Biological Control of Noxious Weeds on Federal Installations in Colorado and Wyoming

Air Force Academy
Buckley Air Force Base
Fort Carson Military Post
Rocky Flats National Wildlife Refuge
F. E. Warren Air Force Base

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2008 Consolidated Report

AgriLIFE RESEARCH
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On the cover: Close up of saltcedar (*Tamarix*) flowers taken from Section 36 at Fort Carson. Over 10,000 Diorhabda elongata ***beetles were released at the site this summer.***

Photo credit: Erin Jones.

Introductory Notes

As of 2008, the biological control of noxious weeds project has been going on for twelve years at Ft. Carson Military Post (FTC), nine years at Air Force Academy (AFA), eight years at Rocky Flats National Wildlife Refuge (RF), six years at Buckley Air Force Base (BAF), and five years at F. E. Warren Air Force Base (WAB). As stated in previous years, the program's focus is threefold:

1. Establish approved insects and mites for control of various federal- and state-listed noxious weeds at various sites within the five locations.
2. Redistribute established insects and mites to additional weed infestations.
3. Monitor the reduction in weed infestations through GPS mapping of infestation perimeters and plant measurements that include density, height, and other variables.

Though this summer marked a transitional period where a new project coordinator has stepped in to take over the project, every effort has been made to maintain the continuity of the program. The focus this year was on conducting the vegetation monitoring when insect populations were at their peak and plants had reached the flowering stage. This change in the monitoring protocol was made to ensure that sampling would be better timed to more accurately reflect the current populations of plant and insect species.

To accomplish this goal, sentinel sites were selected to represent each insect and plant type and sites were sampled weekly. When plants and insects were determined to be at their peak, the sentinel site and all other sites of that plant species were mapped. Ideally, sentinel sites continued to be monitored until insect populations declined for two consecutive weeks. To further streamline the data taking process, changes were made to the number of samples taken at a site, with 30 quadrats sampled in sentinel sites and 10 points sampled in all other sites. In 2008 we continued monitoring the progress of sites in all four stages of control (new, young, populations in consistent decline and "crashed") as well as seeking out potential new sites. Due to limited resources this summer, both in labor and insect availability, we focused on marking out new sites only and will begin mapping them and performing additional insect releases next summer if agents are available.

Finally, you will notice the return this year of data on the infestation of field bindweed by the bindweed mite *Aceria malherbae* (Table 8). Biocontrol efforts on this mite began in 2006 and additional releases were made in 2008 from mites harvested in Amarillo, TX. We hope to continue with mite introductions, mowing to distribute the mites, and monitoring infestations at all the installations with field bindweed sites.

Navigating the 2008 Report

Figure 1 illustrates the locations of noxious weed biological control work over the past eleven years. For the 2008 season we have focused on five installations, Air Force Academy, Buckley Air Force Base, Fort Carson Military Post, Rocky Flats National Wildlife Refuge, and F. E. Warren Air Force Base. Table 1 presents an overview of the general trends in noxious weed intensity and growth over the past year. Table 2 provides a quick reference to the changes in weed population parameters, density and height, on a site-by-site basis for each of the participating installations. Sites discontinued in 2008 were not included in this quick summary table.

Beginning on page 13, we present the supplementary laboratory and field data collection from 2006 and 2008 that helps us to assess the establishment efficacy and damage potential of released bio-agents. Table 3 represents the results of knapweed seedhead collections in 2008 quantifying populations of the seed-feeders *Larinus minutus*, *Metzneria paucipunctella*, *Urophora affinis* and *U. quadrifasciata*. Tables 4 and 5 contain information about *Apthona* sp. establishment and Table 7 describes the success of the control of St. John's wort at the Air Force Academy. As mentioned in the introductory notes, Table 8 contains data on field bindweed infestations across four installations. In previous years a comparison of establishment levels of toadflax stem-borer, *Mecinus janthinus*, from the previous field season were included in this section. Results from the 2007 field season are missing because we did not have an opportunity to collect toadflax stems this spring, results of the 2008 field season will be included in next year's report.

In the remainder of this consolidated report, we discuss the details of activities at the various locations in alphabetical order, beginning with the Air Force Academy and ending with F. E. Warren Air Force Base. As in previous reports, this format provides a written narrative of the key observations and activities at each location, followed by tabular material with historic site data, plant parameter changes, and biocontrol agent release and recovery records. Additionally, maps and graphs of individual infestations provide detailed information on the current distribution of and changes to a weed's density and height throughout its monitoring history.

Characteristics of each weed infestation (i.e. total area covered, density of infested patches, height of plants, seedhead production, etc.) are summarized within the initial table for each installation. Plant density measurements are taken from counts of individual stems/plants within a given number of $0.5m^2$ quadrat samples (n). The additional table presented for each installation identifies which biological control agents have been released and recovered at a given site to date. Due to the changes in sampling protocol this year, sentinel sites were monitored several times in the season and therefore bio-agents had a better chance of being detected than in previous years when only one survey was conducted. The species recovery tables therefore reflect data from both sentinel site visits and data from species counted during site mapping.

Just as they were last year, the current year's weed density and height estimates are then presented in detail as colorful maps illustrating the distribution of each plant parameter within an infestation's perimeter. The maps are generated using a Geographic Information Systems (GIS) technique called spatial interpolation based on the data collected at various points sampled throughout an infestation. For each weed infestation we present the following maps:

a) Perimeter of the Infestation – we present a map of the current area infested by a particular weed, superimposed over both the previous year's infestation extent and cumulative area covered by the weed throughout all previous monitoring years

b) Weed Density – the interpolation map represents the variation in weed density across its infestation area in 2008

c) Weed Height – the interpolation map displays the variation in plant maximum height (a proxy measurement for weed vigor or quality) across the current year's infestation

In addition to weed parameter distribution maps, we provide graphs showing the change in plant density and height over the duration of our biocontrol release and monitoring activities. Error bars in the graphs represent the 95% confidence interval (p=0.05). Where the top error bar for a given year does not overlap the bottom error bar for another year, or vice versa, the change is statistically significant.

All maps and graphs presented in our annual consolidated reports are generated from georeferenced data, obtained in the field using GPS-enabled data collectors. All of the data collected on weed infestation perimeters, plant density and height, bio-agent release and detection up to the 2007 field season are contained within a geodatabase. Using this information, we are able to analyze data both statistically and spatially, along with converting data to visual maps, using GIS. In order to provide our cooperating installations with the opportunity to utilize the data we have collected to meet their own planning and analysis needs, we are making these comprehensive geodatabases available to you. Information for the 2008 field season will be incorporated into the database in the winter of 2008 and distributed to our cooperators at the meeting in 2009. Photopoint photos for all years available will also be incorporated into the database this winter. The information contained within each geodatabase is compatible with ArcGIS products; however, individual database, or .dbf files, can be viewed as standalone tables in MS Excel. These data will also be supplemented by the raw plant dissection and insect observation information that was used to produce Tables 3-8.

General Trends in 2008

Of the sites monitored in both 2007 and 2008, the overall trend across all species and all installations was a decrease in both plant density and plant height (Table 1). The majority of sites showing a decrease in density were not significantly less dense than last summer (16 sites out of 21) whereas a little over half of the sites that showed a decrease in height had plants that were significantly shorter than last year (18 sites out of 31). The only species that had more than two sites with an increase in either parameter was spotted knapweed, with three sites having significant increases in density, three sites with a non-significant increase in density and two sites with a non-significant increase in height. Only one site, Monument Trail Road at the Air Force Academy, had an increase (non-significant) in both parameters. The overall decline in density and plant robustness may be attributed to a long dry spell during the late spring and summer. The number of bio-agents observed was also low, and in some sites non-existent, which may be linked to the lack of precipitation as well. According to the National Oceanic and Atmospheric Administration (NOAA), the average precipitation in the Colorado Springs area over the period from June 3rd to the end of August was from 0 up to 4.5 inches lower than normal. Two agents that were particularly successful this year despite the dry weather were *Larinus minutus* and *Rhinocyllus conicus*, the latter of which self-dispersed to sites on Air Force Academy, Buckley Air Force Base, Fort Carson Military Post and Rocky Flats National Wildlife Refuge.

Each installation also had several sites where the area and density of weeds were reduced to such low levels that accurate mapping was not possible. Though in the past sites that had diminished weed populations have rebounded to mappable levels in subsequent years, it is encouraging to see so many sites reduced to a few scattered plants. There were four sites at the Air Force Academy, one at Buckley Air Force Base, three at Fort Carson Military Post, two at Rocky Flats National Wildlife Refuge and five at F.E. Warren Air Force Base that were un-mappable due to low density.

This summer we were not able to make as many insect releases as we had planned due to low insect numbers at established sites. However, one bio-agent that we had in abundant supply was the field bindweed mite *Aceria malherbae*. A large number of infested runners were collected from a site in Amarillo, Texas, and distributed to 11 previously-established field bindweed sites at Buckley Air Force Base, Fort Carson Military Post, and Rocky Flats National Wildlife Refuge. The addition of infected runners combined with mowing of the sites to redistribute the mite should increase the efficacy of this bio-agent. As mites become established at sites on each of the bases these sites can then serve as nurseries to distribute the mite to other Field Bindweed patches on the installation.

As always, please send us any comments you may have regarding either our biocontrol efforts or the reporting format. We appreciate the continued opportunity to carry on this important work.

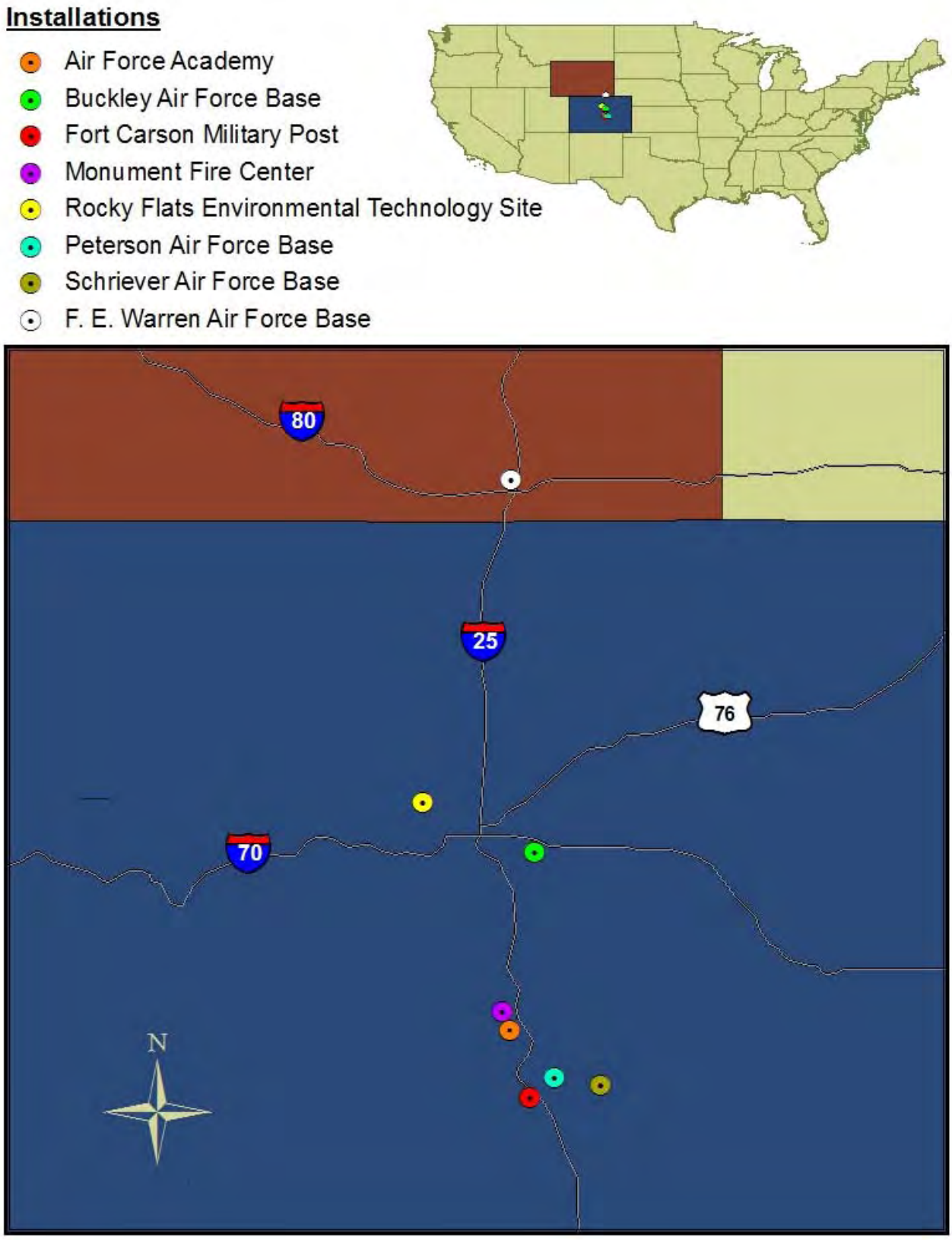


Figure 1. Map showing the federal installations in Colorado and Wyoming on which noxious weed biological control efforts are being/have been made by Texas AgriLife Research.

Table 1. Overall summary of the trends in noxious weed parameter changes, 2007-2008, at the five participating installations in Colorado and Wyoming.

		Change in Parameter, 2007-2008				
Noxious Weed	Parameter	Significant decrease[1]	Decrease	Significant increase[1]	Increase	Total Compared Sites
Canada Thistle	Density	0	5	0	0	9
Canada Thistle	Height	5	4	0	0	9
Dalmatian Toadflax	Density	1	0	0	2	3
Dalmatian Toadflax	Height	0	3	0	0	3
Leafy Spurge	Density	2	4	0	0	6
Leafy Spurge	Height	2	4	0	0	6
Musk Thistle	Density	0	0	0	1	1
Musk Thistle	Height	1	0	0	0	1
Diffuse Knapweed	Density	1	2	0	0	3
Diffuse Knapweed	Height	2	0	0	1	3
Spotted Knapweed	Density	0	1	3	3	7
Spotted Knapweed	Height	3	2	0	2	7
Mixed Knapweed	Density	0	1	0	0	1
Mixed Knapweed	Height	0	1	0	0	1
St. John's wort	Density	0	1	0	1	2
St. John's wort	Height	2	0	0	0	2
Yellow Toadflax	Density	1	2	0	0	3
Yellow Toadflax	Height	3	0	0	0	3
Total		**23**	**30**	**3**	**10**	**70**

[1]Significance level, p=0.05

Table 2. Details of the changes in noxious weed parameters, 2007-2008, at Air Force Academy (AFA), Buckley Air Force Base (BAF), Fort Carson Military Post (FTC), Rocky Flats National Wildlife Refuge (RF), and F. E. Warren Air Force Base (WAB). Sites that were monitored only one of these years are not included in the summary.

Installation	Site	Noxious Weed	Parameter	Annual Change	
AFA	Ice Lake Road I	Canada Thistle	Density	decrease	ns
AFA	Ice Lake Road I	Canada Thistle	Height	decrease	*
AFA	Ice Lake Road II	Canada Thistle	Density	increase	ns
AFA	Ice Lake Road II	Canada Thistle	Height	decrease	*
AFA	Kettle Lake	Canada Thistle	Density	decrease	ns
AFA	Kettle Lake	Canada Thistle	Height	decrease	*
AFA	Parade Loop	Canada Thistle	Density	increase	ns
AFA	Parade Loop	Canada Thistle	Height	decrease	*
AFA	Deadman's Trail	Leafy Spurge	Density	decrease	ns
AFA	Deadman's Trail	Leafy Spurge	Height	increase	ns
AFA	Douglass School	Leafy Spurge	Density	decrease	ns
AFA	Douglass School	Leafy Spurge	Height	decrease	ns
AFA	Highway 83	Diffuse Knapweed	Density	decrease	ns
AFA	Highway 83	Diffuse Knapweed	Height	decrease	*
AFA	Water Treatment Plant	Mixed Knapweed	Density	decrease	ns
AFA	Water Treatment Plant	Mixed Knapweed	Height	decrease	ns
AFA	Monument Trail Road	Spotted Knapweed	Density	increase	ns
AFA	Monument Trail Road	Spotted Knapweed	Height	increase	ns
AFA	New Monument Creek	Spotted Knapweed	Density	increase	ns
AFA	New Monument Creek	Spotted Knapweed	Height	decrease	ns
AFA	Old Monument Creek	Spotted Knapweed	Density	increase	*
AFA	Old Monument Creek	Spotted Knapweed	Height	decrease	ns
AFA	Parade Loop	Spotted Knapweed	Density	increase	*
AFA	Parade Loop	Spotted Knapweed	Height	decrease	*
AFA	Kettle Creek	St. John’s wort	Density	increase	ns
AFA	Kettle Creek	St. John’s wort	Height	decrease	*
AFA	Midway Kettle Creek	St. John’s wort	Density	decrease	ns
AFA	Midway Kettle Creek	St. John’s wort	Height	decrease	*
AFA	Community Center Drive I	Yellow Toadflax	Density	decrease	*
AFA	Community Center Drive I	Yellow Toadflax	Height	decrease	*
AFA	Community Center Drive III	Yellow Toadflax	Density	decrease	ns
AFA	Community Center Drive III	Yellow Toadflax	Height	decrease	*
AFA	Ice Lake Road II	Yellow Toadflax	Density	decrease	ns
AFA	Ice Lake Road II	Yellow Toadflax	Height	decrease	*
BAF	Aspen	Canada Thistle	Density	decrease	ns
BAF	Aspen	Canada Thistle	Height	decrease	*

Table 2. Cont.

Installation	Site	Noxious Weed	Parameter	Annual Change	
BAF	Williams Lake	Canada Thistle	Density	increase	ns
BAF	Williams Lake	Canada Thistle	Height	decrease	ns
BAF	Southwest Williams Lake	Leafy Spurge	Density	decrease	ns
BAF	Southwest Williams Lake	Leafy Spurge	Height	decrease	*
BAF	Williams Lake	Leafy Spurge	Density	decrease	*
BAF	Williams Lake	Leafy Spurge	Height	decrease	ns
BAF	Runway	Leafy Spurge	Density	decrease	ns
BAF	Runway	Leafy Spurge	Height	decrease	*
BAF	South Fence	Spotted Knapweed	Density	decrease	ns
BAF	South Fence	Spotted Knapweed	Height	increase	ns
BAF	South Aspen Way	Dalmatian Toadflax	Density	decrease	*
BAF	South Aspen Way	Dalmatian Toadflax	Height	decrease	ns
BAF	South Fence	Dalmatian Toadflax	Density	increase	ns
BAF	South Fence	Dalmatian Toadflax	Height	decrease	ns
FTC	ARA II	Canada Thistle	Density	decrease	ns
FTC	ARA II	Canada Thistle	Height	decrease	ns
FTC	Duckpond	Canada Thistle	Density	increase	ns
FTC	Duckpond	Canada Thistle	Height	decrease	ns
FTC	Wildlife	Musk Thistle	Density	increase	ns
FTC	Wildlife	Musk Thistle	Height	decrease	*
FTC	Gun Club	Diffuse Knapweed	Density	decrease	*
FTC	Gun Club	Diffuse Knapweed	Height	decrease	*
FTC	Fuel Site	Spotted Knapweed	Density	increase	ns
FTC	Fuel Site	Spotted Knapweed	Height	decrease	*
FTC	Turkey Creek	Spotted Knapweed	Density	increase	*
FTC	Turkey Creek	Spotted Knapweed	Height	decrease	*
RF	Lindsay Ranch	Canada Thistle	Density	decrease	ns
RF	Lindsay Ranch	Canada Thistle	Height	decrease	ns
RF	South Fence Transects	Dalmatian Toadflax	Density	increase	ns
RF	South Fence Transects	Dalmatian Toadflax	Height	decrease	ns
RF	North Buffer Transects	Diffuse Knapweed	Density	decrease	ns
RF	North Buffer Transects	Diffuse Knapweed	Height	increase	ns
WAB	Black Powder Road	Leafy Spurge	Height	decrease	ns
WAB	Black Powder Road	Leafy Spurge	Density	decrease	*

at p=0.05 * indicates parameters are significantly different, ns indicates no significant difference

Summary of 2008 Laboratory and Field Support Efforts

In addition to weed mapping and monitoring efforts on federal installations, our program performs a number of surveys/studies to support the assessment of biological control efficacy. These analyses include biocontrol insect surveys in the field and dissection of plant materials from bio-agent release areas, generally conducted in the fall and winter after the field season. Summaries of the population densities of various biological control agents that are presented in this section include the following:

- Knapweed seedhead occupants, collected after the 2008 field season (Table 3)
- Comparative spring collections of *Aphthona* beetle populations found at mapped leafy spurge infestations during peak beetle emergence in 2004, 2005, 2006, 2007 and 2008 (Table 5).
- Comparative spring collections of *Aphthona* populations found at supplementary leafy spurge release sites in 2006, 2007 and 2008, from which 10 random sweeps were taken to collect the beetles in lieu of mapping the sites (Table 6).
- Comparative spring collections of *Chrysolina* beetle populations found at mapped St. John's wort infestations during peak beetle emergence in 2004, 2005, 2006, 2007 and 2008 (Table 7).

Discussions of the bio-agent establishment and damage reported in these tables will take place within the subsequent sections for individual installations.

Table 3. Knapweed seedhead dissections from sampled plants in 2008 at Air Force Academy (AFA), Fort Carson Military Post (FTC) and Rocky Flats National Wildlife Refuge (RF), identifying the proportion of knapweed seedheads attack (%) and the seed-feeding agents responsible.

Installation Abbreviation	Sample Site Name	n	Percent Heads Attacked	Seedheads with Biological Control Agents (%)			
				L. minutus	*U. affinis*	*U. quadrifasciata*	*M. paucipunctella*
AFA	Bike Trail[1]						
AFA	Deadman's Creek[1]						
AFA	Highway 83	300	86	30	33	6	34
AFA	New Monument Creek	198	33	1	26	4	8
AFA	Monument Trail Road	197	86	16	56	17	37
AFA	NPWR[1]						
AFA	Old Monument Creek	200	78	45	11	0.5	28
AFA	Parade Loop (combined)	192	42	0.5	20	17	45
AFA	Water Treatment Plant	200	79	19	24	0	51
FTC	Fuel Site[1]						
FTC	Gun Club[1]						
FTC	Hazmat[1]						
FTC	Turkey Creek[1]						
RF	N Buffer Transects	100	95	19	32	24	20

Note: The columns containing the percentages of seedheads attacked by respective insect species will not necessarily sum to the "percent heads attacked" column, as there are often multiple insects/species found per seedhead.

[1] Not sampled this year

Table 4. Knapweed root dissections from sampled plants in 2008 at Air Force Academy (AFA), Fort Carson Military Post (FTC) and Rocky Flats National Wildlife Refuge (RF), identifying the proportion of knapweed roots attack (%) and the root-feeding agents responsible.

Installation Abbreviation	Site Name	n	Percent Roots Attacked	Roots with Biological Control Agents (%)		
				C. achates	*A. zoegana*	*S. jugoslavica*
AFA	Bike Trail[1]					
AFA	Deadman's Creek[1]					
AFA	Highway 83	70	34	13	23	0
AFA	New Monument Creek	20	15	10	0	5
AFA	Monument Trail Road	39	39	3	18	3
AFA	NPWR[1]					
AFA	Old Monument Creek	38	11	0	11	0
AFA	Parade Loop (combined)	47	23	4	9	11
AFA	Water Treatment Plant	51	47	10	28	10
FTC	Fuel Site[1]					
FTC	Gun Club[1]					
FTC	Hazmat[1]					
FTC	Turkey Creek[1]					
RF	N Buffer Transects[2]	8	75	62	0	25

Note: The columns containing the percentages of roots attacked by respective insect species will not necessarily sum to the "percent roots attacked" column, as there are often multiple insects/species found per root.

[1] Not sampled this year
[2] Extremely low knapweed density

Table 5. Proportion of sampled leafy spurge 0.5m^2 quadrats populated by *Aphthona* species biological control agents, as identified through sweep net captures in 2004-2008 at mapped sites from Air Force Academy (AFA), Buckley Air Force Base (BAF) and F. E. Warren Air Force Base (WAB). The number of quadrat samples taken at a site is indicated by n.

Installation Abbreviation	Site Name	2008 Sweeps		2007 Sweeps		2006 Sweeps		2005 Sweeps		2004 Sweeps	
		n	% Infested	n	% Infested	n	% Infested	n	% Infested	n	% Infested
AFA	Deadman's Trail	33	27	32	28	37	0	30	37	31	45
AFA	Douglass School	12	0	30	17	43	0	36	3	5	20
AFA	FERL	10	0	50	22	33	0	45	6	30	20
AFA	North FERL [2]	71	21	--	--	35	0	--	--	--	--
BAF	Interior [3]	11	0	--	--	10	20	28	36	--	--
BAF	Runway [3]	31	19	45	47	28	86	32	31	44	0
BAF	South Fence [1]	10	40	30	17	28	0	--	--	--	--
BAF	Southwest Williams Lake [3]	10	0	31	19	34	44	42	57	24	0
BAF	Williams Lake	19	16	56	43	45	2	31	32	77	9
WAB	Black Powder Road [2]	27	0	129	50	96	27	28	0	--	--
WAB	Control [3]	--	--	--	--	64	23	50	54	31	0
WAB	Nature I [3]	--	--	60	8	54	6	35	34	44	0
WAB	Nature II [3]	--	--	62	39	54	56	37	73	42	0

[1] Site initiated in 2006
[2] Site initiated in 2005
[3] Site initiated in 2004

Table 6. Comparison of establishment rates at additional *Aphthona* species biological control release sites at Buckley Air Force Base (BAF) and F. E. Warren Air Force Base (WAB) *in years following mass introduction in 2005*. Insects were released at these sites, but infestation perimeters have not been mapped. Instead, 10 random leafy spurge 0.5m^2 quadrats have been sampled at each release location in 2006-2008.

Installation Abbreviation	Sample Site Name	2008 Sweep Samples		2007 Sweep Samples		2006 Sweep Samples	
		% Quadrats Infested	# Insects/quadrat	% Quadrats Infested	# Insects/quadrat	% Quadrats Infested	# Insects/quadrat
BAF	North Runway 1	10	1	60	3	0	--
BAF	North Runway 2	0	--	50	1	0	--
BAF	North Runway 3 [1]	0	--	0	--	--	--
WAB	Black Powder 1 [2]	0	--	100	4	80	4
WAB	Black Powder 2 [2]	50	2	100	18	60	2
WAB	Black Powder 3 [2]	90	5	40	1	10	0.2
WAB	Black Powder 4 [2]	20	1.5	100	5	10	0.3
WAB	Black Powder 5 [2]	0	--	10	0.1	10	0.2
WAB	Black Powder 6 [2]	0	--	10	0.1	30	0.4
WAB	Bridge I [2]	20	1	60	1	60	5
WAB	Bridge II [2]	20	2	50	1	60	1
WAB	Nature III	0	--	0	--	70	3
WAB	Nature IV [2]	0	--	0	--	30	0.6
WAB	Propane [2]	67	2	80	5	100	9

[1] Initial release of *Aphthona* species beetles made in 2007.
[2] Supplementary release of *Aphthona* species beetles made in 2007 (following the insect establishment survey).

Table 7. Proportion of sampled St. John's wort $0.5m^2$ quadrats populated by *Chrysolina* species biological control agents at Air Force Academy, as identified through visual counts in 2004-2008. The number of quadrat samples taken at a site is indicated by n.

	2008 Insect Counts		2007 Insect Counts		2006 Insect Counts		2005 Insect Counts		2004 Insect Counts	
Site Name	n	% Infested	n	% Infested	n	% Infested	n	% Infested	n	% Infested
Kettle Creek	39	31	47	32	32	13	33	49	71	10
Midway Kettle Creek	34	3	32	44	30	7	40	48	19	32
Santa Fe	--	--	--	--	--	--	40	68	24	8

Note: The Santa Fe site was not sampled in 2006, 2007 or 2008, as there were not enough plants left at this site to sample.

Table 8. Proportion of sampled Field Bindweed 0.5m^2 quadrats populated by biological control agent *Aceria malherbae* at Air Force Academy (AFA), Buckley Air Force Base (BAF), and Fort Carson Military Post (FTC) as identified through random sampling in 2006-2008. The number of quadrat samples taken at a site is indicated by n.

Installation Abbreviation	Sample Site Name	2008 Sample n	2008 Sample % Infested	2007 Sample n	2007 Sample % Infested	2006 Sample n	2006 Sample % Infested
AFA	Stadium[5]	30	0	30	0	--	--
AFA	FERL[1]	10	0	10	0	--	--
BAF	Breckenridge	10	30	10	0	10	0
BAF	FW1[4,6]	10	40	10	0	10	10
BAF	FW2[4,6]	10	70	20	0	10	30
BAF	FW3[5]	10	50	10	0	10	0
BAF	NE Gate 1[5,6]	10	10	10	0	--	--
BAF	NE Gate 2[5]	10	0	10	0	--	--
BAF	NE Gate 3[5]	10	20	10	0	--	--
BAF	NE Gate 4[5]	10	0	10	0	--	--
BAF	NE Gate 5[5]	10	10	10	0	--	--
BAF	Playground[5,6]	10	30	10	30	10	0
BAF	POV Resale[5,6]	10	0	10	0	10	30
BAF	RV [5]	10	0	10	0	10	10
BAF	RV West5	10	0	10	0	10	0
BAF	Fence 1[5]	10	20	10	0	10	0
BAF	Fence 2[5]	10	10	10	0	10	0
BAF	Steamboat[6]	10	40	10	0	10	0
FTC	ARA 1[1,6]	10	10	10	0	10	40
FTC	ARA 2a	10	20	10	0	10	0
FTC	ARA 2b	10	0	10	0	10	20
FTC	ARA Building[3]	10	10	10	0	10	0
FTC	Basketball field 1	10	0	10	0	10	0

Table 8. Proportion of sampled Field Bindweed 0.5m^2 quadrats populated by biological control agent *Aceria malherbae* at Air Force Academy (AFA), Buckley Air Force Base (BAF), and Fort Carson Military Post (FTC) as identified through random sampling in 2006-2008. The number of quadrat samples taken at a site is indicated by n.

Installation Abbreviation	Sample Site Name	2008 Sample		2007 Sample		2006 Sample	
		n	% Infested	n	% Infested	n	% Infested
FTC	Basketball field 2	10	10	10	0	--	--
FTC	Basketball field 3	10	20	10	0	--	--
FTC	Basketball field 4	10	10	10	0	--	--
FTC	Basketball field 5	10	0	10	0	--	--
FTC	Basketball field 7	10	0	10	0	--	--
FTC	Curation 2	10	30	10	0	10	0
FTC	Curation 3	10	0	10	0	10	0
FTC	Curation 5	10	40	10	0	10	0
FTC	Curation 6	10	10	10	0	--	--
FTC	Golf Course[5]	10	0	10	0	10	0
FTC	Hospital[5]	10	0	10	0	10	0
FTC	Range Control[2,6]	10	0	20	0	10	0
RF	Highroad 1[6]	10	60	--	--	--	--
RF	Highroad 2[6]	10	20	--	--	--	--
RF	Site 8[6]	10	30	--	--	10	30
RF	Site 9	10	30	--	--	10	20

[1] Denotes sites where mites were released in 2000
[2] Denotes sites where mites were released in 2001
[3] Denotes sites where mites were released in 2004
[4] Denotes sites where mites were released in 2005
[5] Denotes sites where mites were released in 2006
[6] Denotes sites where mites were released in 2008

Air Force Academy

Nineteen noxious weed infestations were mapped at Air Force Academy this year over a total area of 2.70 ha (6.66 acres). Two additional sites, Stadium and FERL field bindweed, were not mapped. Instead, random sampling was conducted to detect the presence of bio-agents on these two sites. Though the total area of infestation decreased almost threefold from last year's 8.6 ha, it is still an increase from 2006's total area of 1.78 ha. Eleven out of the twenty sites saw a decrease in area, results that are consistent with an overall decrease in height and density of weeds both at the Air Force Academy (Table 2) and throughout all the installations monitored this summer (Table 1). Mapped and monitored sites this year included four Canada thistle sites over 0.19 ha (0.47 acres), four leafy spurge sites over 0.37 ha (0.91 acres), six knapweed sites over 1.89 ha (4.67 acres) two St. John's wort sites over 0.13 ha (0.33 acres) and two Yellow toadflax sites over 0.12 ha (0.29 acres). Of the 17 sites that were surveyed in both 2007 and 2008, 15 saw a decrease in height (11 sites with significant changes) while only ten sites had a decrease in density (with only one site significantly less dense). See Table 10 for a year by year summary of each site including area, density, height, and where applicable, seedhead number and size.

Figure 2. Success! The Ice Lake Road I Musk thistle site. Student worker Brian Mulhern expresses excitement over the fact that only a few plants remain (large brown seedheads in the middle ground) at this site. The infestation was reduced to a handful of plants in an area covering less than 5 x 5 m^2.

As in previous years, the six knapweed sites mapped in 2008, covering 1.89 ha of land, comprised the largest percentage (70%) of the total area mapped at the Air Force Academy this year. This majority held despite the Total Parade Loop site being reduced by 94%, the largest reduction in area of any site (Figure 3; Table 10). The dramatic expansion and decline of this site over the course of two growing seasons illustrates the dynamic and often stochastic nature of plant populations, underscoring the need for long term monitoring. One explanation for the large reduction in the knapweed populations may be the strong attack in 2007 of seedheads and roots by several species of biocontrol agents. This year also seemed to be a particularly favorable one

for the bio-agent *Larinus minutus,* as a large numbers of insects were observed at all the knapweed sites on the base. *L. minutus* were recovered at each of the knapweed sites every time they were sampled, and recoveries continue to be made at sites where the insect has self-dispersed (i.e. Highway 83). The insects were so numerous that we were able to use the three AFA sites as nursery sites and sent about 250 insects to Dr. Tim Kring, Professor of Entomology at the University of Arkansas, to use in a new biocontrol program for knapweed in northern and central Arkansas. Enough samples of seedheads and roots were taken this year from knapweed sites to analyze the percent heads and roots attacked by plant-boring insects (Tables 3 and 4). Almost every insect was present at each site with few exceptions (i.e. *U. quadrifasciata* at Water Treatment Plant). Overall, *Agapeta zoegana* had the largest population (or second largest) population at all sites except New Monument Creek. The population of Agapeta zoegana was an unexpected but pleasant surprise. This biocontrol agent was not previously found in large numbers, but seems to now be well established at the Academy.

Figure 3. Photopoint of Parade Loop II in 2007 (left) and 2008 (right). Though the photo in 2008 was taken after flowering, the plants appear smaller and less robust than last year's plants.

Just as with the knapweeds, it was also a bad year for populations of yellow toadflax; the plants remained small throughout the growing season and many plants were withered and dry by early August (Figure 4). No *Gymnetron antirrhini* were observed on any of the four sites during mapping, though a total of 21 insects were observed at the Ice Lake Road II sentinel site from 30 May to 14 July. There were no *Mecinus janthinus* agents observed at any of the toadflax sites, though they have been observed in sites at the Air Force Academy in the past three years the insects have not been able to successfully establish a self-sustaining population.

Some species of insects were observed this season that had either not been observed before or only observed in low numbers. Galls of the Canada thistle feeder *Urophora cardui* were observed at the Kettle Lake and Parade Loop sites where they had not been seen previously (Figure 4). The Parade Loop site in particular was had many galls. Many thistle plants also exhibited "window-paneing" from *Cassida rubiginosa*, though few adult insects were observed (Figure 4). FERL North had *Aphthona* sp. releases in 2005 and we are now beginning to recover *A. nigriscutis* and *A. cyparissiae*. The observation of these insects may be the result of the new

sentinel site monitoring protocol. Sentinel sites were visited multiple times throughout the growing season allowing us to observe insects that emerge at different times over the course of the summer that would have been missed if the site were only sampled once.

Figure 4. Photo of an *U. cardui* gall on a Canada thistle plant at the Kettle Lake site (left). This photo was taken in the first week of August. Much evidence of *C. rubiginosa* was seen at the thistle sites in the form of "window-paneing" on the leaves, though few adults were observed (Right, bottom). Yellow toadflax plants remained small and un-flowered through early August (right, top).

There were six sites monitored in previous years that were not monitored this year. As in 2006 and 2007, the Ice Lake Road I musk thistle and Santa Fe St. John's wort sites had only a few plants with not enough left to monitor. The newly-created Bike Trail diffuse knapweed site also had plants that were too few and scattered to monitor effectively. This site was created last summer to serve as a nursery site for *L. minutus* and *Cyphocleonus achates* removed from other sites slated to be sprayed with herbicide in fall of 2007. The sudden influx of bio-agents may have been responsible for this site's rapid decline. The NPWR spotted knapweed site was destroyed by construction this summer. However, the FERL North site, (destroyed last year) came back stronger this year with an area almost twice as large as in 2006, though plant density was half of what it was in the first year. The Deadman's Creek spotted knapweed site, which is usually not mapped but randomly sampled for insects, was not sampled this year.

No insect releases were made at the Air Force Academy this year. Though the redistribution of *Aceria anthocoptes* from a thistle site at Fort Carson Military Post was planned, no mites were observed this summer. The bindweed mite *Aceria malherbae* was distributed from a site in Amarillo, Texas to other military installations in Colorado. These sites will

hopefully serve as nursery sites in the coming years that we can use to distribute mites to sites at the Air Force Academy. No new sites were established this summer either, though some sites (i.e. Kettle Lake Canada thistle and Old Monument Creek spotted knapweed) had infestations of yellow toadflax in addition to the original weed infestation. Unfortunately, as stated in the 2006 report we do not yet have highly successful agents for yellow toadflax, though some *G. antirrhini* were recovered this year from Ice Lake Road I where releases were made last year. Next year we will focus on searching for self-dispersed agents at these new toadflax sites and/or redistributing agents from established sites to these areas. We will also consider supplementing *G. antirrhini* at the Academy if commercial or other sources can be found.

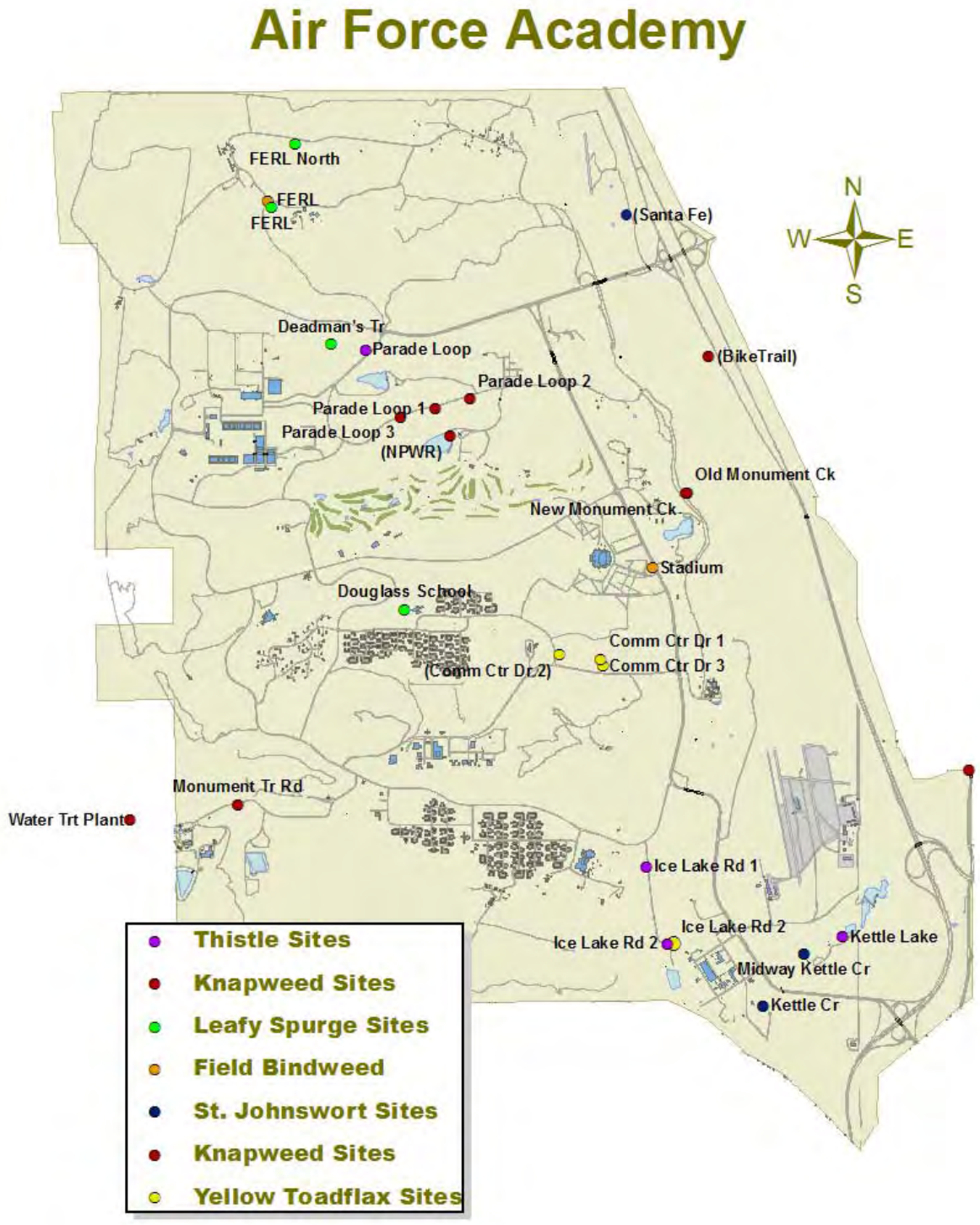


Figure 5: Schematic diagram of Air Force Academy with current weed biological control study areas superimposed. Sites listed in parentheses were not surveyed in 2008.

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Canada thistle – Ice Lake Road I													
2000			9.00		66.83								
2001	976	39	7.48	40	91.80	143	47.38	0.52		-16.89	37.36		
2002	449	33	2.26	21	14.56	97	0.46	0.90	-54.00	-69.79	-84.14		
2003	80	49	2.61	14	33.02	107	6.78	0.25	-82.22	15.49	126.79		
2004	244	45	1.27	16	45.62	74	3.23	0.54	205.84	-51.34	38.16		
2005	244	30	3.67	17	49.04	82	7.30	0.39	0	188.97	7.50		
2006	272	27	4.52	13	33.76	62	1.71	0.23	11.48	23.16	-31.16		
2007	406	31	4.32	12	72.19	129	12.85	0.50	49.26	-4.42	113.83		
2008	278	10	3.40	16	40.31	74	6.38	3.63	-31.53	-21.30	-44.16	-71.51	-62.22
Canada thistle – Ice Lake Road II													
2000	341	65	7.21	36	64.53	115							
2001	434	32	4.70	46		79			27.45	-34.81			
2002	214	27	1.74	18	16.12	124	3.85	0.21	-50.78	-62.97			
2003	46	18	2.28	16	39.72	100	10.33	0.27	-78.45	31.03	146.40		
2004	145	31	1.09	11	44.85	145	5.76	3.50	214.94	-52.19	12.92		
2005	114	24	5.21	17	79.69	110	25.91	2.05	-21.38	377.98	77.68		
2006	206	27	3.19	9	31.21	52	4.89	0.39	80.70	-38.77	-60.84		
2007	288	56	3.71	16	71.52	123	11.90	5.06	39.81	16.30	129.16		
2008	674	11	4.55	14	38.58	50	16.83	4.83	134.03	22.64	-32.94	97.65	-36.89
Canada thistle – Kettle Lake													
2003	1,153	72	6.03	110	62.35	132	9.32	0.38					
2004	1,165	52	6.90	23	50.53	87	9.06	0.94	1.07	14.43	-18.96		
2005	917	31	5.34	13	75.25	121	12.86	0.61	-21.27	-22.61	48.92		
2006	943	33	4.67	26	30.83	59	0.93	0.12	2.84	-12.55	-59.03		
2007	959	22	3.00	12	63.78	129	9.17	0.47	1.70	-35.76	106.87		
2008	541	31	2.32	8	29.78	82	4.35	2.3	-43.59	-22.67	-53.31	-53.08	-61.53

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Canada thistle – Parade Loop													
2003	6	1	0.82	10	24.09	70							
2004	36	10	4.30	13	62.29	87	6.00	2.40	483.36	424.39	158.57		
2005	61	26	3.32	14	71.92	105	18.2	0.62	69.44	-22.79	15.46		
2006	92	30	5.07	19	32.09	62	9.73	0.47	50.82	52.71	-55.38		
2007	153	20	3.50	14	126.09	167	19.45	0.79	66.30	-30.97	292.93		
2008	388	10	5.40	9	62.78	103	8.33	4.22	153.59	54.29	50.21	6,366.67	558.54
Musk thistle – Ice Lake Road I													
2000	1,016	129	7.76	82	58.87	171							
2001	976	39	1.13	6	23.82	158	2.57	0.90	-3.95	-85.44	-59.54		
2002	449	7	2.00	6	63.66	111	9.00	2.18	-54.00	76.99	167.25		
2003													
2004	98	30	1.26	8	31.93	131	1.11	10.40	-78.17**	-37.00**	-49.84**		
2005	*(see Note a)*												
2006	*(see Note a)*												
2007	567	20	1.15	4	122.08	189	7.17	32.67	478.57	-8.73**	282.33**		
2008	*(see Note a)*												
Leafy spurge – Deadman's Trail													
2000	406	28	63.50	195	44.33	76							
2001	1,148	66	59.78	214	50.25	97			182.75	-5.86	13.35		
2002	1,145	117	40.51	196	33.66	89			-0.27	-32.23	-33.01		
2003	249	21	9.00	22	49.25	85			-78.24	-77.78	46.32		
2004	494	31	31.03	93	42.10	80			98.21	244.78	-14.52		
2005	780	30	42.10	169	45.96	70			57.89	35.68	9.17		
2006	840	37	24.38	117	24.08	44			7.69	-42.09	-47.61		
2007	1,263	32	17.28	85	45.89	79			50.36	-29.12	90.57		
2008	429	33	11.97	40	52.62	83			-66.03	-30.73	-14.67	5.67	-81.15

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Leafy spurge – Douglass School													
2000	187	30	16.62	56	36.96	62							
2001	290	93	29.11	103	53.32	82			55.43	75.15	44.26		
2002	380	72	3.33	60	12.24	66			31.03	-88.56	-77.04		
2003	67	5	2.40	3	65.00	80			-82.35	-27.93	431.05		
2004	52	10	11.60	23	50.25	62			-23.20	383.33	-22.69		
2005	81	36	11.05	39	46.62	65			55.77	-4.74	-7.22		
2006	261	43	9.95	59	26.42	52			222.22	-9.95	-43.33		
2007	323	30	24.13	62	56.20	77			23.75	142.51	112.72		
2008	335	12	11.75	30	45.00	75			3.72	-51.31	-19.93	79.14	-29.30
Leafy spurge - FERL													
2000	1,139		5.21		19.54								
2001	1,528	24	4.26	194	24.59	67			34.15	-18.23	25.84		
2002	796	66	11.29	66	19.85	49			-47.89	165.92	-19.28		
2003	329	28	11.54	51	40.54	85			-58.71	2.21	104.23		
2004	2,145	103	7.31	88	31.85	54			551.95	-36.66	-21.44		
2005	196*	45	16.64	141	39.00	61			-90.86*	127.63	22.45		
2006	470	33	21.36	116	21.22	37			139.80	28.37	-45.59		
2007	3,865	50	16.10	91	45.04	68			722.34	-24.63	112.25		
2008	882	10	16.30	36	28.88	63			-77.18	1.24	-35.88	-22.56	212.86
Leafy spurge – FERL North													
2006	696	35	10.69	32	27.69	46							
2007	*(see Note b)*												
2008	2042	71	5.04	41	36.67	60			193.39**	-52.85**	32.43**	193.39	-52.85
Diffuse knapweed – Bike Trail													
2007	628	33	1.21	5	79.70	115	389.14	3.95					
2008	(*see Note a)*												

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Diffuse knapweed – Highway 83													
2003	606	61	1.58	3	49.17	97	46.31	0.07					
2004	2,601	41	2.02	12	47.93	108	88.28	2.60	329.06	27.85	-2.52		
2005	3,001	35	2.58	8	53.23	82	65.36	0.38	15.38	27.72	11.06		
2006	2,278	27	5.74	37	13.03	29			-24.09	122.48	-75.52		
2007	5,750	38	2.87	20	56.48	85			152.41	-50.00	333.46		
2008	6,029	44	2.27	12	34.40	62	43.80	3.76	4.85	-20.91	-39.09	894.88	43.67
Diffuse/Spotted knapweed – Water Treatment Plant													
2003	1,162	97	2.16	23	54.75	107	36.13	0.13					
2004	1,539	42	9.81	38	47.28	91	9.00	2.60	32.47	354.17	-13.64		
2005	2,118	32	5.22	22	56.89	100	49.43	0.42	37.62	-46.79	20.33		
2006	3,525	30	5.53	19	34.88	54	29.53	3.04	66.43	5.94	-38.69		
2007	6,291	37	2.92	9	54.77	81	111.57	5.03	78.47	-47.20	57.02		
2008	6,388	11	2.00	11	40.80	75	87.00	1.73	1.54	-31.50	-25.51	449.74	-7.41
Spotted knapweed – Monument Trail Road													
2003	484	20	1.50	7	27.09	115	23.02						
2004	1,937	32	3.00	17	69.57	112	48.24	4.00	300.26	100.00	153.12		
2005	2,074	39	7.94	25	93.65	148	49.17	0.60	7.07	164.67	34.61		
2006	1,948	30	1.33	11	34.30	58	7.00	0.30	-6.08	-83.25	-63.37		
2007	519	26	2.04	15	56.79	77	35.47	5.62	-73.36	53.38	65.57		
2008	444	10	4.40	18	61.40	75	47.40	5.00	-14.45	115.69	8.12	-8.26	193.33
Spotted knapweed – New Monument Creek													
2004	700	44	3.36	23	28.96	90	35.07	1.70					
2005	629	35	2.94	16	74.22	111	51.19	0.42	-10.14	-12.50	156.28		
2006	522	30	1.60	9	20.75	35	29.42	0.29	-17.01	-45.58	-72.04		
2007	5,385	31	1.94	10	73.63	127	224.39	4.74	931.61	21.25	254.84		
2008	2,444	11	2.09	8	40.57	54	63.71	4.29	-54.61	7.73	-44.90	249.14	-37.80

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Spotted knapweed – Non-potable Water Reservoir (NPWR)													
2003	124	29	0.97	5	24.43	100	9.62	0.61					
2004	491	31	1.35	13	44.25	78	26.33	2.70	295.03	39.18	81.13		
2005	234	30	4.37	29	49.48	89	18.39	0.61	-52.34	223.70	11.82		
2006	98	31	1.55	5	32.15	69	29.95	0.53	-58.12	-64.53	-35.02		
2007	1,937	40	1.55	7	59.72	122	84.26	5.52	1876.53	0	85.75		
2008	*(see Note c)*												
Spotted knapweed – Old Monument Creek													
2000	622	35	9.00	25	37.30	80							
2001	948	45	9.52	68	39.70	98	133.15		52.36	5.78	6.43		
2002	746	41	2.19	26	8.40	73	2.62	0.26	-21.32	-77.00	-78.84		
2003	236	44	1.50	9	27.09	93	23.02	0.28	-68.37	-31.51	222.50		
2004	*(see Note a)*												
2005		49	0.30	14	33.00	39	0.50	2.00					
2006	389	38	0.32	11	25.25	35	13.00	0.60		6.67	-23.49		
2007	1,834	33	0.76	5	72.04	127	226.93	5.54	371.47	137.50	185.30		
2008	456	30	7.30	35	50.50	68	27.75	5.00	-75.14	860.53	-29.90	-26.69	-18.88
Spotted knapweed – Parade Loop I***													
2003	1,437	65	0.81	4	34.18	130	7.10	0.39					
2004	921	43	3.58	13	45.07	97	7.51	3.00	-35.91	341.98	31.86		
2005	941	30	3.93	25	59.44	89	13.87	0.51	2.17	9.78	31.88		
2006	1,108	36	2.00	14	40.50	75	27.00	0.50	17.75	-49.11	-31.86		
Spotted knapweed – Parade Loop II***													
2004	578	33	0.79	3	34.15	118	118.11	2.90					
2005	282	28	3.24	13	57.71	88	9.59	0.31	-51.21	310.13	68.99		
2006	953	36	0.89	9	40.25	69	31.08	0.53	237.94	-72.53	-30.25		

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Spotted knapweed – Parade Loop III***													
2004	1,412	41	1.53	11	21.37	73	11.68	2.60					
2005	106*	22	2.68	14	76.17	117	18.00	0.59	-92.49*	75.16	256.43		
2006	2,235	30	1.60	9	33.05	51	13.18	0.53	2008.49	-40.30	-56.61		
Spotted knapweed – Total Parade Loop***													
2007	53,820	64	1.95	22	71.38	118	108.81	5.47					
2008	3,124	30	10.27	30	51.32	101	29.64	4.55	-94.20	427.67	-28.10	-94.20	426.66
St. John's wort – Kettle Creek													
2004	1,254	90	30.94	85	53.92	85							
2005	224	33	20.00	53	68.18	94			-82.14	-35.36	26.45		
2006	619	32	13.43	60	33.09	68			176.34	-32.85	-51.47		
2007	1,599	47	8.21	47	69.61	95			158.32	-38.87	110.37		
2008	1,011	39	16.62	54	48.16	72			-36.77	102.44	-30.81	-19.38	-46.28
St. John's wort – Midway Kettle Creek													
2004	196	19	28.63	60	54.95	70							
2005	678	40	23.88	73	69.72	93			245.92	-16.59	26.88		
2006	134	30	21.53	59	42.24	62			-80.24	-9.84	-39.41		
2007	776	32	19.03	85	74.61	101			479.10	-11.61	76.63		
2008	322	56	17.32	56	49.19	87			-58.51	-8.99	-34.07	64.29	-39.50
St. John's wort – Santa Fe													
2004	266	24	33.96	96	46.75	73							
2005	420	40	35.35	130	71.41	85			57.89	4.09	52.75		
2006	*(see Note a)*												
2007	*(see Note a)*												
2008	*(see Note a)*												

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Yellow toadflax – Community Center Drive I													
2003	52	4	9.25	15	26.25	40							
2004	30	18	19.61	57	21.00	44			-42.21	112.00	-20.00		
2005	100	32	19.11	65	27.45	46			233.33	-2.55	30.71		
2006	93	25	13.64	72	15.50	29			-7.00	-28.62	-43.53		
2007	134	37	34.92	239	39.71	63			44.09	156.01	156.19		
2008	130	10	9.00	40	14.36	21			-2.99	-74.23	-63.84	150.00	-2.70
Yellow toadflax – Community Center Drive II													
2003	96	8	8.63	34	29.88	95							
2004	112	34	6.44	47	9.18	44			16.82	-25.38	-6 9.28		
2005	59	23	11.00	40	23.25	60		1.31	-47.32	70.81	153.27		
2006	110	27	1.74	16	12.38	29			86.44	-84.18	-46.75		
2007	129	23	13.96	44	25.97	38			17.27	702.30	109.77		
2008	*(see Note a)*												
Yellow toadflax – Community Center Drive III													
2005	21	10	12.90	28	44.77	57							
2006	*(see Note a)*												
2007	30	10	32.90	63	34.70	47			42.86**	155.04**	-22.49**	42.86**	
2008	138	10	16.30	29	20.78	30			360.00	-50.46	-40.12	557.14	
Yellow toadflax – Ice Lake Road													
2007	538	21	20.90	68	33.93	65							
2008	909	35	13.49	61	17.12	32			68.96	-35.45	-49.54	68.96	4.57

n – number of samples or observations
n/a – not applicable, data represent first year of sampling
* - a complete perimeter could not be mapped at this site, area recorded reflects the weed patch available at the time of sampling
** - values given in the year-to-year change column reflect 2- or 3-year changes, as sampling was not done at all sites all years

Table 9. Historic noxious weed infestation parameters, Air Force Academy, Colorado Springs, Colorado, 2000-2008.

