**
	Control	7.25	3.22	15.00	2.04
	Picloram	3.58	0.57	26.67	2.56
	Metsulfuron	7.58	1.06	35.42	2.78
	Time				
	Control			15.00	2.04
	Fall			25.00	2.50
	Spring-pre burn			33.13	4.43
	Spring-post burn			35.00	2.83
Mixed effects	**Herbicide * time of application**				
	Control			15.00	2.04
	Picloram * fall			21.25	4.27
	metsulfuron * fall			28.75	1.25
	Picloram * spring- pre burn			23.75	3.15
	metsulfuron * spring-pre burn			42.50	4.79
	Picloram * spring- post burn			35.00	2.89
	metsulfuron * spring-post burn			35.00	5.40

1. Percent cover
    a. Percent cover between sites.
        i. There were significant differences in percent cover between the burned site and unburned site for D. toadflax, grass and rock (table 7).
            1. The percentage of D. toadflax was and rock was higher on the burned site, whereas the percent grass cover was higher on the unburned site (figure 1).
    b. Percent cover by herbicide treatment was analyzed separately for each site.
        i. Unburned site
            1. At the unburned site time of application had a significant effect on the percent cover of D. toadflax (table 8).
                a. The mean percent cover was greatest in the plots treated with metsulforon (table 9).
            2. Litter cover was significantly affected by the time of the herbicide application (table 8)
                a. Percent cover of litter was higher in the plots treated in the fall compared to the spring (table 9)(with a 90% C.I.).
            3. There was also significant interaction between the herbicide used and the time of application (table 8).
                a. The percent litter cover was significantly greater for the plots treated with picloram in fall compared with the plots treated with picloram in the spring (table 9).
            4. There were no other significant differences for any of the growth forms at the unburned site.

ii. Burned site

1. At the burn site the herbicide used has a significant effect on percent cover of the D. toadflax (table 8).
    a. The mean percent cover was significantly lower in plots treated with picloram compared to plots treated with metsulfuron (table 10).
    b. Neither herbicide differed significantly form the control (table 10).
2. Herbicide used and the time of application had a significant effect on the percent grass cover at the burn site (table 8).
    a. The control plots had significantly lower percent grass cover compared to the two herbicides and metsulfuron had the greatest overall (table 10).
    b. The control plots also had significantly less percent grass compared to all the application timings (10).
    c. Of the treatments the plots that receive the herbicide application in the fall had significantly less grass cover that those that received herbicide applications in the pre or post burn spring treatments (table 10).
    d. The pre and post burn spring treatments did not differ from each other (table 10).
3. There was also a significant interaction effect between herbicide and timing (table 8).
    a. Percent grass cover did not differ between herbicide treatments in for the plots treated in the fall or the spring post fire but the plots treated with metsulfuron were greater than the picloram plots in for those treated in the spring pre fire.
4. There were no other significant differences for any of the growth forms at the burned site.

2. D. toadflax density

Figure 2.