*** - Parade Loop spotted knapweed sites 1, 2 and 3 became part of a large, continuous weed infestation in 2007 and, as such, were mapped and monitored as the larger mega-site, Total Parade Loop
Note - Could not map this site, as: a) few scattered plants remained to survey, b) weeds were chemically treated prior to our survey or c) site was destroyed

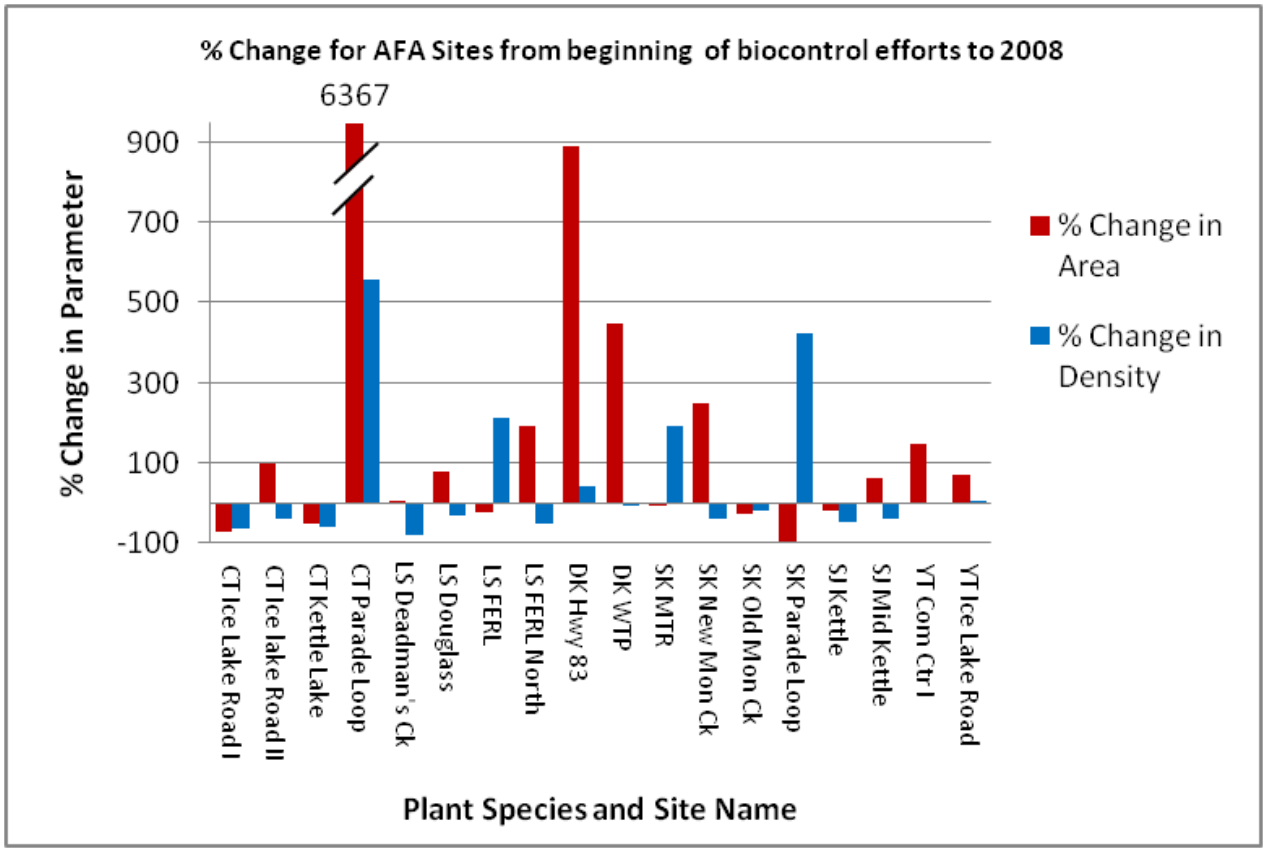


Figure 6. Percent change in area and density of all sites monitored this year at the Air Force Academy. The percent change is calculated by dividing the difference in the parameters between the first year they were monitored and this year's data by the area or density from this year. The number of years represented vary and depend on when the sites were established.

Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Rhinocyllus conicus*	X[2]		
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Trichosirocalus horridus*	X		
AFA	Canada thistle	Ice Lake Road I	*Urophora cardui*			
AFA	Canada thistle	Ice Lake Road I	*Larinus planus*	X[1,2]		
AFA	Canada thistle	Ice Lake Road II	*Cassida rubiginosa*			
AFA	Canada thistle	Ice Lake Road II	*Larinus planus*			
AFA	Canada thistle	Ice Lake Road II	*Urophora cardui*			
AFA	Canada thistle	Kettle Lake	*Cassida rubiginosa*	X		
AFA	Canada thistle	Kettle Lake	*Ceutorhynchus litura*			
AFA	Canada thistle	Kettle Lake	*Larinus planus*	X[1,2]		
AFA	Canada thistle	Kettle Lake	*Rhinocyllus conicus*	X[1,2]		
AFA	Canada thistle	Kettle Lake	*Urophora cardui*	X[1,2]		
AFA	Canada thistle	Parade Loop	*Urophora cardui*	X[1]		
AFA	Field bindweed	FERL	*Aceria malherbae*			
AFA	Field bindweed	Stadium	*Aceria malherbae*	X		
AFA	Leafy spurge	Deadman's Trail	*Aphthona cyparissiae*	X[1,2]		
AFA	Leafy spurge	Deadman's Trail	*Aphthona czwalinae*	X		
AFA	Leafy spurge	Deadman's Trail	*Aphthona lacertosa*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona nigriscutis*	X		
AFA	Leafy spurge	Douglas School	*Aphthona czwalinae*			
AFA	Leafy spurge	Douglas School	*Aphthona lacertosa*			
AFA	Leafy spurge	Douglas School	*Aphthona nigriscutis*	X		
AFA	Leafy spurge	FERL	*Aphthona cyparissiae*	X		
AFA	Leafy spurge	FERL	*Aphthona czwalinae*			
AFA	Leafy spurge	FERL	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL	*Aphthona nigriscutis*	X		

Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

Release Location	Target Weed	Release Site	Species released	Species recovered	New releases	New site
AFA	Leafy spurge	FERL North	*Aphthona cyparissiae*	X[1]		
AFA	Leafy spurge	FERL North	*Aphthona czwalinae*			
AFA	Leafy spurge	FERL North	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL North	*Aphthona nigriscutis*	X[1]		
AFA	Leafy spurge	Bike Trail	*Agapeta zoegana*			
AFA	Leafy spurge	Bike Trail	*Cyphocleonus achates*			
AFA	Leafy spurge	Bike Trail	*Larinus minutus*	X[1]		
AFA	Leafy spurge	Highway 83	*Agapeta zoegana*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Cyphocleonus achates*	X		
AFA	Diffuse knapweed	Highway 83	*Larinus minutus*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Mtzneria paucipunctella*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Urophora affinis*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Urophora quadrifasciata*	X[1,2]		
AFA	Spotted knapweed	Deadman's Creek[3]	*Cyphocleonus achates*			
AFA	Spotted knapweed	Deadman's Creek[3]	*Larinus minutus*			
AFA	Spotted knapweed	Monument Trail Road	*Agapeta zoegana*	X[1,2]		
AFA	Spotted knapweed	Monument Trail Road	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	Monument Trail Road	*Larinus minutus*	X		
AFA	Spotted knapweed	Monument Trail Road	*Metzneria paucipunctella*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Sphenoptera jugoslavica*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Urophora affinis*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Urophora quadrifasciata*	X[1,2]		
AFA	Spotted knapweed	New Monument Creek	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	New Monument Creek	*Larinus minutus*	X		
AFA	Spotted knapweed	New Monument Creek	*Metzneria paucipunctella*	X[2]		
AFA	Spotted knapweed	New Monument Creek	*Sphenoptera jugoslavica*	X[1,2]		
AFA	Spotted knapweed	New Monument Creek	*Urophora affinis*	X[2]		
AFA	Spotted knapweed	New Monument Creek	*Urophora quadrifasciata*	X[1,2]		

Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Rhinocyllus conicus*	X[2]		
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Trichosirocalus horridus*	X		
AFA	Canada thistle	Ice Lake Road I	*Urophora cardui*			
AFA	Canada thistle	Ice Lake Road I	*Larinus planus*	X[1,2]		
AFA	Canada thistle	Ice Lake Road II	*Cassida rubiginosa*			
AFA	Canada thistle	Ice Lake Road II	*Larinus planus*			
AFA	Canada thistle	Ice Lake Road II	*Urophora cardui*			
AFA	Canada thistle	Kettle Lake	*Cassida rubiginosa*	X		
AFA	Canada thistle	Kettle Lake	*Ceutorhynchus litura*			
AFA	Canada thistle	Kettle Lake	*Larinus planus*	X[1,2]		
AFA	Canada thistle	Kettle Lake	*Rhinocyllus conicus*	X[1,2]		
AFA	Canada thistle	Kettle Lake	*Urophora cardui*	X[1,2]		
AFA	Canada thistle	Parade Loop	*Urophora cardui*	X[1]		
AFA	Field bindweed	FERL	*Aceria malherbae*			
AFA	Field bindweed	Stadium	*Aceria malherbae*	X		
AFA	Leafy spurge	Deadman's Trail	*Aphthona cyparissiae*	X[1,2]		
AFA	Leafy spurge	Deadman's Trail	*Aphthona czwalinae*	X		
AFA	Leafy spurge	Deadman's Trail	*Aphthona lacertosa*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona nigriscutis*	X		
AFA	Leafy spurge	Douglas School	*Aphthona czwalinae*			
AFA	Leafy spurge	Douglas School	*Aphthona lacertosa*			
AFA	Leafy spurge	Douglas School	*Aphthona nigriscutis*	X		
AFA	Leafy spurge	FERL	*Aphthona cyparissiae*	X		
AFA	Leafy spurge	FERL	*Aphthona czwalinae*			
AFA	Leafy spurge	FERL	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL	*Aphthona nigriscutis*	X		

Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

Release Location	Target Weed	Release Site	Species released	Species recovered	New releases	New site
AFA	Leafy spurge	FERL North	*Aphthona cyparissiae*	X[1]		
AFA	Leafy spurge	FERL North	*Aphthona czwalinae*			
AFA	Leafy spurge	FERL North	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL North	*Aphthona nigriscutis*	X[1]		
AFA	Leafy spurge	Bike Trail	*Agapeta zoegana*			
AFA	Leafy spurge	Bike Trail	*Cyphocleonus achates*			
AFA	Leafy spurge	Bike Trail	*Larinus minutus*	X[1]		
AFA	Leafy spurge	Highway 83	*Agapeta zoegana*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Cyphocleonus achates*	X		
AFA	Diffuse knapweed	Highway 83	*Larinus minutus*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Mtzneria paucipunctella*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Urophora affinis*	X[2]		
AFA	Diffuse knapweed	Highway 83	*Urophora quadrifasciata*	X[1,2]		
AFA	Spotted knapweed	Deadman's Creek[3]	*Cyphocleonus achates*			
AFA	Spotted knapweed	Deadman's Creek[3]	*Larinus minutus*			
AFA	Spotted knapweed	Monument Trail Road	*Agapeta zoegana*	X[1,2]		
AFA	Spotted knapweed	Monument Trail Road	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	Monument Trail Road	*Larinus minutus*	X		
AFA	Spotted knapweed	Monument Trail Road	*Metzneria paucipunctella*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Sphenoptera jugoslavica*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Urophora affinis*	X[2]		
AFA	Spotted knapweed	Monument Trail Road	*Urophora quadrifasciata*	X[1,2]		
AFA	Spotted knapweed	New Monument Creek	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	New Monument Creek	*Larinus minutus*	X		
AFA	Spotted knapweed	New Monument Creek	*Metzneria paucipunctella*	X[2]		
AFA	Spotted knapweed	New Monument Creek	*Sphenoptera jugoslavica*	X[1,2]		
AFA	Spotted knapweed	New Monument Creek	*Urophora affinis*	X[2]		
AFA	Spotted knapweed	New Monument Creek	*Urophora quadrifasciata*	X[1,2]		

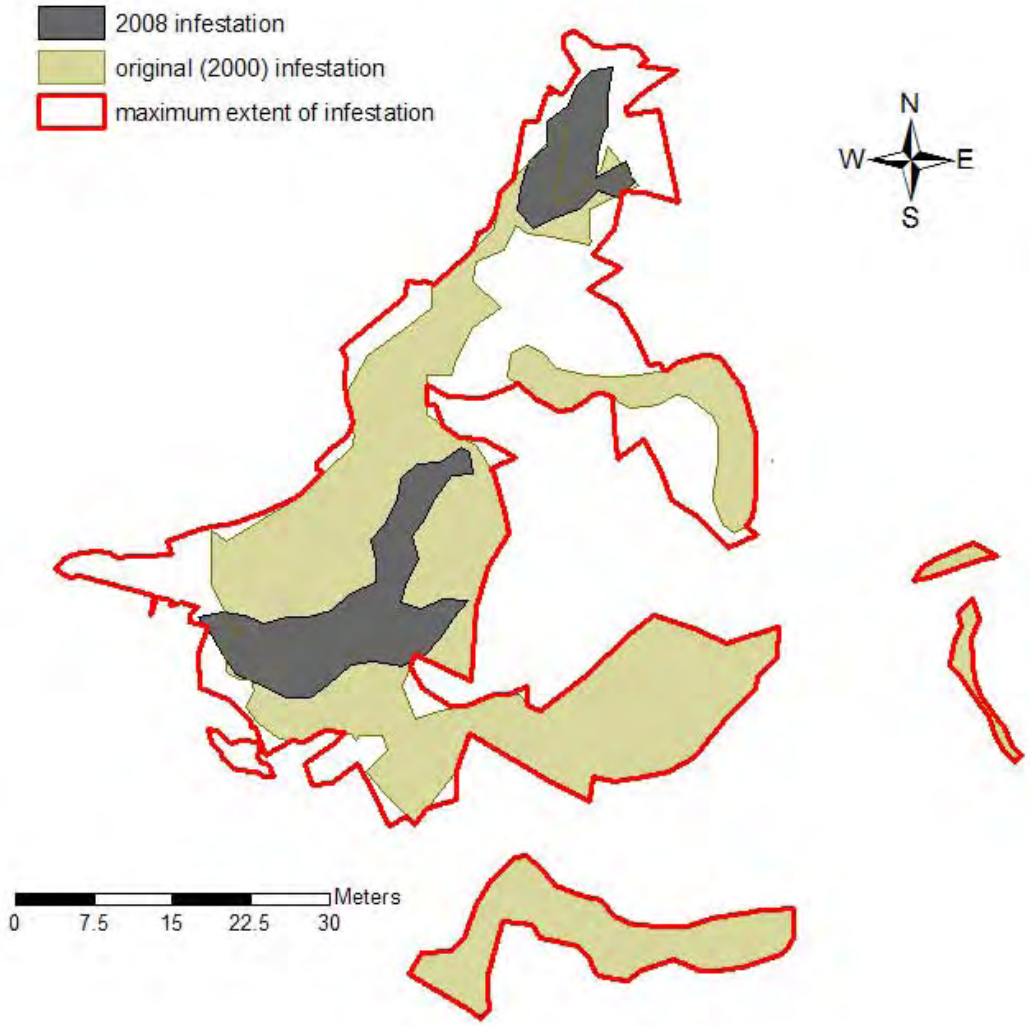
Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

Release Location	Target Weed	Release Site	Species released	Species recovered	New releases	New site
AFA	Spotted knapweed	NPWR[3]	*Larinus minutus*			
AFA	Spotted knapweed	NPWR[3]	*Metzneria paucipunctella*			
AFA	Spotted knapweed	NPWR[3]	*Sphenoptera jugoslavica*			
AFA	Spotted knapweed	NPWR[3]	*Urophora affinis*			
AFA	Spotted knapweed	Old Monument Creek	*Agapeta zoegana*	X[1,2]		
AFA	Spotted knapweed	Old Monument Creek	*Cyphocleonus achates*			
AFA	Spotted knapweed	Old Monument Creek	*Larinus minutus*	X		
AFA	Spotted knapweed	Old Monument Creek	*Metzneria paucipunctella*	X		
AFA	Spotted knapweed	Old Monument Creek	*Urophora affinis*	X[2]		
AFA	Spotted knapweed	Old Monument Creek	*Urophora quadrifasciata*	X[1,2]		
AFA	Spotted knapweed	Parade Loop		X[4]		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Agapeta zoegana*	X[1,2]		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Cyphocleonus achates*	X		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Larinus minutus*	X		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Metzneria paucipunctella*	X[2]		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Sphenoptera jugoslavica*	X[1,2]		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Urophora affinis*	X[2]		
AFA	St. John's wort	Kettle Creek	*Chrysolina* sp.	X		
AFA	St. John's wort	Midway Kettle Creek	*Chrysolina* sp.	X		
AFA	St. John's wort	Santa Fe[3]	*Chrysolina* sp.			
AFA	Yellow toadflax	Comm Center Drive I	*Mecinus janthinus*			
AFA	Yellow toadflax	Comm Center Drive II[3]	*Gymnetron antirrhini*			
AFA	Yellow toadflax	Comm Center Drive II[3]	*Mecinus janthinus*			
AFA	Yellow toadflax	Comm Center Drive III	*Gymnetron antirrhini*			
AFA	Yellow toadflax	Ice Lake Road	*Gymnetron antirrhini*	X[1]		

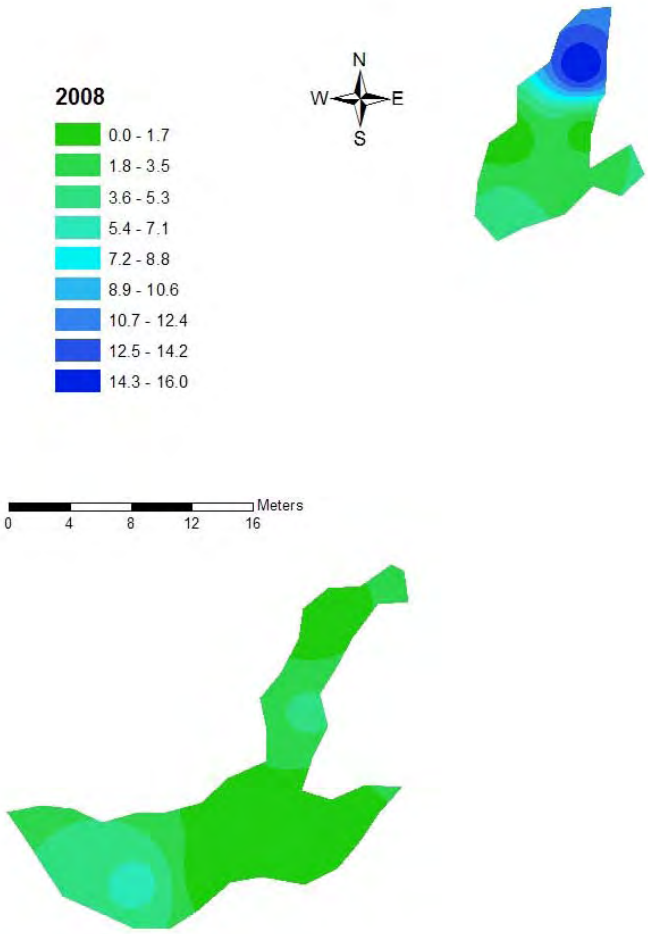
[1] New insect recovery in 2008 [2] Adventitious recovery, no release made at this site [3] Site not monitored for insects this year

Table 10. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2008.

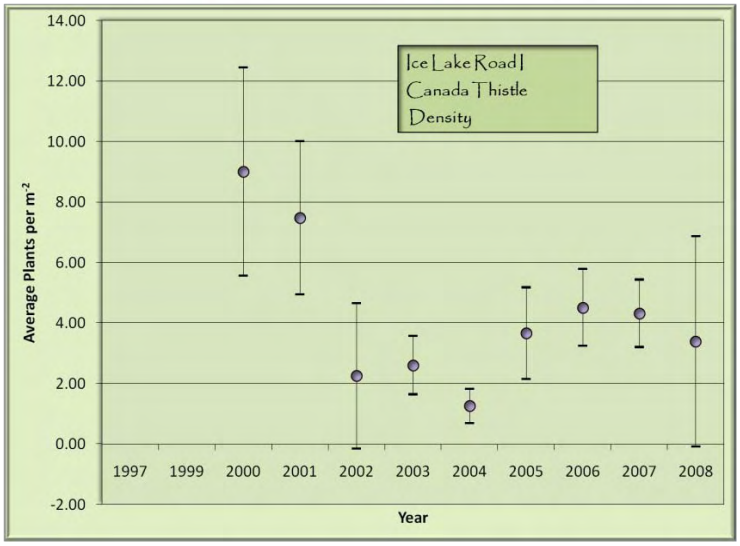
[4] No insect releases were made at this site, however, the following biological control agents have been recovered from seedheads and roots collected within the mapped weed perimeter since 2005: *L. minutus, U. affinis, U. quadrifasciata, M. paucipunctella, C. achates, S. jugoslavica, A. zoegana.*

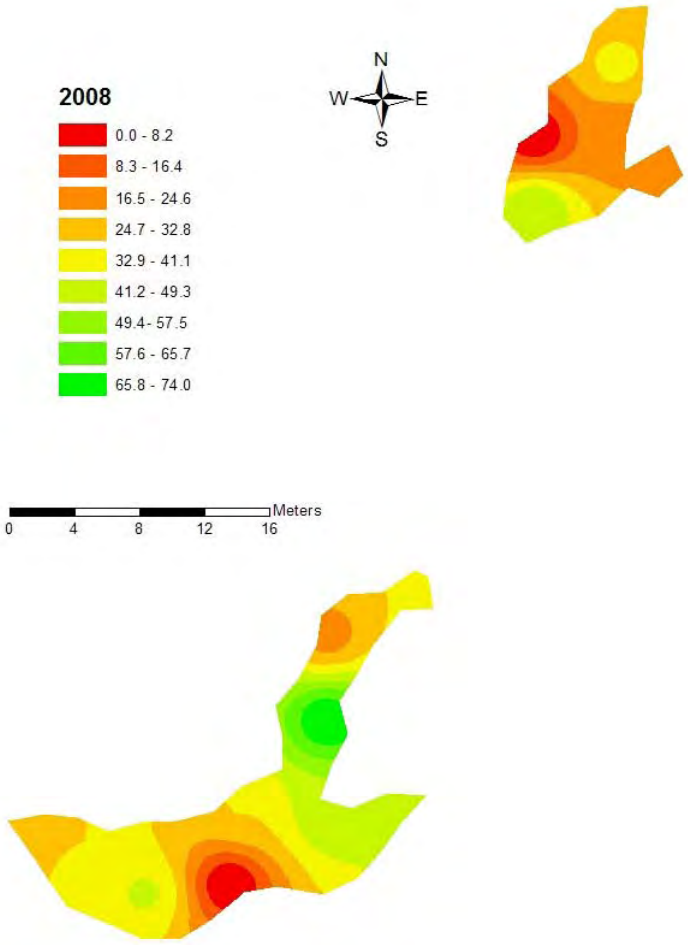


Ice Lake Road I Canada thistle perimeter in 2008.

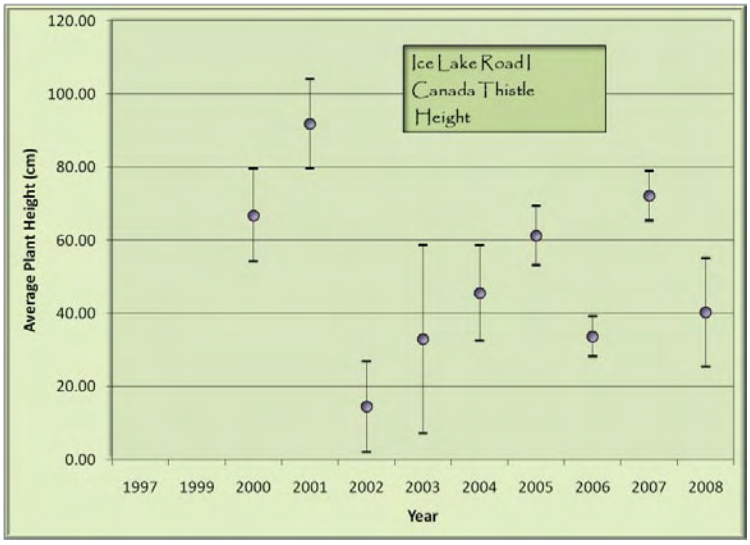


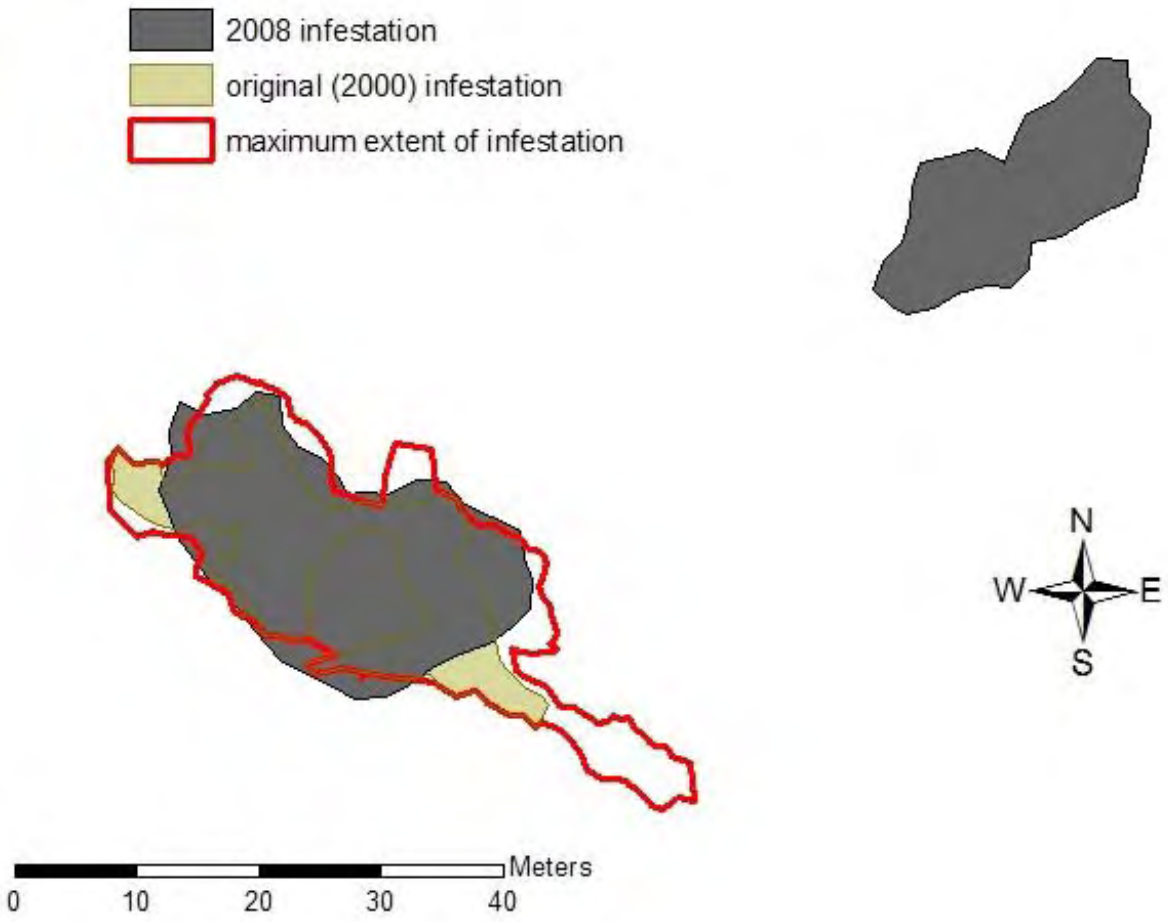
Ice Lake Road I Canada thistle density in 2008.



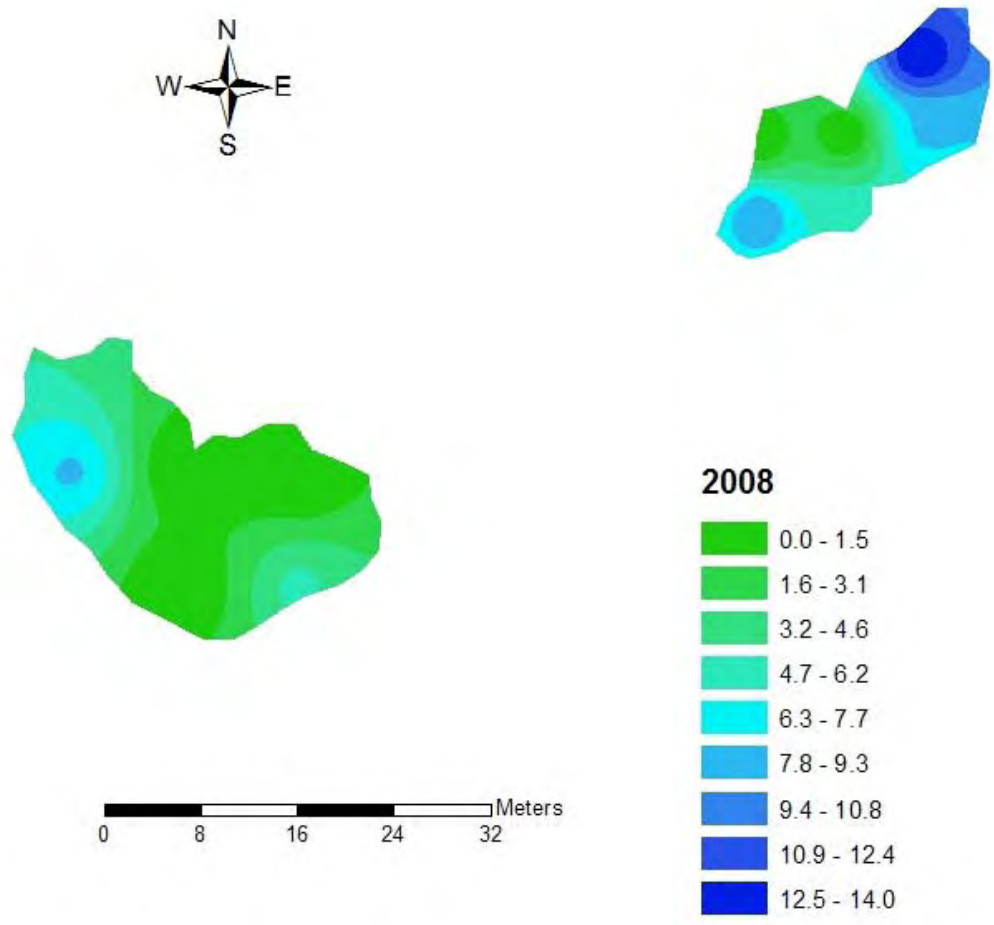


Ice Lake Road I Canada thistle height in 2008.

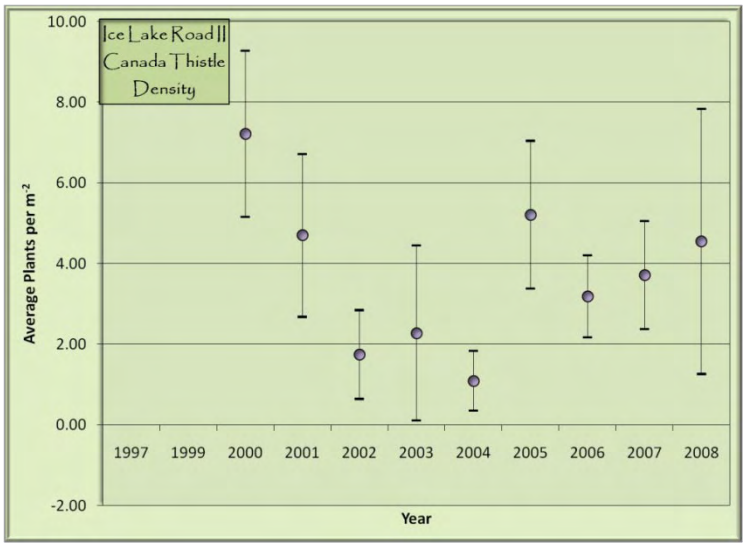


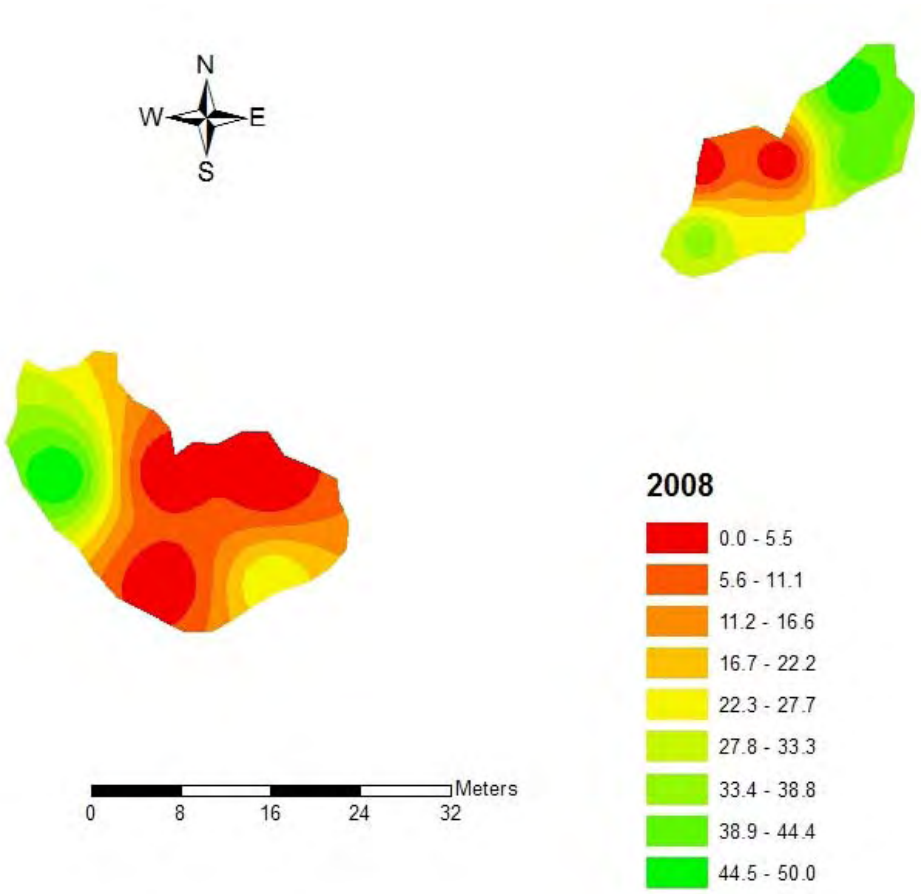


Ice Lake Road II Canada thistle perimeter in 2008.

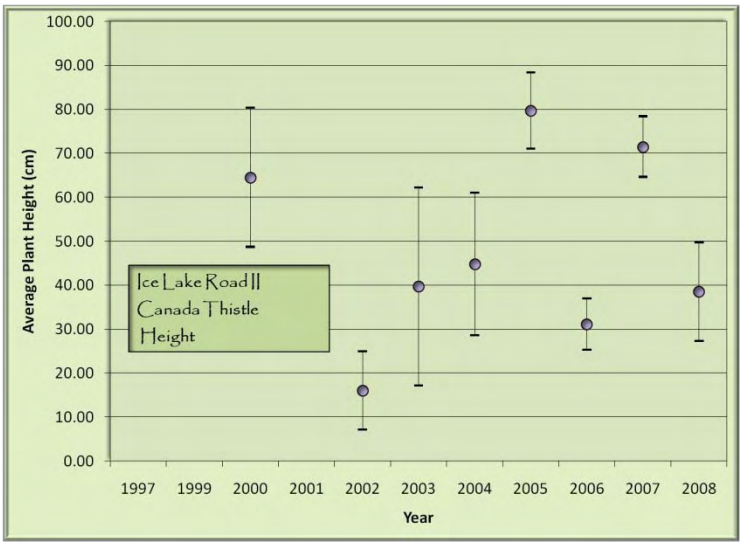


Ice Lake Road II Canada thistle density in 2008.

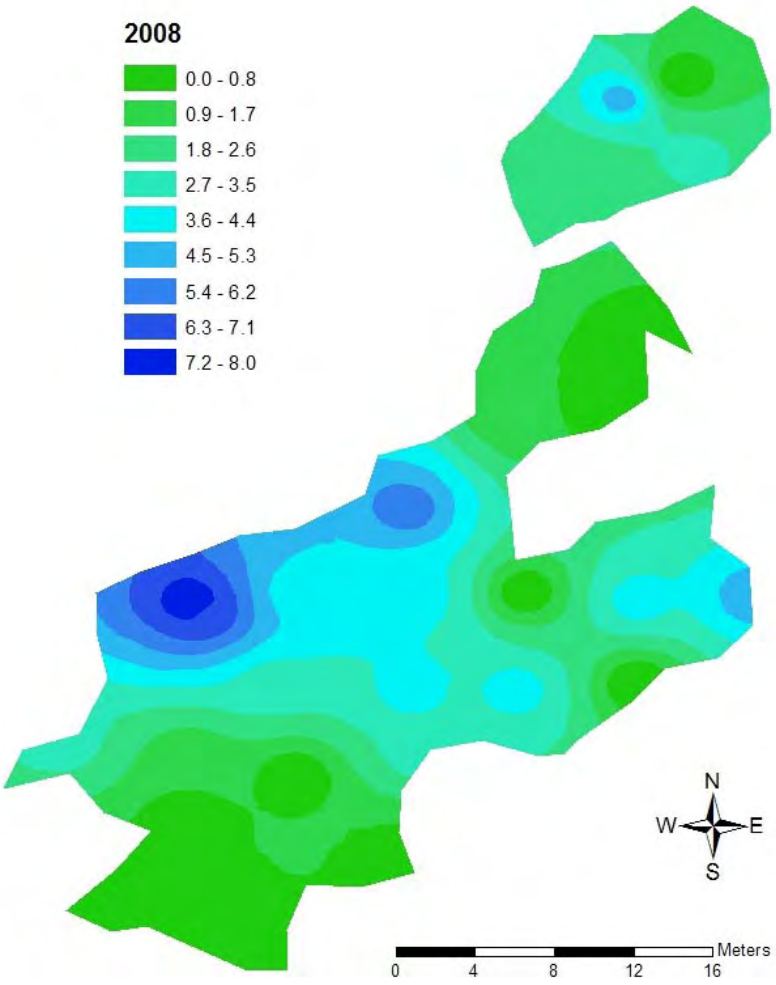




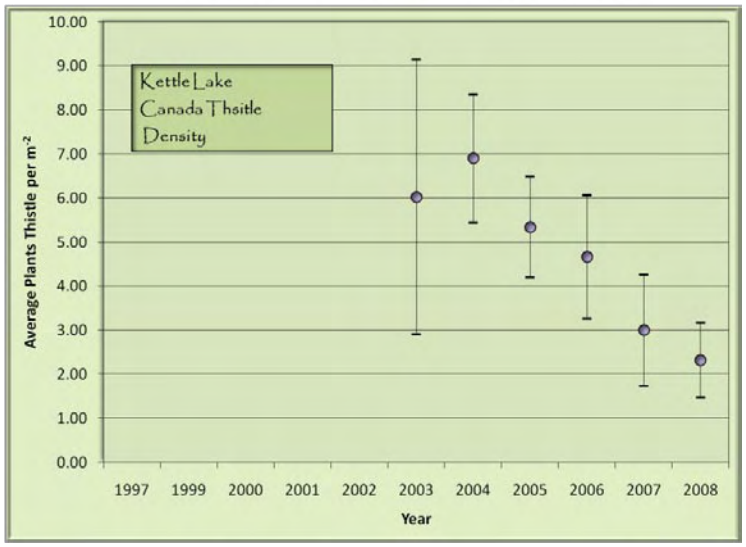
Ice Lake Road II Canada thistle height in 2008.

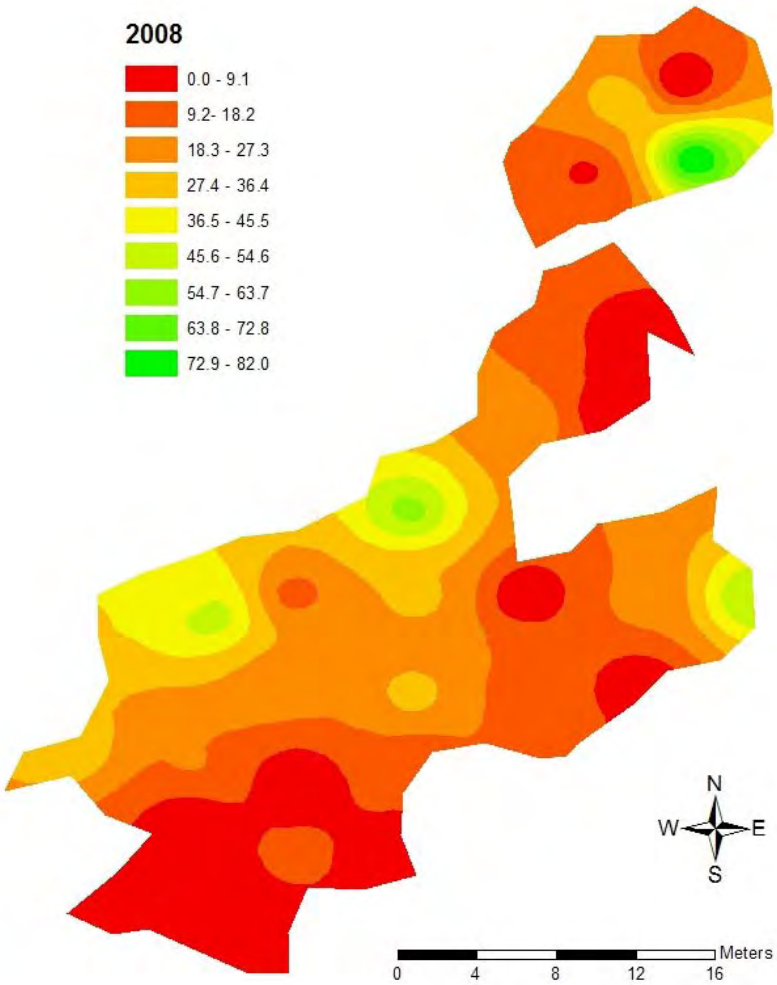


Kettle Lake Canada thistle perimeter in 2008.

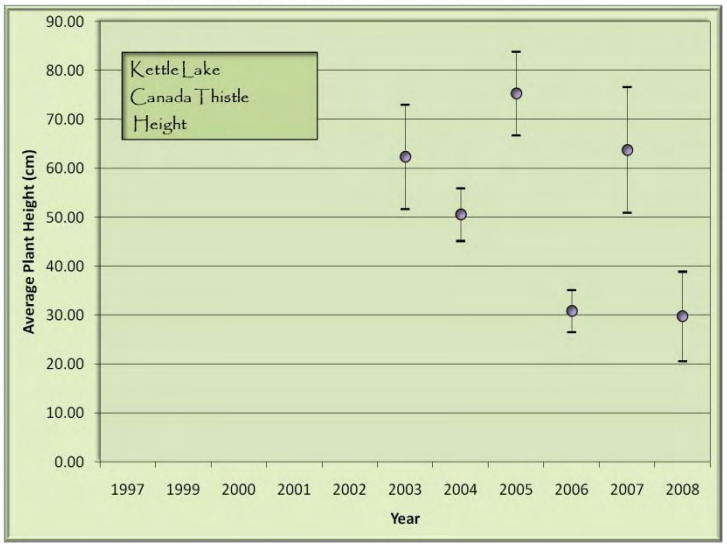


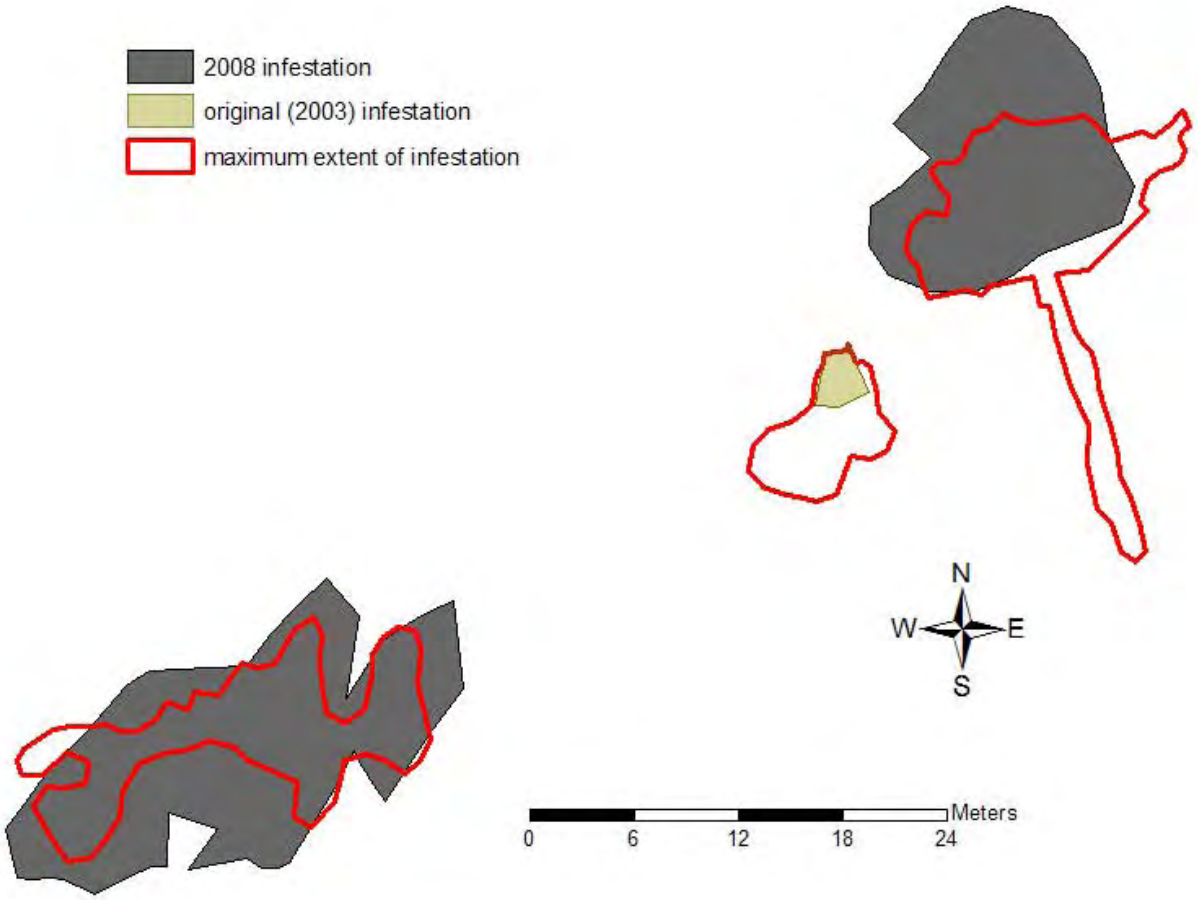
Kettle Lake Canada thistle density in 2008.



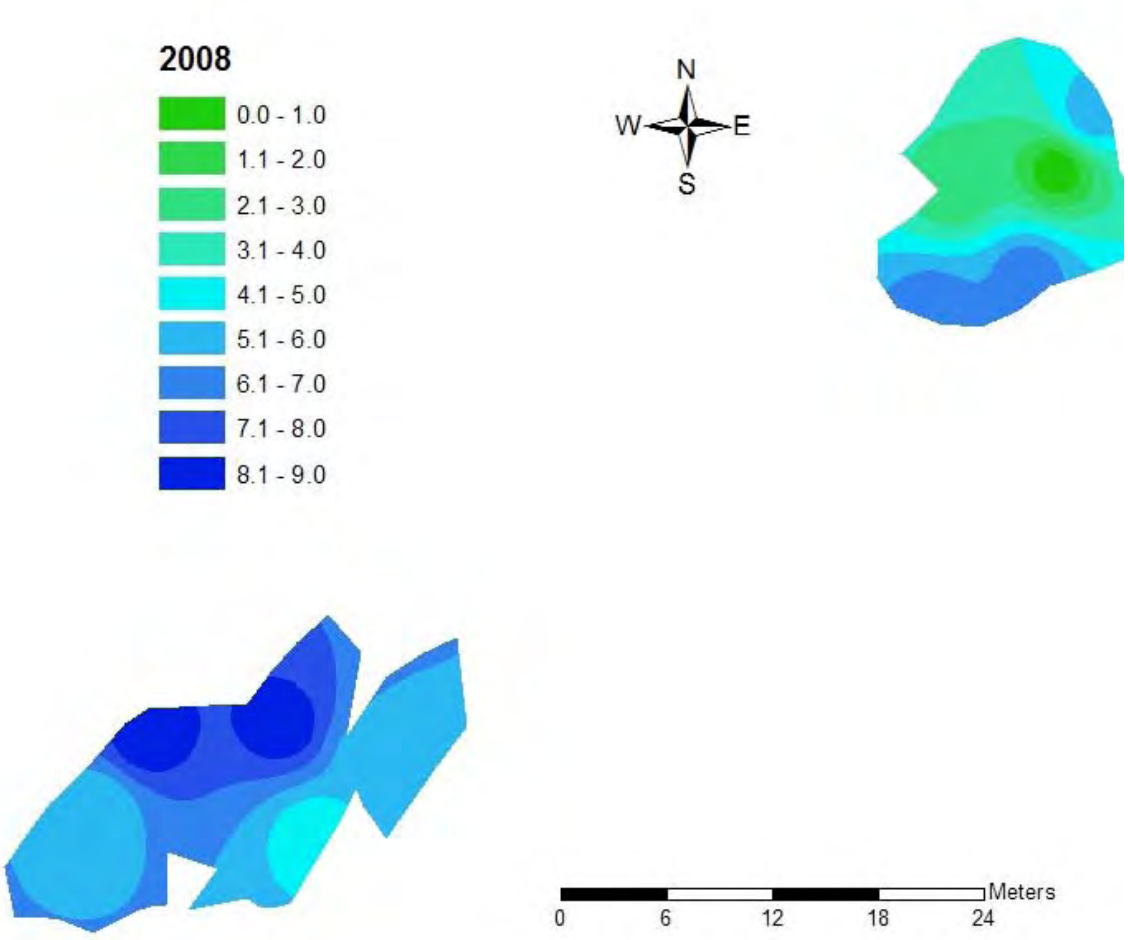


Kettle Lake Canada thistle height in 2008.

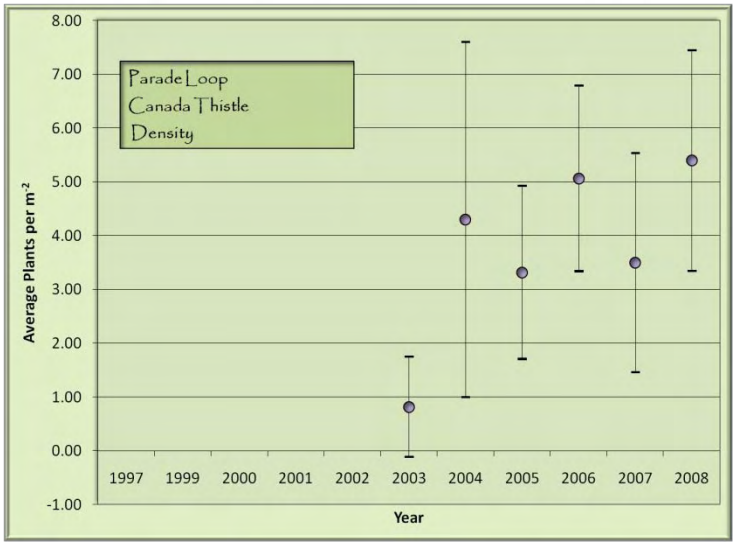


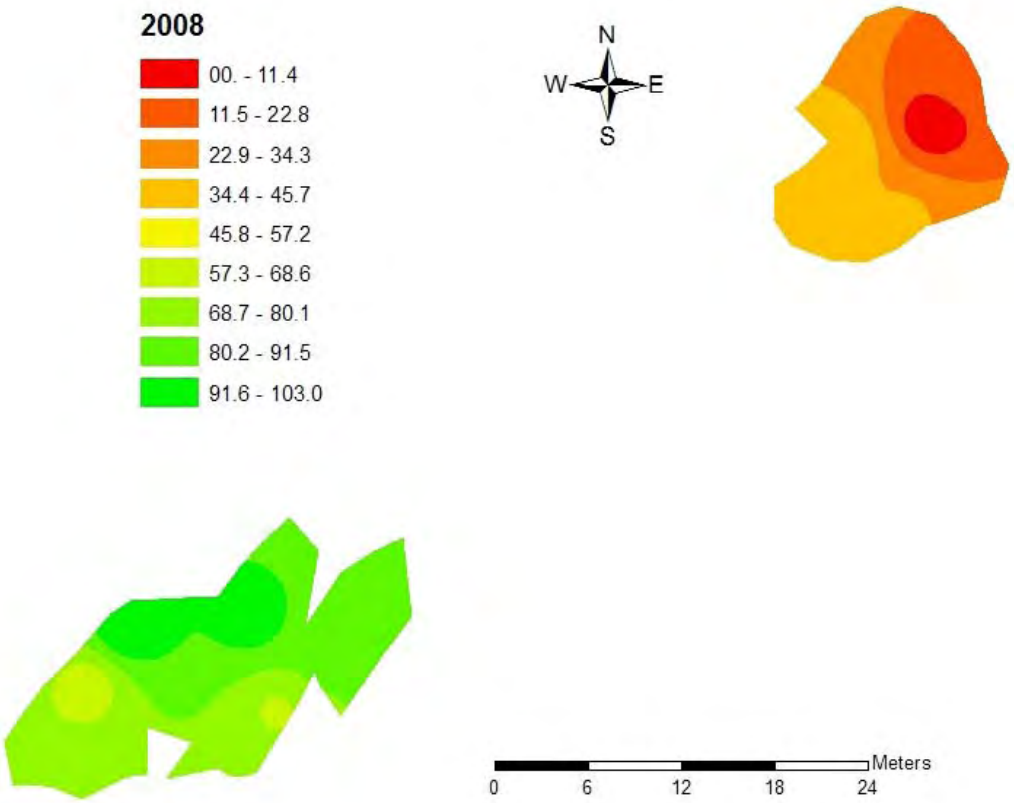


Parade Loop Canada thistle perimeter in 2008.

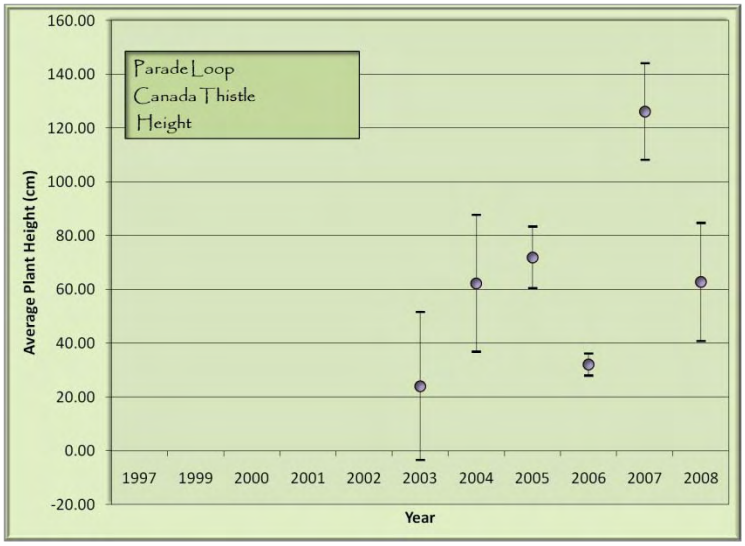


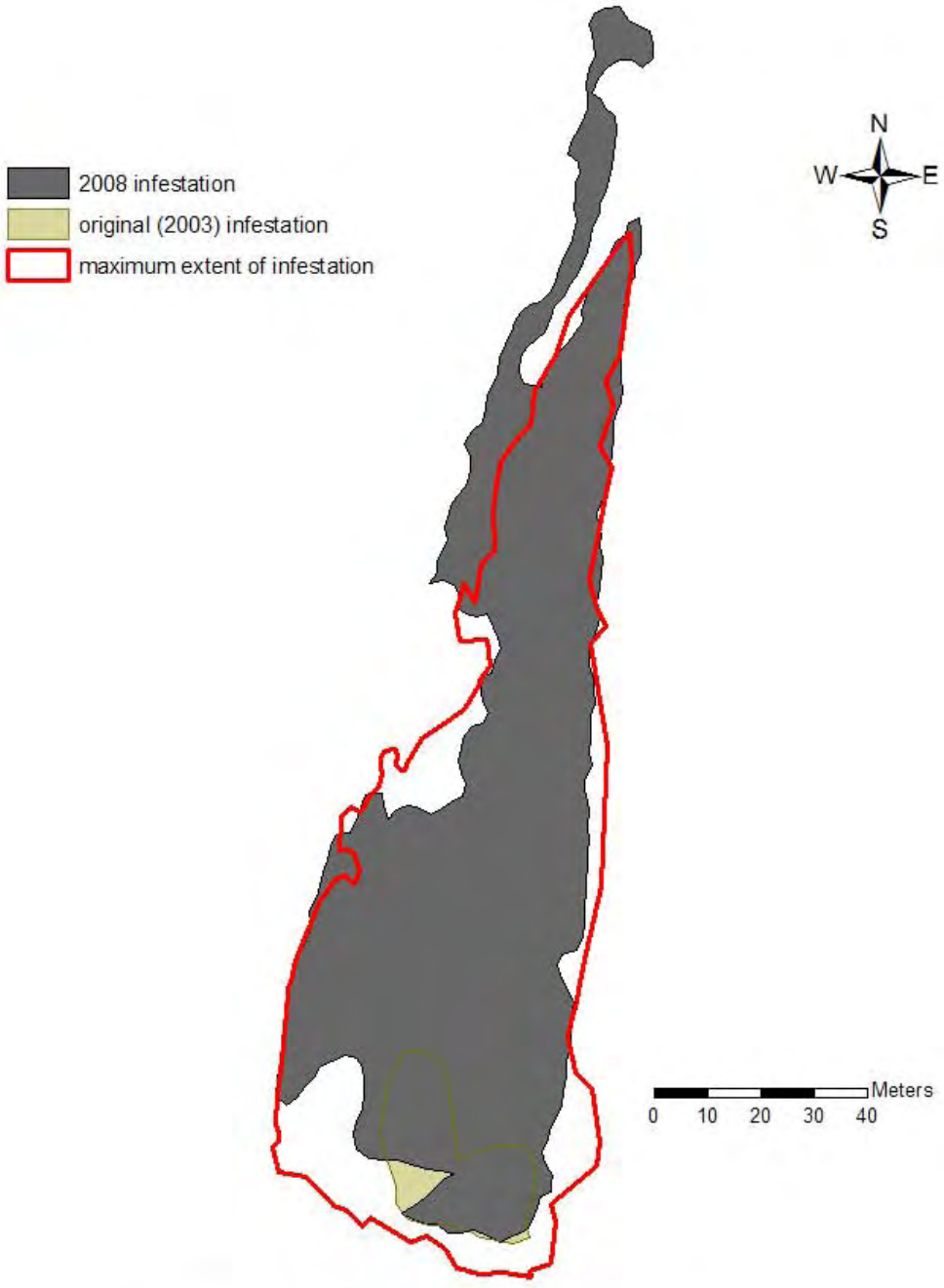
Parade Loop Canada thistle density in 2008.



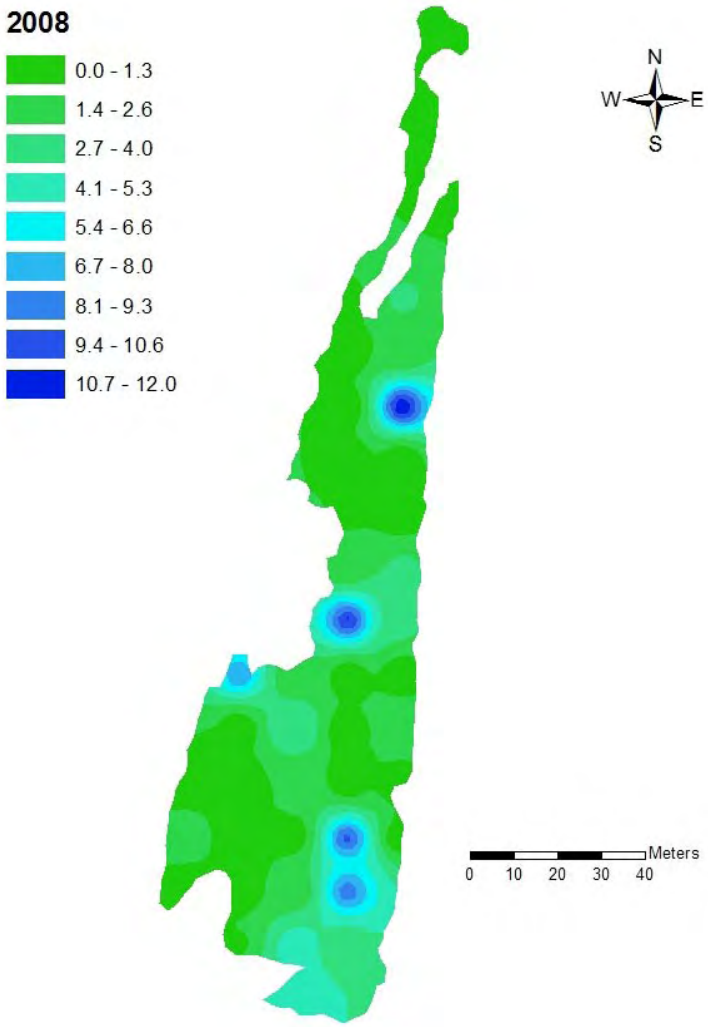


Parade Loop Canada thistle height in 2008.

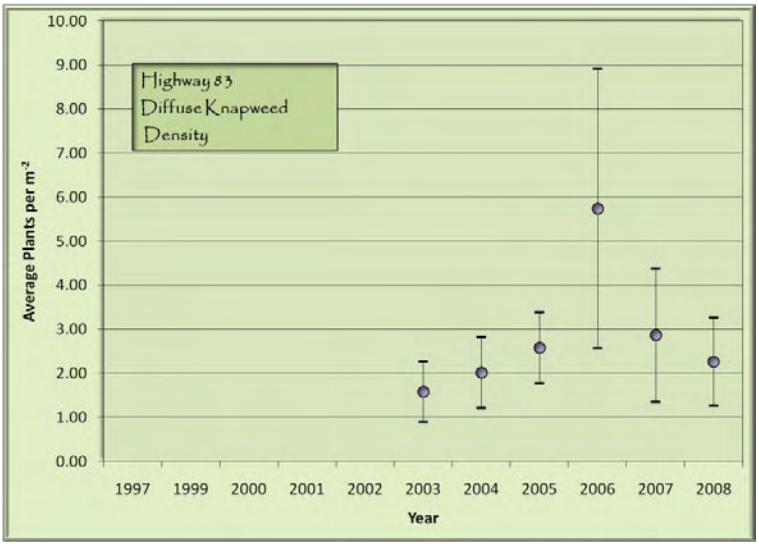


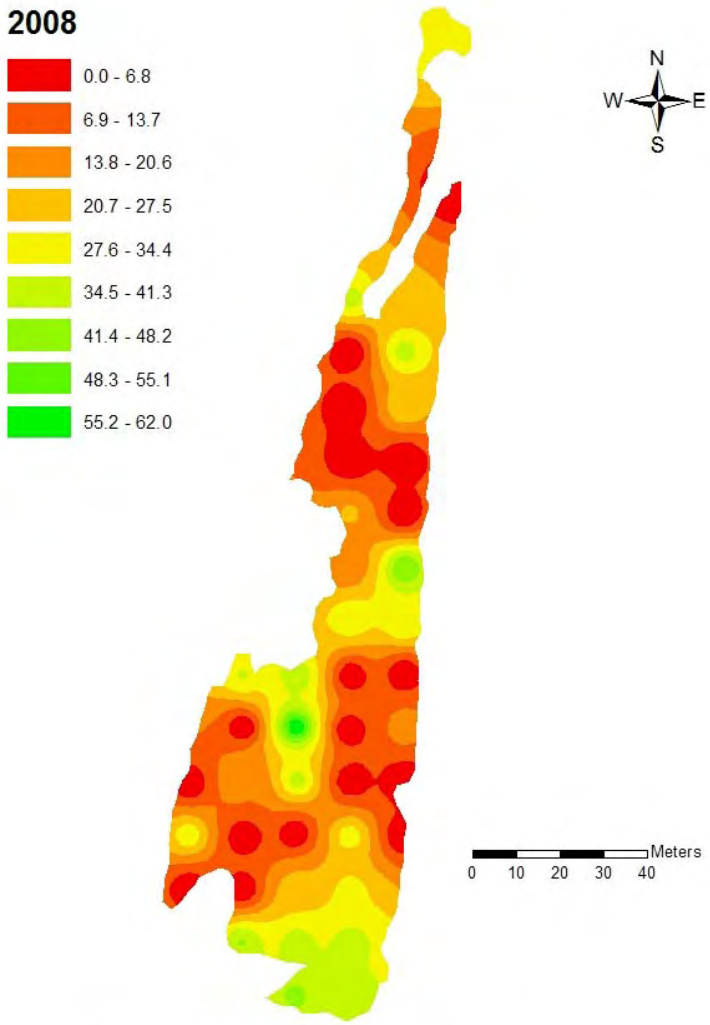


HIghway 83 diffuse knapweed perimeter in 2008.

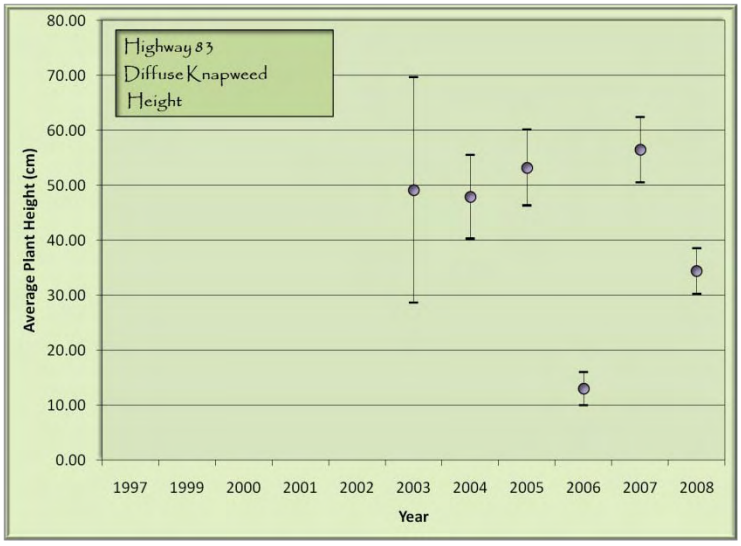


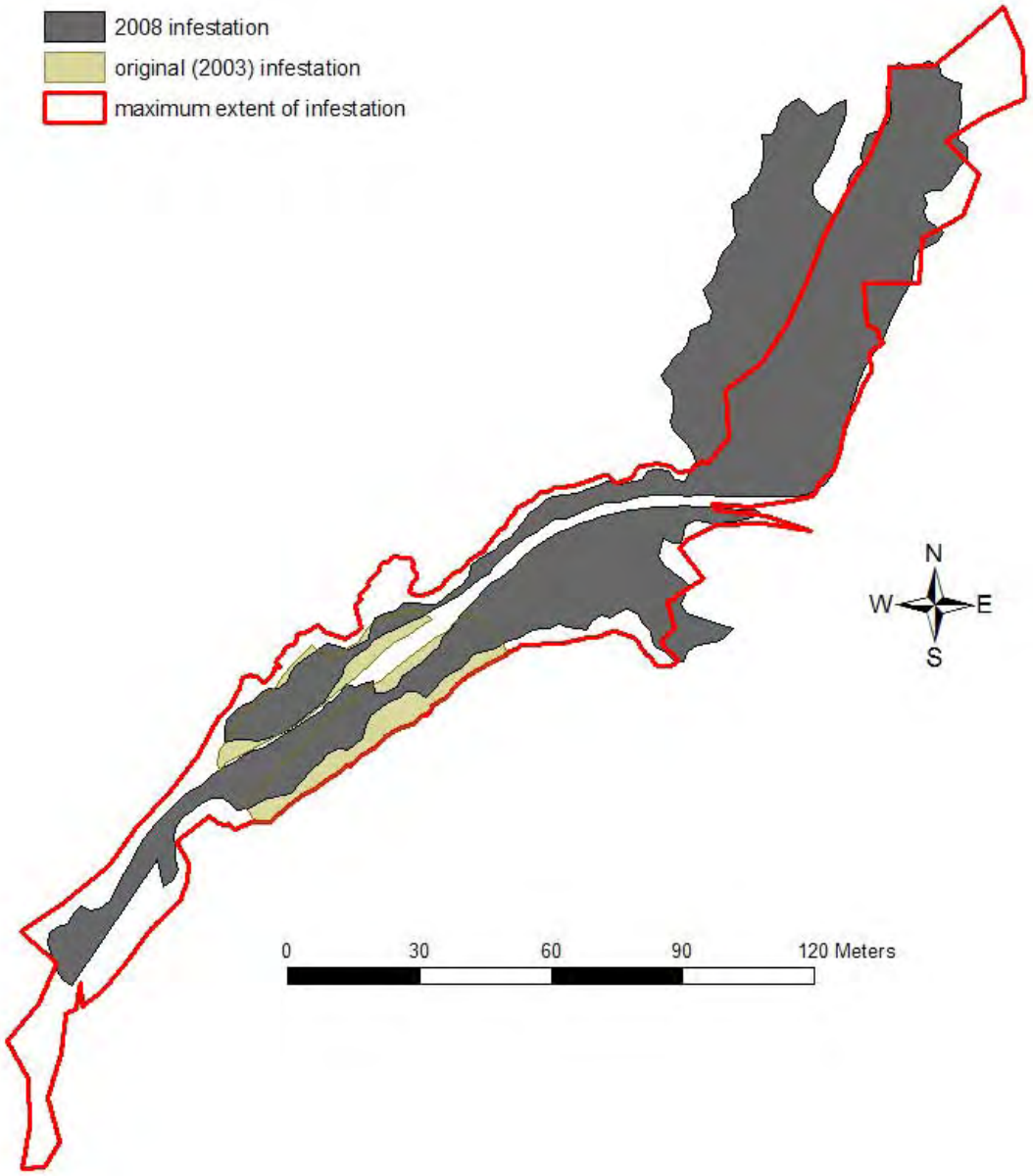
Highway 83 diffuse knapweed density in 2008



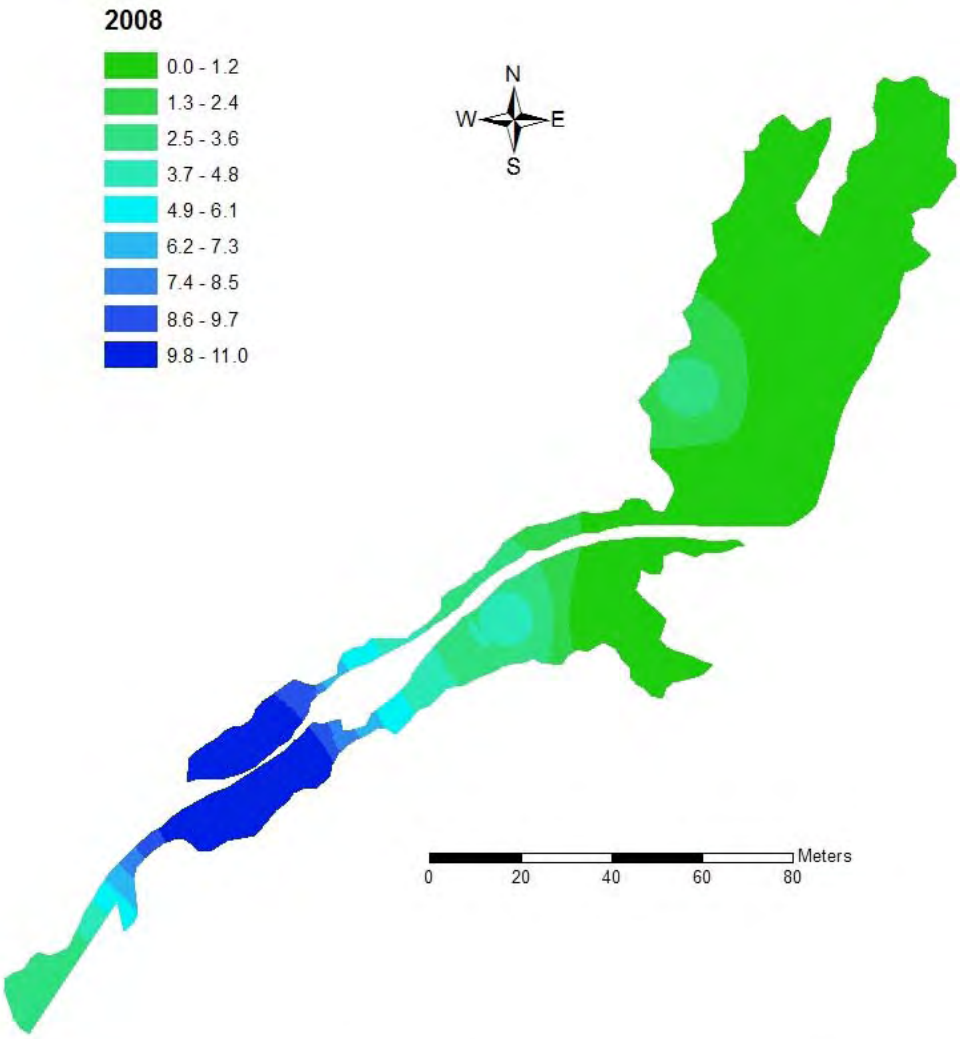


Highway 83 diffuse knapweed height in 2008.

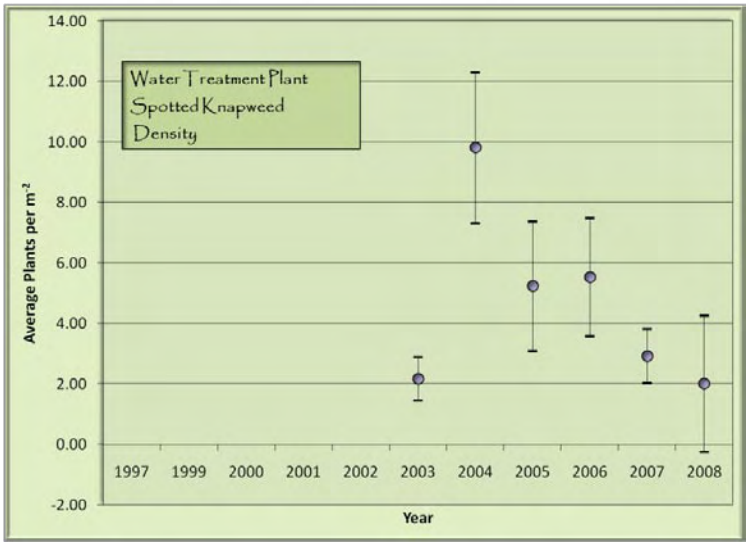


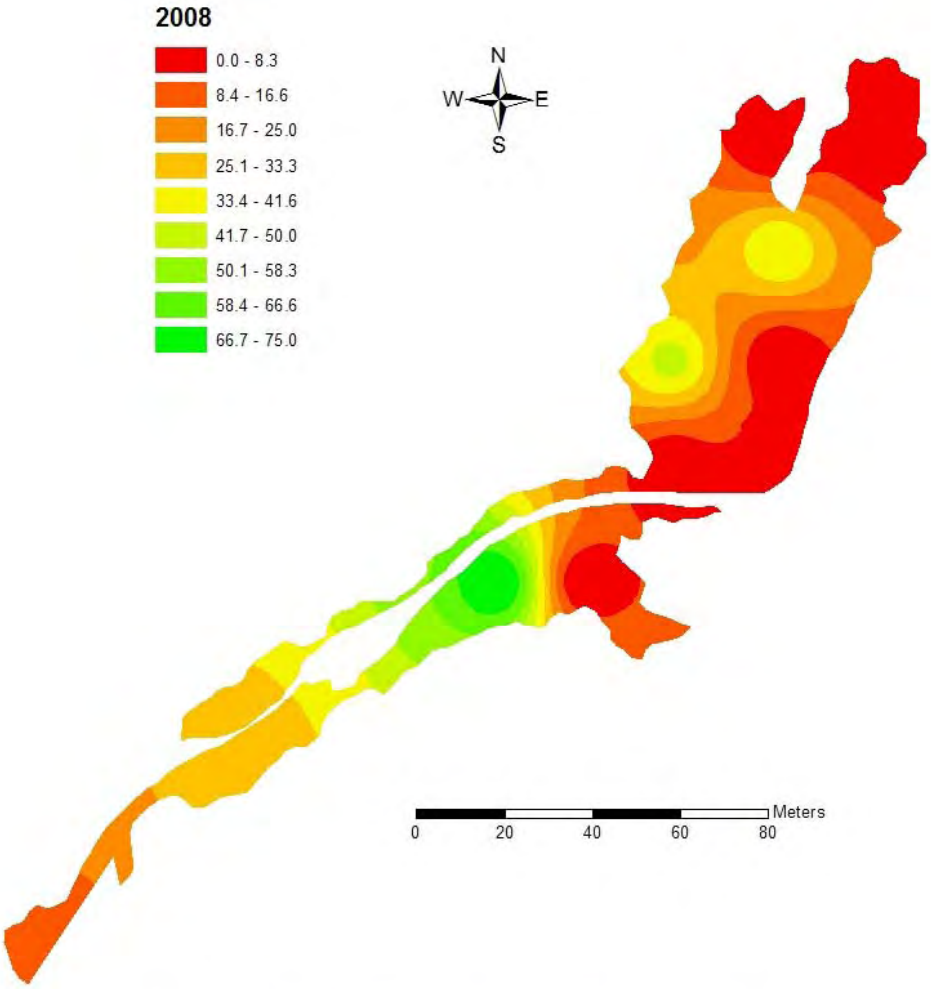


Water Treatment Plant diffuse and spotted knapweed perimeter in 2008.

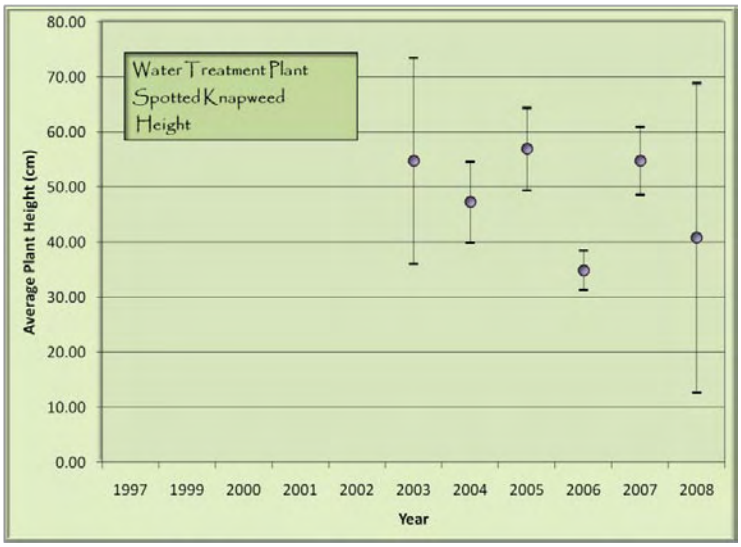


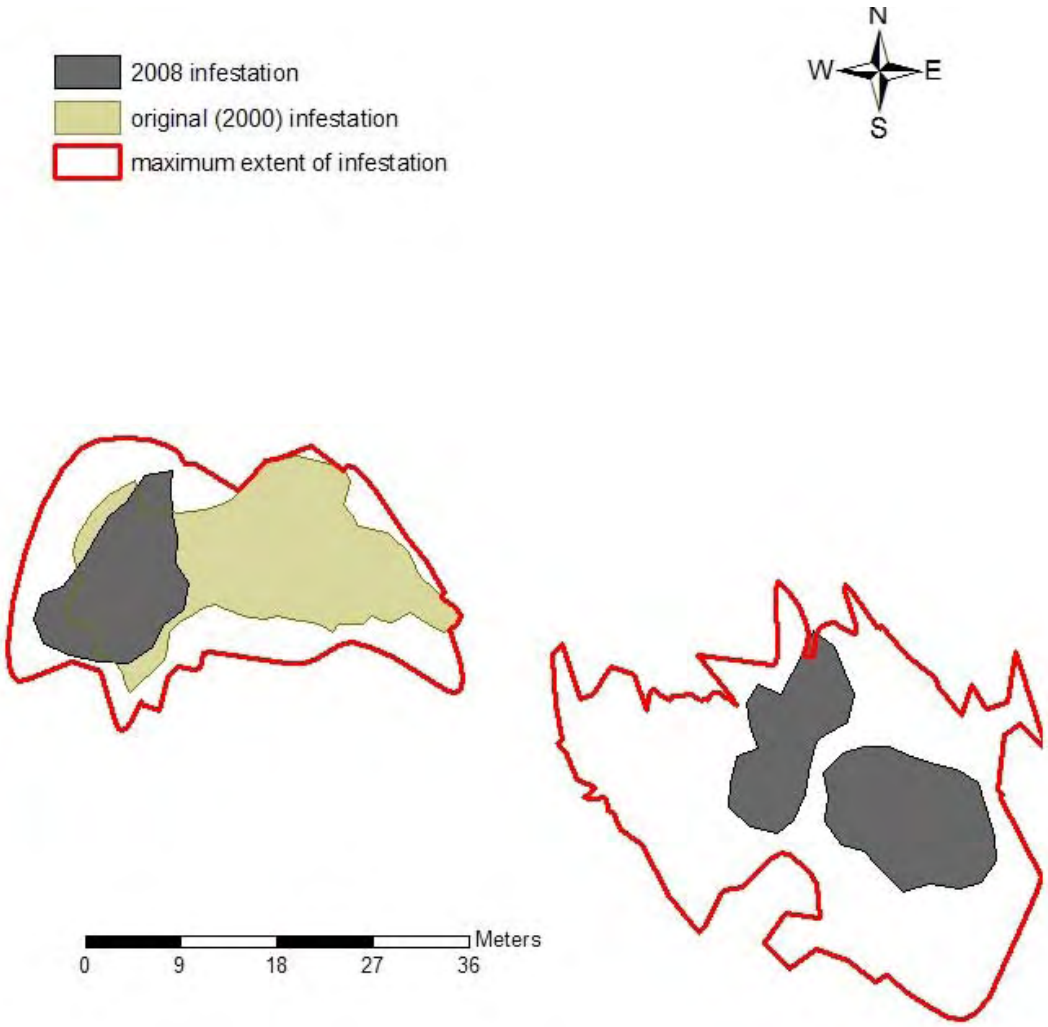
Water Treatment Plant diffuse and spotted knapweed density in 2008.



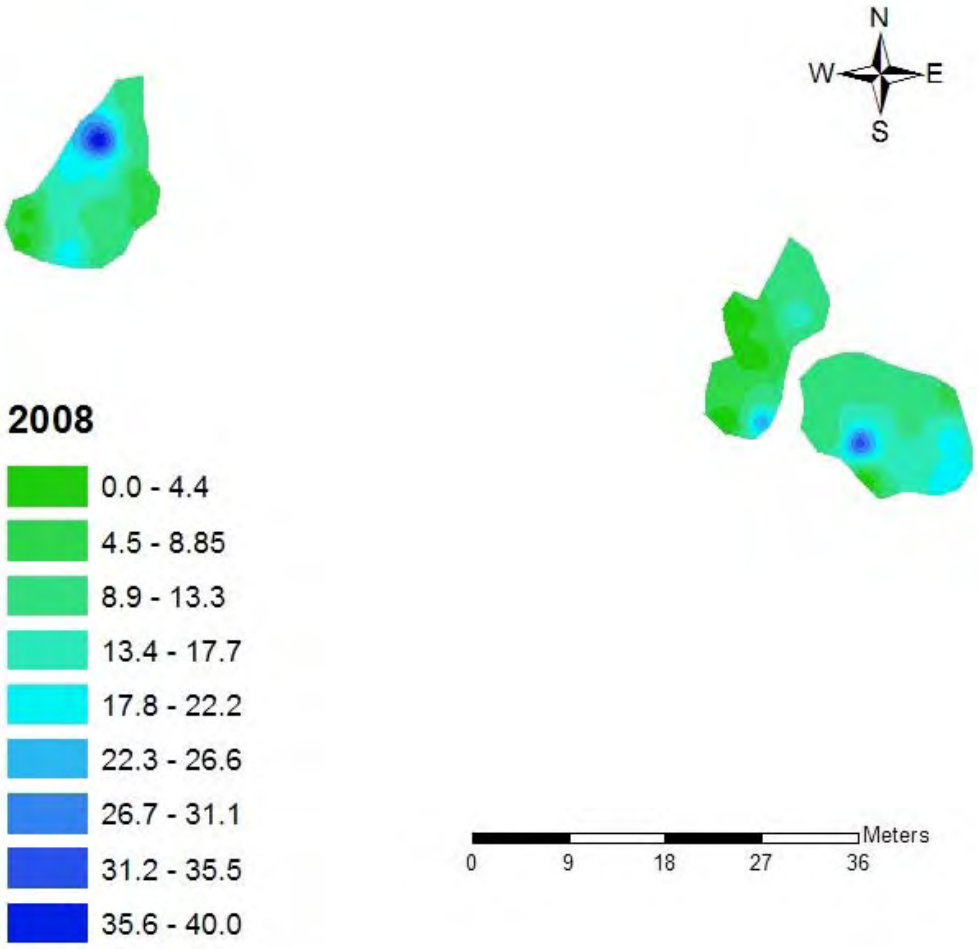


Water Treatment Plant diffuse and spotted knapweed height in 2008.

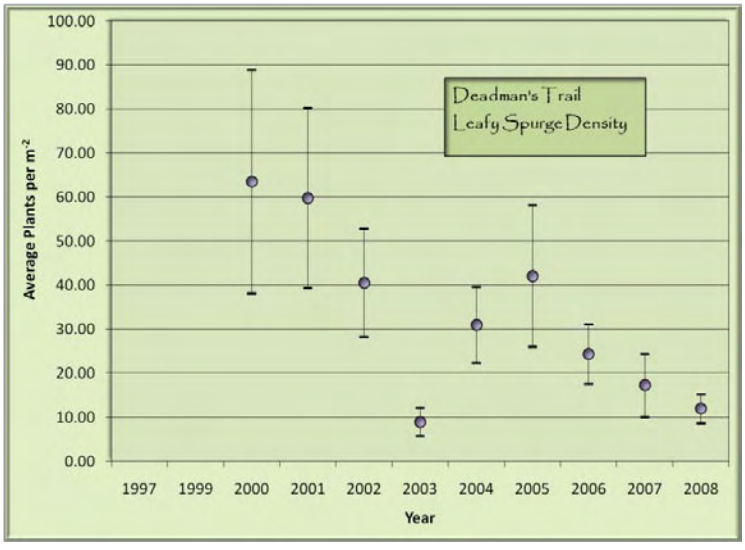


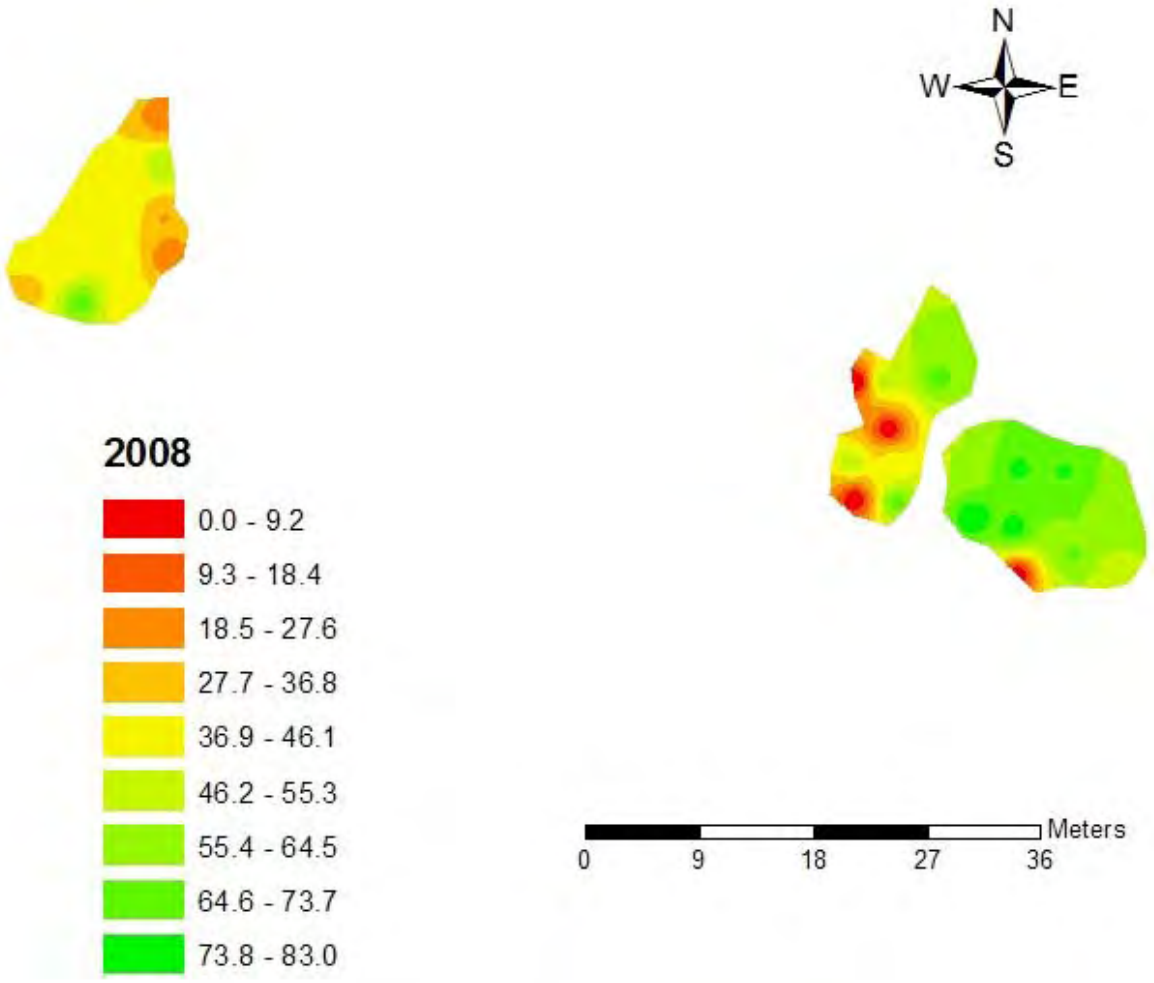


Deadman's Trail leafy spurge perimeter in 2008.

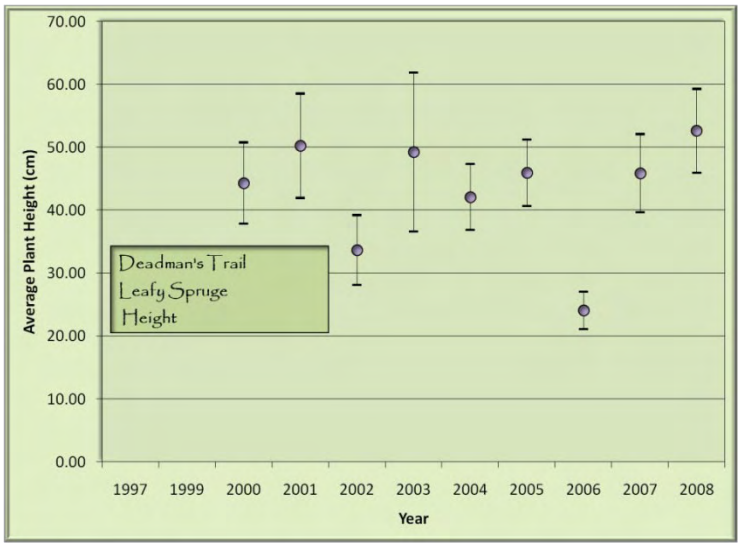


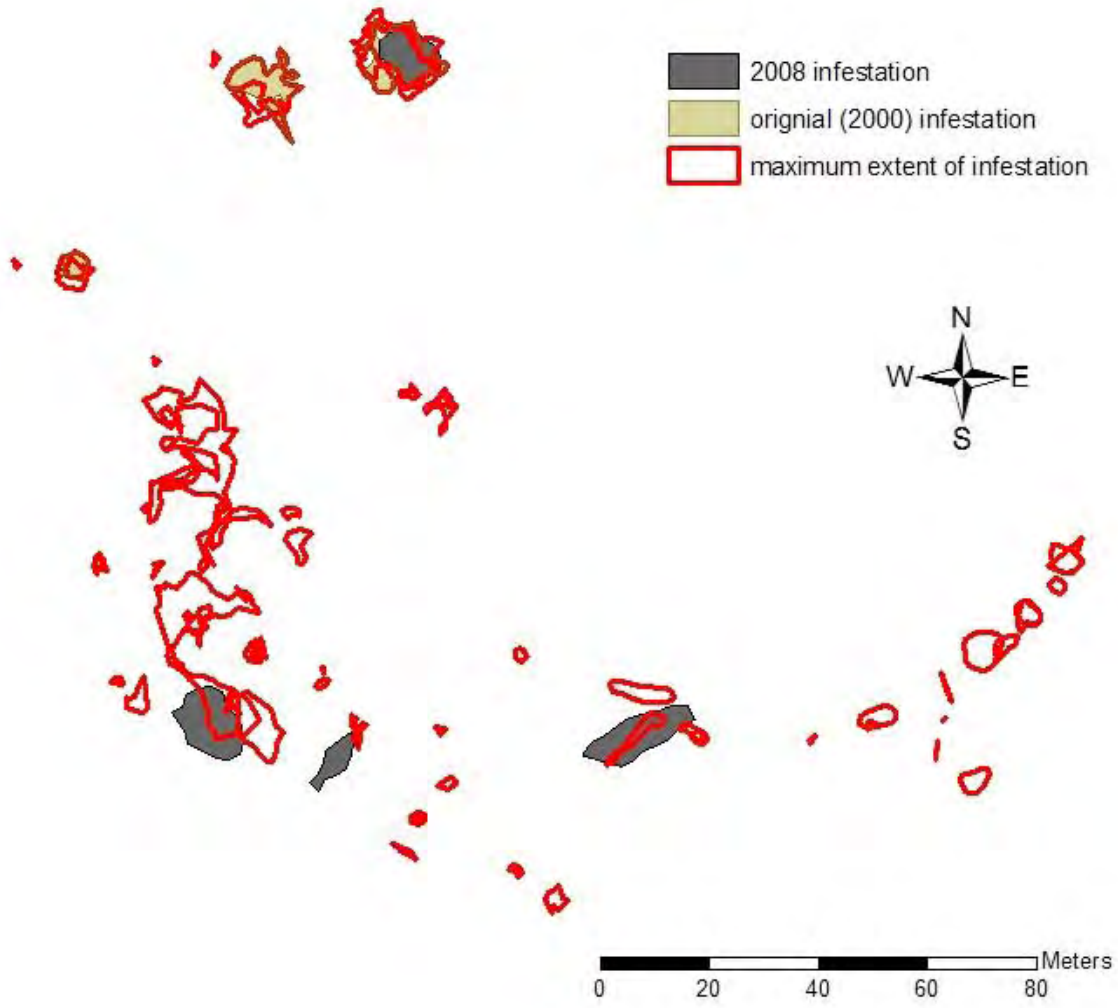
Deadman's Trail leafy spurge density in 2008.



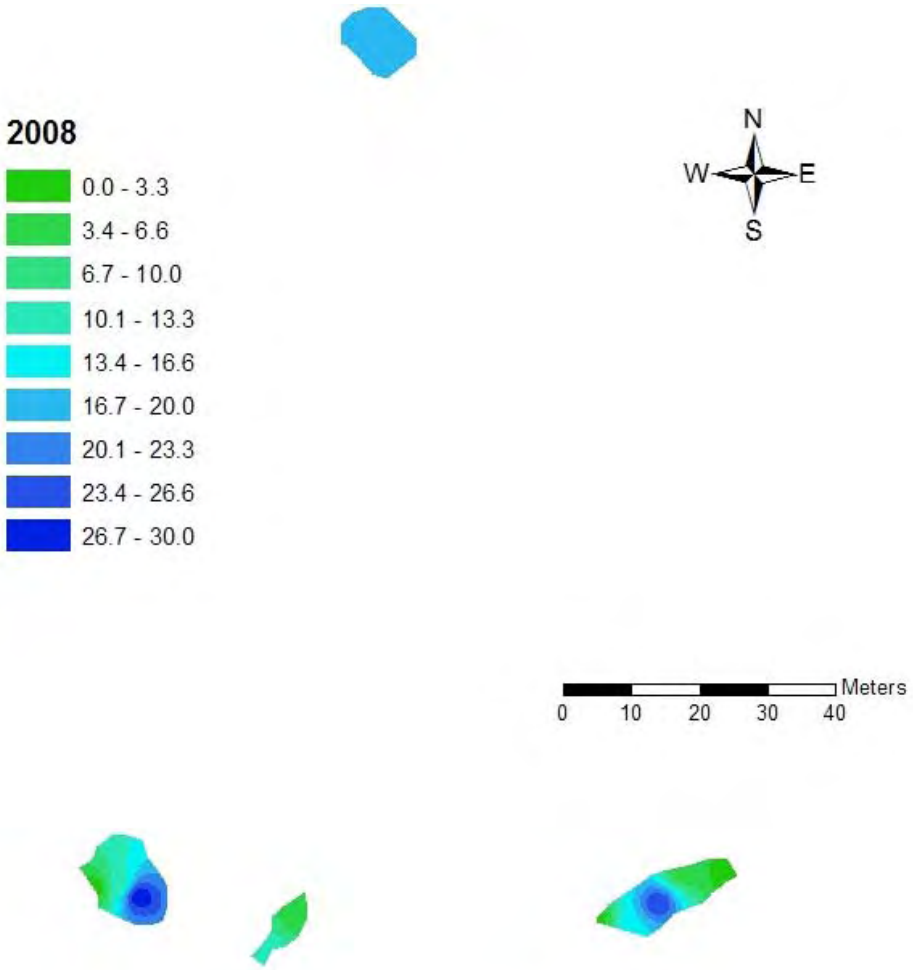


Deadman's Trail leafy spurge height in 2008

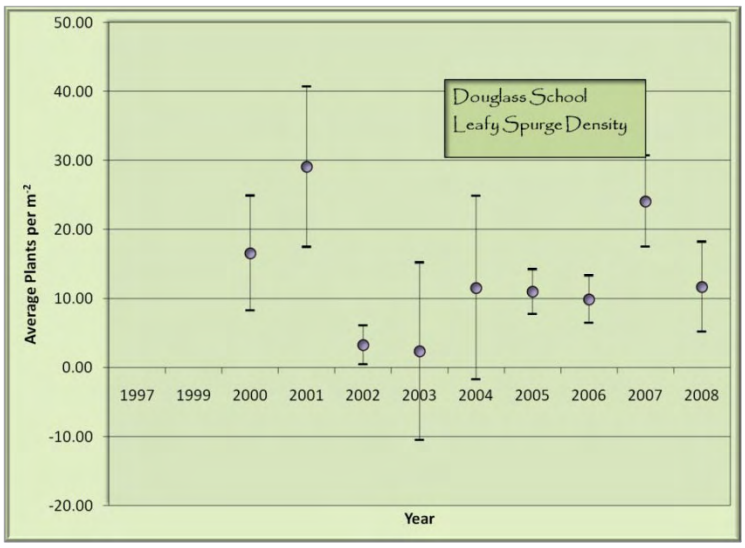


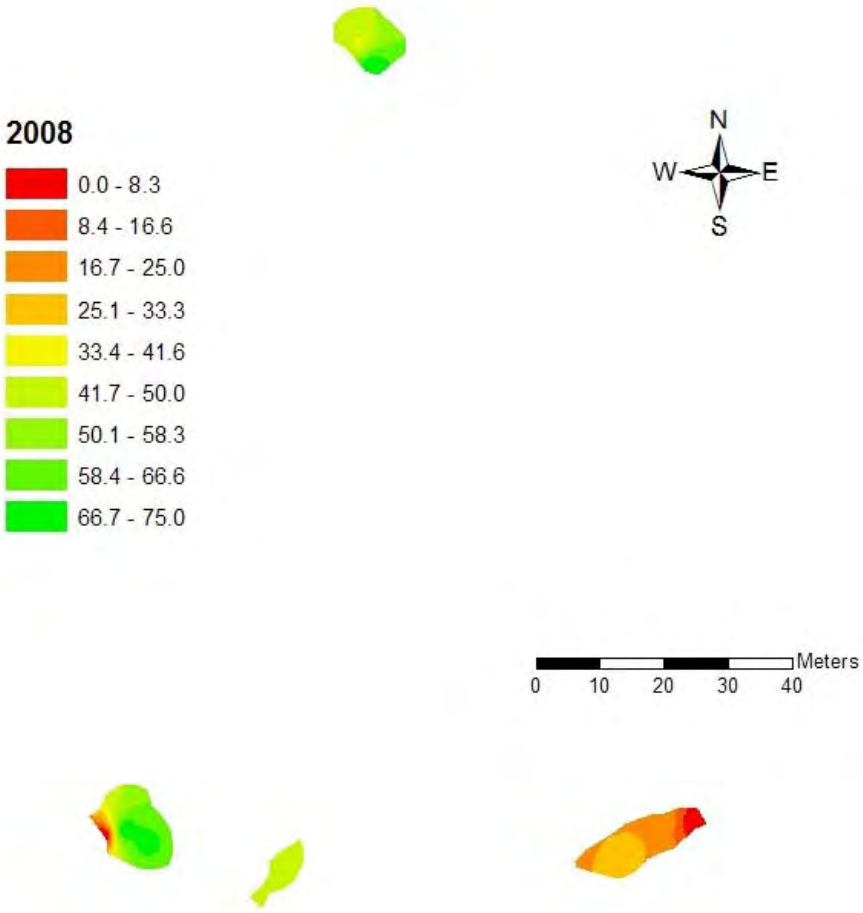


Douglass School leafy spurge perimeter in 2008.