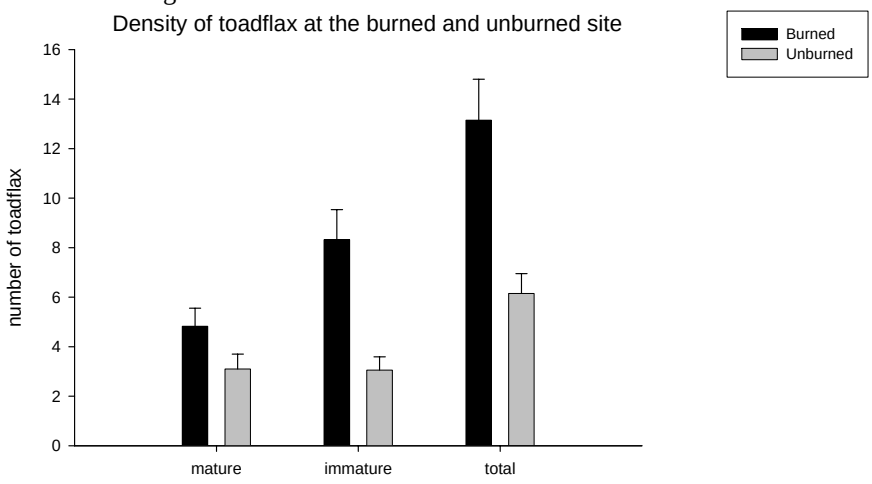

Table 11

P values of toadflax density between the burned and unburned sites

Variable	Df	p-value
Density of mature toadflax	45.989	0.0753
Density of immature toadflax	36.755	0.0003

Total toadflax density	38.115	0.0005
Average mature toadflax height	37.741	0.8948
Average immature toadflax height	43.503	0.5818

a. Between sites
    a. Density of D. toadflax differed significantly between the burned and unburned sites for the mature, immature and total densities (table 11).
    b. For all three densities the mean were significantly greater in the burned site (figure 2).
    c. The heights of the D. toadflax did not differ between sites.

Table 12
P values of toadflax density by herbicide treatment for the burned and unburned site

		Unburned		Burned	
Variable	**factor**	**df**	**p-value**	**Df**	**p-value**
Total toadflax density	herbicide	2	0.8109	2	0.05708
*transformed with sqrt	time of application	1	0.3182	2	0.79659
	herbicide* time	1	0.3292	2	0.92432
Density of immature toadflax	herbicide	2	0.62700	2	0.04232
*burned site transformed with sqrt	time of application	1	0.77800	2	0.87364
	herbicide* time	1	0.92500	2	0.85408
Density of mature toadflax	herbicide	2	0.25746	2	0.13620
*burned site transformed with sqrt	time of application	1	0.07824	2	0.79910
	herbicide* time	1	0.07824	2	0.63130

Table 13
Means of toadflax density at the unburned site for for significant variables

		Mature toadflax density	
Main Effects	**Time**	**mean**	**S.E.**
	Control	3.50	1.71
	Fall	1.88	0.61
	Spring	4.13	1.04
Mixed effects	**Herbicide * time of application**		
	Picloram * fall	2.00	0.71
	metsulfuron * fall	1.75	1.11
	Picloram * spring	2.00	0.41
	metsulfuron * spring	6.25	1.38
	Control	3.50	1.71

Table 14
Means of toadflax density at the burned site for significant variables

	Total toadflax density		Immature toadflax density	
Time	**mean**	**S.E.**	**Mean**	**S.E.**
Control	20.00	7.39	14.25	0.90
Picloram	8.25	1.14	5.17	1.59
Metsulfuron	15.75	2.28	9.50	5.69

b. Density by herbicide treatment analyzed separately for each site.
    a. The unburned site
        i. At the burn site time of herbicide application had a significant effect on the density of the mature D. toadflax (table 12).
            1. Mean toadflax density was greater in plots treated with the herbicides in the spring compared to the fall (table 13).

ii. There was also a significant interaction effect between herbicide and timing on density (table 12). Plots treated with metsufluron in the spring had the greatest toadflax density wheras plots treated with metsulfuron in the fall had the lowest (table 13).
iii. There were no other significant effects by the herbicide treatments at the unburned site on D. toadflax density.

b. The burned site
   i. At the burned site herbicide had a significant effect on total D. toadflax density and density of immature stems (table 12).
      1. Total D. toadflax density was highest in the control plots compared to both herbicide treatments and the plots treated with picloram were lower than the plots treated with metsulfuron.
      2. The same is true for the immature D. toadflax density.