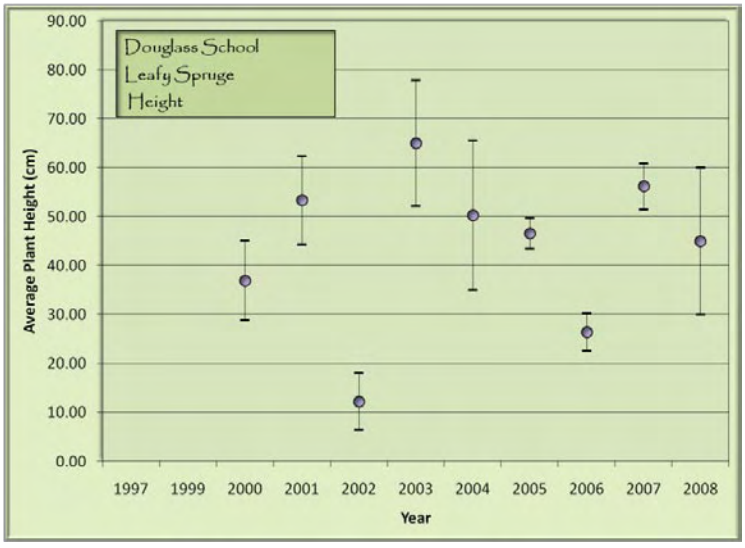


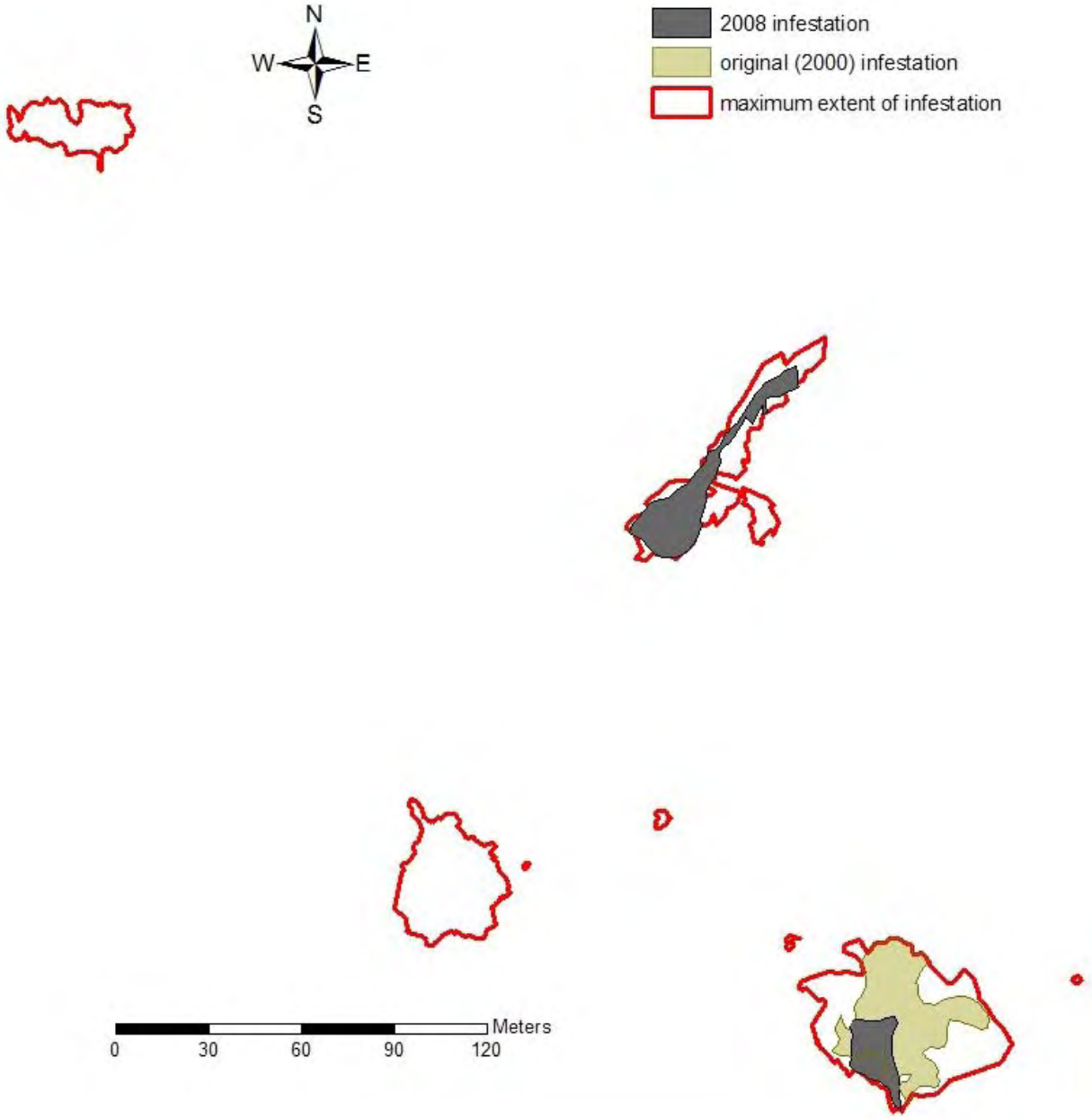
Douglass School leafy spurge density in 2008.



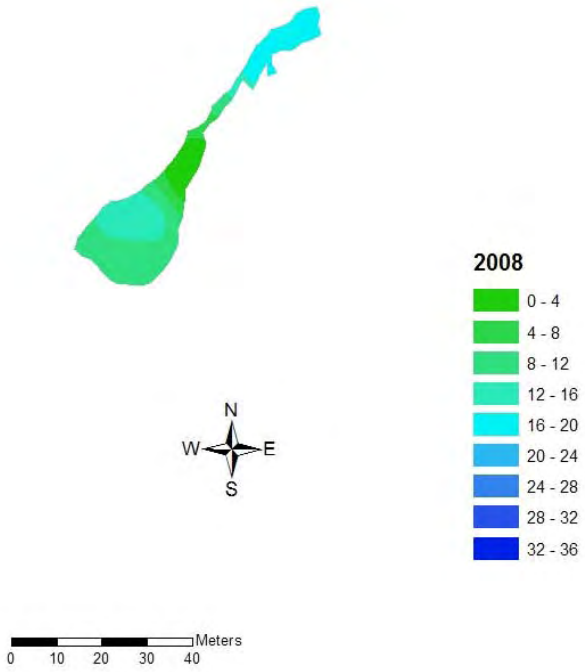


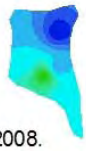
Douglass School leafy spurge height in 2008.



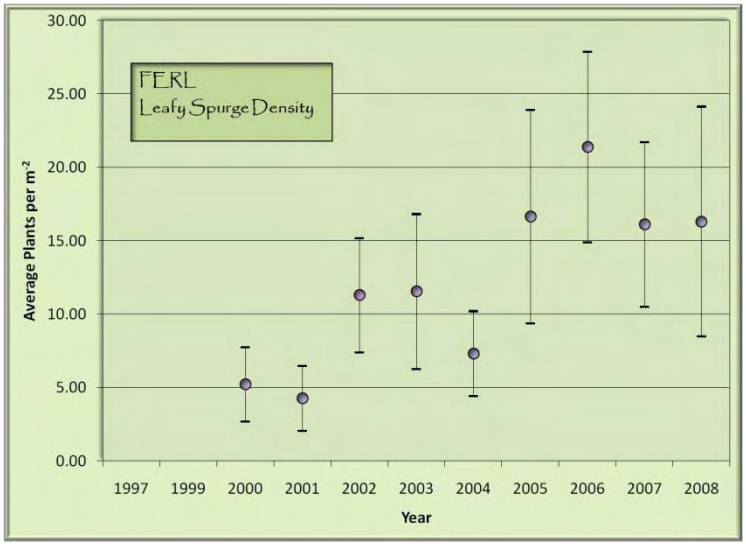


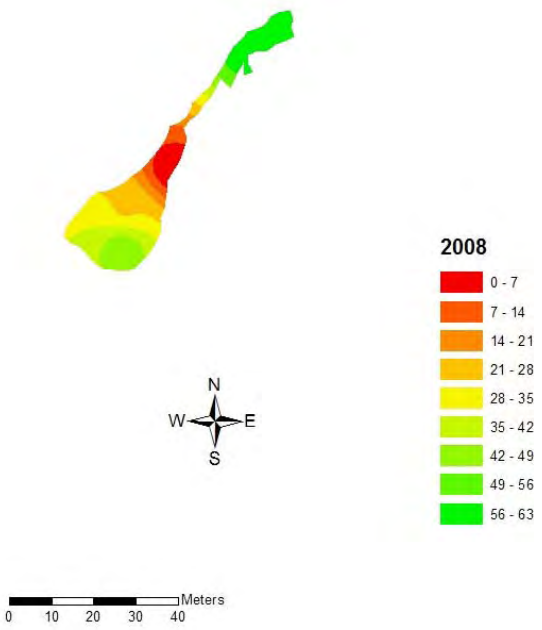
FERL Leafy spurge perimeter in 2008.



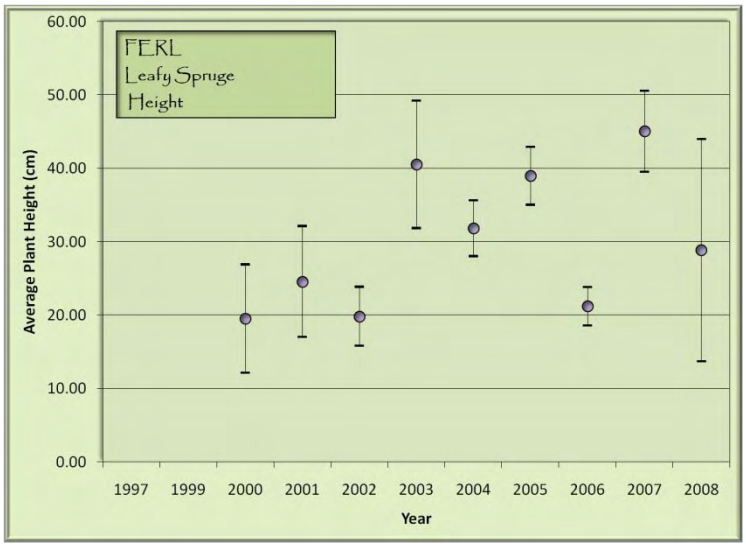


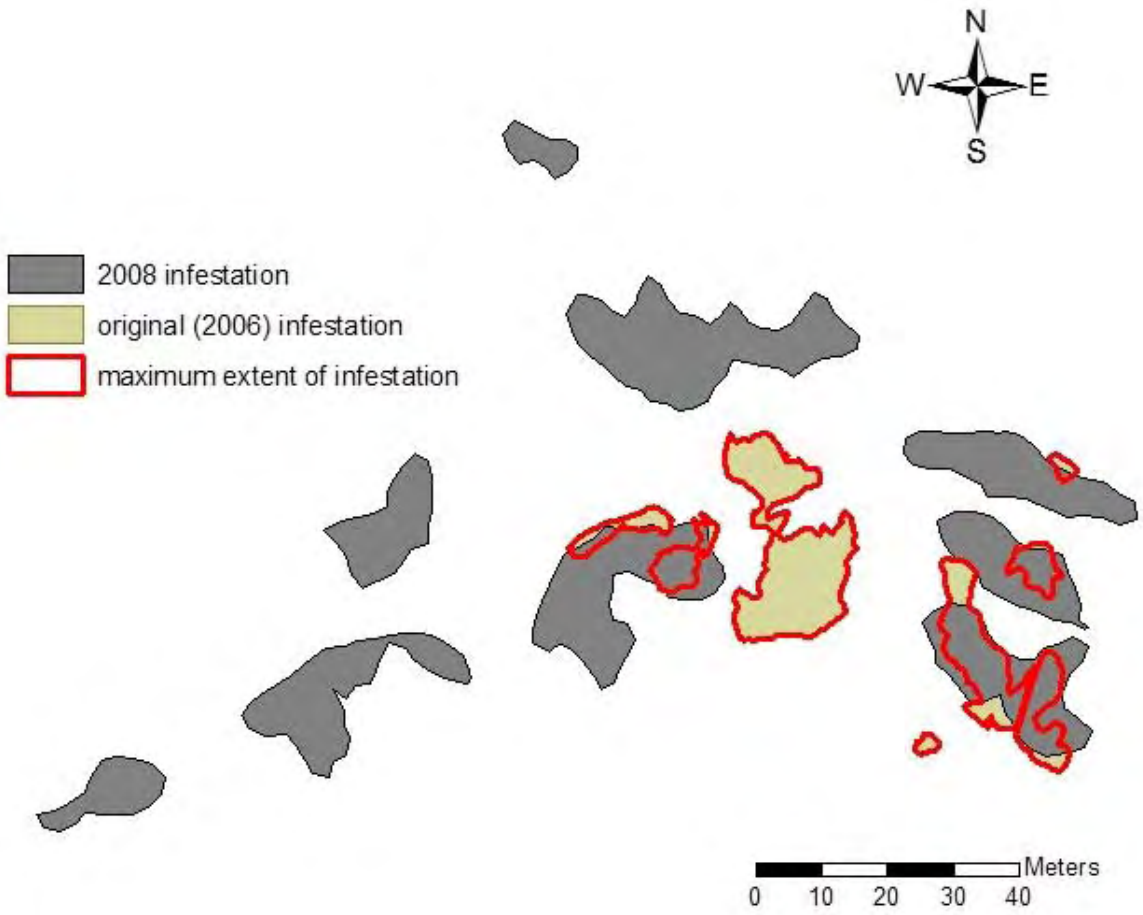
FERL leafy spurge density in 2008.



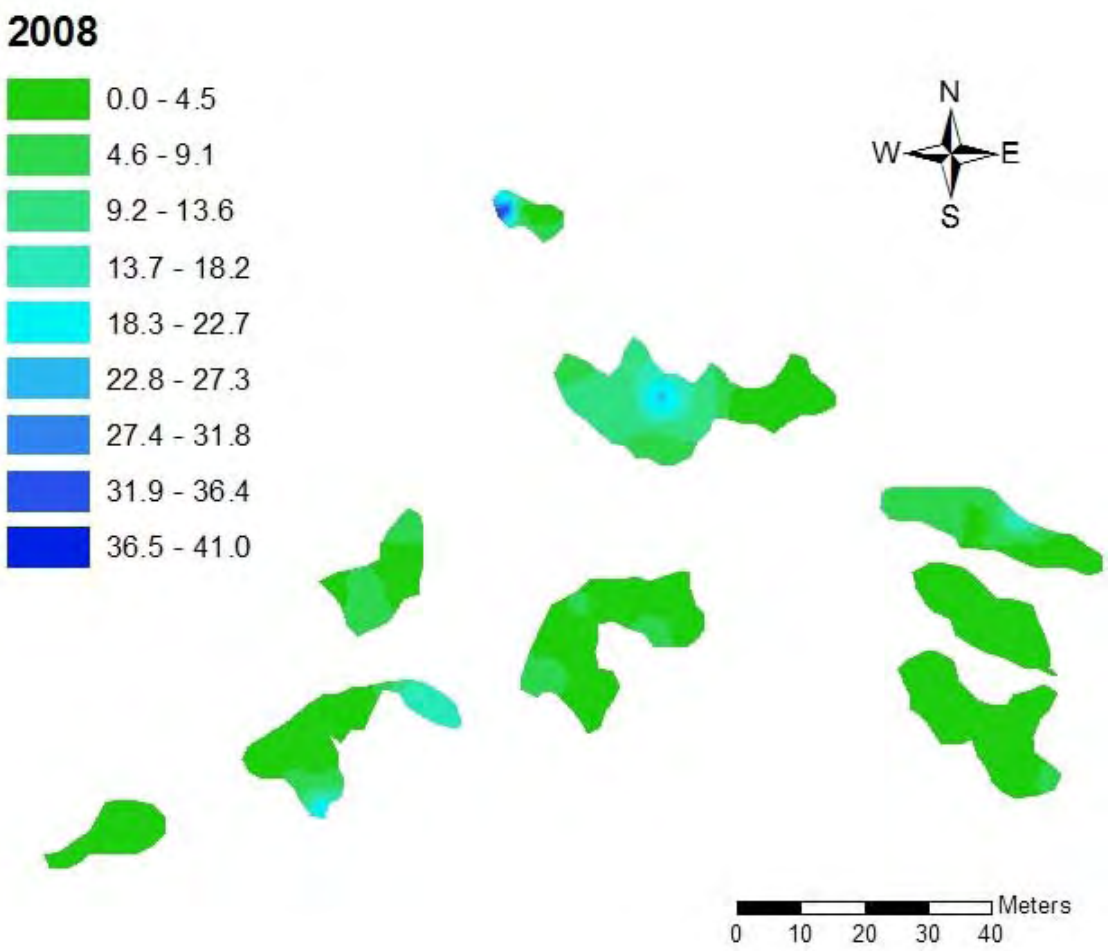


FERL leafy spurge height in 2008.

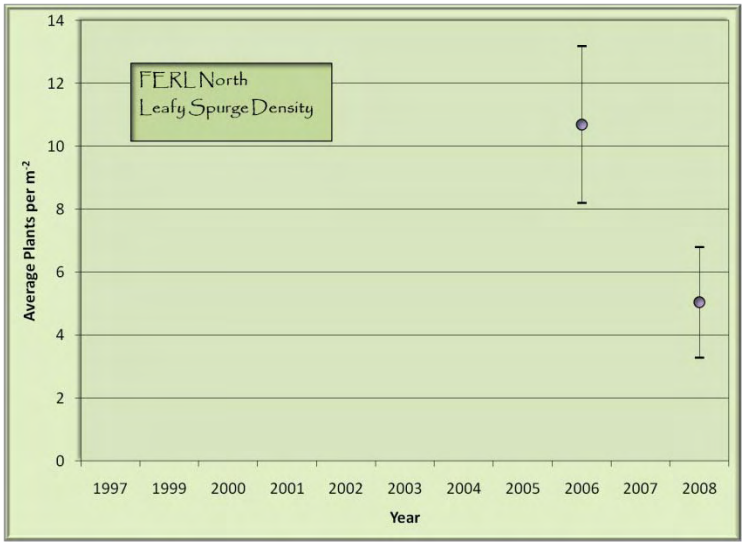


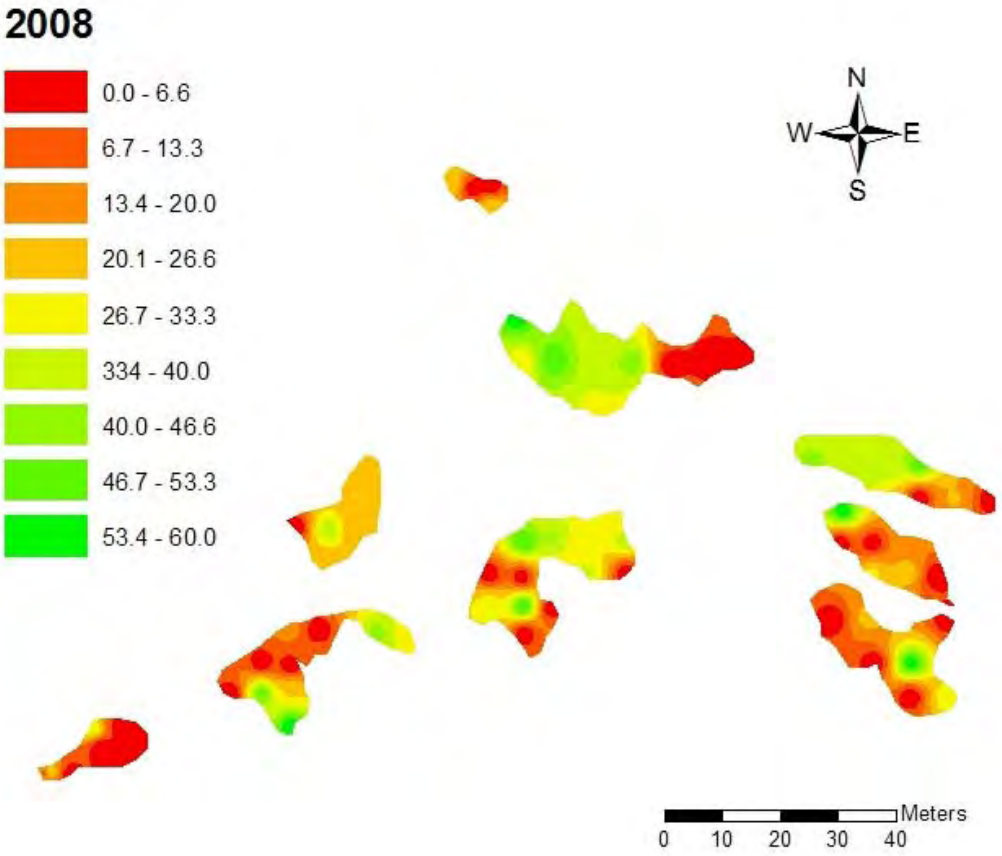


FERL North leafy spurge perimeter in 2008

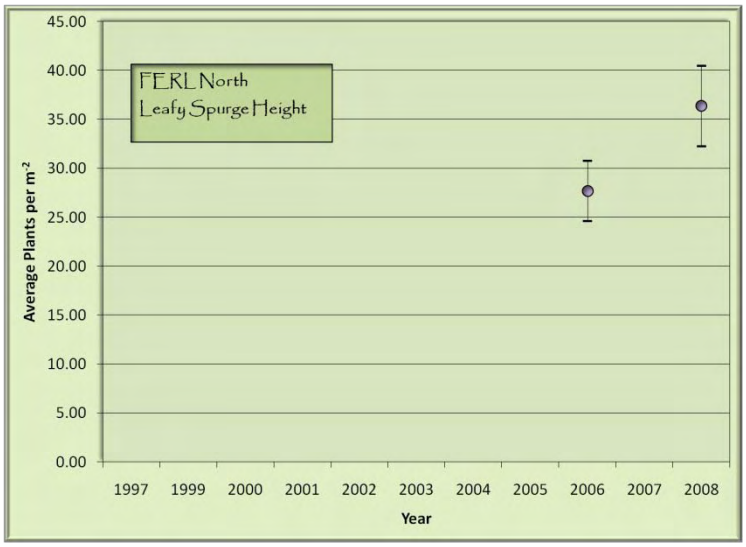


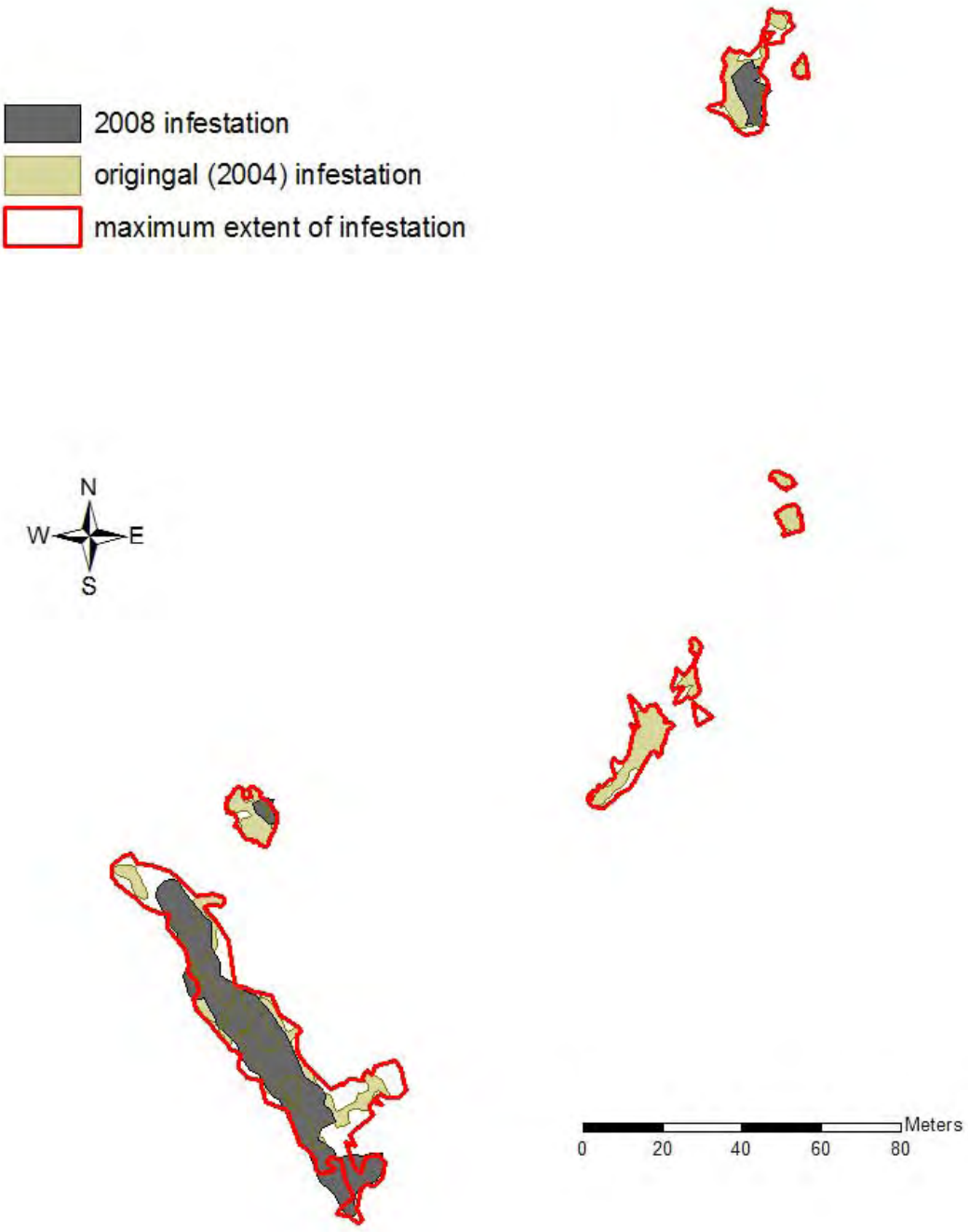
FERL North leafy spurge density in 2008



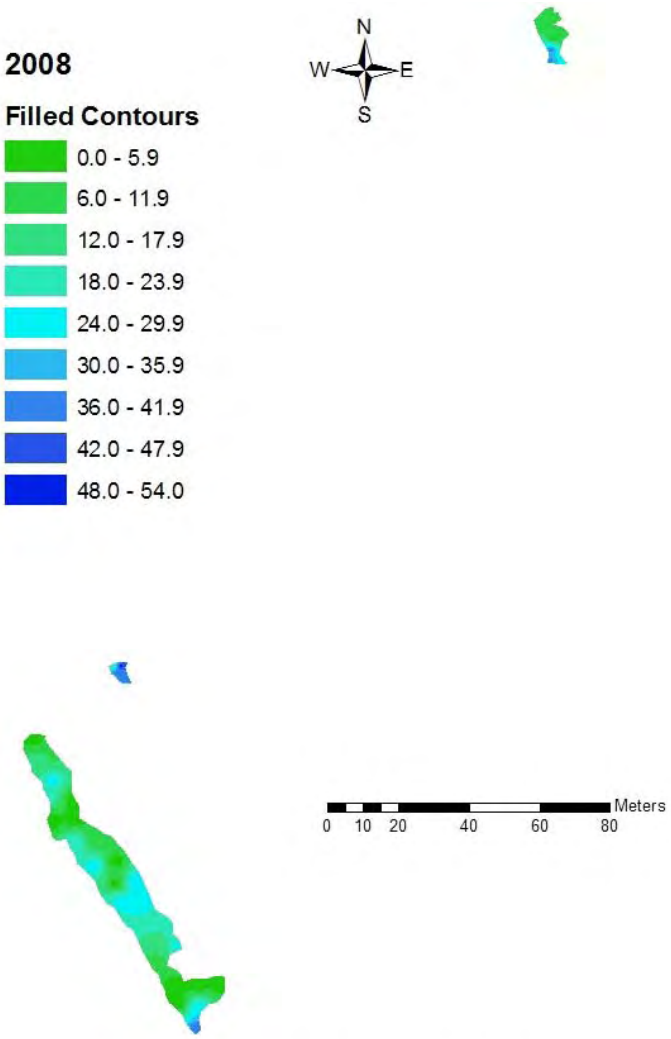


FERL North leafy spurge height in 2008

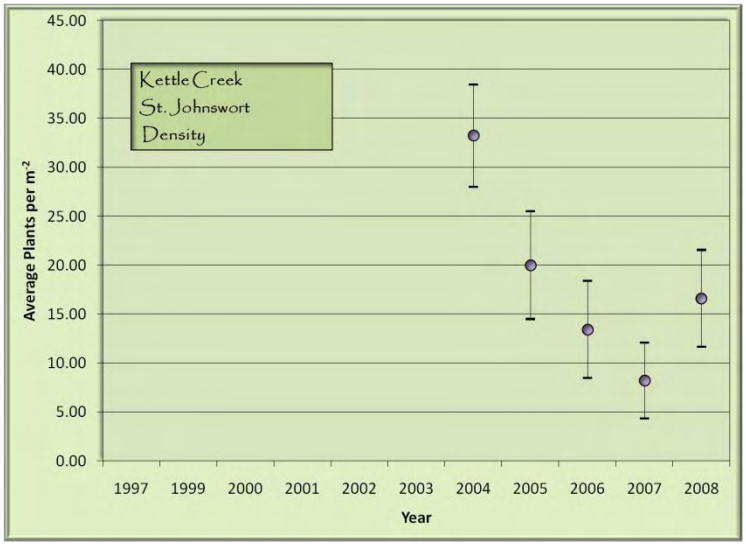


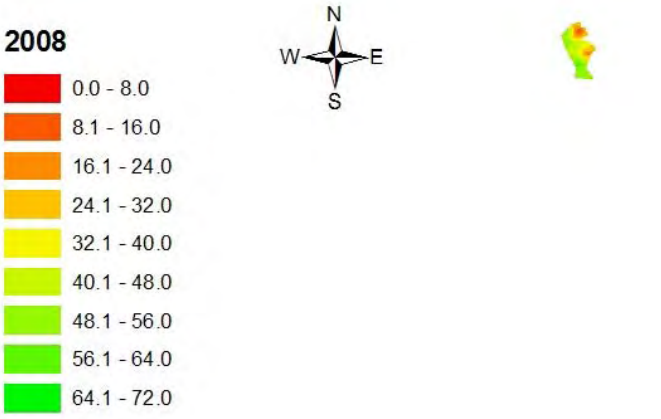


Kettle Creek St. Johnswort perimeter in 2008

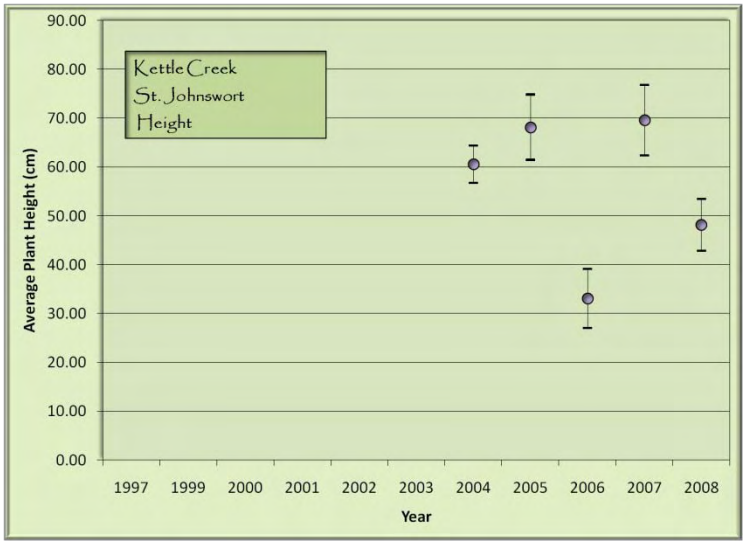


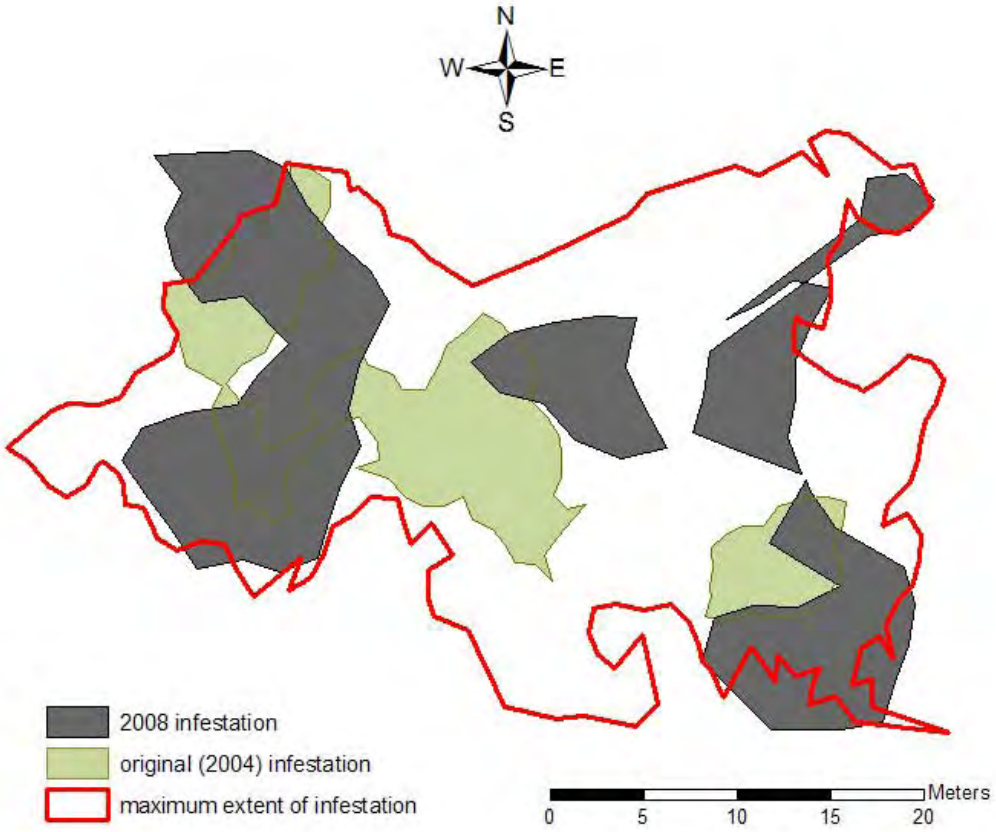
Kettle Creek St. Johnswort density in 2008.



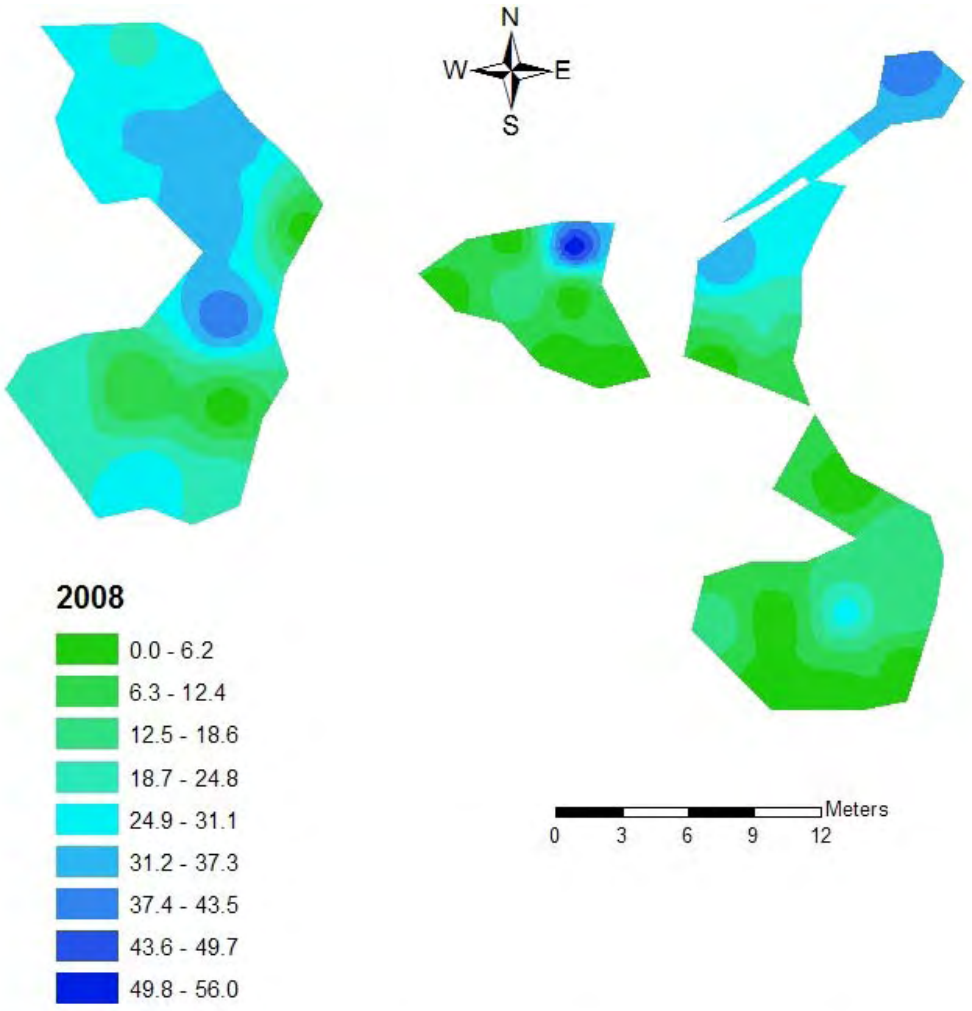


Kettle Creek St. Johnswort height in 2008

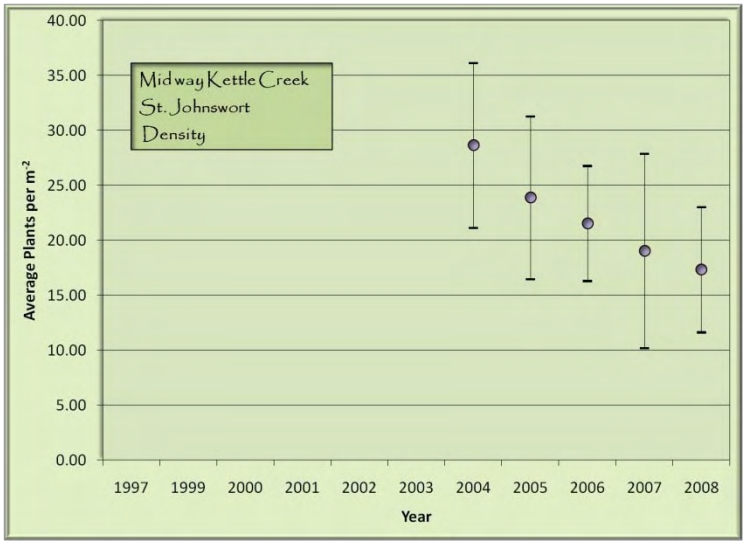


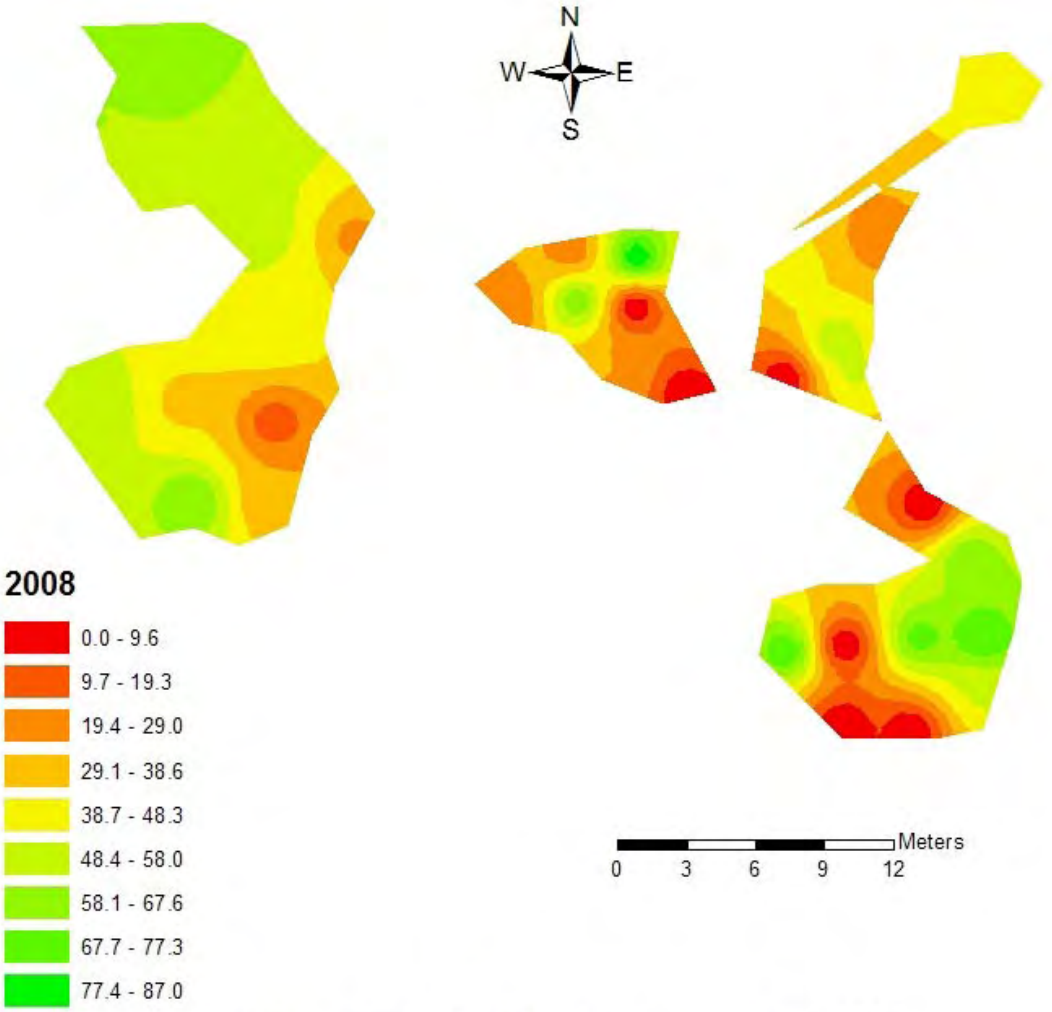


Midway Kettle Creek St. Johnswort perimeter in 2008.

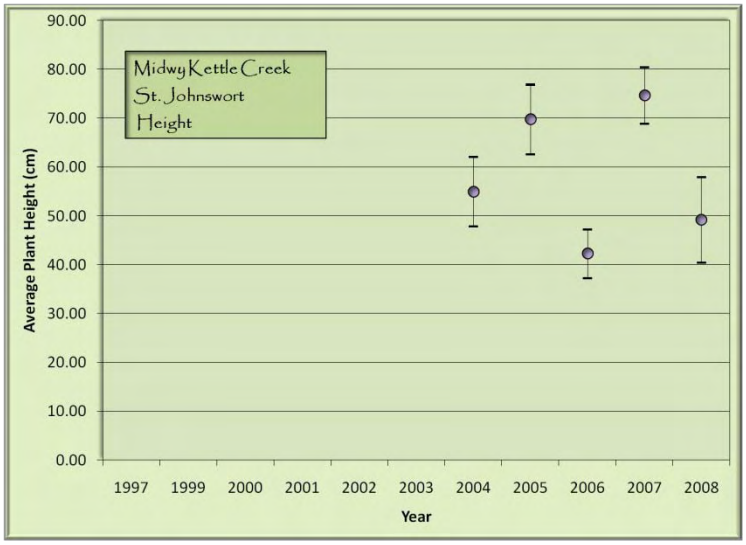


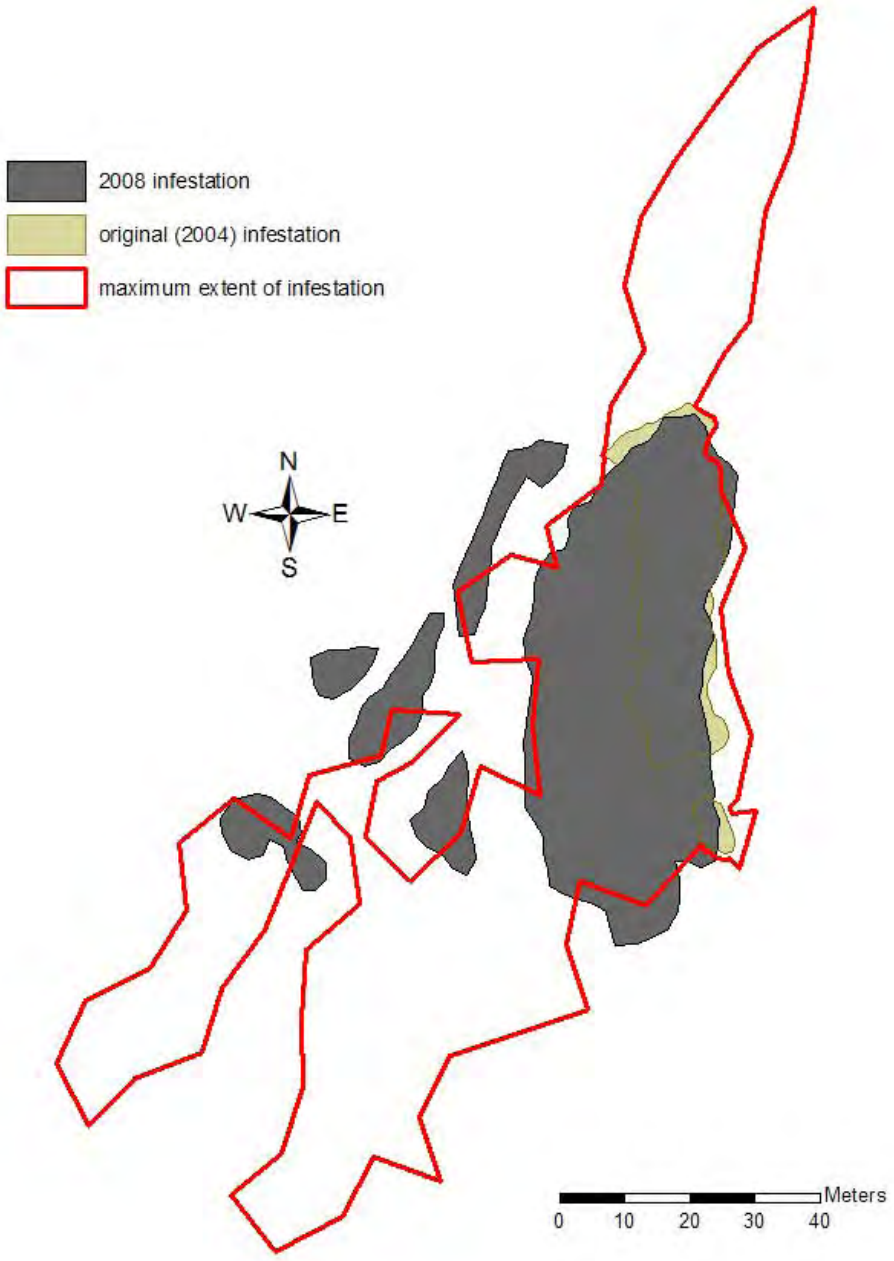
Midway Kettle Creek St. Johnswort density in 2008.



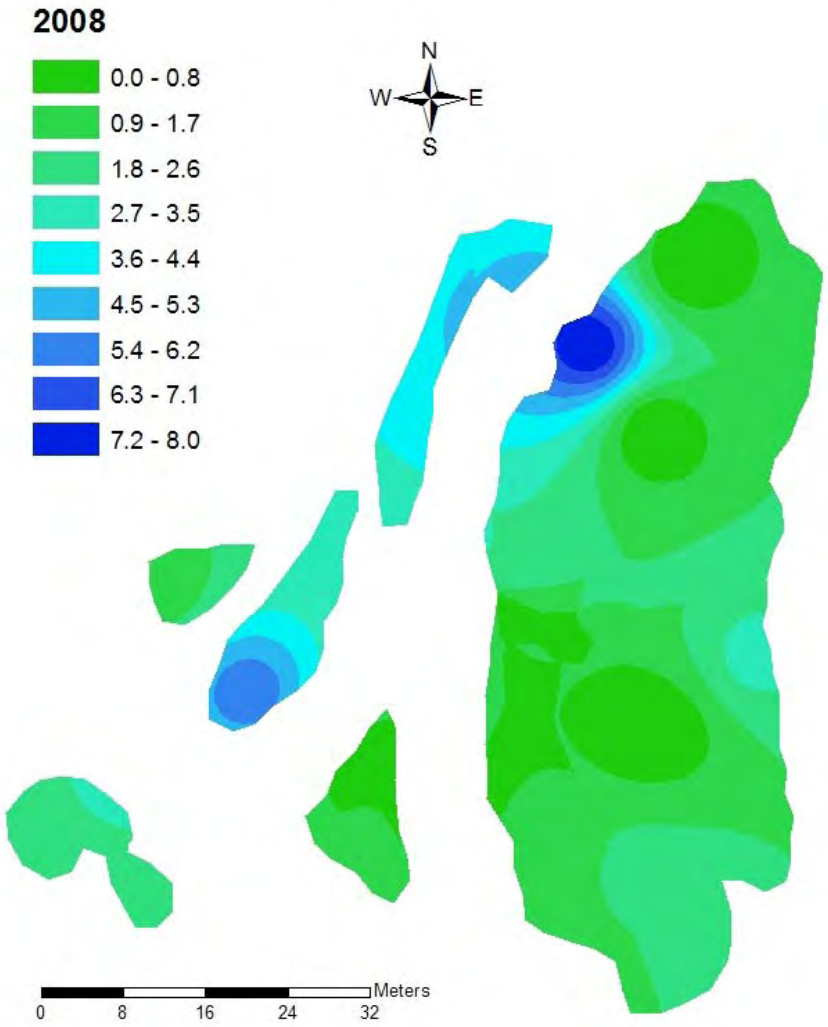


Midway Kettle Creek St. Johnswort height in 2008.

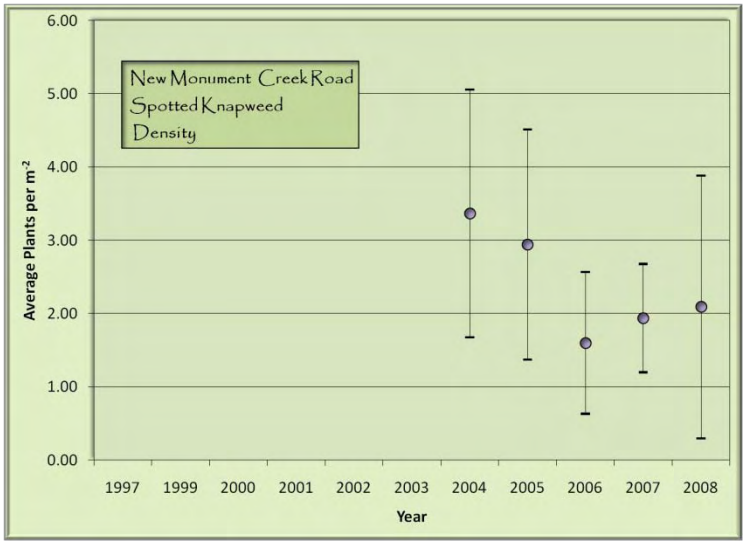


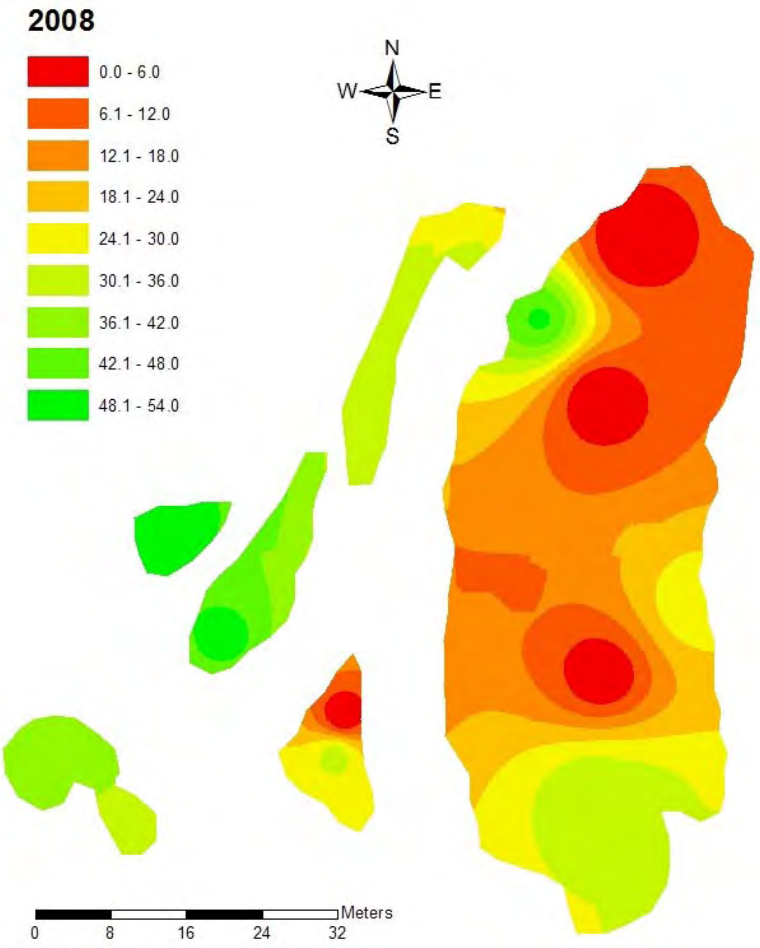


New Monument Creek spotted knapweed perimeter in 2008.

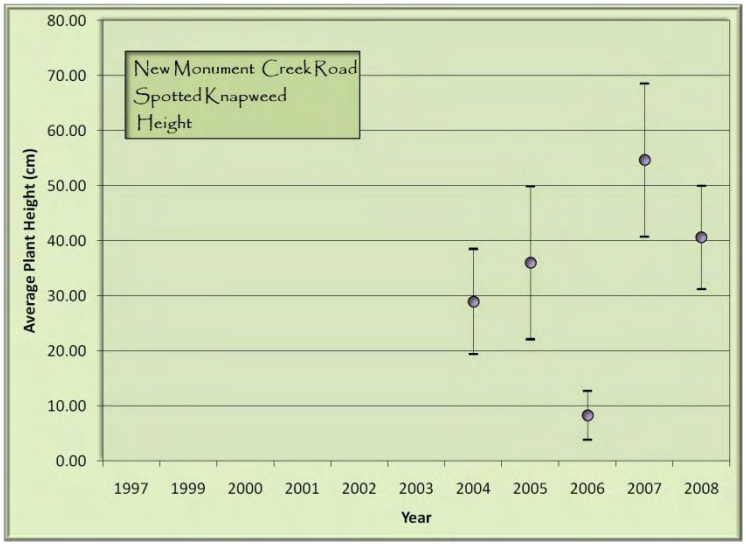


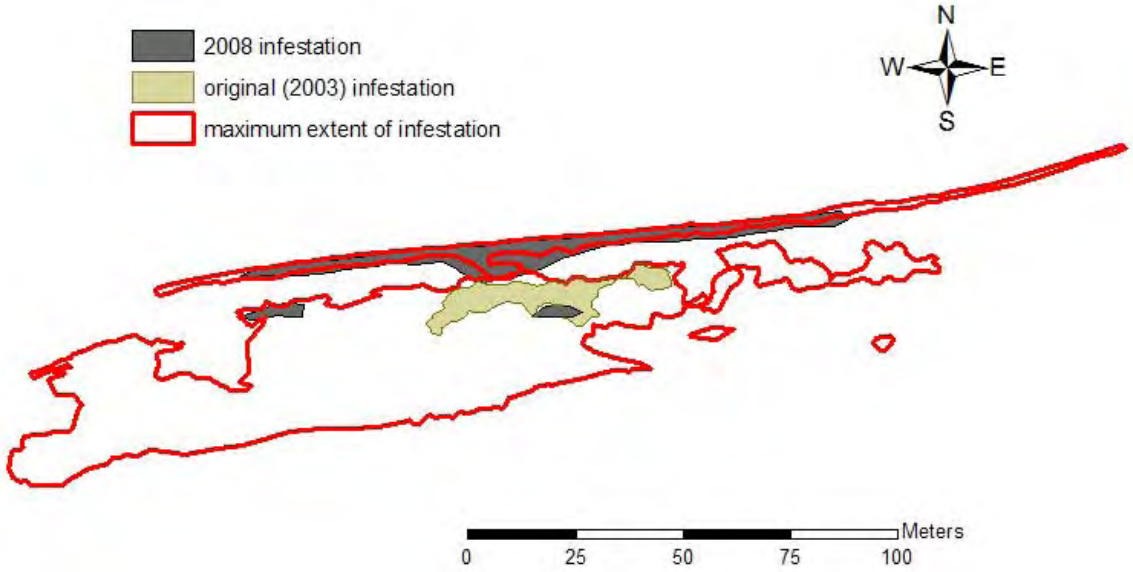
New Monument Creek spotted knapweed density in 2008.



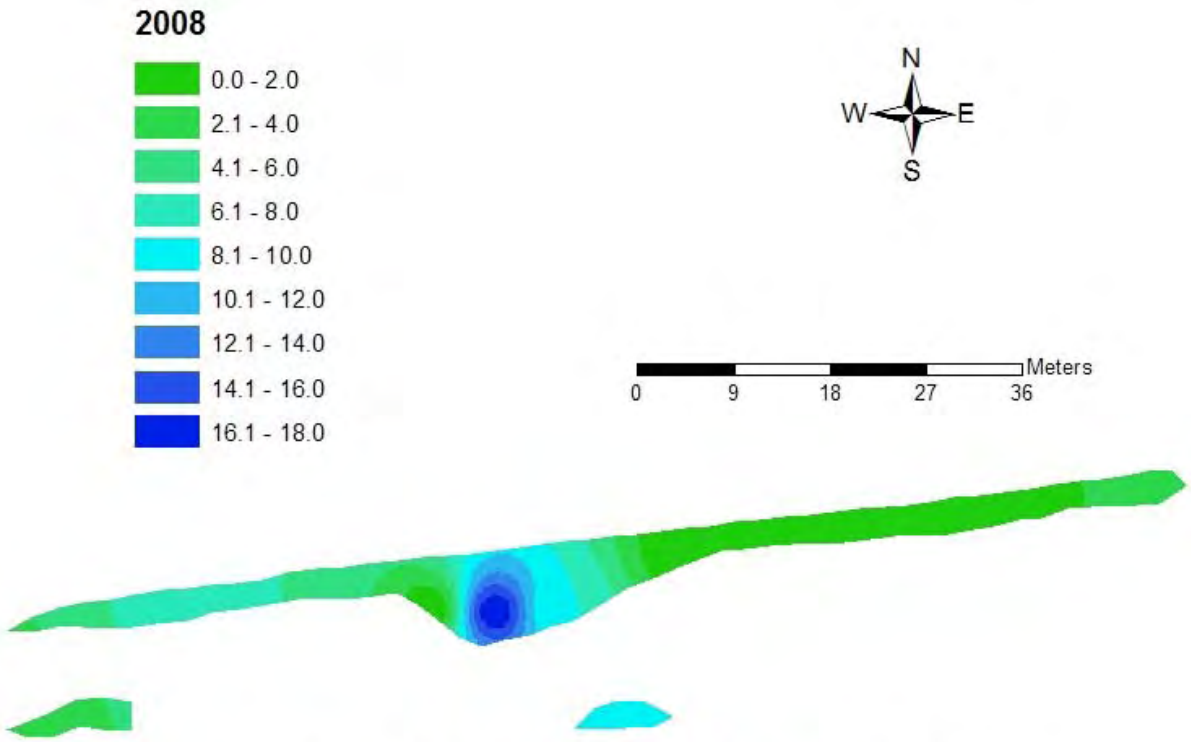


New Monument Creek spotted knapweed height in 2008.

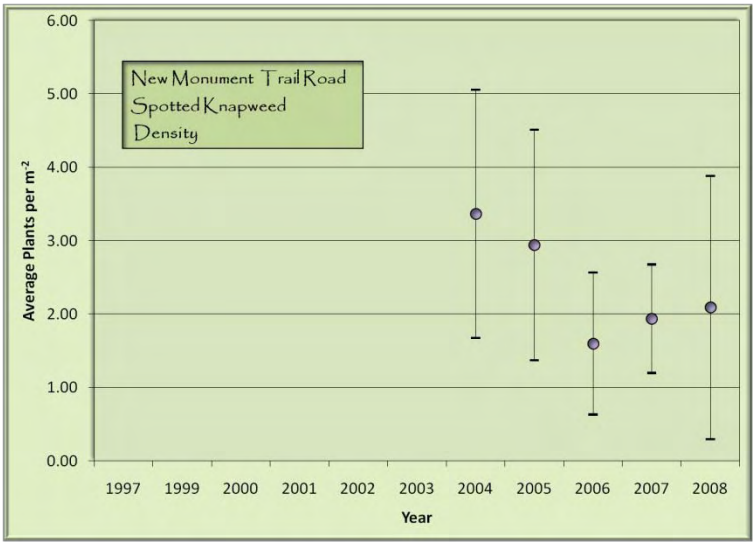


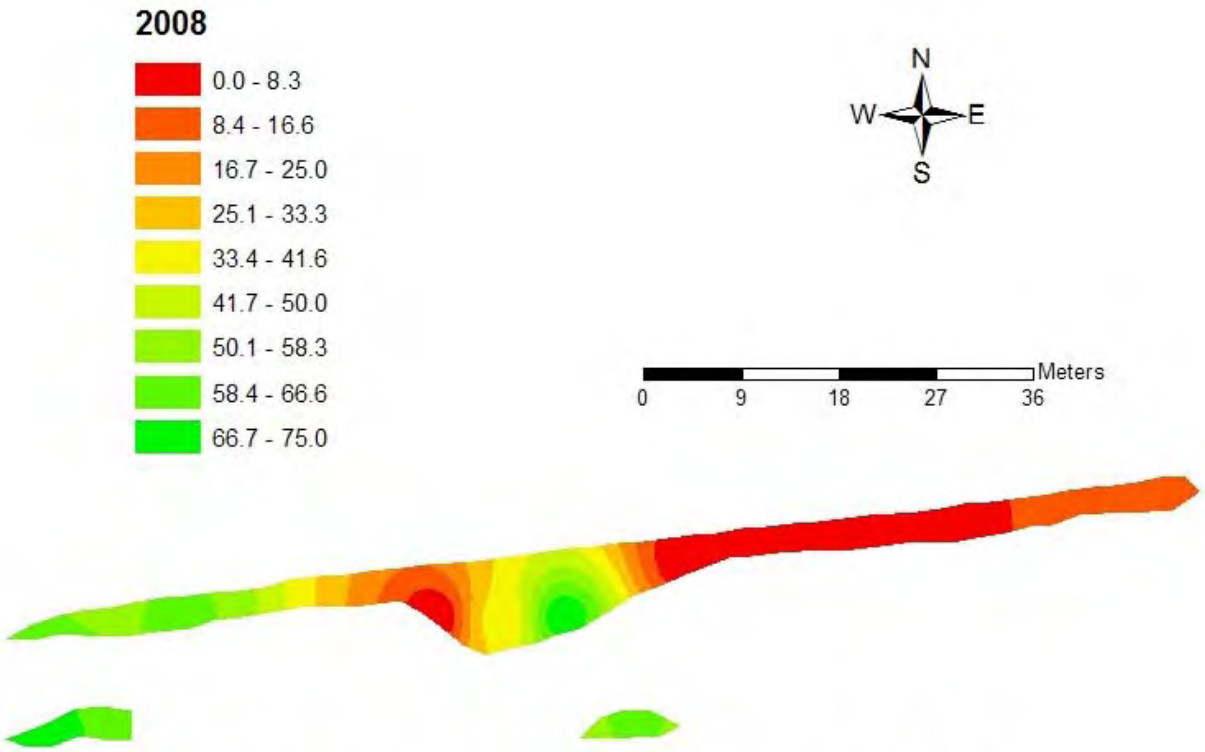


Monument Trail Road spotted knapweed perimeter in 2008.

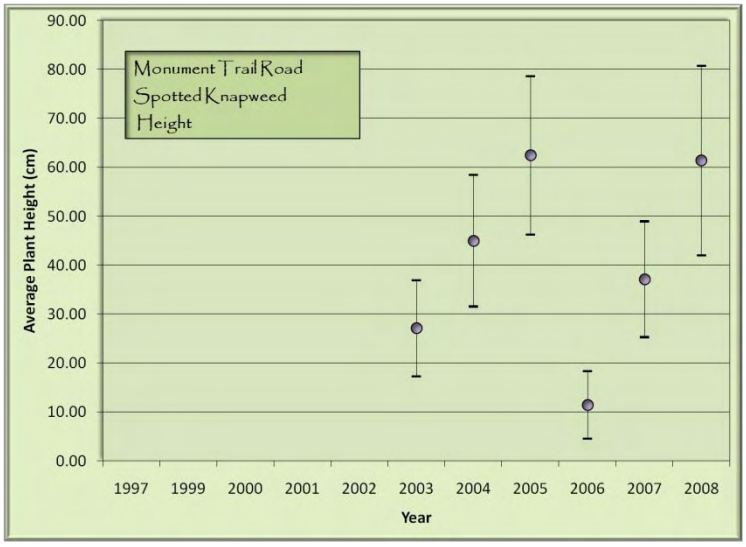


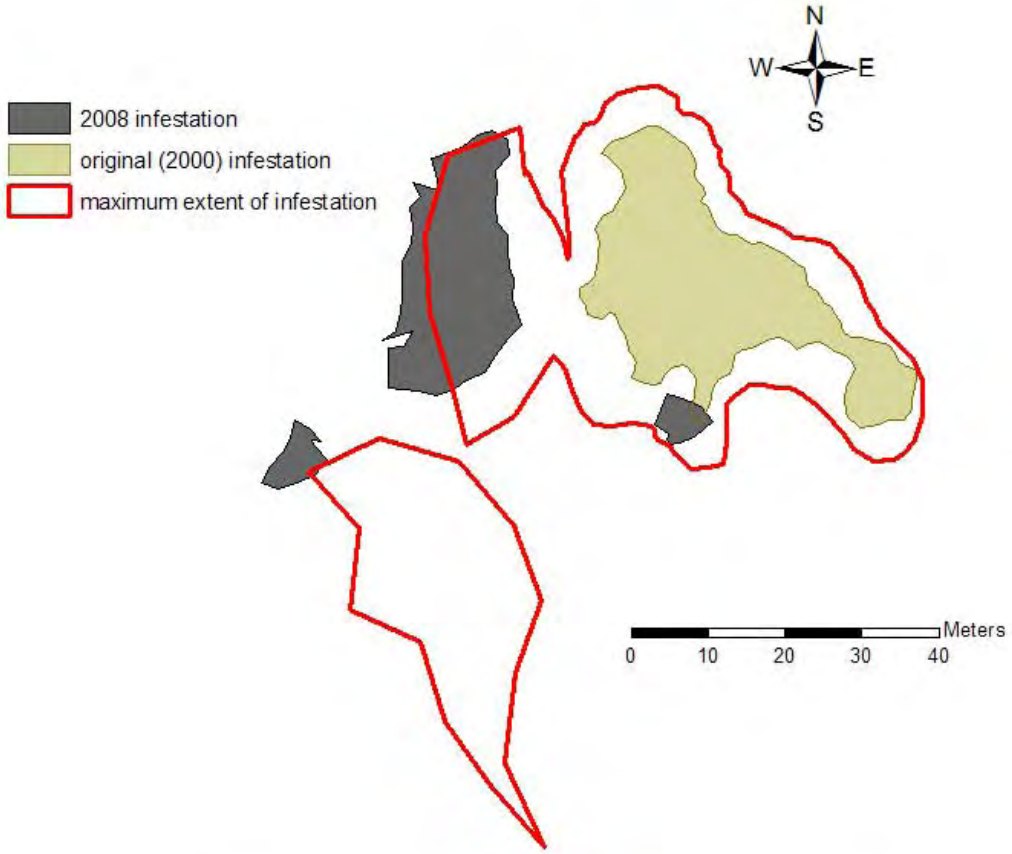
Monument Trail Road spotted knapweed density in 2008.



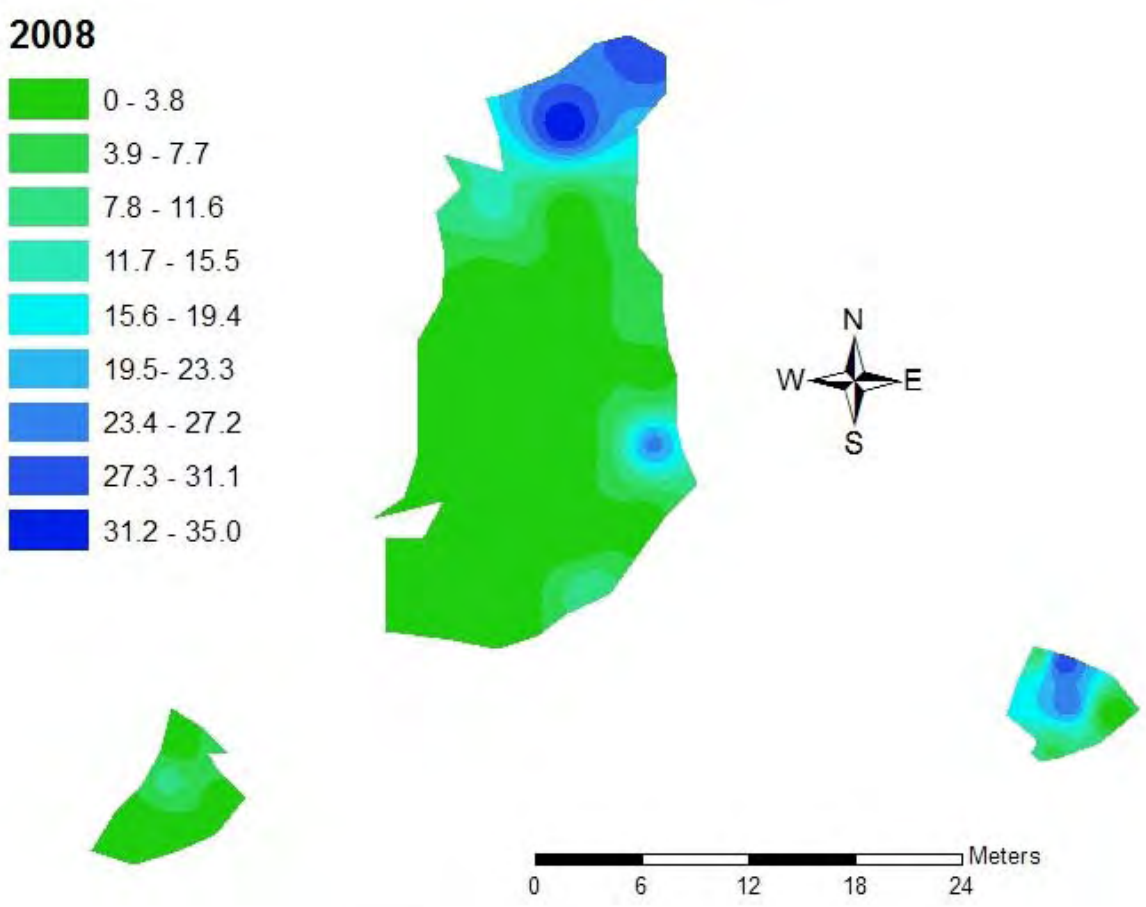


Monument Trail Road spotted knapweed height in 2008.

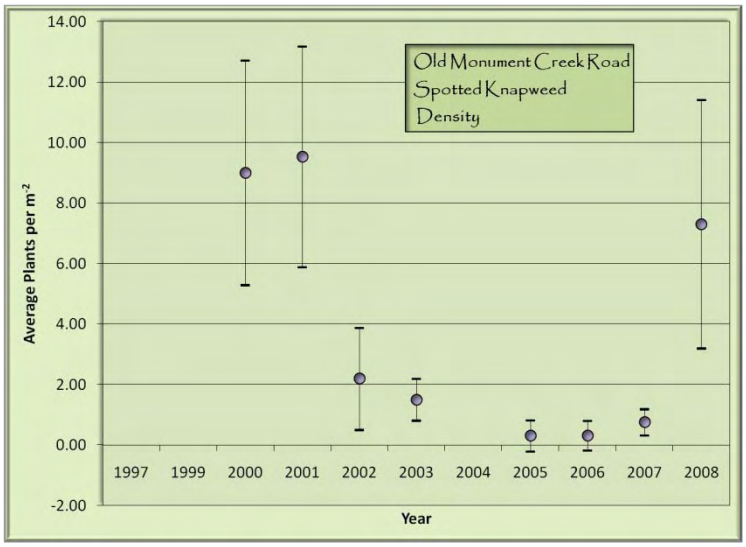


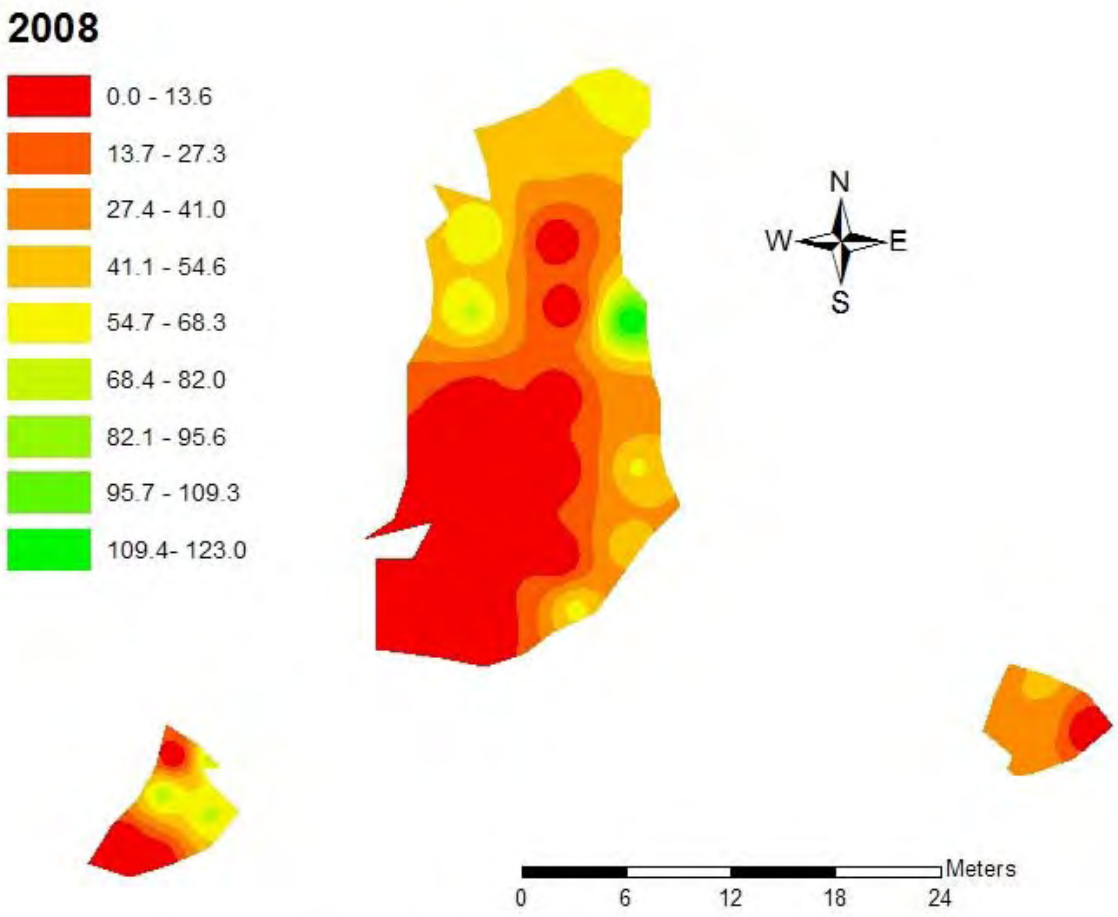


Old Monument Creek spotted knapweed perimeter in 2008.

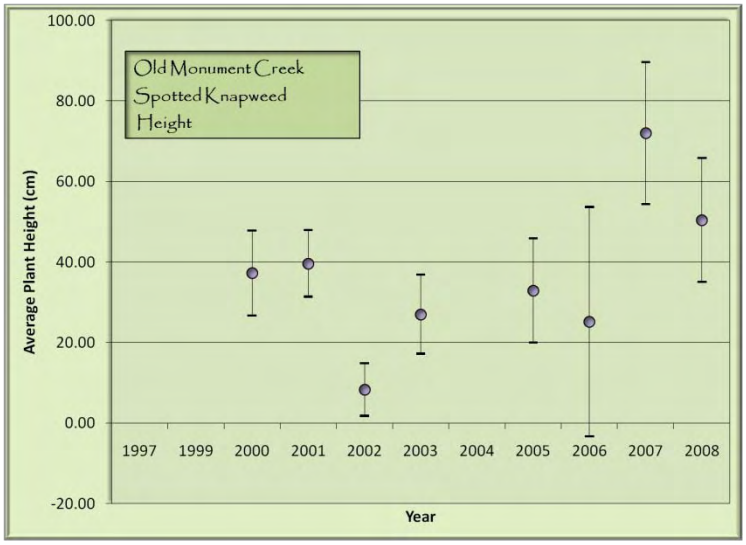


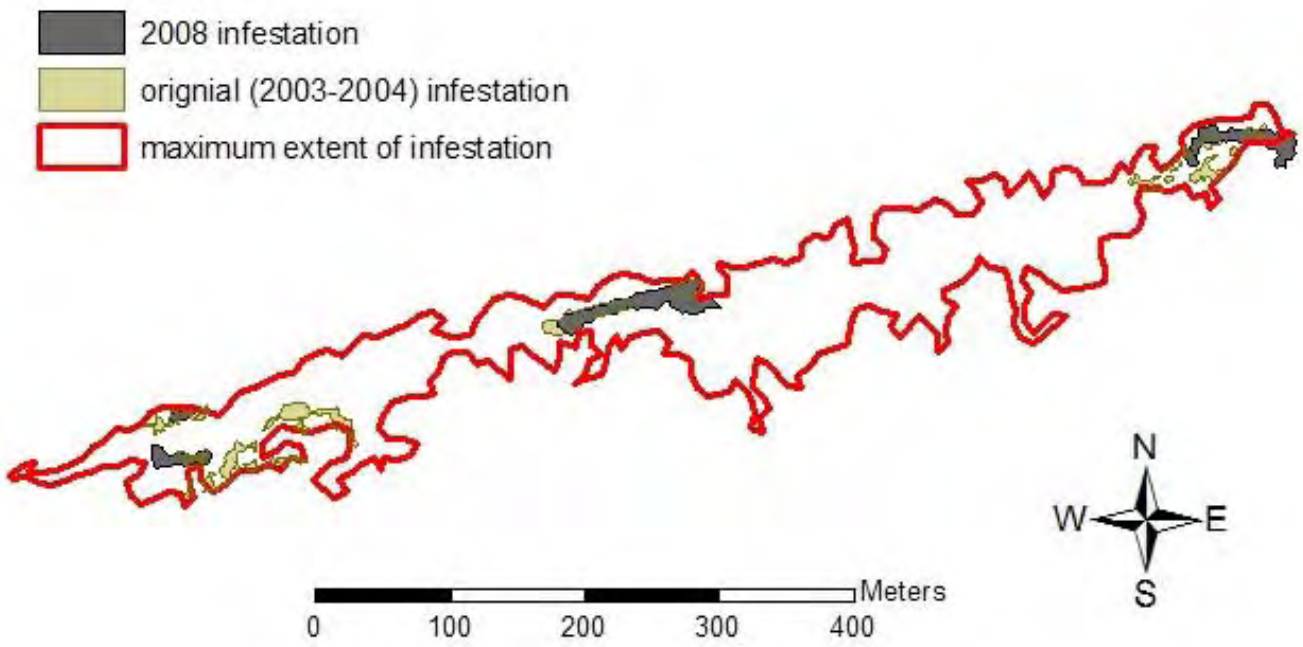
Old Monument Creek spotted knapweed density in 2008.



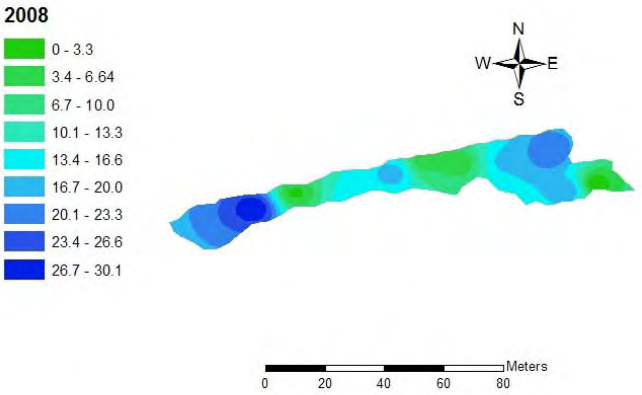


Old Monument Creek spotted knapweed height in 2008.

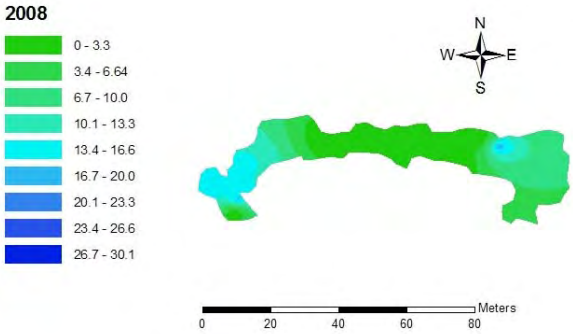




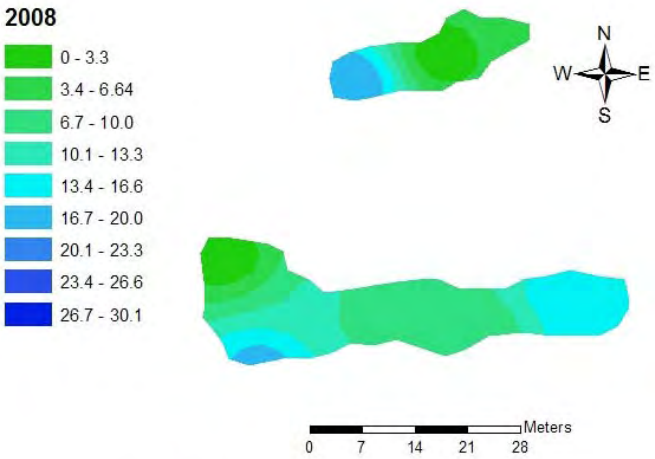
Total Parade Loop spotted knapweed perimeter in 2008.



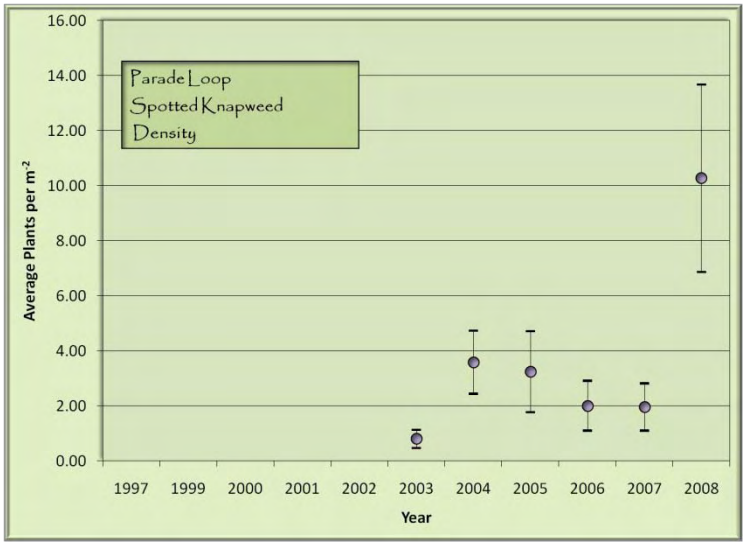
Parade loop 1 spotted knapweed density in 2008.

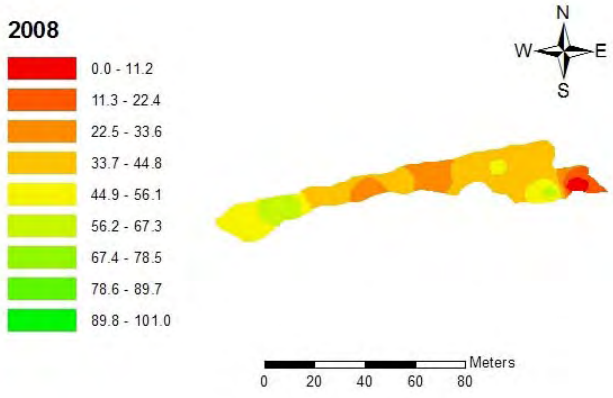


Parade loop 2 spotted knapweed density in 2008.

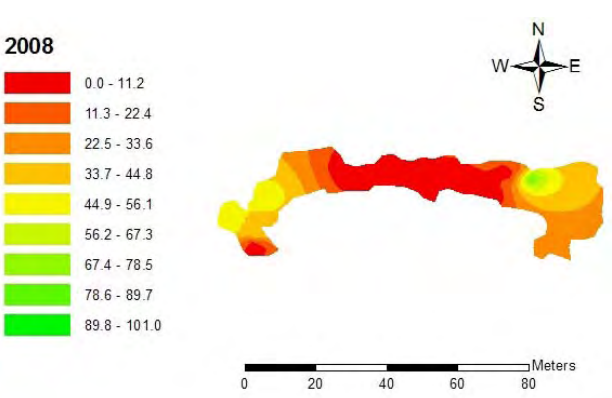


Parade loop 3 spotted knapweed density in 2008.

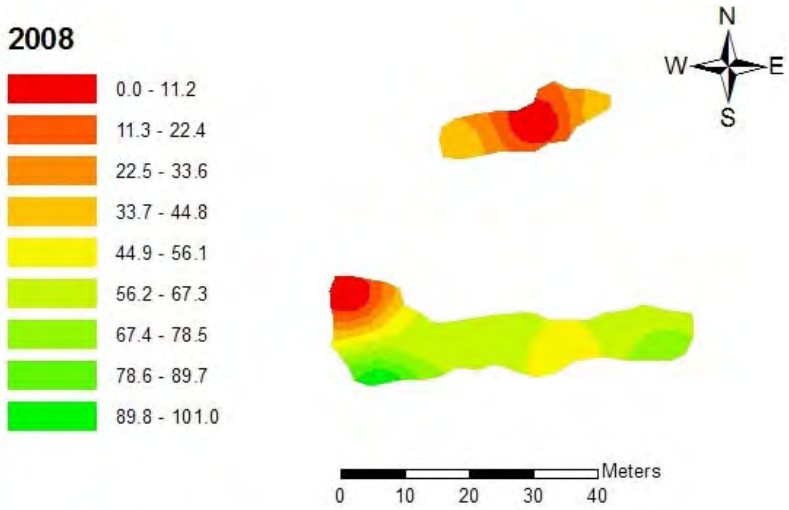




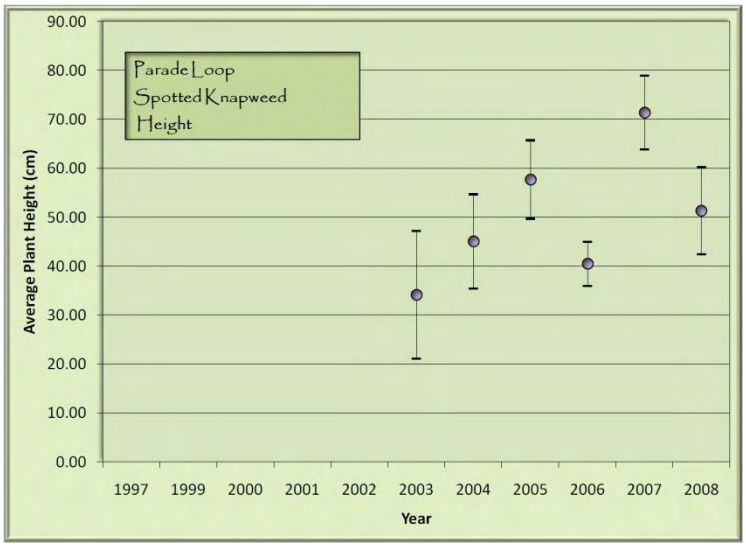
Parade loop 1 spotted knapweed height in 2008.

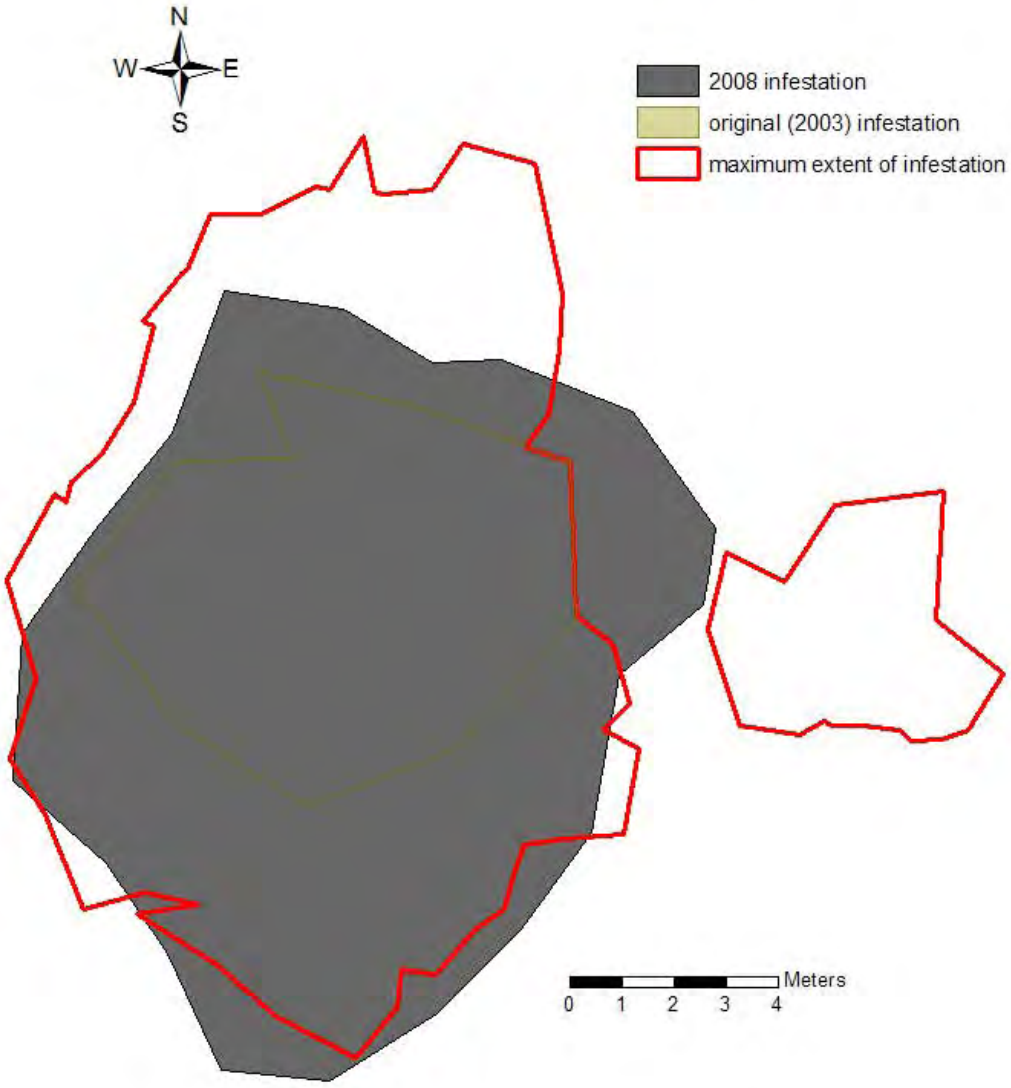


Parade loop 2 spotted knapweed height in 2008.

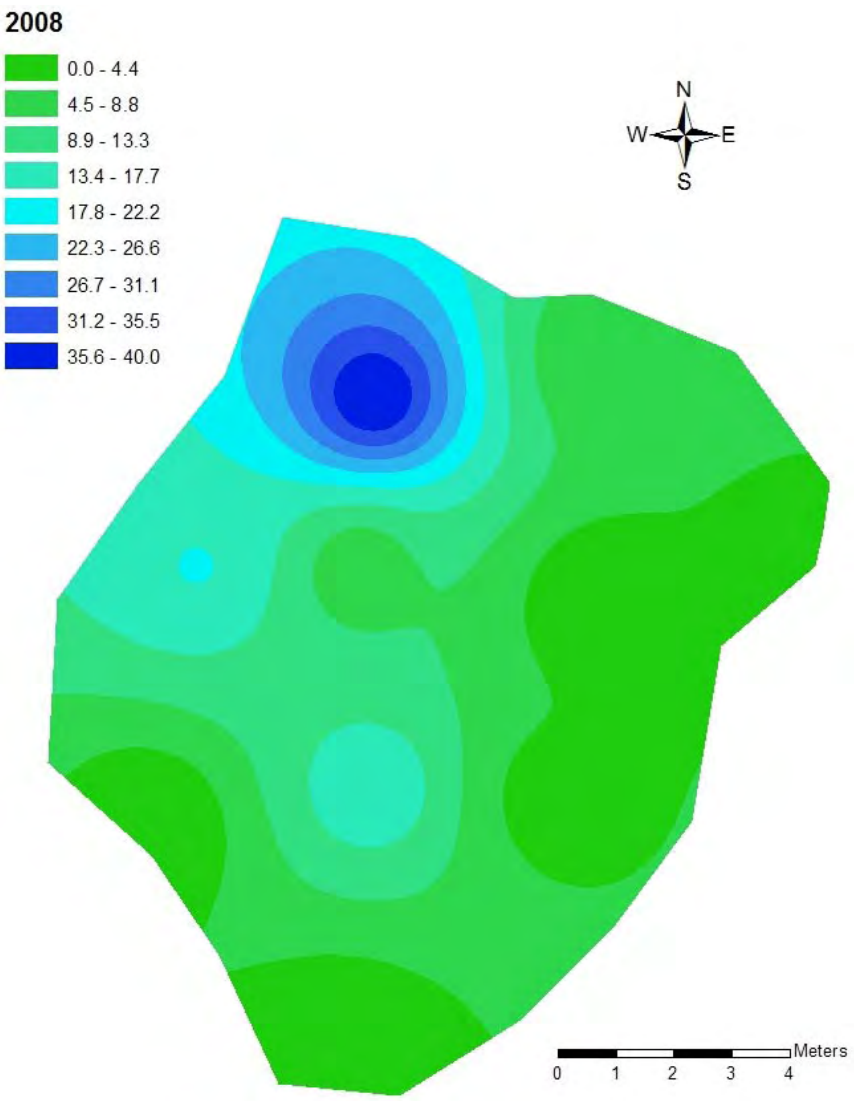


Parade loop 3 spotted knapweed height in 2008.

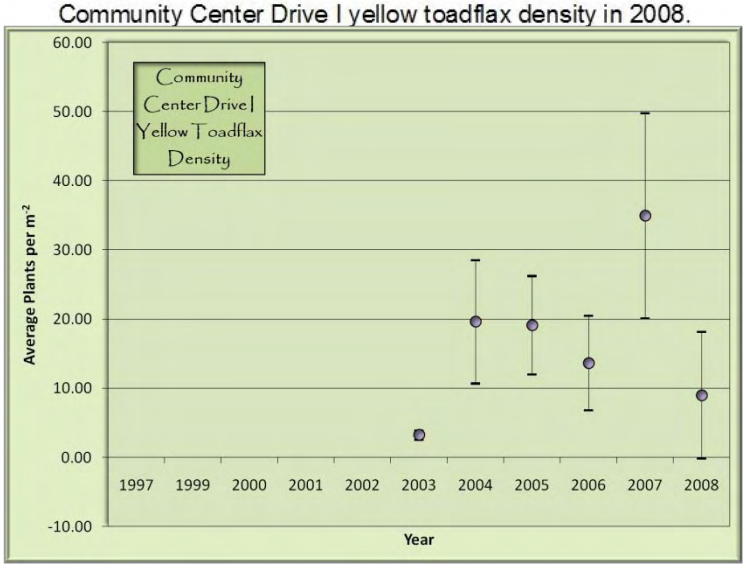


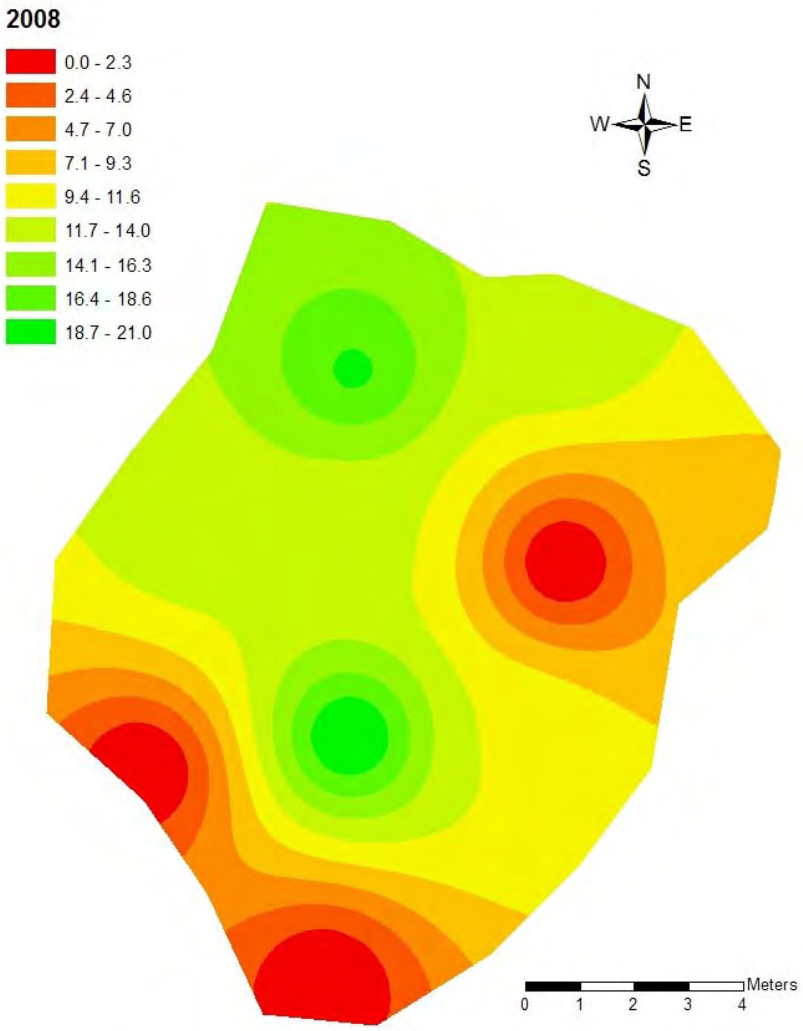


Community Center Drive I yellow toadflax perimeter in 2008.

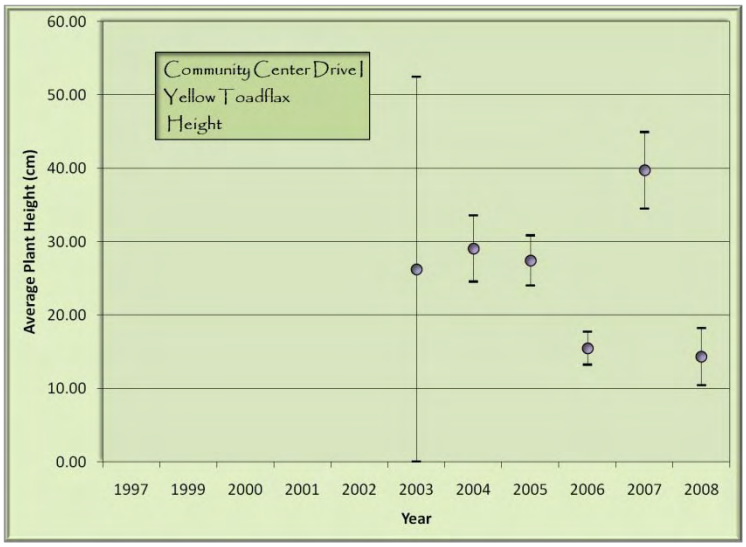


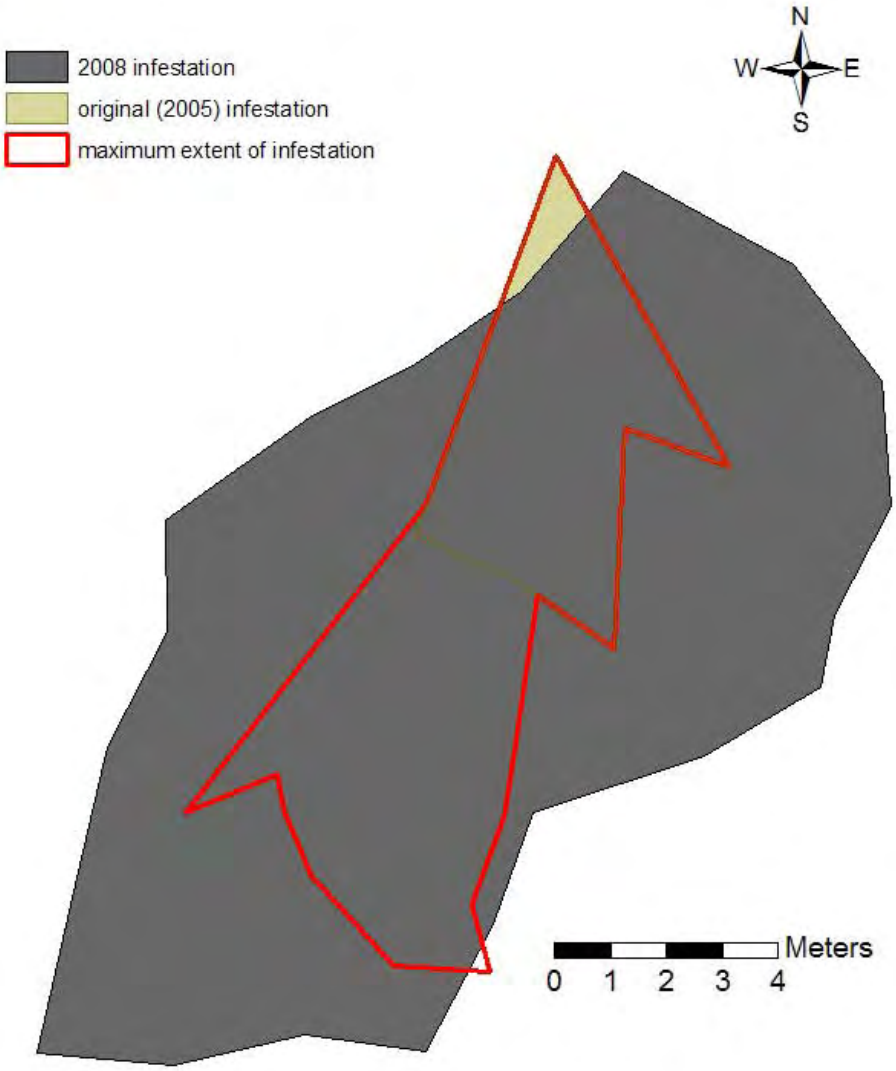
Community Center Drive I yellow toadflax density in 2008.



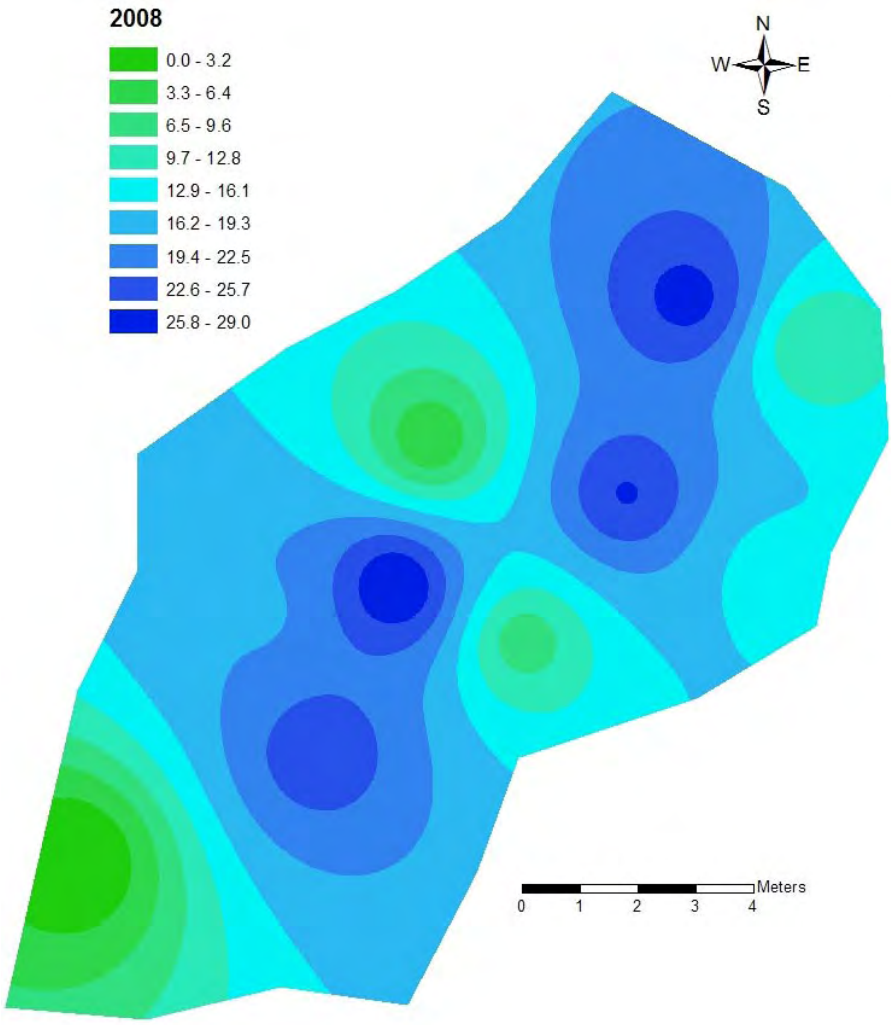


Community Center Drive I yellow toadflax height in 2008.

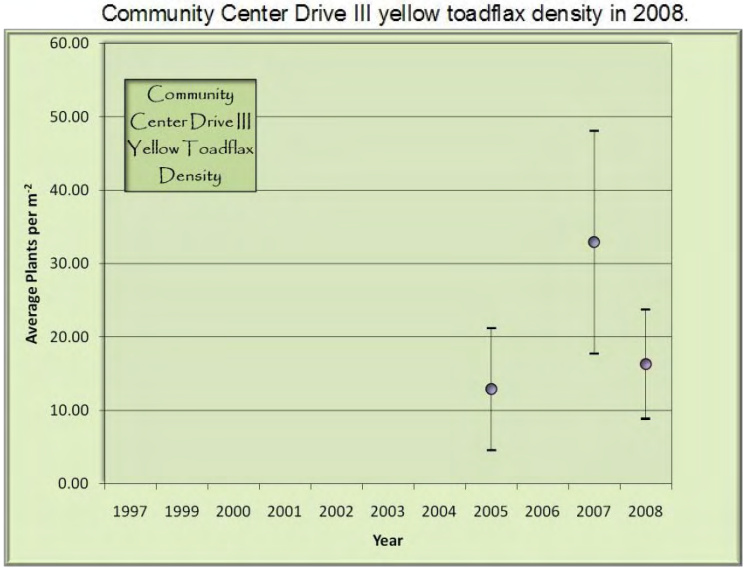


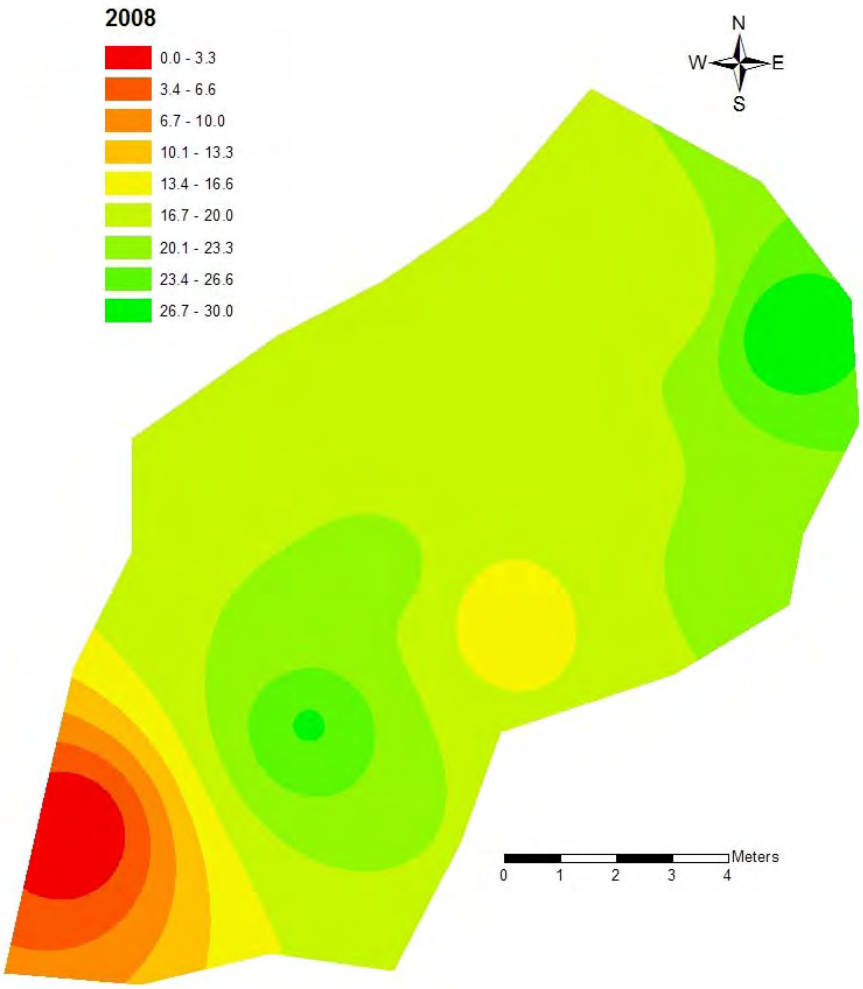


Community Center Drive III yellow toadflax perimeter in 2008.