Table 15
P values of correlation between toadflax density and percent cover at the non burn site

Non burn site						
	Total toadflax density		**Mature toadflax density**		**Immature toadflax density**	
Variable	**Estimate Std.**	**p-value**	**Estimate Std.**	**p-value**	**Estimate Std.**	**p-value**
(Intercept)	65.4424	0.00668	24.8257	0.185	40.6166	0.0222
% forb	-0.6614	0.03220	-0.1949	0.430	-0.4665	0.0459
% grass	-0.6444	0.00707	-0.2889	0.124	-0.3555	0.0401
% bare ground	-0.5122	0.01805	-0.2260	0.193	-0.2862	0.0716
% litter	-0.9944	0.05929	-0.1135	0.790	-0.8809	0.0320

Total toadflax density =65.4424 -0.6614*(%forb) -.6444*(%grass) -51.22*(%bare ground) -.9944*(%litter)
-854.2456 -1004.9224 -1767.7728 -2275.8414 -1260.6986 -1772.0672 -2022.4696
-2022.5546 -1060.7698 -1517.8664 -1769.5916 -1510.4396 -2019.6748 -1516.9686
-2023.7074 -1520.3628 -1514.8994 -1261.1074 -2781.0186 -2779.9554

Immature toadflax density =40.6166 -0.4665*(%forb) -0.3555*(%grass) -0.8809*(%litter)
8.2576 10.9003 13.5744 15.6778 10.5901 12.1666 14.7001 14.1451 9.0781 11.3221
12.9226 13.5901 14.7836 9.4801 14.3221 7.6736 11.4346 10.3453 20.5876 19.4933

Table 16
P values of correlation between toadflax density and percent cover at the burn site

Burn site						
	Total toadflax density		**Mature toadflax density**		**Immature toadflax density**	
Variable	**Estimate Std.**	**p-value**	**Estimate Std.**	**p-value**	**Estimate Std.**	**p-value**
(Intercept)	77.5748	0.00306	40.9761	0.000503	36.59870	0.0555
% forb	-0.5750	0.10270	-0.3346	0.031528	-0.24043	0.3691
% grass	-0.6181	0.01532	-0.3201	0.004585	-0.29805	0.1167
% bare ground	-0.8725	0.00656	-0.4635	0.001259	-0.40899	0.0836
% rock	-0.4511	0.09814	-0.3669	0.003613	-0.08416	0.6821
% litter	-0.7589	0.13811	-0.4914	0.030682	-0.26754	0.4920

Total toadflax density= 77.5748 - 0.6181 *(% grass) - 0.8725*(% bare ground)
27.2223 22.4603 24.1318 28.4943 20.4948 24.8573 35.4008 11.0443 37.7658 34.1288
50.3068 35.1483 24.6048 33.0038 32.8568 32.8568 42.1283 18.4973 22.3133 25.9503
16.1323 33.3298 37.2193 44.1993 52.1988 49.0348 28.4208 38.9643

Mature toadflax density =40.9761 - 0.3346*(% forb)- 0.3201*(% grass)-0.4635*(% bare ground)-0.3669*(% rock)- 0.4914*(% litter)

4.8352 0.2566 5.0341 1.7778 3.8099 4.4544 5.5083 0.7468 10.8031 6.5791 8.2786 3.2866 5.5671 9.1211 7.3736 4.9668 6.2106 1.6534 4.4736 6.2406 3.6358 2.4031 3.4036 4.8491 3.9146 7.5381 4.9381 3.2801

C. The correlation of percent ground cover by toadflax density.
    a. The unburned site
        1. Total D. toadflax density was negatively correlated to all cover types (table 15).
        2. There was no correlation between mature D. toadflax density and percent cover.
        3. Immature D. toadflax density was only negatively correlated with the percent of bare ground (table 15).
    b. The burned site.
        1. Total D. toadflax density was negatively correlated with the percent of grass, bare ground and rock (table 16).
        2. Mature D. toadflax was negatively correlated with all cover types except forbs (table 16).
        3. Immature D. toadflax density was only negatively correlated with percent bare ground (table 16).