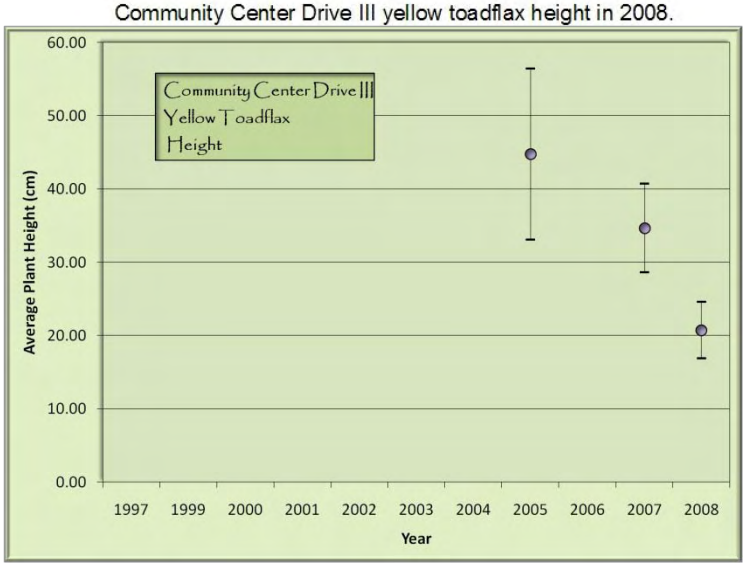


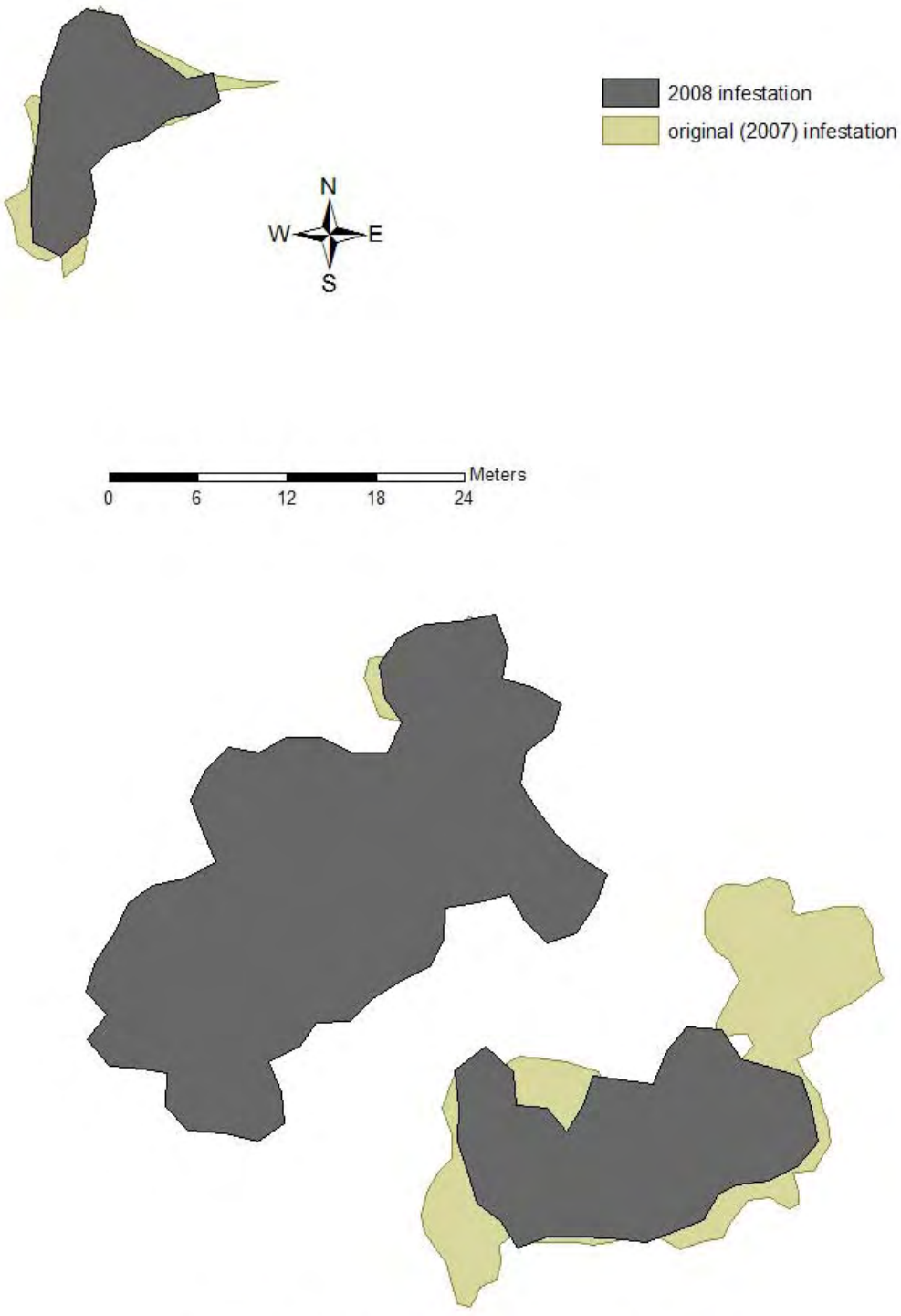
Community Center Drive III yellow toadflax density in 2008.



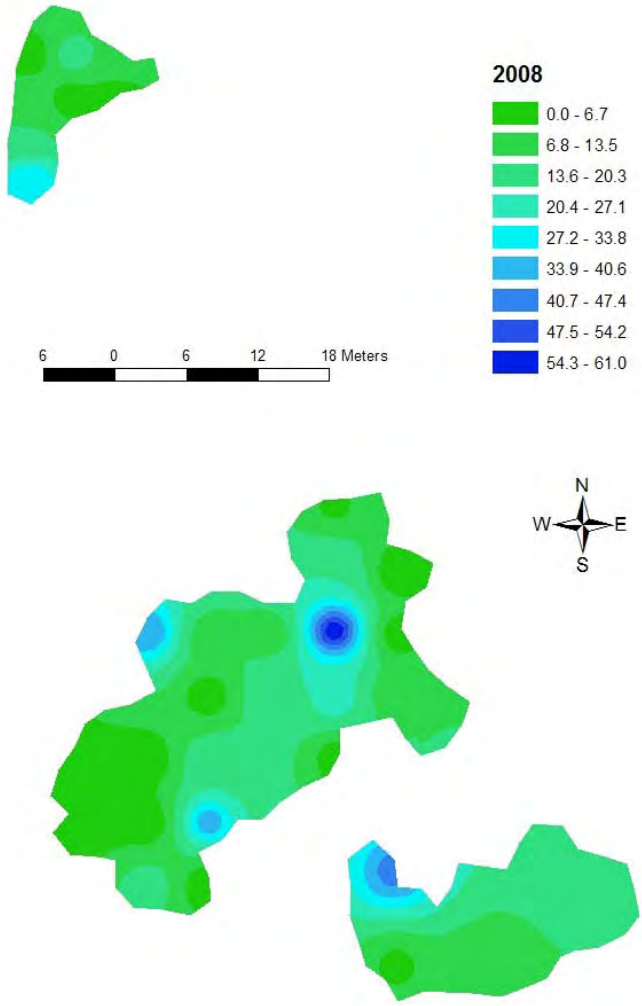


Community Center Drive III yellow toadflax height in 2008.

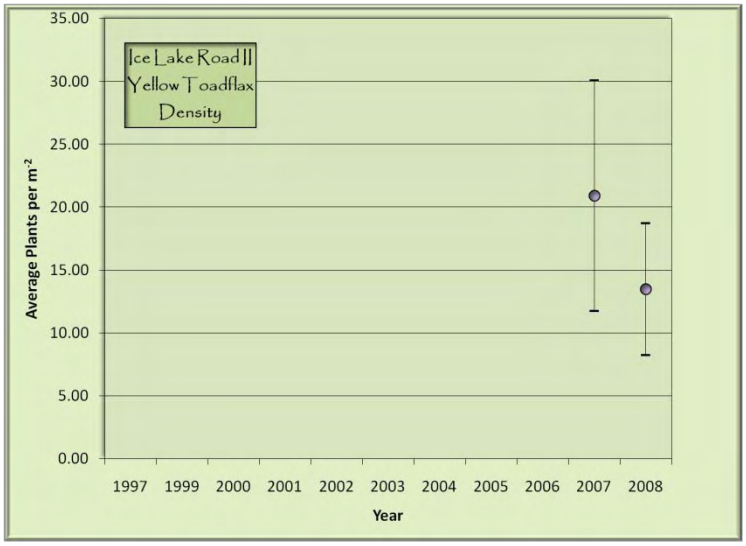


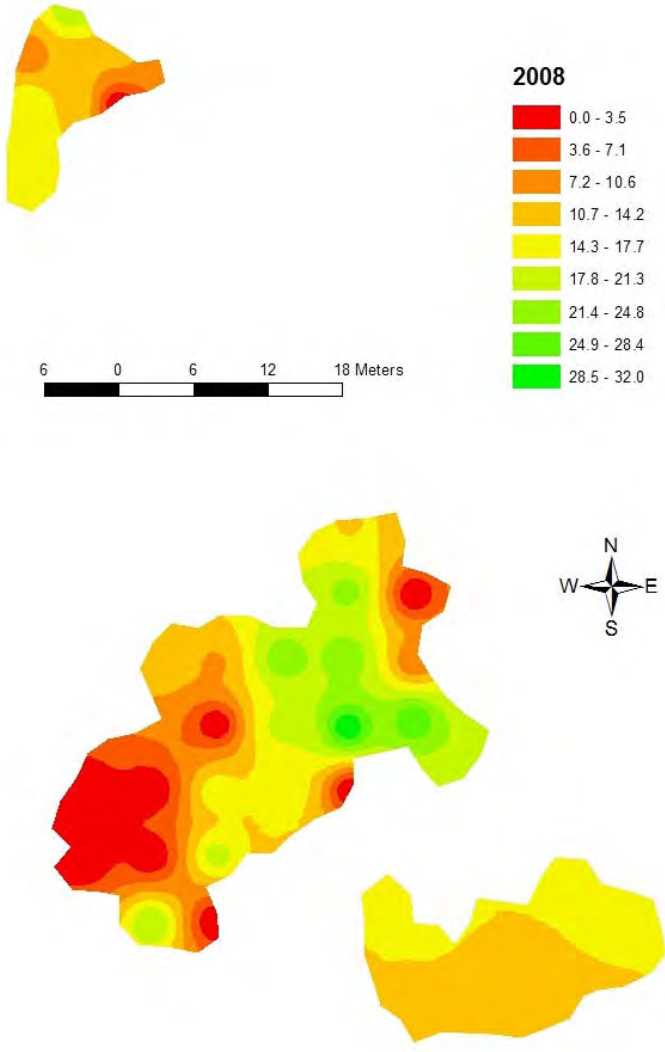


Ice Lake Road II yellow toadflax perimeter in 2008.

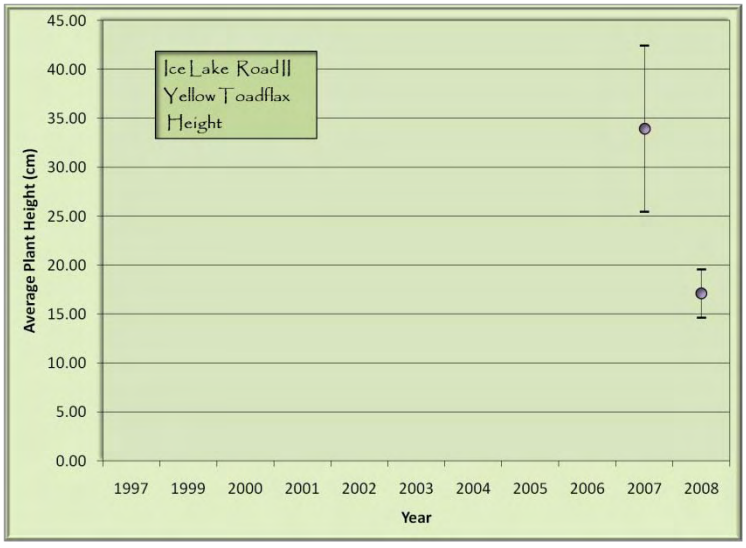


Ice Lake Road II yellow toadflax density in 2008.





Ice Lake Road II yellow toadflax height in 2008.

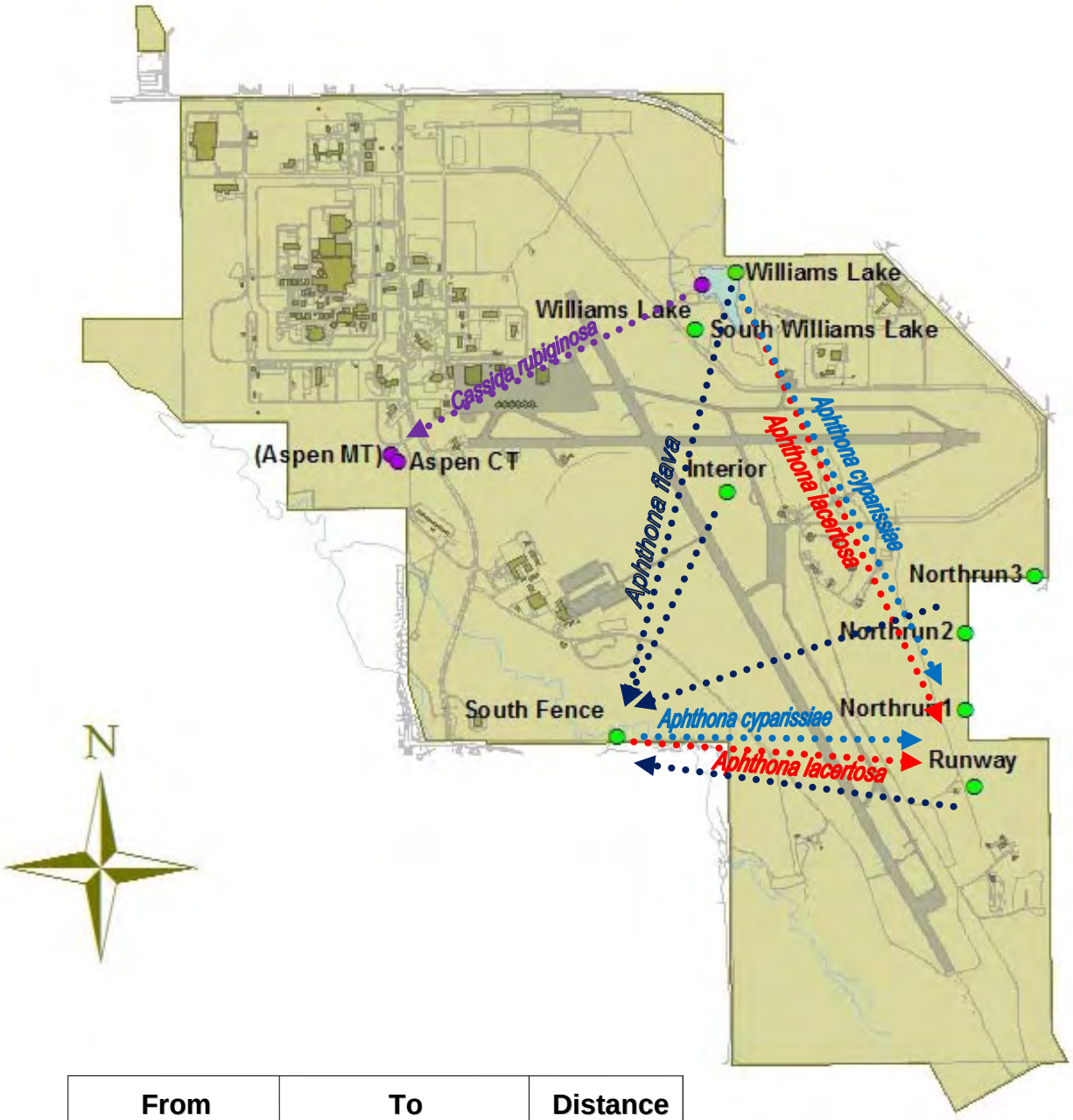


Buckley Air Force Base

A total of eight sites were fully mapped this year, covering 3.24 hectares (8.01 acres). Two Canada thistle sites comprised the largest area (2.57 ha; 6.35 acres), a single Dalmatian toadflax site covered 0.47 ha (1.16 acres) and five leafy spurge sites comprised 0.20 ha (0.49 acres). Sixteen field bindweed sites were randomly sampled for the mite *Aceria malherbae*. An additional three leafy spurge sites (North Runway I, II, and III, also called North Fence) were randomly sampled for the *Aphthona* sp. beetles released in 2005. Mapping was not conducted at the South Fence Dalmatian toadflax site as access to the site was once again restricted this year. Only a few scattered plants remained at the musk thistle Aspen site so it was not mapped this year (Figure 7). The leafy spurge Interior site, however, had rebounded somewhat from last year and was fully mapped this summer (Figure 7).

Figure 7. Only a few scattered plants remain in the Aspen musk thistle site in 2008 (top left); a dramatic decrease from just last year (top right). In contrast the leafy spurge Interior site (bottom left) doubled in size from 2006 after being considered eliminated in 2007 (bottom right).

The loss of the Aspen musk thistle site is perhaps responsible for the bulk of the decrease in total area covered by thistles from 12.0 ha in 2007 to a scant 2.57 ha in 2008. However, the remaining two thistle sites (Aspen and Williams Lake Canada thistle) also showed a decrease in area both from last year and since site monitoring began. This year seemed to be a good one for



From	To	Distance
Williams Lake	Aspen	1.9 km
Williams Lake	South Fence	2.4 km
Williams Lake	North Run 1	2.5 km
Williams Lake	Runway	2.8 km
South Fence	Runway	1.8 km

Figure 8. Schematic map of Buckley Air Force Base and table showing dispersal distances traveled by biological control agents, *Cassida rubiginosa*, *Aphthona cyparissiae*, *A. flava* and *A. lacertosa* during self-dispersal.

thistle agents, several were recovered from the Aspen musk thistle site, and three bio-agents were recovered at the Williams Lake site where no agents had been recovered previously (Table 12). *Cassida rubiginosa* was recovered from the musk thistle Aspen site and may have self-dispersed from the Williams Lake Canada thistle site 1.9 km away (Figure 8). *Rhinocyllus conicus* had not previously been released on Buckley Air Force Base and appears to have self-dispersed from an unknown location to both the Aspen musk thistle and Williams Lake Canada thistle sites.

Though no plants were tested for the mite *Aceria anthocoptes*, several plants at the Williams Lake Canada thistle site exhibited the characteristic chlorosis, hypertrophy and overall unhealthy look associated with the mite (Figure 9). Plans are underway to collect samples next year to determine if this condition is indeed due to mite damage and not simply dry conditions.

The Canada thistle Aspen site, at least a portion of it, is slated for construction this fall. While the construction will probably reduce the size of the site, the disturbance is likely to provide ideal habitat for the establishment of new invasive species. Two additional thistle sites were marked this year, and monitoring of these sites along with insects releases are planned for next summer.

Figure 9. Canada thistle plants exhibiting possible symptoms of *A. anthocoptes* mite infestations (left and bottom right). The Williams Lake thistle site also showed a thriving population of *C. rubiginosa* not previously recorded at this site (left, top right).

Buckley Air Force Base has had dense monocultures of field bindweed for several years despite efforts to establish the gall forming mite *A. malherbae*. This year several releases of infected runners collected from a site in Amarillo, Texas were made at FW1, FW2, Steamboat, NE Gate, POV Resale, Playground, and South Fence sites. Sixteen field bindweed sites were randomly sampled for mites, with eleven out of the sixteen containing infected runners (Table 8).

Efforts to establish nursery sites both in Texas and Colorado should allow us to continue to make releases in future seasons until populations are established on the base.

Overall, the total area of the leafy spurge sites were reduced by 22% (from 0.9 ha to 0.2 ha). No "halos" of spurge free areas were observed this summer, though sites that had releases in 2007 (Runway North) are not be expected to exhibit halos until 2011-2013. The self dispersal of bio-agents continued this year from sites of releases in 2005, with various agents dispersing 2-3 km away to the Runway North, Runway, and South Fence sites (Figure 8).

Figure 10. Student workers Sundhya Solanki and Nathanial (JJ) Engel use sweep-nets to sample for *Aphthona sp.* beetles at the Runway site. Two species of beetles self-dispersed to and one dispersed from this site to another site this year (Figure 7).

This year was not a good one for Dalmatian toadflax as the remaining accessible site saw a significant decline in plant height, though plant density seemed unaffected and area decreased by a mere 6% (Table 11). It was also a bad year for the stem-feeding weevil *Mecinus janthinus*. Only a handful of insects were observed from early June to early July, and only during sentinel site sweeps. Dissection of this year's stems to determine the size of weevil populations are planned for next spring.

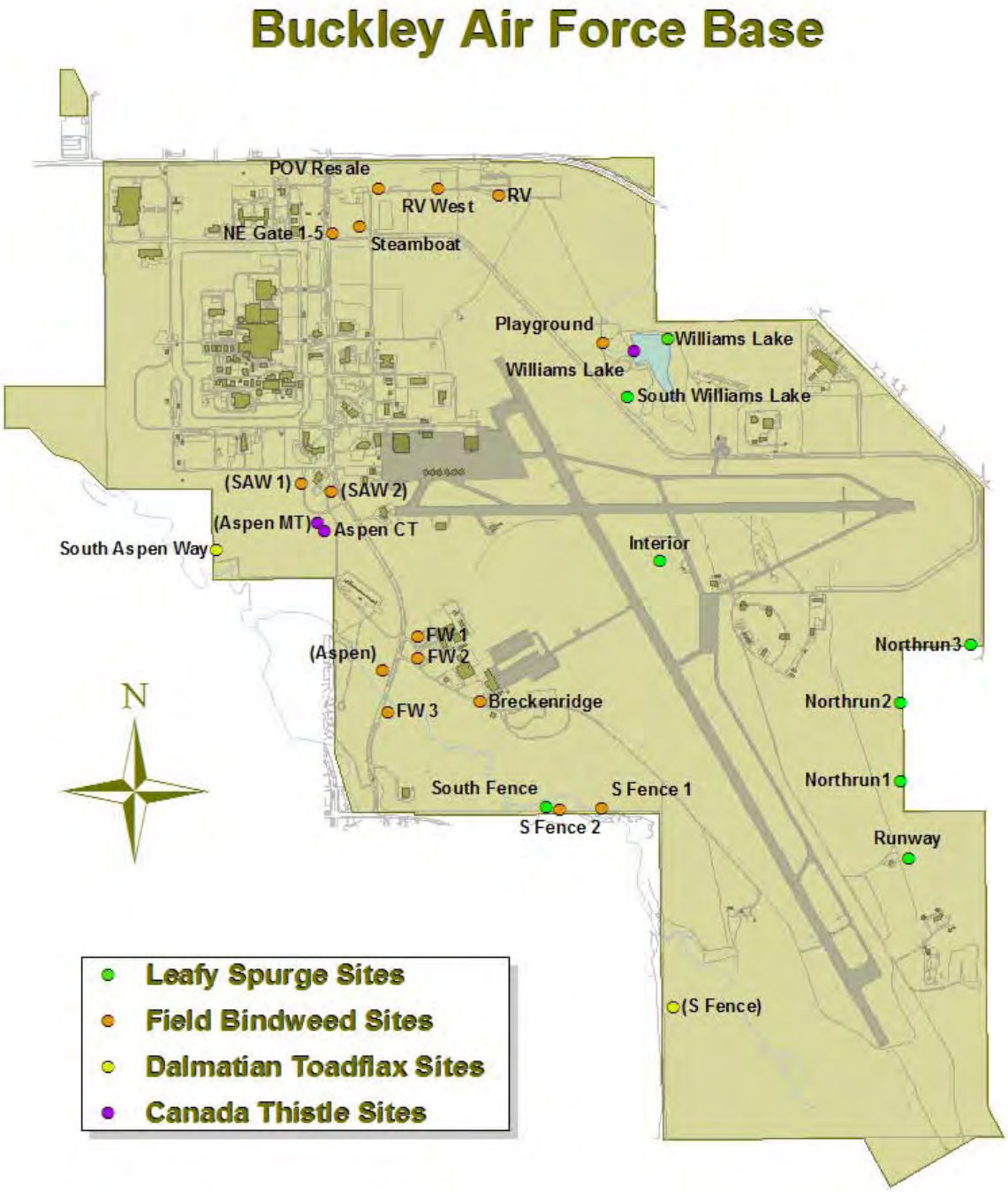


Figure 11. Schematic diagram of Buckley Air Force Base with weed biological control study areas superimposed. Sites listed in parentheses were not surveyed in 2008.

Table 11. Historic Noxious weed infestation parameters, Buckley Air Force Base, Colorado, 2003-2008.

Year	Area (m^2)	n	Density ($1/2m^2$) Avg.	Density ($1/2m^2$) Max	Height (cm) Avg.	Height (cm) Max	Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change Area (m^2)	Year to year % change Avg. density	Year to year % change Avg. height	% Change to date Area	% Change to date Avg. Density
Canada thistle – Aspen													
2006	30,861	48	11.17	74	55.56	92	19.21	0.69					
2007	36,229	44	6.52	22	84.05	127	14.03	7.76	17.39	-41.63	51.28		
2008	25,151	30	4.87	16	54.90	108	10.34	4.86	-30.58	-25.31	-34.68	-18.50	-56.40
Canada thistle – Williams Lake													
2003	1,070	129	6.45	26	65.92	145	17.83	0.71					
2004	1,419	66	9.52	47	51.92	98	1.40	1.80	32.63	47.60	-21.24		
2005	2,004	40	5.26	18	74.31	105	18.97	0.88	41.23	-44.75	43.12		
2006	1,117	33	6.48	32	35.61	76	4.11	0.33	-44.26	23.19	-52.08		
2007	1,074	56	2.71	14	76.68	111	9.44	6.06	-3.85	-58.18	115.33		
2008	510	36	4.19	15	70.82	104	5.07	4.64	-52.51	54.61	-7.64	-52.34	-35.04
Musk thistle - Aspen													
2007	83,162	47	2.17	20	124.28	197			n/a	n/a	n/a		
2008	*(see Note b)*												
Leafy spurge - Interior													
2005	102	28	8.07	99	39.59	57							
2006	111	10	1.00	4	22.00	34			8.82	-87.61	-44.43		
2007	*(see Note a)*												
2008	218	11	1.45	10	25.00	30			96.40**	45.00**	13.64**	113.73	-82.03
Leafy spurge - Runway													
2004	597	44	22.61	42	35.09	54							
2005	751	34	29.50	95	43.92	66			25.80	30.47	25.16		
2006	656	28	10.57	39	8.42	25			-12.65	-64.17	-80.83		
2007	1,037	45	28.24	169	45.94	71			58.08	167.17	445.61		
2008	329	31	21.23	37	37.67	54			-68.27	-24.82	-18.00	-44.89	-6.10
Leafy spurge – South Fence													
2006	705	28	13.07	48	42.46	76							
2007	794	30	23.80	55	67.83	103			12.62	82.10	59.75		
2008	708	10	15.50	30	70.60	108			-10.83	18.59	66.27	0.43	18.59

Table 11. Historic Noxious weed infestation parameters, Buckley Air Force Base, Colorado, 2003-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Leafy spurge – Southwest Williams Lake													
2004	530	24	8.92	26	25.13	52							
2005	646	40	16.62	77	29.64	54			21.89	86.32	17.95		
2006	1,039	34	7.91	32	12.02	23			60.84	-52.41	-59.45		
2007	1,066	31	24.03	167	25.77	63			2.60	203.79	114.39		
2008	120	10	6.60	28	12.00	20			-88.74	-72.53	-53.43	-77.36	-26.01
Leafy spurge – Williams Lake													
2003	4,615	112	36.53	123	51.06	98							
2004	3,617	77	15.01	52	39.61	73			-21.63	-58.91	-22.42		
2005	2,890	33	27.52	97	39.69	63			-20.10	83.34	0.20		
2006	3,572	45	19.62	97	30.80	89			23.60	-28.71	-22.40		
2007	6,386	56	28.82	182	48.92	77			78.78	46.89	58.83		
2008	627	19	4.68	26	43.08	68			-86.41	-83.76	-11.94	-86.41	-87.19
Dalmatian toadflax – South Aspen Way													
2003	3,185												
2004	300	20	0.95	7	11.40	38			-99.08				
2005	275	28	12.00	61	39.47	59	10.61		-8.33	1163.16	246.23		
2006	1,328	29	2.76	18	14.43	28			382.91	-77.00	-63.44		
2007	5,044	47	4.19	35	64.97	98			279.82	51.81	350.24		
2008	4,735	40	3.89	14	37.68	60			-6.13	-7.16	-42.00	48.67	309.47
Dalmatian toadflax – South Fence													
2003	32,556	374	3.50	78	36.10	128							
2004	20,657	101	3.31	18	29.28	82			-36.55	-5.43	-18.89		
2005	20,443	68	18.70	56	56.76	78	20.71		-1.04	464.95	93.85		
2006	35,786	35	3.03	15	33.03	57	10.55		75.05	-83.80	-41.81		
2007	*(see Note b)*												
2008	*(see Note c)*												

Table 11. Historic Noxious weed infestation parameters, Buckley Air Force Base, Colorado, 2003-2008.

n – number of samples or observations n/a – not applicable, data represent first year of sampling
* - a complete perimeter could not be mapped at this site, area recorded reflects the weed patch available at the time of sampling
** - values given in the year-to-year change column reflect 2- or 3-year changes, as sampling was not done at all sites all years
*** - Parade Loop spotted knapweed sites 1, 2 and 3 became part of a large, continuous weed infestation in 2007 and, as such, were mapped and monitored as the larger mega-site, Total Parade Loop
Note - Could not map this site, as: a) few scattered plants remained to survey, or b) weeds were chemically treated prior to our survey c)access to the site restricted.

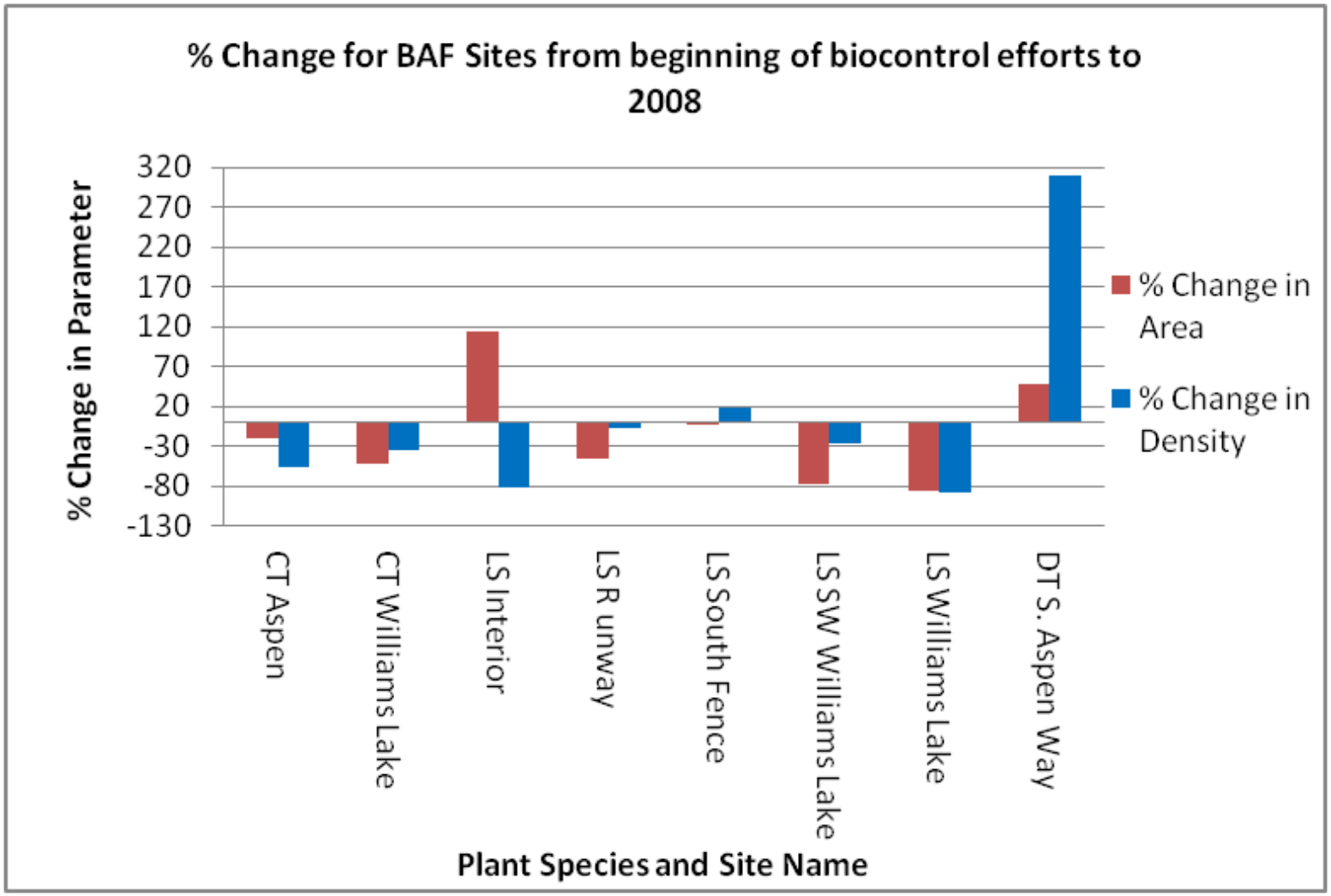


Figure 12. Percent change in area and density of all sites monitored this year at Buckley Air Force Base. The percent change is calculated by dividing the difference in the parameters between the first year they were monitored and this year's data by the area or density from this year. The number of years represented vary and depend on when the sites were established.

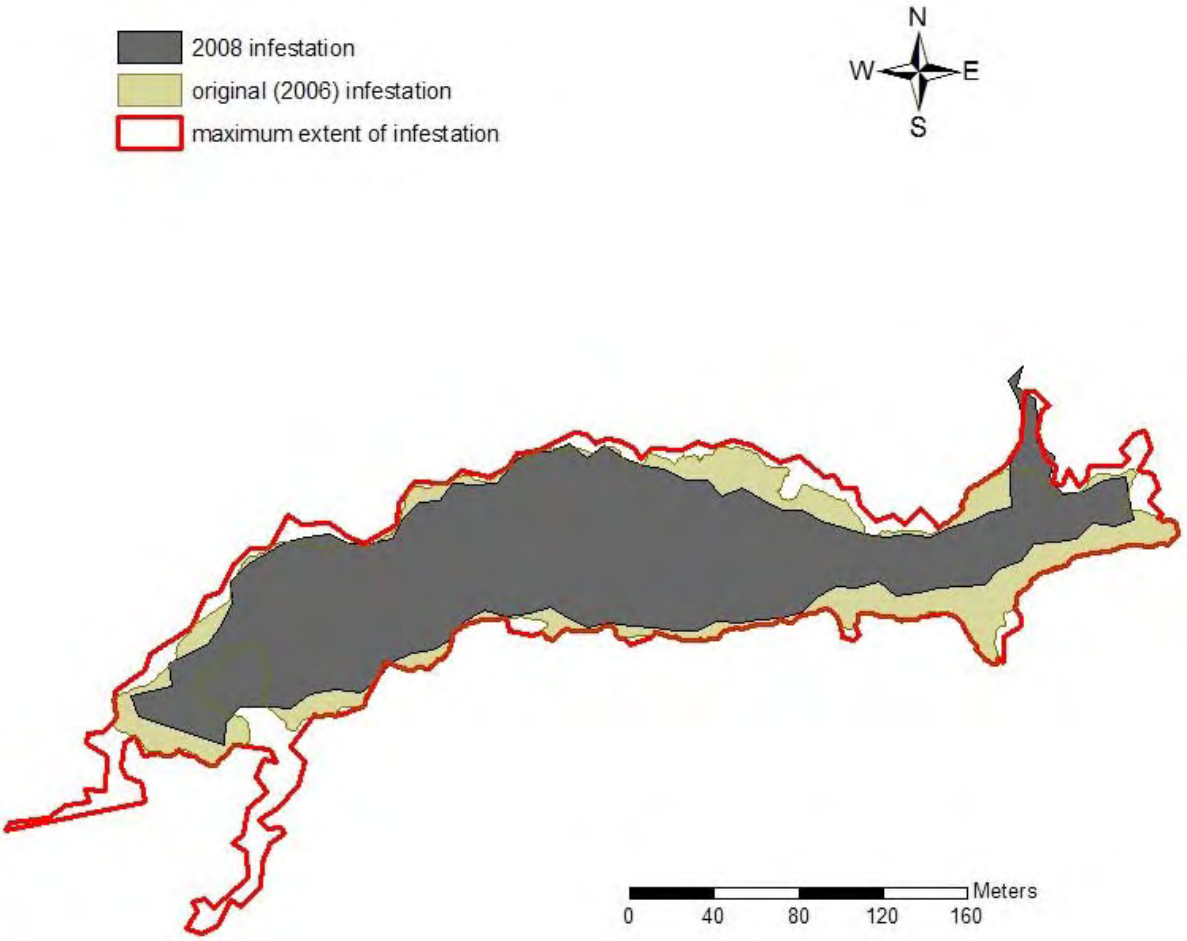
Table 12. Noxious weed biological control sites, target weeds, species released and recoveries at Buckley Air Force Base, Colorado, 2008.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
BAF	Canada thistle	Aspen	*Aceria anthocoptes*			
BAF	Canada thistle	Aspen	*Trichosirocalus horridus*			
BAF	Canada thistle	Williams Lake	*Cassida rubiginosa*	X[2]		
BAF	Canada thistle	Williams Lake	*Rhinocyllus conicus*	X[1,2]		
BAF	Canada thistle	Williams Lake	*Trichosirocalus horridus*			
BAF	Canada thistle	Williams Lake	*Urophora cardui*	X[2]		
BAF	Musk thistle	Aspen[3]	*Cassida rubiginosa*	X[1,2]		
BAF	Musk thistle	Aspen[3]	*Rhinocyllus conicus*	X[1,2]		
BAF	Musk thistle	Aspen[3]	*Trichosirocalus horridus*	X		
BAF	Field bindweed	Multiple Sites	*Aceria malherbae*	X	X	
BAF	Leafy spurge	Interior	*Aphthona flava*			
BAF	Leafy spurge	Interior	*Aphthona nigriscutis*			
BAF	Leafy spurge	Runway North	*Aphthona cyparissiae*	X[1,2]		
BAF	Leafy spurge	Runway North	*Aphthona czwalinae*			
BAF	Leafy spurge	Runway North	*Aphthona flava*	X		
BAF	Leafy spurge	Runway North	*Aphthona nigriscutis*			
BAF	Leafy spurge	Runway	*Aphthona cyparissiae*	X[1,2]		
BAF	Leafy spurge	Runway	*Aphthona flava*	X		
BAF	Leafy spurge	Runway	*Aphthona lacertosa*	X[1,2]		
BAF	Leafy spurge	Runway	*Aphthona nigriscutis*	X		
BAF	Leafy spurge	South Fence	*Aphthona cyparissiae*	X		
BAF	Leafy spurge	South Fence	*Aphthona czwalinae*			
BAF	Leafy spurge	South Fence	*Aphthona flava*	X[1,2]		
BAF	Leafy spurge	South Fence	*Aphthona lacertosa*			
BAF	Leafy spurge	South Fence	*Aphthona nigriscutis*			
BAF	Leafy spurge	Williams Lake	*Aphthona cyparissiae*	X		
BAF	Leafy spurge	Williams Lake	*Aphthona czwalinae*			
BAF	Leafy spurge	Williams Lake	*Aphthona flava*	X		

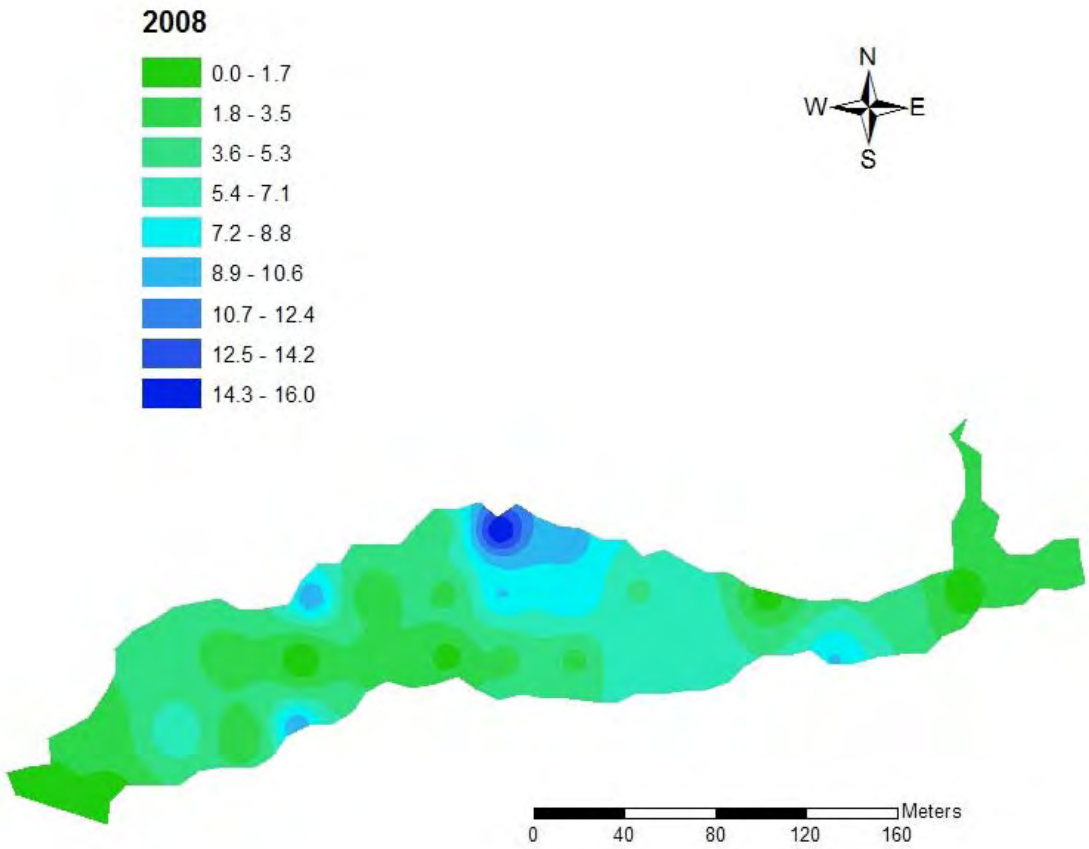
Table 12. Noxious weed biological control sites, target weeds, species released and recoveries at Buckley Air Force Base, Colorado, 2008.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
BAF	Leafy spurge	Williams Lake	*Aphthona lacertosa*			
BAF	Leafy spurge	Williams Lake	*Aphthona nigriscutis*			
BAF	Leafy spurge	Williams Lake	*Spurgia esula*			
BAF	Leafy spurge	Southwest Williams Lake	*Aphthona cyparissiae*			
BAF	Leafy spurge	Southwest Williams Lake	*Aphthona czwalinae*			
BAF	Leafy spurge	Southwest Williams Lake	*Aphthona flava*			
BAF	Leafy spurge	Southwest Williams Lake	*Aphthona lacertosa*			
BAF	Leafy spurge	Southwest Williams Lake	*Aphthona nigriscutis*			
BAF	Dalmatian toadflax	South Aspen Way	*Mecinus janthinus*	X		
BAF	Dalmatian toadflax	South Fence[3]	*Mecinus janthinus*			

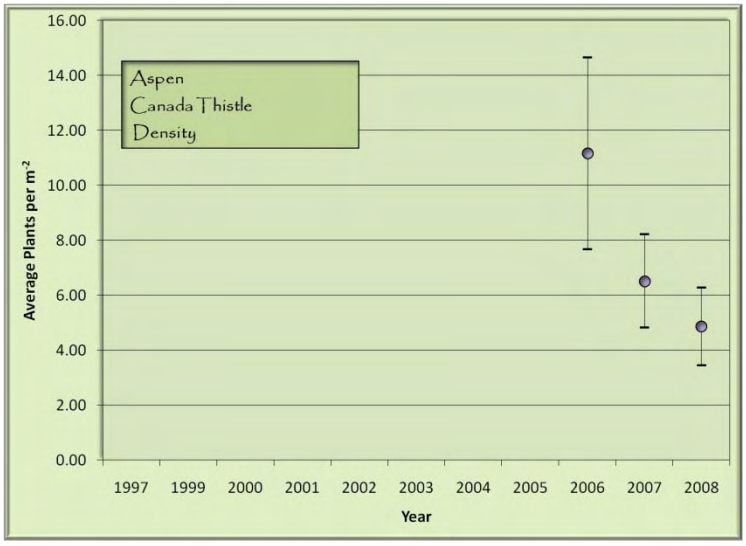
[1] Adventitious recovery, none released at this site
[2] New insect recovery in 2008
[3]Site not mapped this year

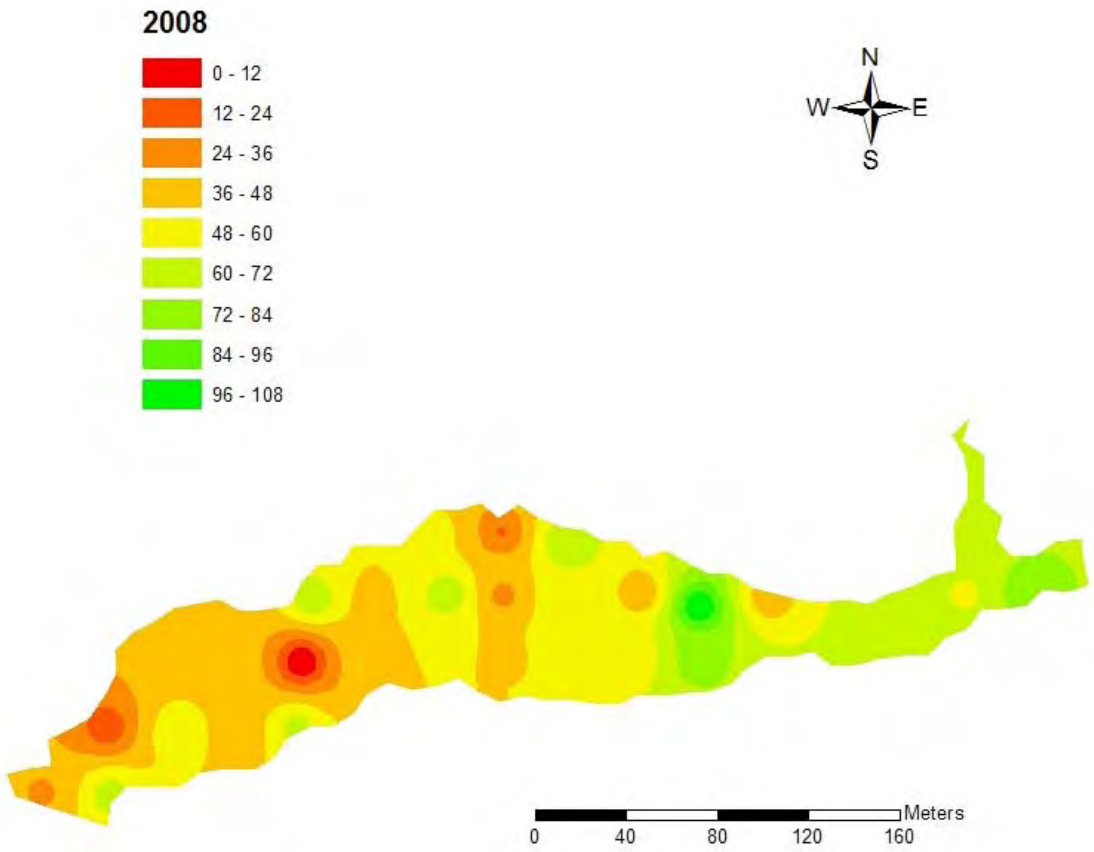


Aspen Canada thistle perimeter in 2008.

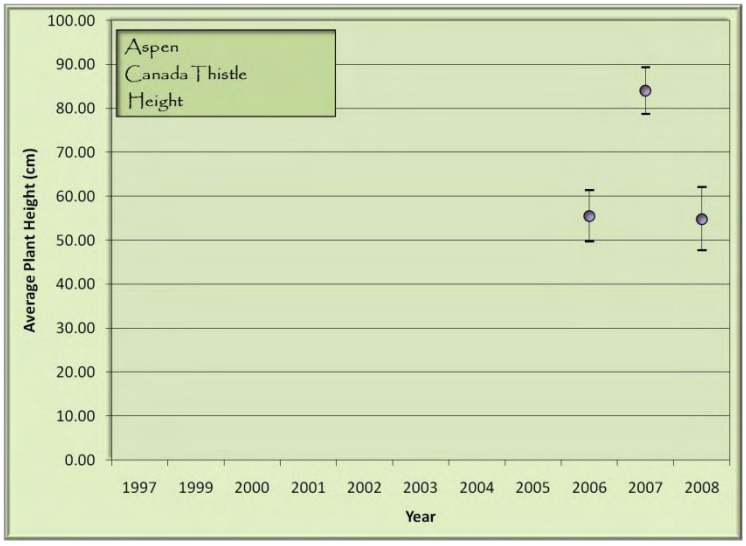


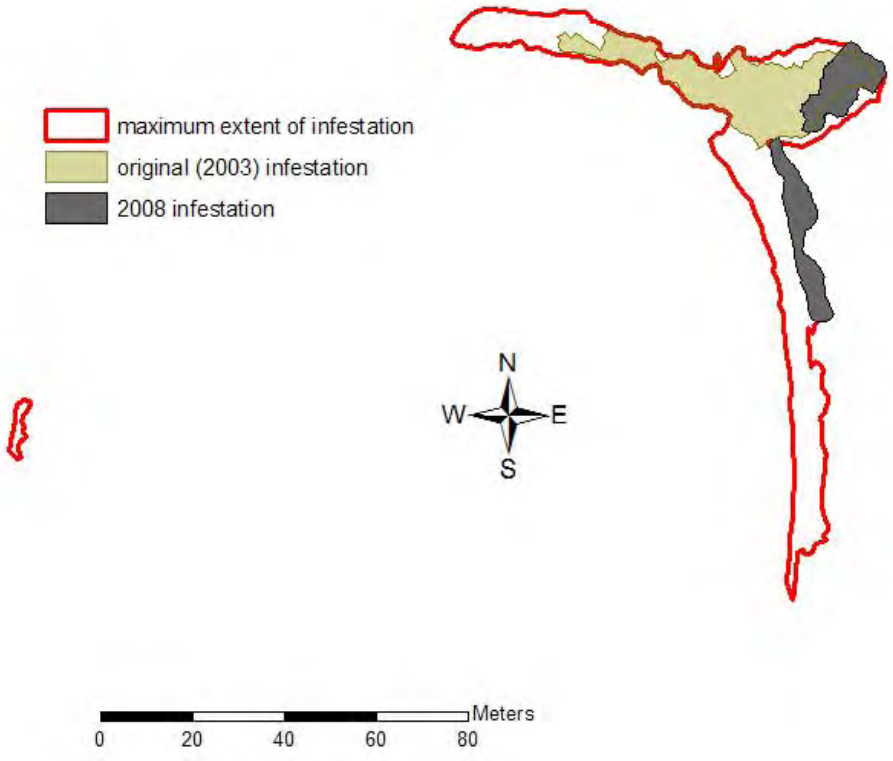
Aspen Canada thistle density in 2008.



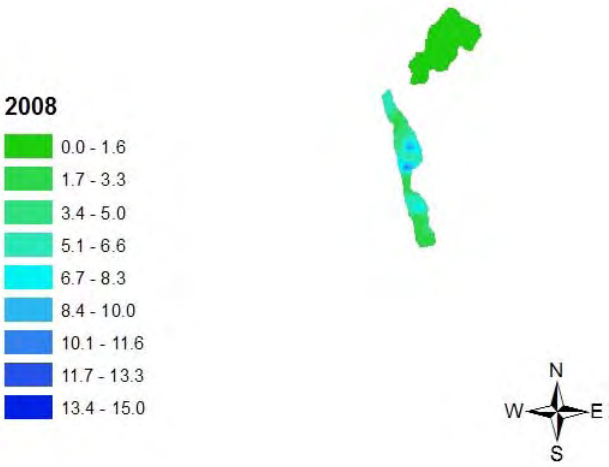


Aspen Canada thistle height in 2008.

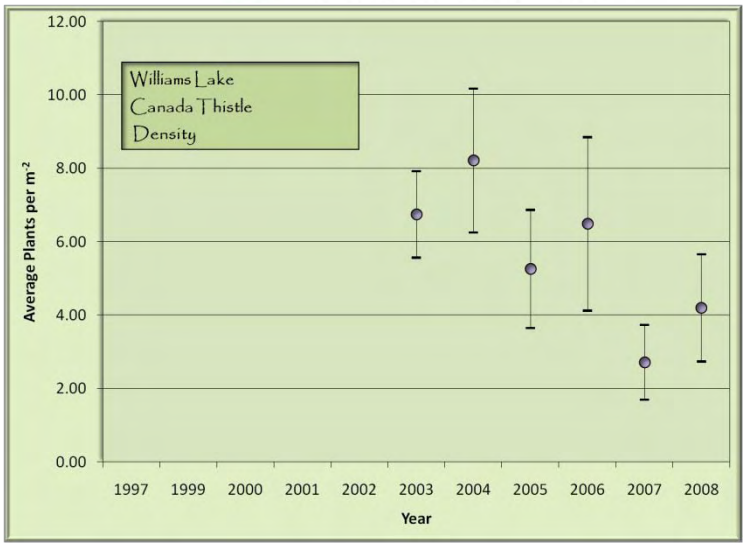


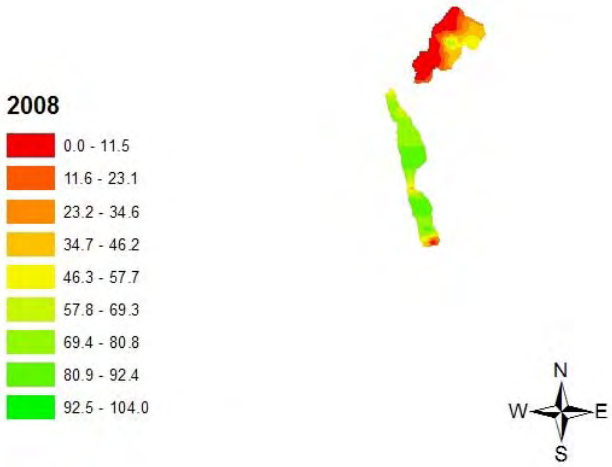


Williams Lake Canada thistle perimeter in 2008.

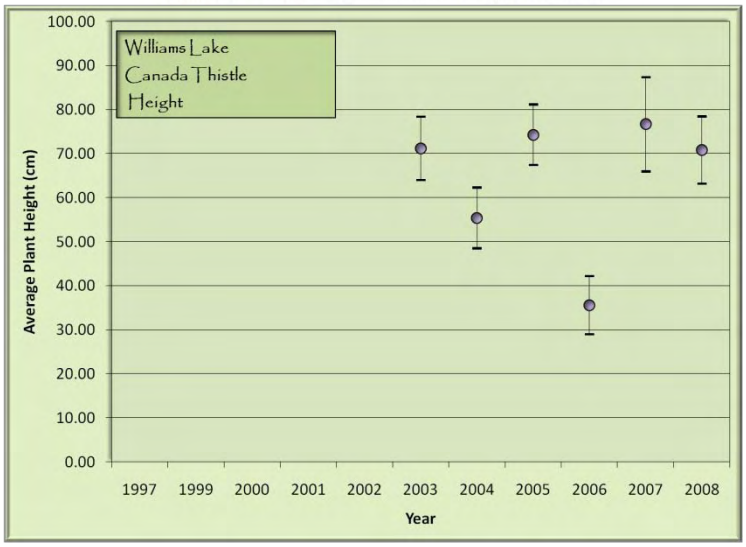


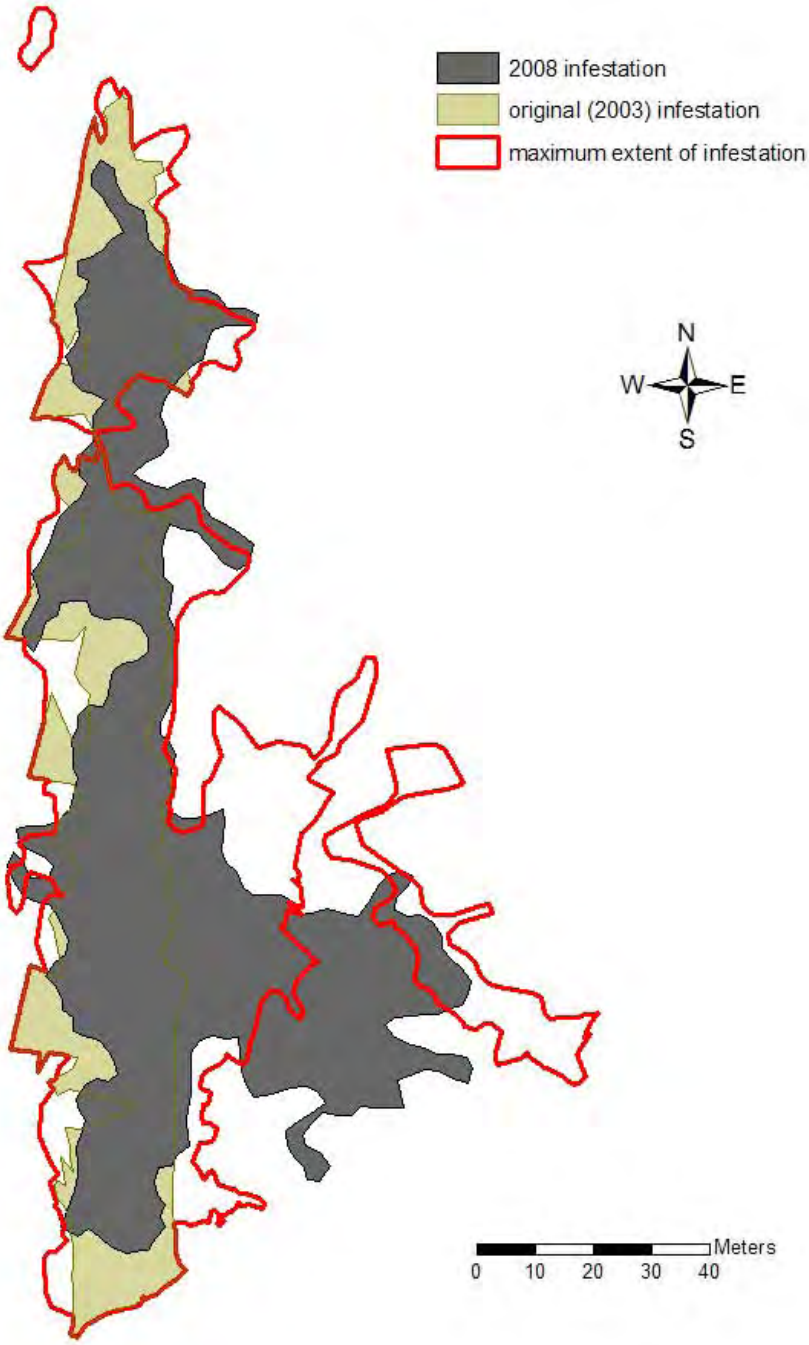
Williams Lake Canada thistle density in 2008.



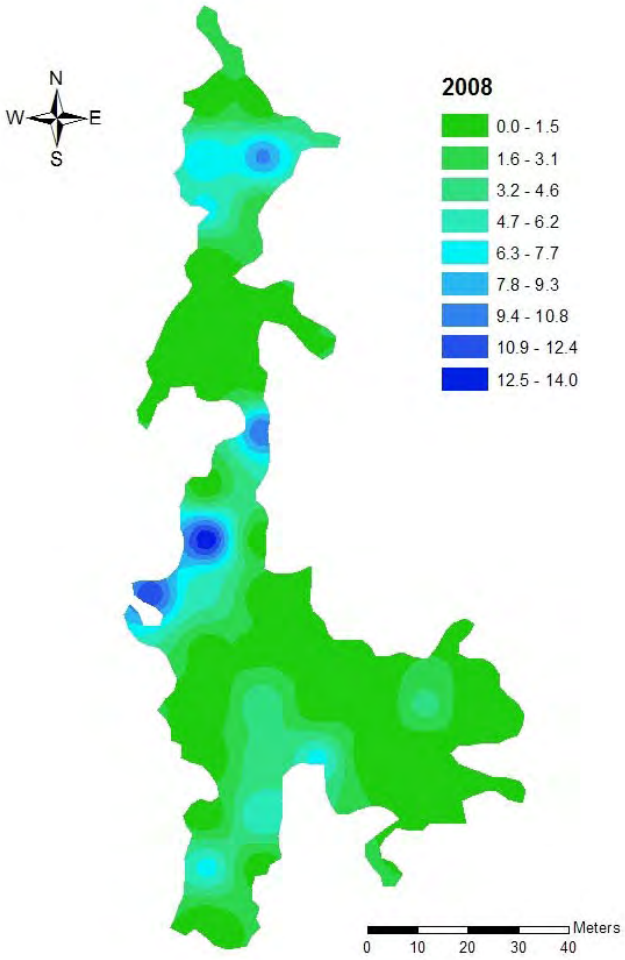


Williams Lake Canada thistle height in 2008.

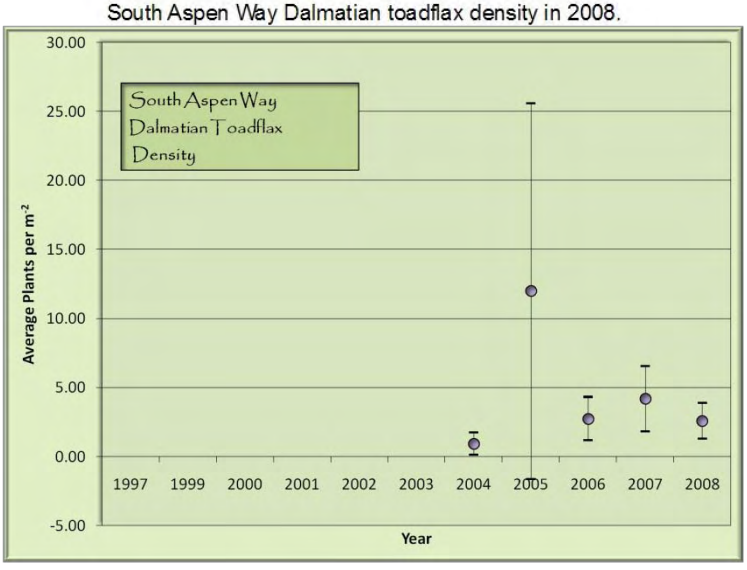


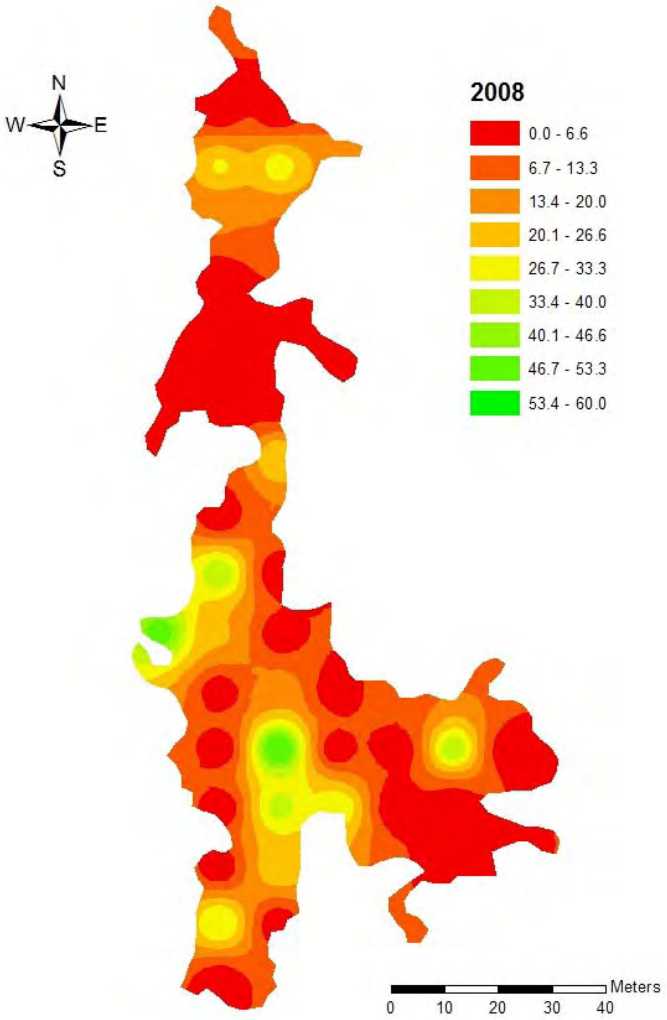


South Aspen Way Dalmatian toadflax perimeter in 2008.

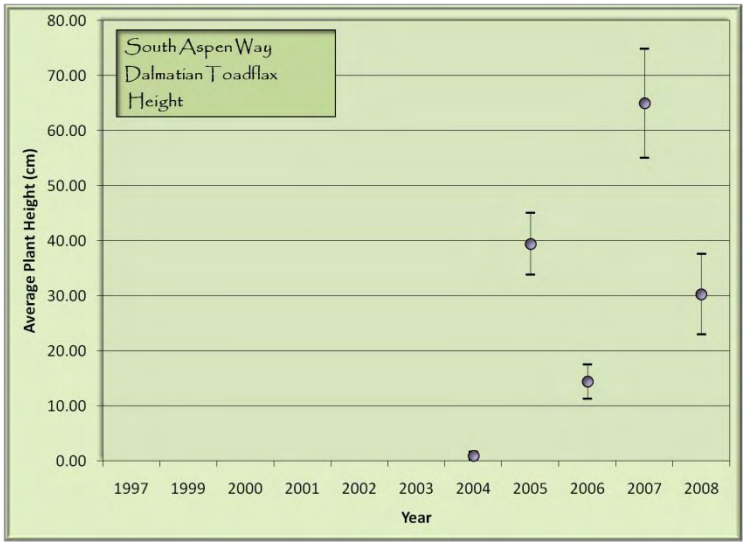


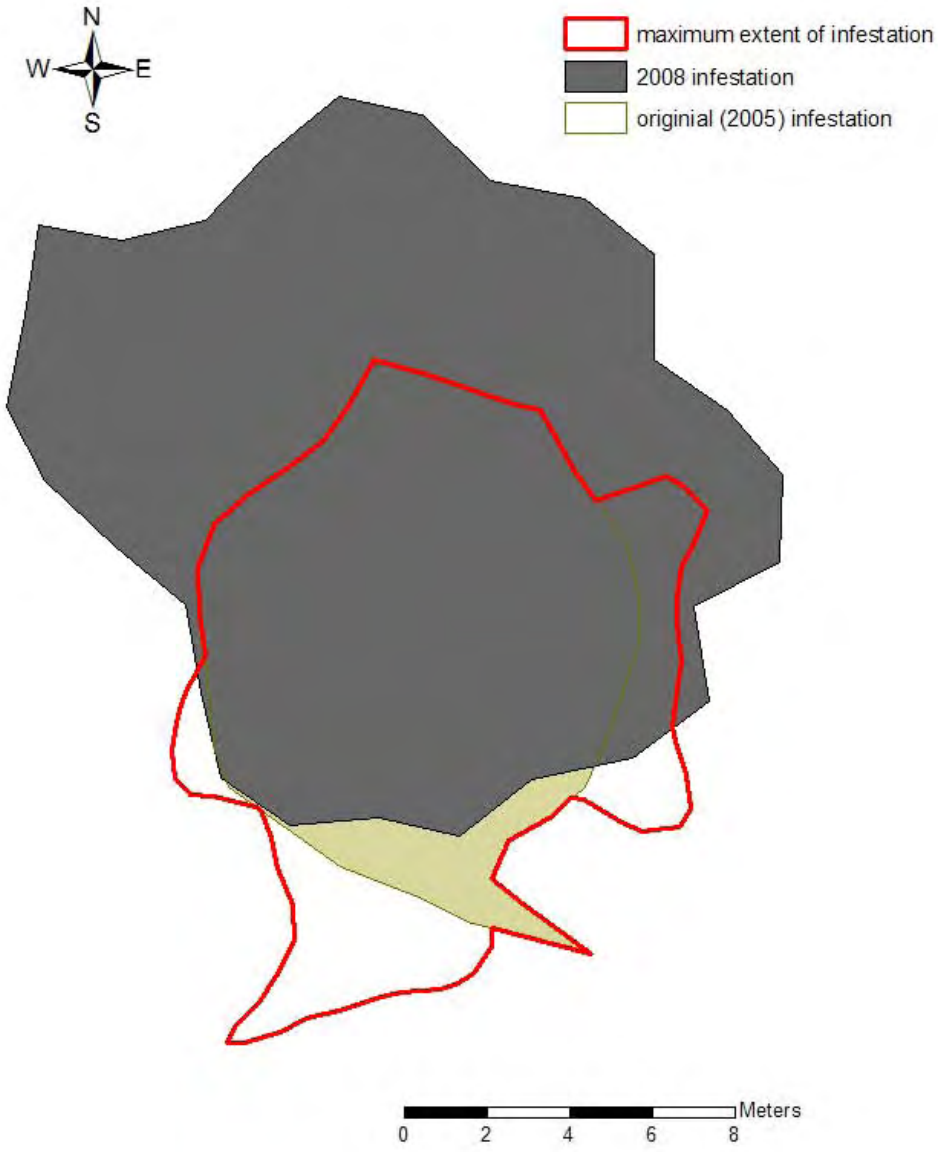
South Aspen Way Dalmatian toadflax density in 2008.



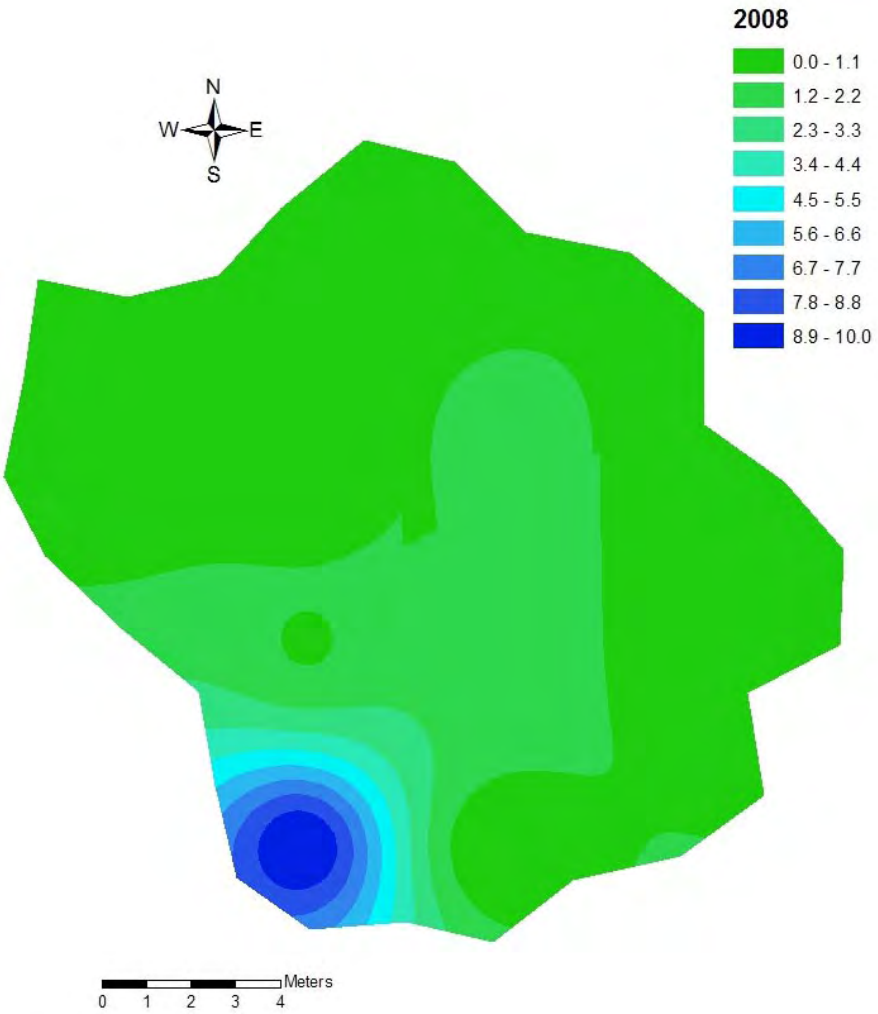


South Aspen Way Dalmatian toadflax height in 2008.

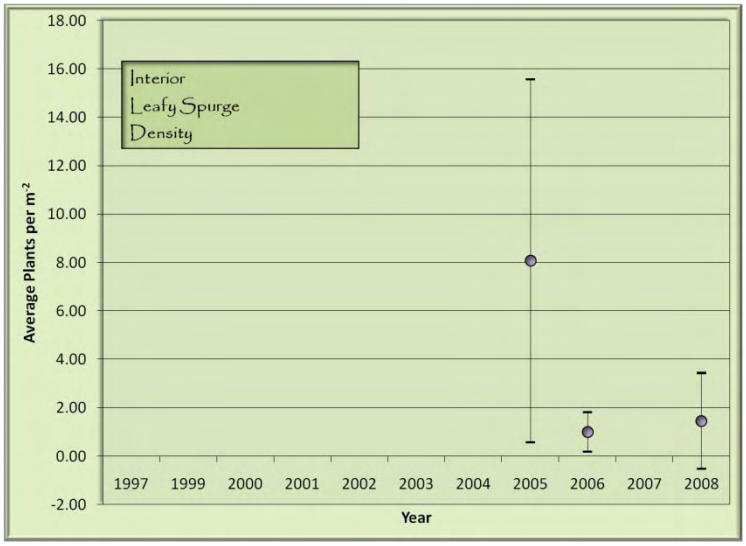


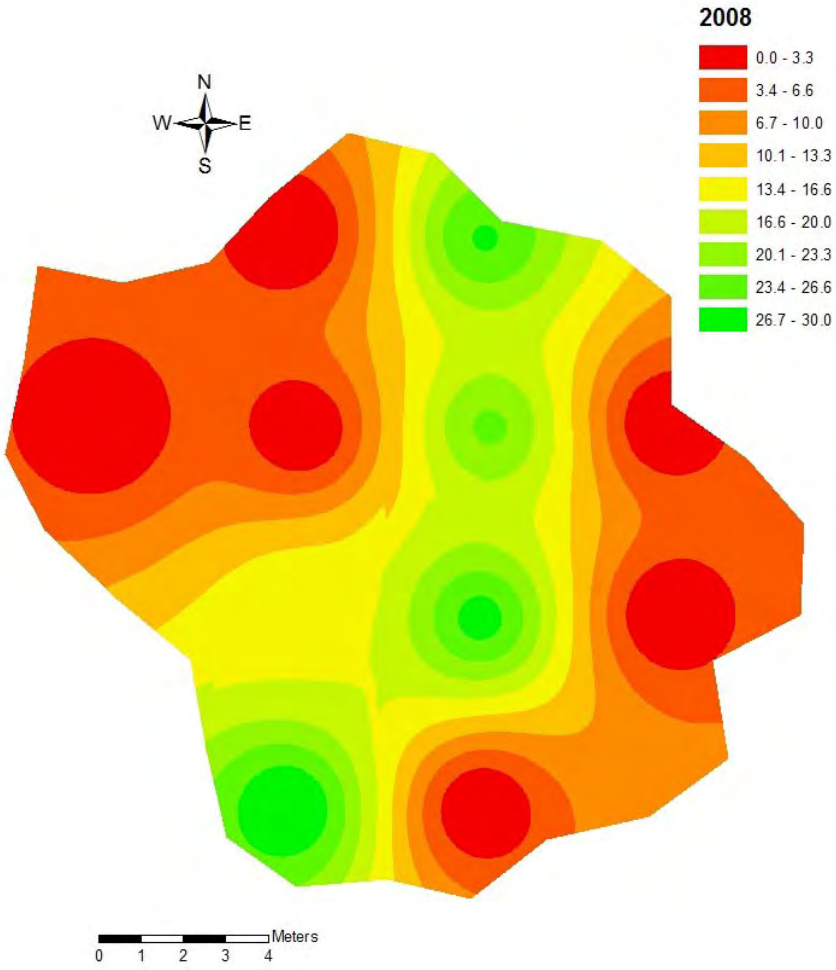


Interior leafy spurge perimeter in 2008.

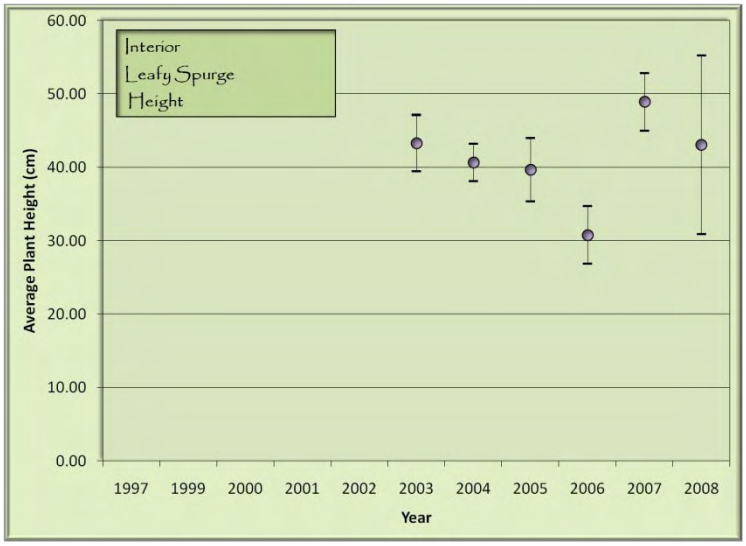


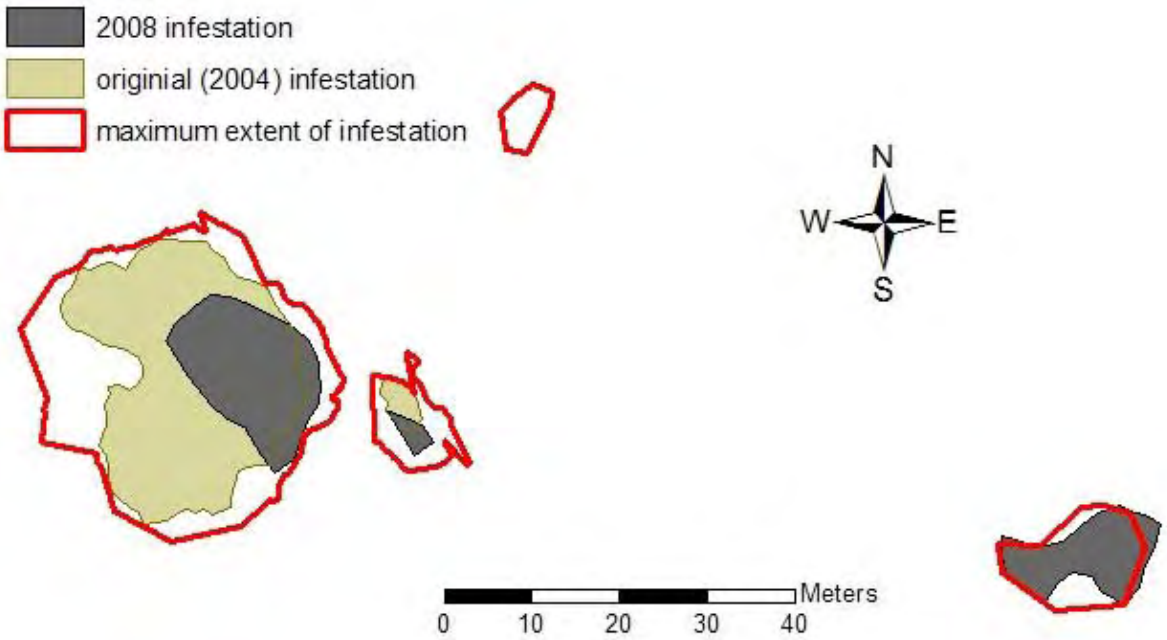
Interior leafy spurge density 2008.



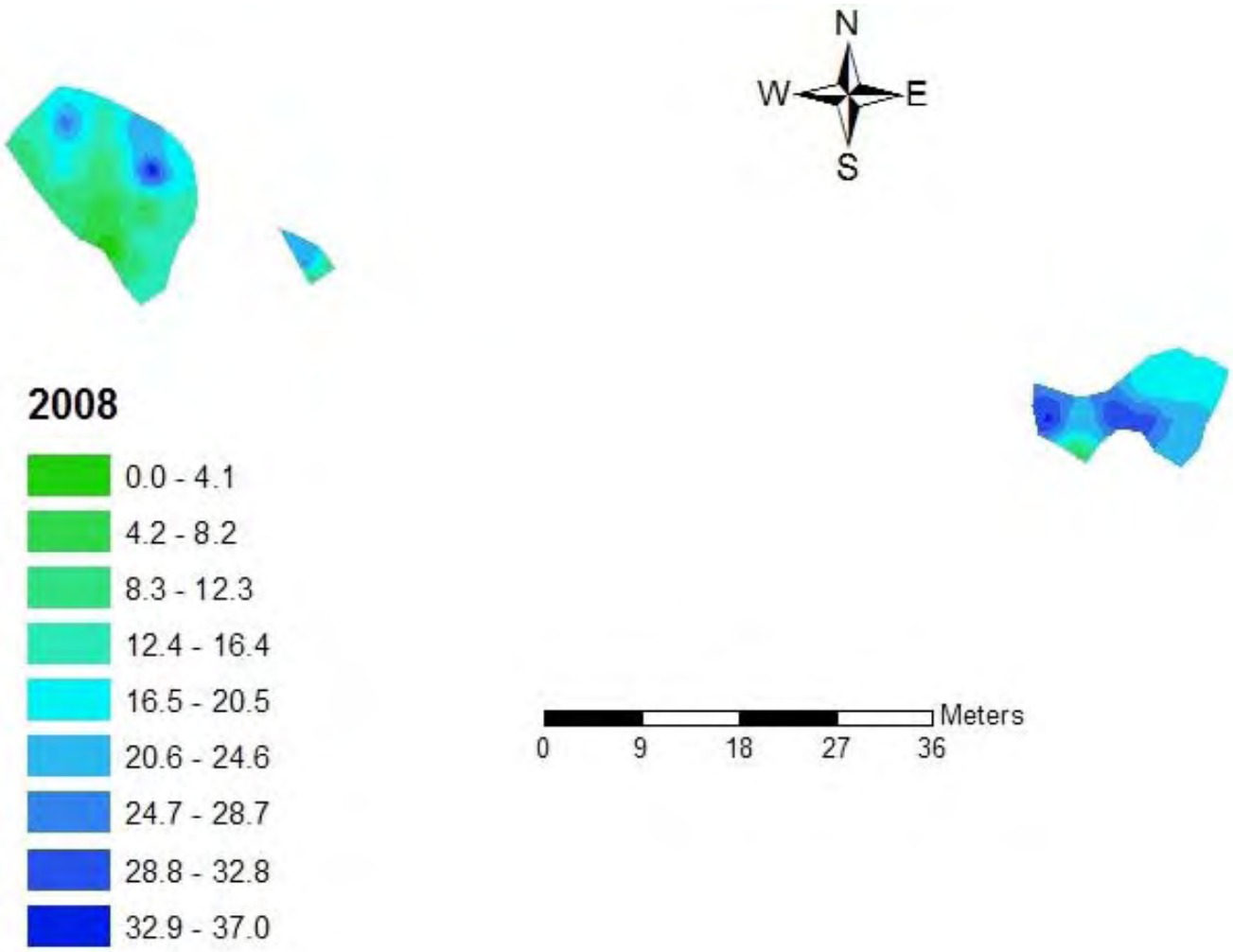


Interior leafy spurge height 2008.

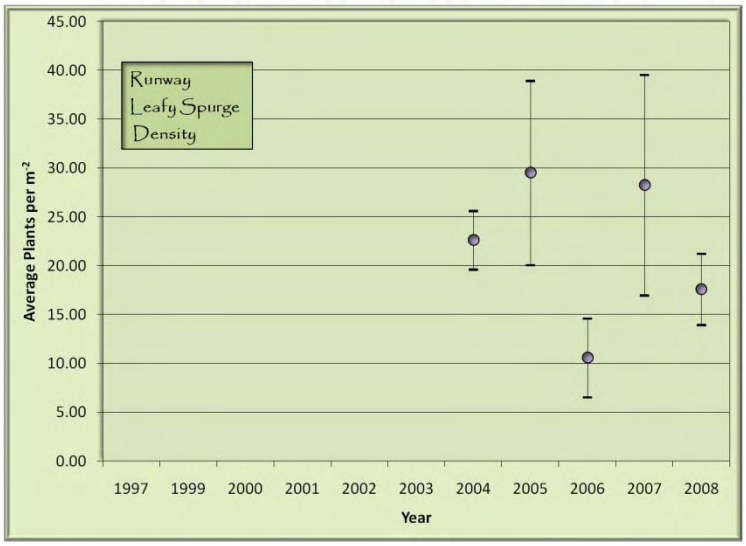


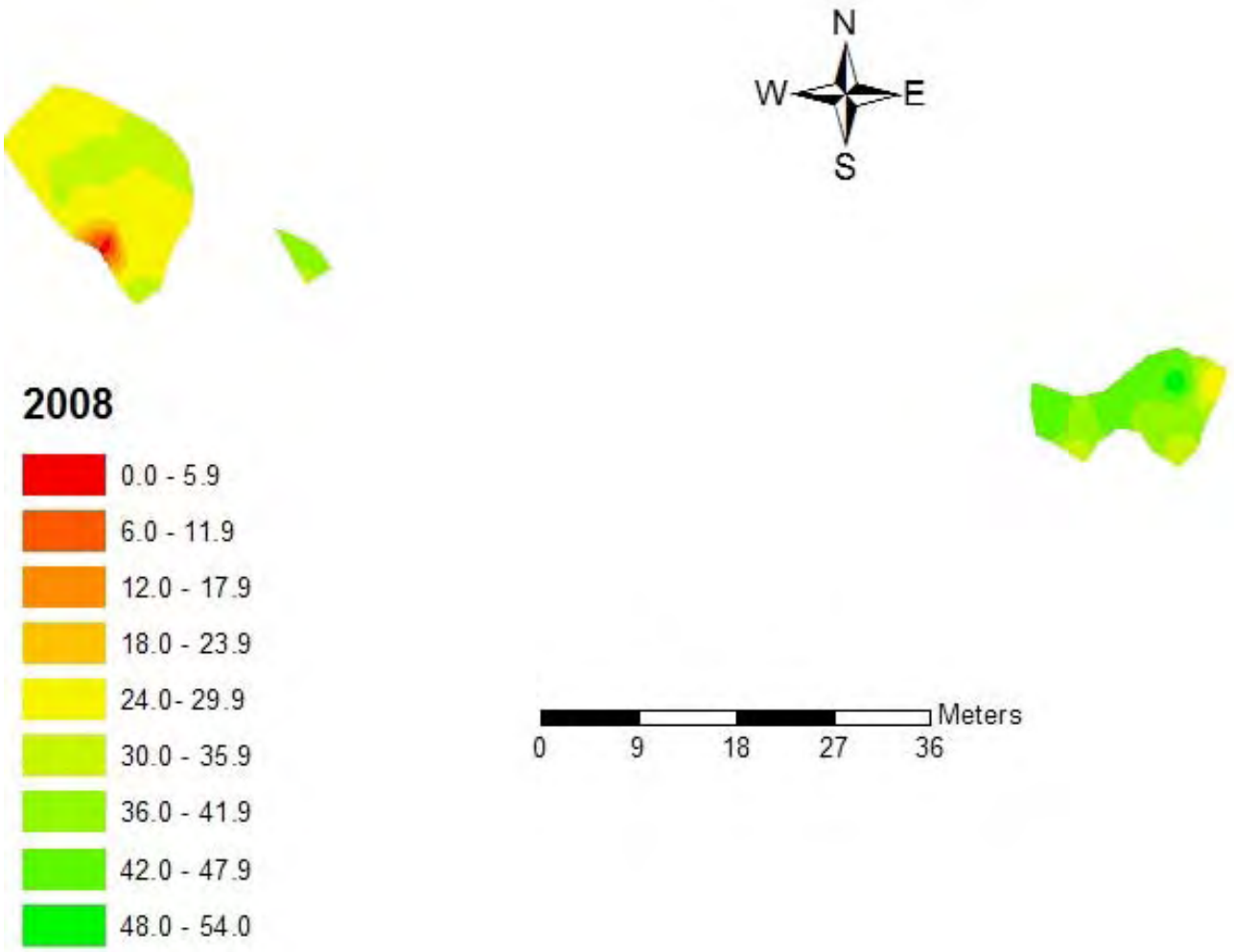


Runway leafy spurge perimeter in 2008.

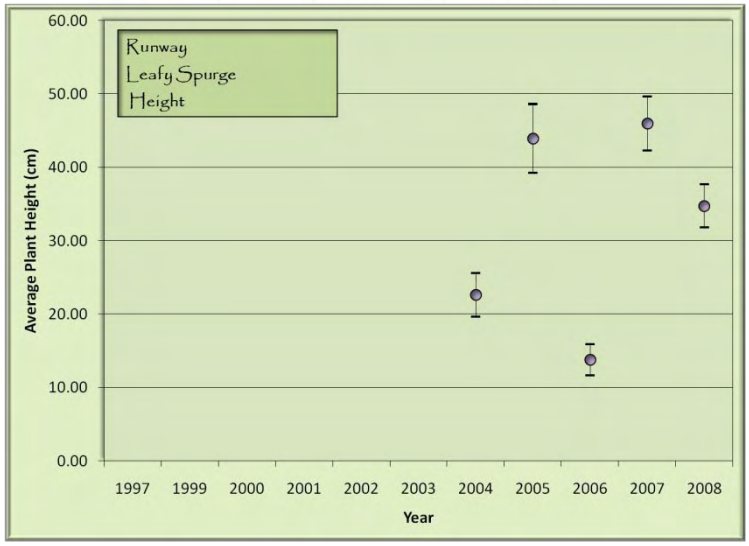


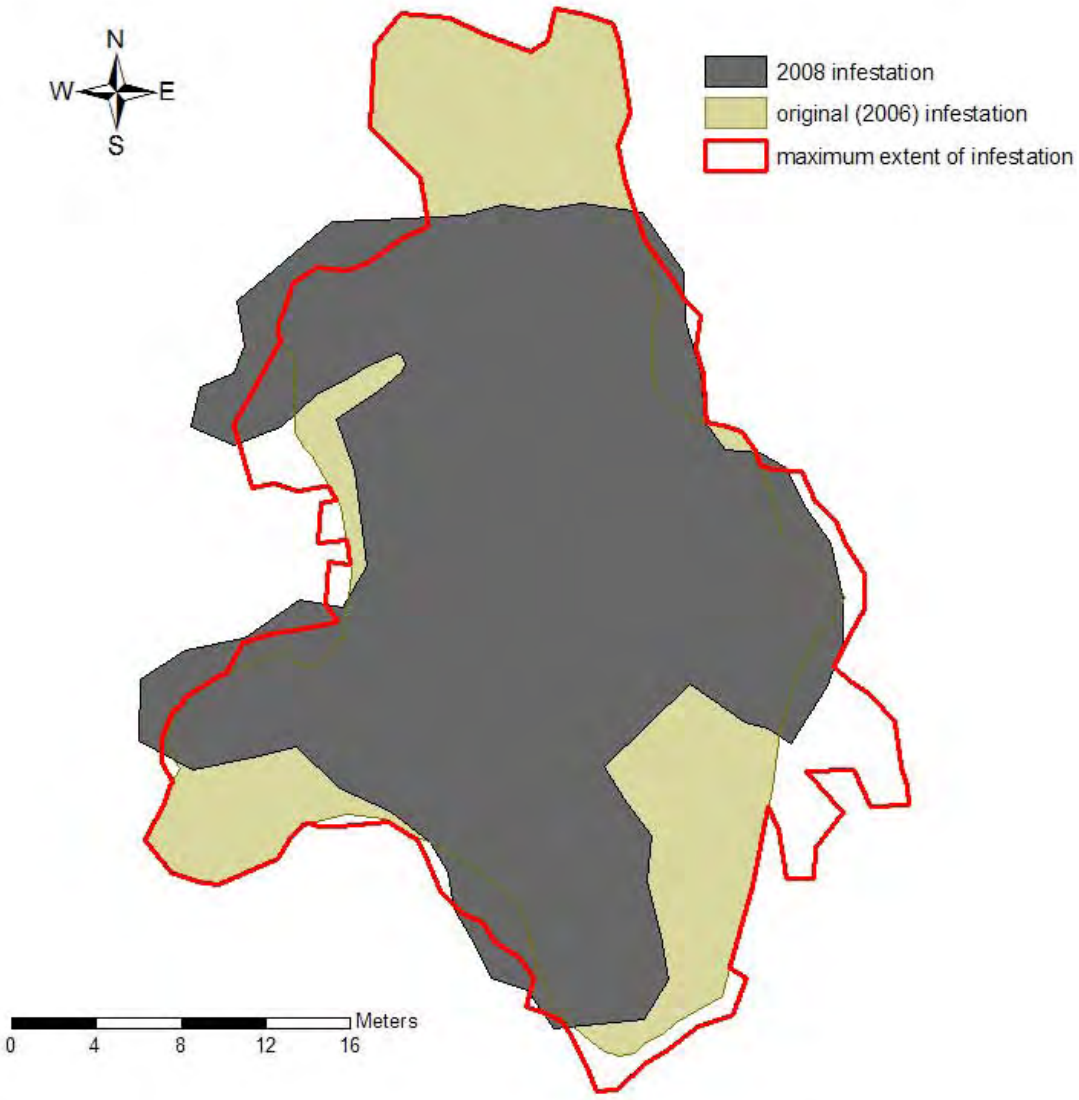
Runway leafy spurge density in 2008.



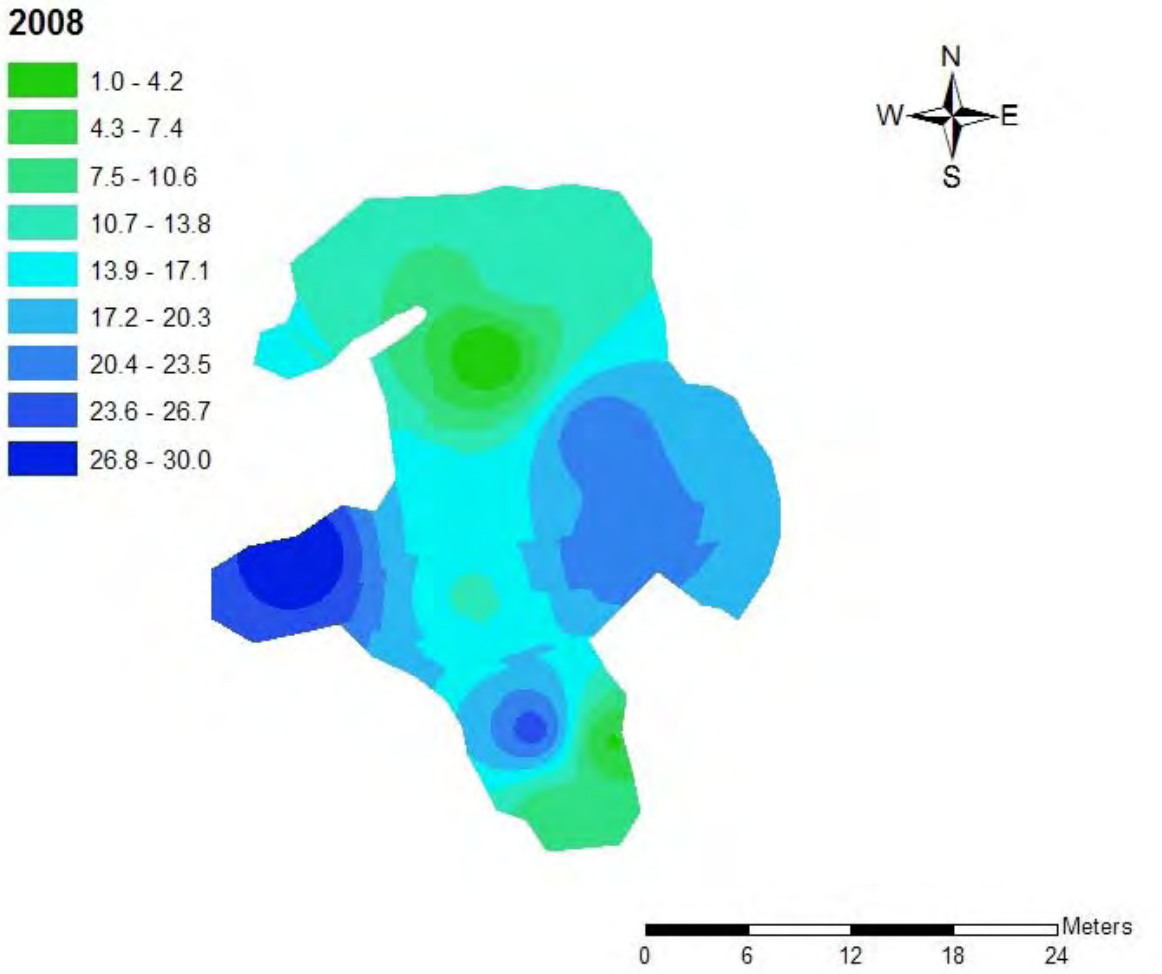


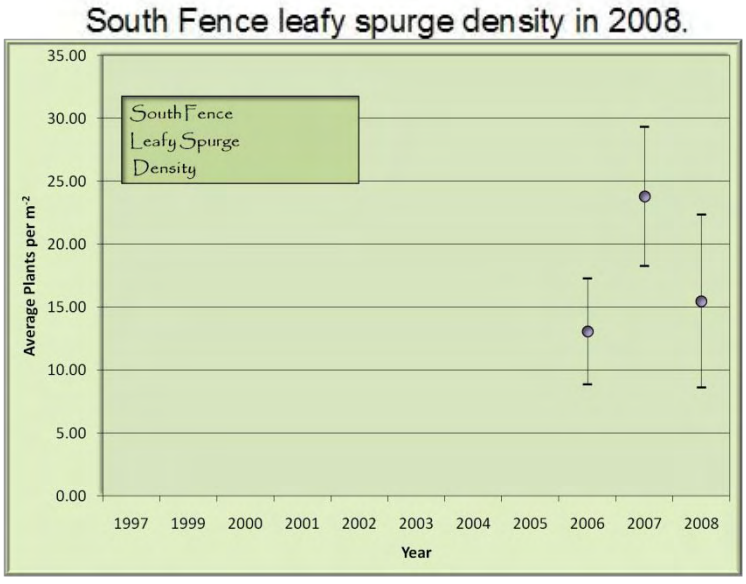
Runway leafy spurge height in 2008.

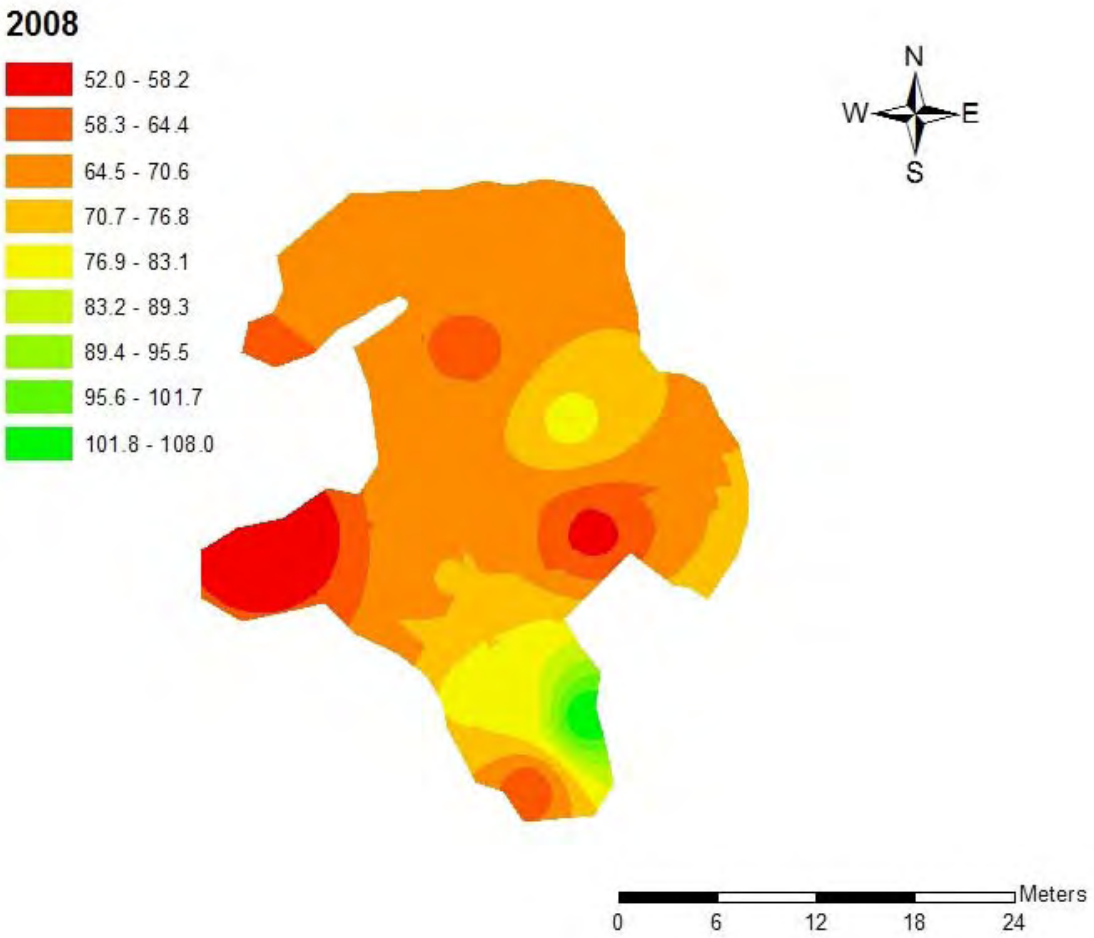




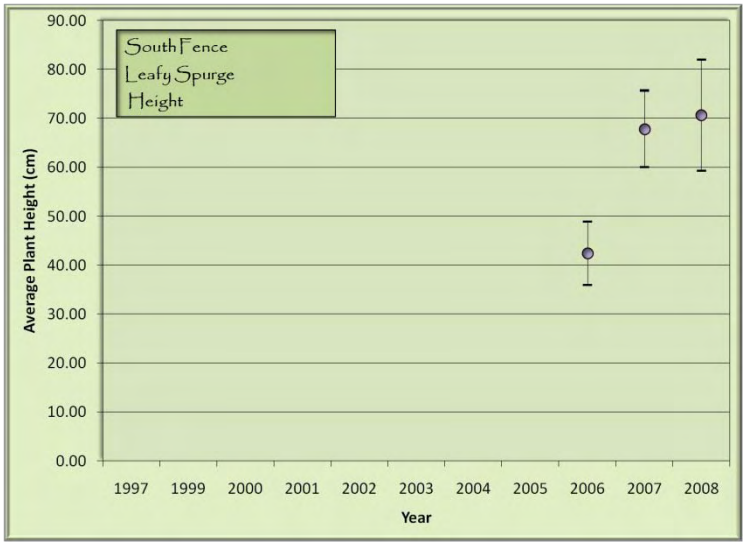
South Fence leafy spurge perimeter in 2008.

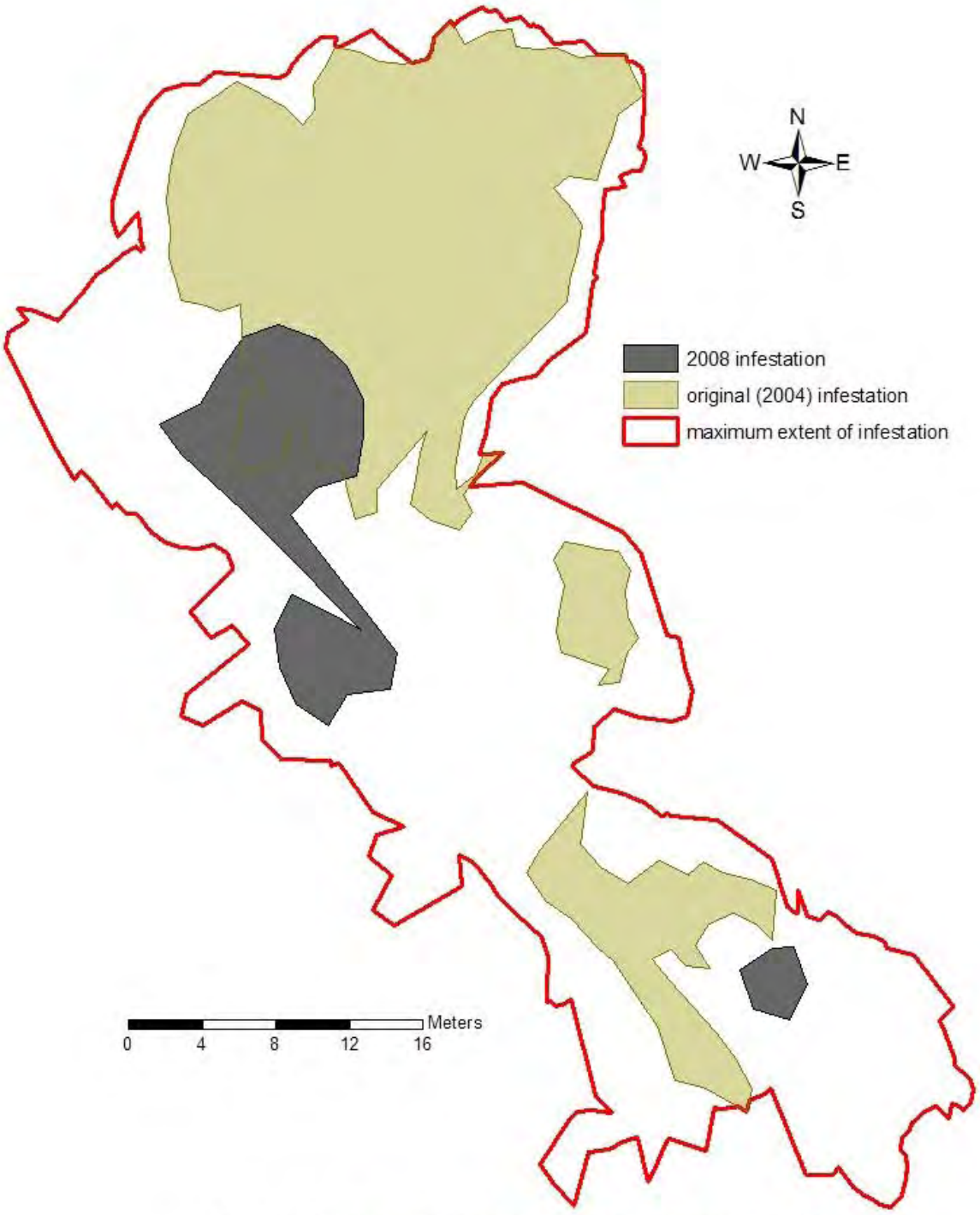

2008
1.0 - 4.2
4.3 - 7.4
7.5 - 10.6
10.7 - 13.8
13.9 - 17.1
17.2 - 20.3
20.4 - 23.5
23.6 - 26.7
26.8 - 30.0
N
W
E
S
Meters
0
6
12
18
24


South Fence leafy spurge density in 2008.
South Fence
Leafy Spurge
Density
Average Plants per m-2
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1997
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Year

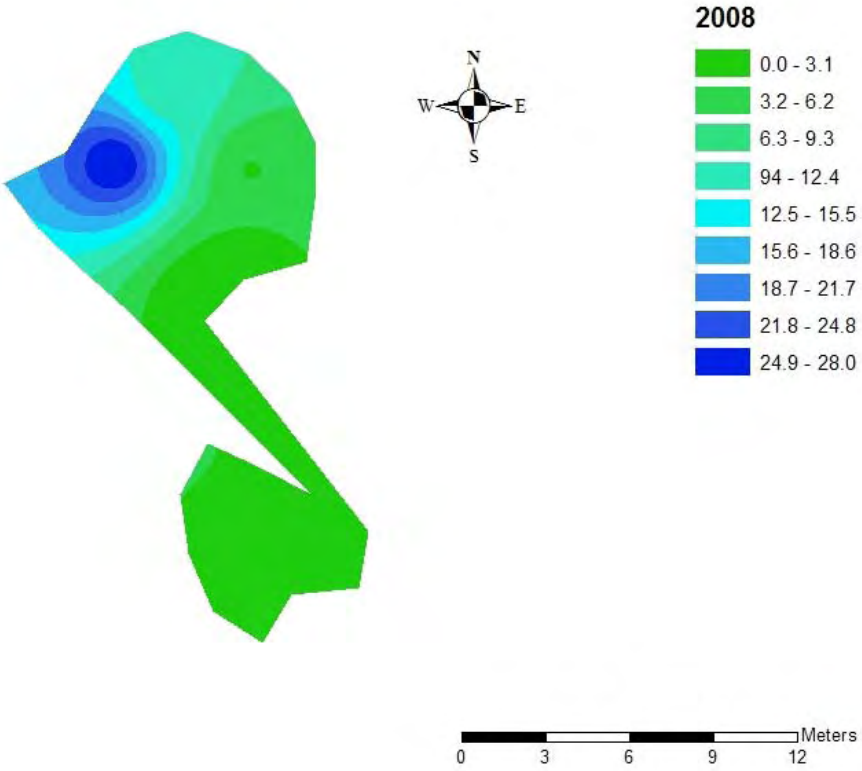


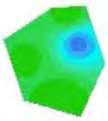
South Fence leafy spurge height in 2008.



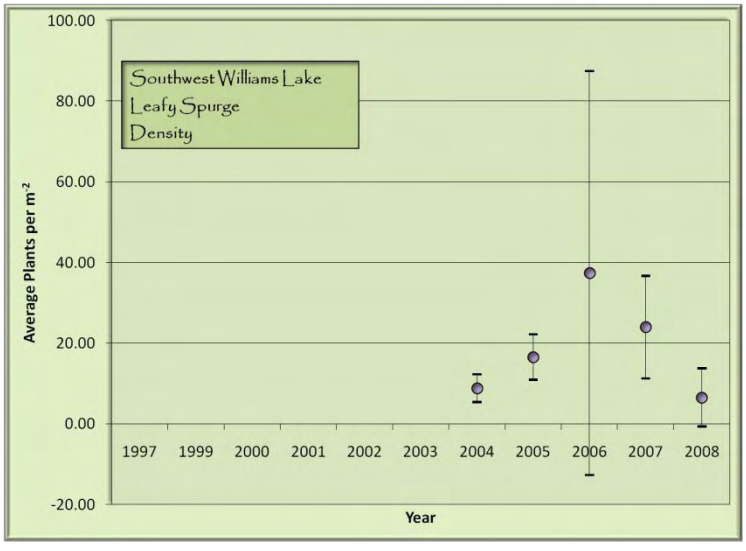


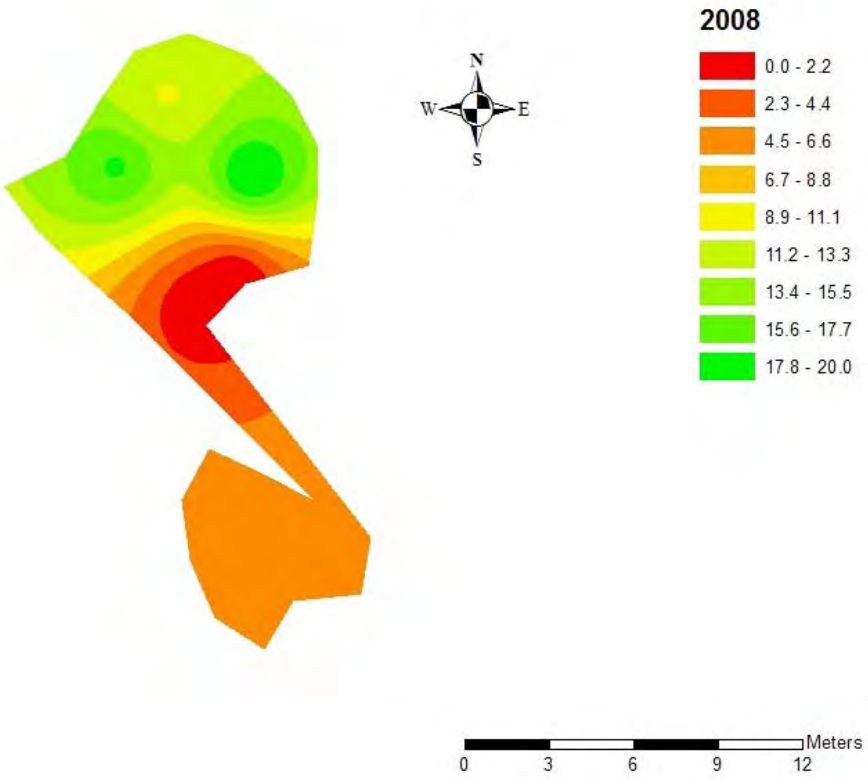
Southwest Williams Lake leafy spurge perimeter in 2008.



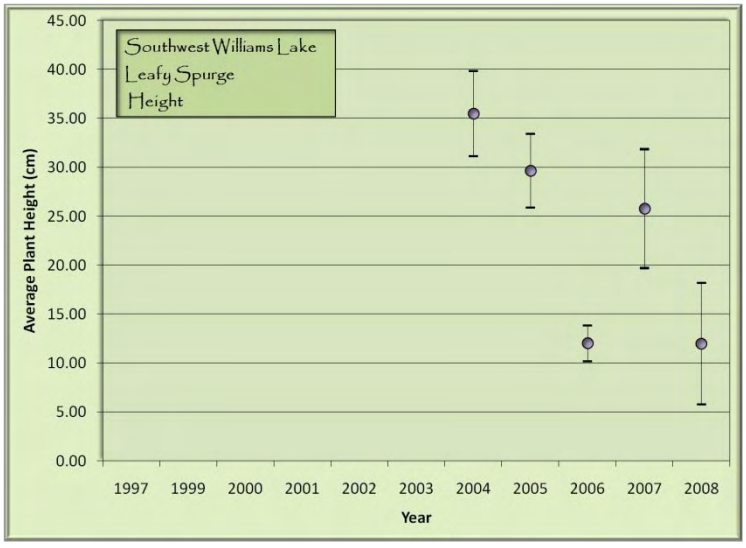


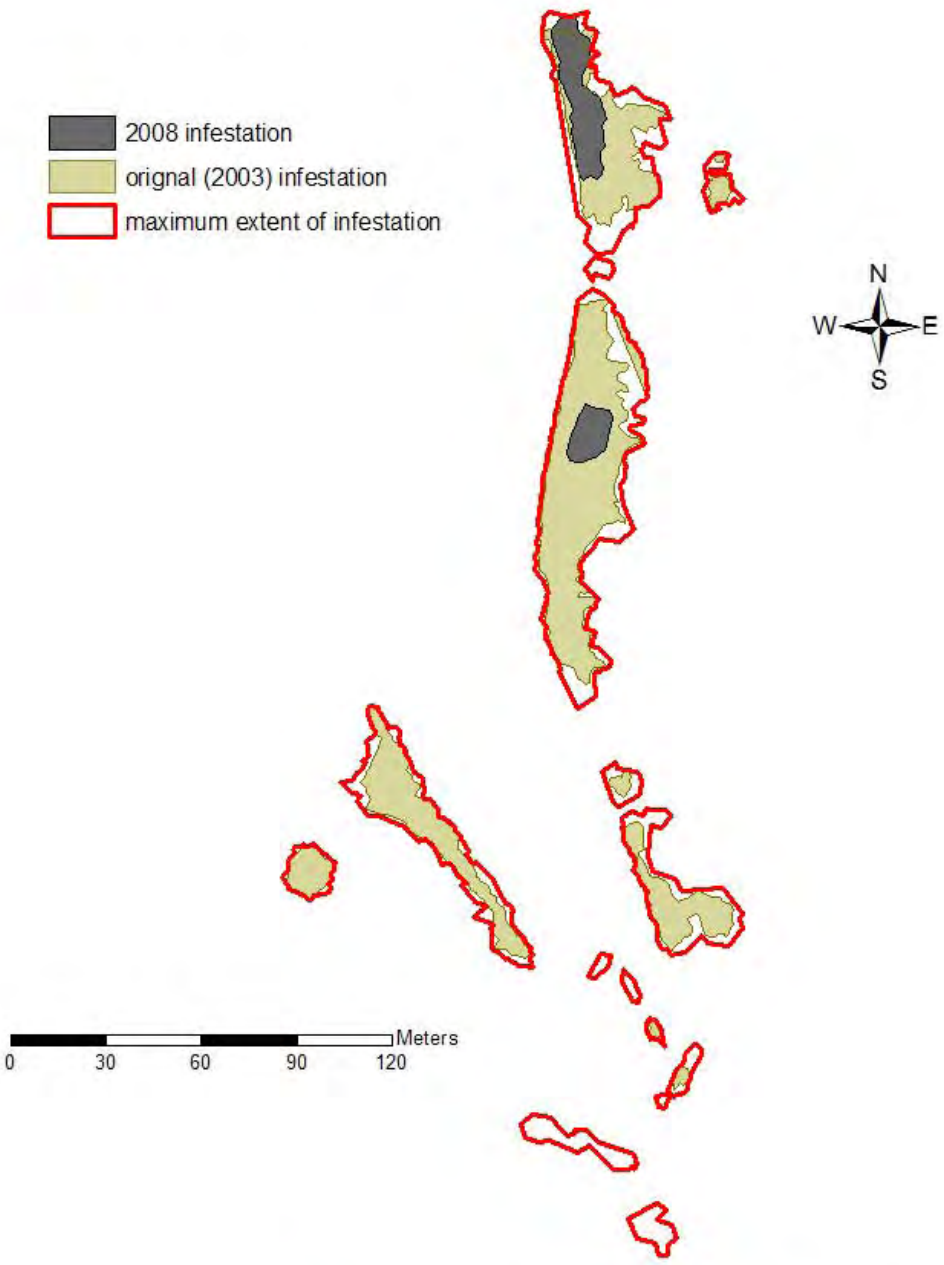
Southwest Williams Lake leafy spurge density in 2008.



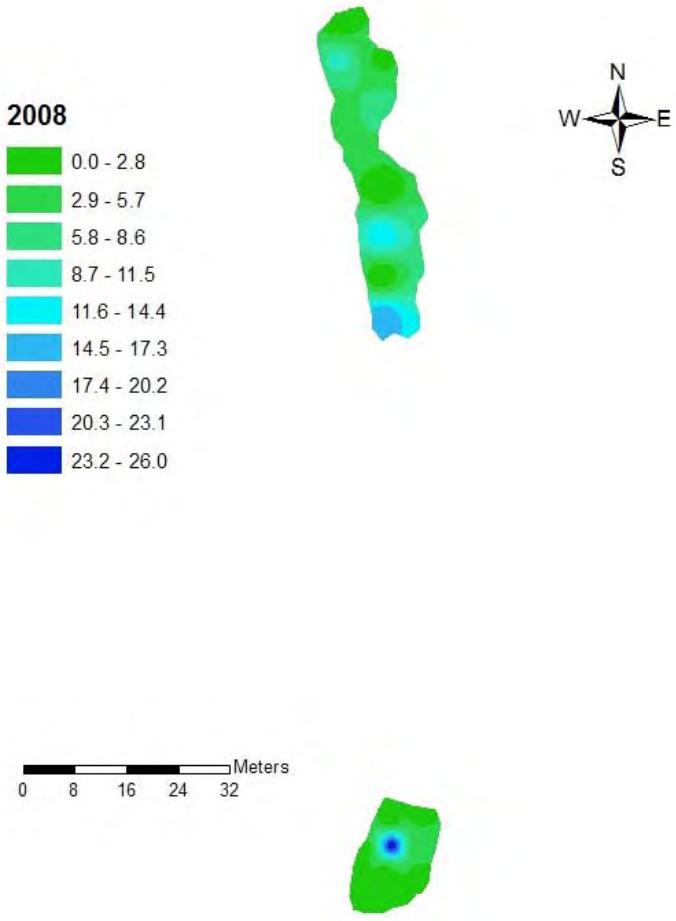


Southwest Williams Lake leafy spurge height in 2008.

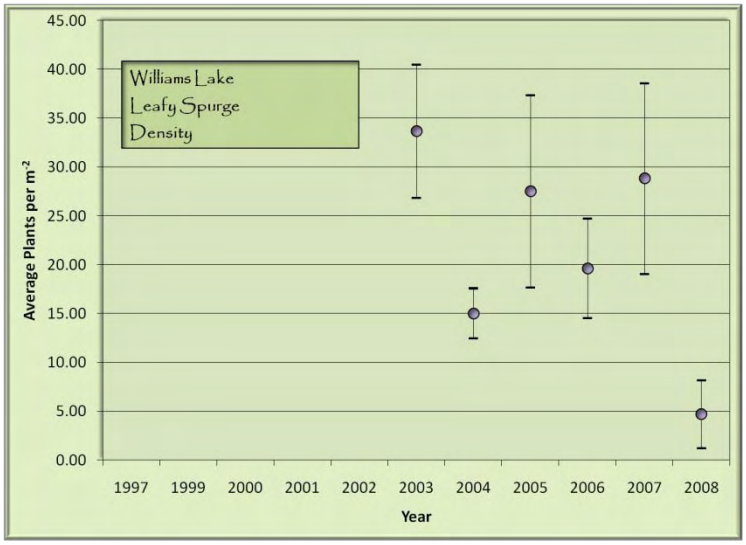


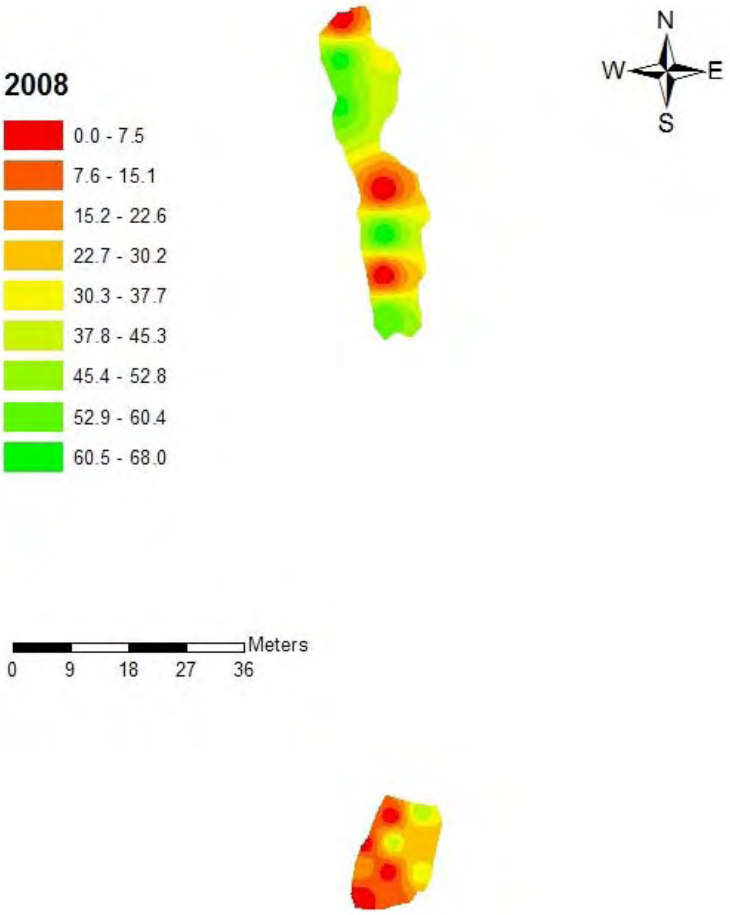


Williams Lake leafy spurge perimeter in 2008

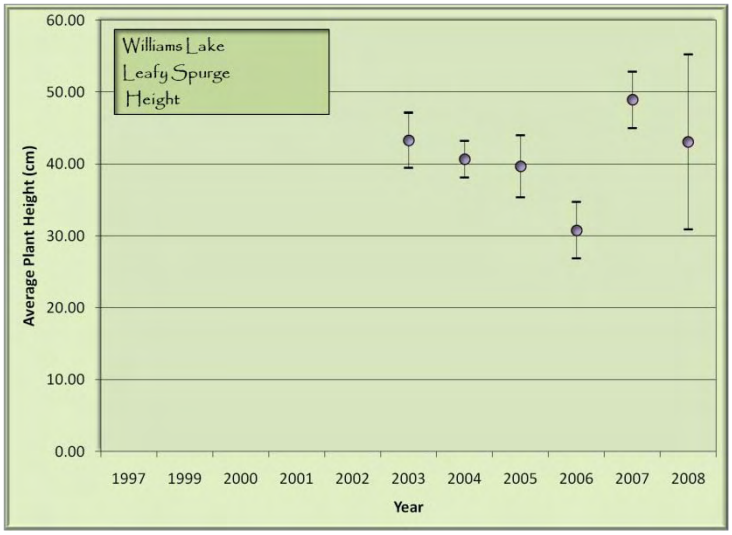


Williams Lake leafy spurge density 2008.





Williams Lake leafy spurge height 2008.



Fort Carson Military Post

Seven sites were fully mapped at Fort Carson this summer, covering a total of 24.7 ha (61.1 acres). Four Canada and musk thistle sites covered 23.7 ha (58.6 acres) and three sites consisted of diffuse and spotted knapweed (1.02 ha, 2.52 acres). Two thistle sites (ARA I and Highway 115) were not monitored this year because the remaining plants were too few and/or scattered to map (Table 14). The HazMat spotted knapweed site was mowed at the beginning of the summer and there were no plants left to monitor this summer. Sixteen of the 34 field bindweed sites were randomly sampled for the presence of the mite *Aceria malherbae* and additional releases of infested runners were made on four sites.

The thistle sites took up the largest percentage of the total area covered by weeds. The ARA II sites was the largest of the thistle sites, with a total area of 22.8 ha and a perimeter of 4 km. In addition to Canada thistle, the site has a large infestation of teasel (*Dipsacus sylvestris*) and Russian olive (*Elaeagnus angustifolia*) indicating that other invasive plants rather than native plants are moving into the site. No evidence was seen this year of establishment of *A. anthocoptes* mites that were released last year, but we will continue to monitor the six established release plots next summer. Two hundred fifty-three *Cassida rubiginosa* beetles were collected from a site at the Rocky Flats National Wildlife Refuge in Golden, Colorado and released at the ARA II site in early July (Table 14). The agent *Rhinocyllus conicus* appears to have self-dispersed from the now defunct ARA I site to both the nearby ARA II and the Wildlife Refuge site (5.8 km away).

Figure 13. ARA I (left) and ARA II (right) Canada thistle sites. The ARA I site is been re-colonized mainly by grasses. Though the picture is a little blurry, there is evidence of a dense Canada thistle population (white specks in foreground) and a dense teasel population (brown lines in background).

All of the knapweed sites mapped this year declined in area and had significant decreases in plant height, though not in plant density. Despite what appeared to be a poor growing season for the plants, this year was particularly good for the knapweed seedhead feeders *Larinus minutus* and the root feeder *Cyphocleonus achates* across many installations and Fort Carson was no exception. *L. minutus* was detected on plants at the Fuel site and both species were detected in visual counts of the Gun Club and Turkey Creek sites (Table 14). Though a forest fire on the Turkey Creek site (Figure 14) gave the plants a later start than at other knapweed sites, bio-

agents seemed to be re-colonizing rapidly from the surrounding areas (Table 14). No seedheads or roots were collected for dissection in the fall, but collections are planned for spring of 2009.

Figure 14. The Turkey Creek spotted knapweed site recovering after a spring fire.

Field bindweed flourished this year across the base despite efforts to establish the gall forming mite *A. malherbae* (Figure 15). This year several releases of infected runners collected from a site in Amarillo, Texas, were made at the ARA I, Range Control, Vet, and Wildlife sites. Seventeen field bindweed sites were randomly sampled for mites, with nine out of the seventeen sites having quadrats containing infected runners (Table 8). Efforts to establish nursery sites both in Texas and Colorado should allow us to continue to make releases in future seasons until populations are established on the base.

Figure 15. The ARA 1 field bindweed site showing a healthy crop of flowers (right). Very few runners showed signs of mite damage, most had healthy leaves and buds (above)

In 2007, 241 *Diorhabda elongata* (salt cedar (*Tamarix*) leaf beetles) were released at a site in Section (Training Area) 36. Unfortunately, the large area of the infestation combined with *D. elongata's* ability to fly long distances made it difficult for such a small number of insects to establish a self-sustaining population. Fortunately this year we were able to release approximately 2000 beetles supplied by the Colorado Department of Agriculture's Palisade, Colorado, laboratory. Some beetles were recovered during three 15 minute visual sweeps one week later. We will continue to monitor the site for beetles next summer and hope to see some indications that a population has established itself. We also anticipate being able to release more beetles in the next few years if necessary.

Figure 16. Student worker Nathanial (JJ) Engel searches for *D. elongata* beetles at the Section 36 release site (top left). Top right; salt cedar plants in flower, bottom; salt cedar growing near some cottonwood trees.

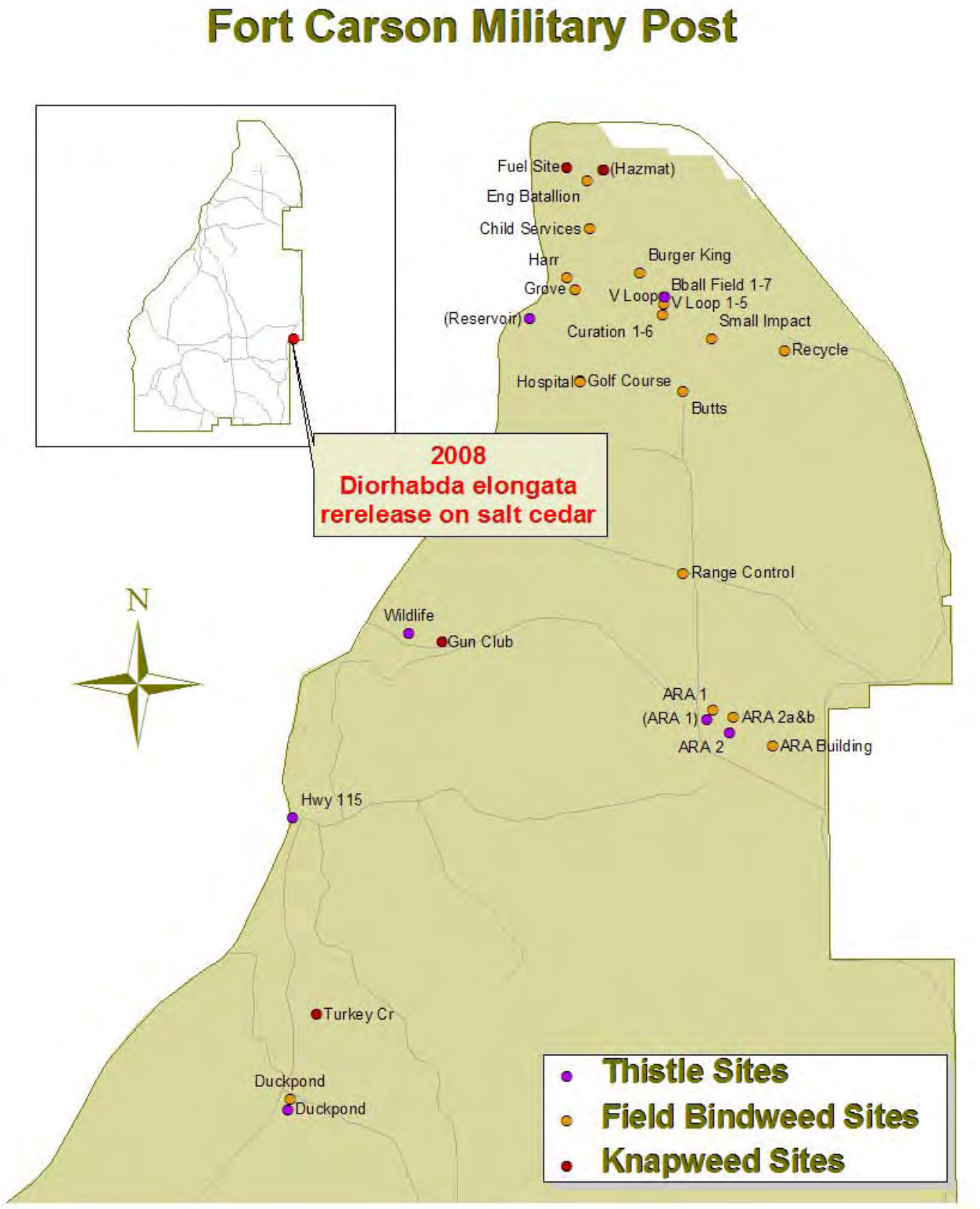


Figure 17. Schematic diagram of Fort Carson Military Post with weed biological control study areas superimposed. Sites listed in parentheses were not surveyed in 2008.

Table 13. Historic noxious weed infestation parameters, Fort Carson Military Post, Colorado, 1997-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Canada thistle – ARA I													
1997		23	25.55	42									
1998													
1999		40			62.33	95							
2000	37,062	166	13.96	58	45.87	91					-26.41		
2001	37,061	299	12.94	64	52.98	122	18.95	0.57	0	-7.31	15.50		
2002	38,002	386	4.95	40	12.89	84	8.54	0.12	2.54	-61.75	-75.67		
2003	14,708	161	0.78	9	12.19	74	1.13	0.15	-61.30	-84.24	-5.43		
2004	4,919	75	2.53	19	10.83	37	0.24	0.26	-66.56	224.36	-11.16		
2005	10,528	34	3.59	14	42.79	62	10.58	0.74	114.03	41.90	295.11		
2006	22,882	32	1.91	11	29.68	64	6.42	0.71	117.34	-46.80	-30.64		
2007	*(see Note a)*												
2008	228,744	31	7.03	29	50.70	91	6.74	5.17	899.67**	2.68**	70.82**	517.19	-72.49
Canada thistle – ARA II													
2003	6,284	63	6.48	24	61.21	125	1.28	0.07					
2004	13,845	64	13.20	38	50.14	98	1.48	2.50	120.33	103.70	-18.09		
2005	270,294	31	9.23	24	69.41	105	20.17	0.66	1852.29	-30.08	38.43		
2006	371,111	34	10.09	36	59.86	111	11.86	0.60	37.30	9.32	-13.76		
2007	241,585	54	9.06	24	59.50	105	9.69	5.75	-34.90	-10.21	-0.60		
2008	*(see Note a)*												
Canada thistle – Duckpond													
1997		19	35.00	82									
1998	27,769												
1999		33			70.82	114	34.88						
2000	28,788	267	9.33	58	76.76	193					8.38		
2001	39,409	26	16.23	70	66.73	136	18.12		36.90	73.95	-13.07		
2002	38,916	196	7.74	56	21.30	124	11.33	0.23	-1.25	-52.31	-68.08		
2003	29,486	147	5.25	29	38.90	143	3.08	0.22	-24.23	-32.17	82.63		

Table 13. Historic noxious weed infestation parameters, Fort Carson Military Post, Colorado, 1997-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
2004	20,724	65	14.17	116	26.03	90	1.18	0.62	-29.72	169.90	-33.08		
2005	21,130	35	9.43	28	61.46	115	25.61	0.74	1.96	-33.45	136.11		
2006	17,902	30	8.03	32	47.52	80	20.67	0.72	245.33	-4.97	3.19		
2007	6,411	54	11.26	112	92.00	184	21.02	6.39	-64.19	40.22	93.60		
2008	4,992	14	13.36	23	76.14	127	18.50	6.79	-22.13	15.72	-17.24	-82.02	-61.83
Canada thistle – HWY 115													
2000	1,445	82	12.47	40	53.49	80							
2001	4,239	54	10.22	48	57.87	147	14.51	0.64	193.36	-18.04	8.88		
2002	1,114	70	1.58	14	7.24	24	2.25	0.06	-73.72	-84.54	-87.49		
2003													
2004	1,287	69	6.29	23	38.33	96	7.95	0.47	15.53**	298.10**	429.62**		
2005	*(see Note a)*												
2006	91	10	3.70	8	30.25	71	2.75	0.21	-92.93**	-41.18**	-21.08**		
2007	965	21	4.43	16	81.47	114	15.37	4.84	960.44	19.73	169.32		
2008	*(see Note a)*												
Musk thistle – HWY 115													
2000	1,445	8	7.13	22									
2001	5,082	30	4.00	14	64.30	121	6.53	2.18	251.70	-43.90			
2002	827	53	2.13	13	6.26	35	0.63	0.43	-83.73	-46.75	-90.26		
2003	1,263	61	0.62	5	17.64	127	0.68		52.72	-70.89	181.79		
2004	9,918	55	1.85	25	24.88	100	3.47	0.97	685.27	198.39	41.04		
2005	735	44	1.05	7	42.31	90	1.56	1.51	-92.59	-43.24	70.06		
2006	*(see Note a)*												
2007	2,101	29	0.69	3	110.65	188	7.23	3.08	185.85**	-34.29**	161.52**		
2008	*(see Note a)*												
Canada thistle - Reservoir													
1997		22	20.82	30									
1998													

Table 13. Historic noxious weed infestation parameters, Fort Carson Military Post, Colorado, 1997-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
1999		26			73.12	109	19.12						
2000													
2001	9,517	143	7.25	31	39.53	84	13.55						
2002	5,268	101	8.16	32	24.26	65	6.36	0.30	-44.64	12.55	-38.63		
2003	3,635	165	6.09	38	41.48	123	6.02	0.38	-31.00	-25.37	70.98		
2004	4,549	68	6.13	28	23.22	57	0.52	0.74	25.13	0.66	-44.02		
2005	5,184	40	8.45	27	46.05	86	15.06	0.61	13.96	37.85	98.32		
2006	2,251	35	6.71	24	20.20	39	2.34	0.33	-56.58	-20.59	-56.13		
2007	*(see Note a)*												
2008	2,057	14	3.86	16	32.38	49	4.63	4.25	-8.62**	-42.47**	60.30**	-78.39	-81.46
						Musk thistle – Wildlife							
1999		59			110.92	175	7.53						
2000	5,035	114	1.76	14	43.14	138							
2001	2,844	68	3.84	21	72.22	174	6.07		-43.52	118.18	67.41		
2002	1,838	61	2.82	36	8.65	57	8.18	0.22	-35.39	-26.56	-88.02		
2003	10,219	77	0.27	3	14.39	124	1.17		456.14	-90.43	66.36		
2004	6,777	46	1.23	7	27.46	173	3.50	7.13	-33.68	355.56	90.83		
2005	3,453	36	1.37	9	98.31	187	8.69	2.75	-49.05	11.38	258.01		
2006	390	30	2.73	9	58.77	105	3.42	1.98	-88.71	99.27	-40.22		
2007	23,861	44	0.80	6	93.58	147	4.25	3.51	6018.21	-70.70	59.23		
2008	1,252	44	1.77	10	37.25	108	4.00	12.94	-94.75	121.25	-60.19	-75.13	0.57
						Diffuse knapweed – Gun Club							
2004	14,941	46	1.59	8	21.87	65	36.04	1.43					
2005	9,685	35	3.40	22	41.36	57	42.48	0.45	-35.18	113.84	89.12		
2006	20,781	30	2.60	12	24.47	40	39.87	0.41	114.57	-23.53	-40.84		
2007	24,806	41	3.51	6	57.37	88	108.17	4.37	19.37	35.00	134.45		
2008	1,978	66	1.47	8	31.56	60	48.09	4.22	-86.76	-58.12	-44.99	-86.76	-7.55

Table 13. Historic noxious weed infestation parameters, Fort Carson Military Post, Colorado, 1997-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Spotted knapweed – Fuel Site (Cantonment I)													
1997		22	55.27	82									
1998													
1999		50			71.68	104							
2000	2,072	154	16.71	50	46.69	91					-34.86		
2001	2,869	113	55.19	564	55.88	104	134.48	1.88	38.46	230.28	19.68		
2002	2,375	155	6.04	36	20.56	72	45.60	0.34	-17.22	-89.06	-63.21		
2003	2,093	92	5.98	35	64.35	150	52.26	1.92	-11.87	-0.99	212.99		
2004	6,830	42	4.64	21	46.64	100	9.39	5.00	226.41	-22.41	-27.52		
2005	2,567	41	5.16	26	42.52	74	13.25	0.52	-62.42	11.21	-8.83		
2006	9,913	37	4.70	21	31.50	91	12.72	0.42	286.17	-8.91	-25.92		
2007	1,984	33	3.27	9	70.37	126	42.15	2.23	-79.99	-30.43	123.40		
2008	1,692	10	6.60	34	17.38	34	6.75	3.50	-14.72	6.00	-75.30	-18.34	-88.06
Spotted knapweed – Hazmat (Cantonment II)													
1997		21	49.05	62									
1998													
1999		100			79.66	42							
2000	8,462	361	10.54	52	42.56	43	127.00				-46.57		
2001	9,094	143	20.66	140	60.48	100	72.35		7.47	96.02	41.11		
2002	3,429	92	12.24	58	22.69	81	31.16	0.35	-62.30	-40.46	-62.48		
2003	5,254	160	5.26	70	57.42	140	64.85	0.67	53.23	-57.03	153.06		
2004	5,779	57	5.37	18	43.07	97	9.41	4.62	10.00	2.09	-24.99		
2005	990	50	12.48	53	52.12	90	20.32	0.58	-82.87	132.40	21.01		
2006	15,458	33	6.24	29	27.68	65	8.57	0.32	1461.41	-50.00	46.89		
2007	27,783	41	7.46	76	63.52	113	39.20	5.07	79.73	19.55	129.48		
2008	*(see Note a)*												

Table 13. Historic noxious weed infestation parameters, Fort Carson Military Post, Colorado, 1997-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Spotted knapweed – Turkey Creek													
1997		22	16.00	18									
1998													
1999	11,818	25	12.72	20	109.67	132	19.36			-20.50			
2000	16,848	285	17.05	68	59.57	101			42.56	34.04	-45.68		
2001	30,681	375	8.83	65	54.66	125	44.30		82.10	48.21	-8.24		
2002	1,314	79	2.24	27	10.99	73	13.51	0.27	-95.72	-74.63	-79.89		
2003	328	48	5.33	43	46.83	118		0.34	-75.01	137.95	326.11		
2004	13,218	73	1.42	10	42.76	101	42.94		3929.79	-73.36	-8.69		
2005	5,937	40	1.70	15	52.47	89	17.67	0.43	-55.08	19.72	22.71		
2006	2,711	34	1.26	10	30.67	46	15.93	0.60	-54.34	-25.88	-41.55		
2007	29,455	45	2.64	14	87.40	148	58.83	1.21	986.50	109.52	184.97		
2008	6,486	47	9.96	39	34.71	57	9.97	5.18	-77.98	2.77	-60.29	-45.12	-37.75

n – number of samples or observations

**values given in year-to-year change column actually reflect 2-year changes, as sampling was not done at all sites in all years

Note: Could not map a perimeter, as: a) the few remaining plants at this site were scattered, or b) the site was inaccessible

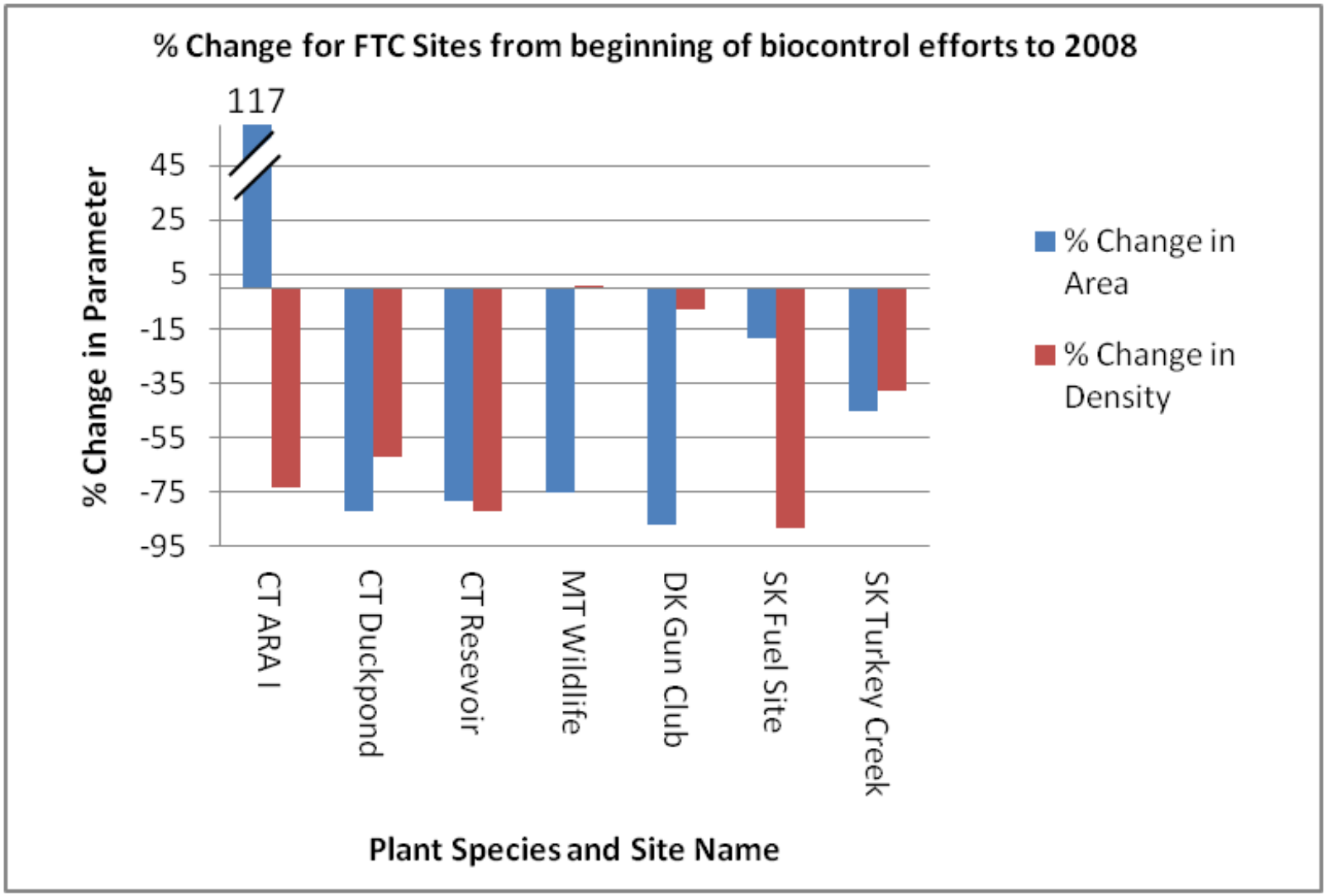


Figure 18. Percent change in area and density of all sites monitored this year at Fort Carson. The percent change is calculated by dividing the difference in the parameters between the first year they were monitored and this year's data by the area or density from this year. The number of years represented vary and depend on when the sites were established.

Table 14. Noxious weed biological control sites, target weeds, species released and recoveries at Fort Carson Military Post, 2008.

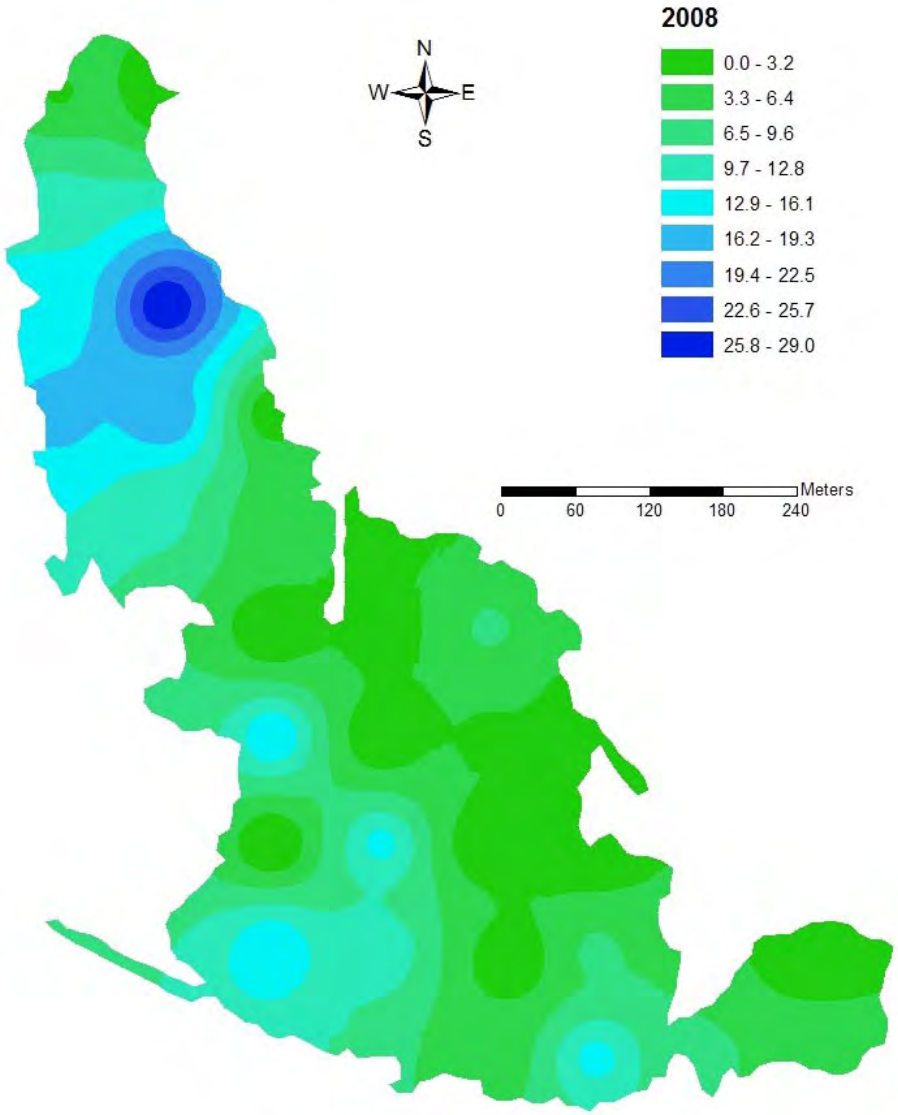
Release Locatio	Target Weed	Release Site	Species	Species recovered	New releases	New site
FTC	Canada thistle	ARA I[3]	*Cassida rubiginosa*			
FTC	Canada thistle	ARA I[3]	*Ceutorhynchus litura*			
FTC	Canada thistle	ARA I[3]	*Larinus planus*			
FTC	Canada thistle	ARA I[3]	*Trichosirocalus horridus*	X		
FTC	Canada thistle	ARA I[3]	*Urophora cardui*			
FTC	Canada thistle	ARA II	*Cassida rubiginosa*		X	
FTC	Canada thistle	ARA II	*Ceutorhynchus litura*			
FTC	Canada thistle	ARA II	*Rhinocyllus conicus*	X[1,2]		
FTC	Canada thistle	Duckpond	*Cassida rubiginosa*			
FTC	Canada thistle	Duckpond	*Ceutorhynchus litura*			
FTC	Canada thistle	Duckpond	*Larinus planus*			
FTC	Canada thistle	Duckpond	*Urophora cardui*			
FTC	Canada thistle & Musk thistle	Highway 115[3]	*Trichosirocalus horridus*			
FTC	Canada thistle & Musk thistle	Highway 115[3]	*Urophora cardui*			
FTC	Canada thistle & Musk thistle	Reservoir	*Cassida rubiginosa*			
FTC	Canada thistle & Musk thistle	Reservoir	*Ceutorhynchus litura*			
FTC	Canada thistle & Musk thistle	Reservoir	*Larinus planus*			
FTC	Canada thistle & Musk thistle	Reservoir	*Urophora cardui*			
FTC	Canada thistle & Musk thistle	Wildlife Refuge	*Rhinocyllus conicus*	X[1,2]		
FTC	Canada thistle & Musk thistle	Wildlife Refuge	*Trichosirocalus horridus*	X		
FTC	Diffuse knapweed	Gun Club	*Agapeta zoegana*			
FTC	Diffuse knapweed	Gun Club	*Cyphocleonus achates*	X		
FTC	Diffuse knapweed	Gun Club	*Larinus minutus*	X		
FTC	Diffuse knapweed	Gun Club	*Metzneria paucipunctella*			
FTC	Diffuse knapweed	Gun Club	*Sphenoptera jugoslavica*			
FTC	Diffuse knapweed	Gun Club	*Urophora affinis*	X[1]		
FTC	Diffuse knapweed	Gun Club	*Urophora quadrifasciata*	X[1]		

Table 14. Noxious weed biological control sites, target weeds, species released and recoveries at Fort Carson Military Post, 2008.

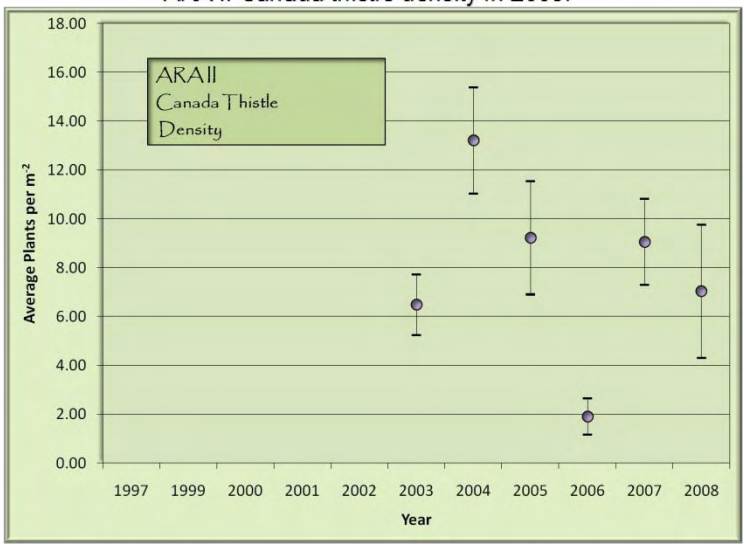
Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
FTC	Field bindweed	Multiple sites	*Aceria malherbae*	X	X	
FTC	Spotted knapweed	Fuel Site	*Agapeta zoegana*			
FTC	Spotted knapweed	Fuel Site	*Bangasternus fausti*			
FTC	Spotted knapweed	Fuel Site	*Cyphocleonus achates*			
FTC	Spotted knapweed	Fuel Site	*Larinus minutus*	X		
FTC	Spotted knapweed	Fuel Site	*Larinus obtusus*			
FTC	Spotted knapweed	Fuel Site	*Mtzneria paucipunctella*			
FTC	Spotted knapweed	Fuel Site	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	Fuel Site	*Urophora affinis*			
FTC	Spotted knapweed	HazMat[3]	*Agapeta zoegana*			
FTC	Spotted knapweed	HazMat[3]	*Bangasternus fausti*			
FTC	Spotted knapweed	HazMat[3]	*Cyphocleonus achates*			
FTC	Spotted knapweed	HazMat[3]	*Larinus minutus*			
FTC	Spotted knapweed	HazMat[3]	*Larinus obtusus*			
FTC	Spotted knapweed	HazMat[3]	*Mtzneria paucipunctella*			
FTC	Spotted knapweed	HazMat[3]	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	HazMat[3]	*Urophora affinis*			
FTC	Spotted knapweed	Turkey Creek	*Agapeta zoegana*			
FTC	Spotted knapweed	Turkey Creek	*Cyphocleonus achates*	X		
FTC	Spotted knapweed	Turkey Creek	*Larinus minutus*	X		
FTC	Spotted knapweed	Turkey Creek	*Mtzneria paucipunctella*			
FTC	Spotted knapweed	Turkey Creek	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	Turkey Creek	*Urophora affinis*			
FTC	Saltcedar	Section 36	*Diorhabda elongata*		X	

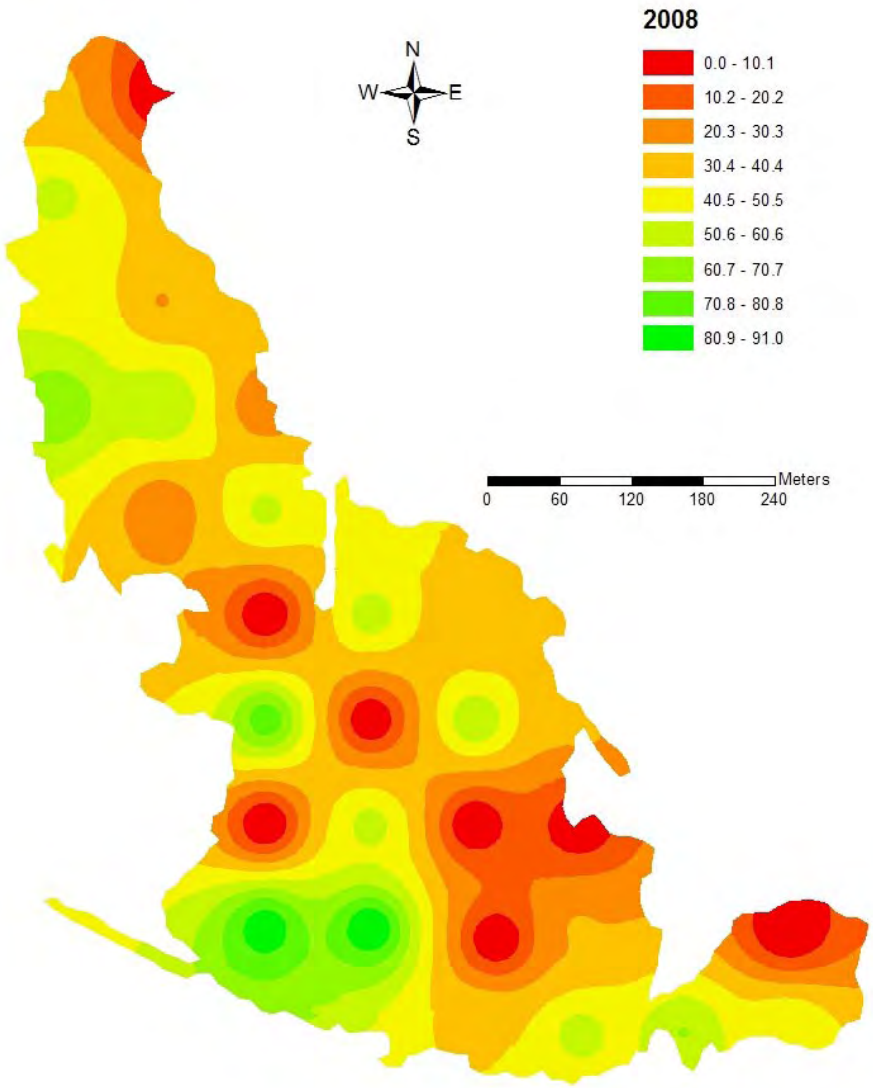
[1] Adventitious recovery, insects were not released at this location
[2] New recovery in 2008
[3] Site not monitored, or only sentinel site data

ARA II Canada thistle perimeter in 2008.

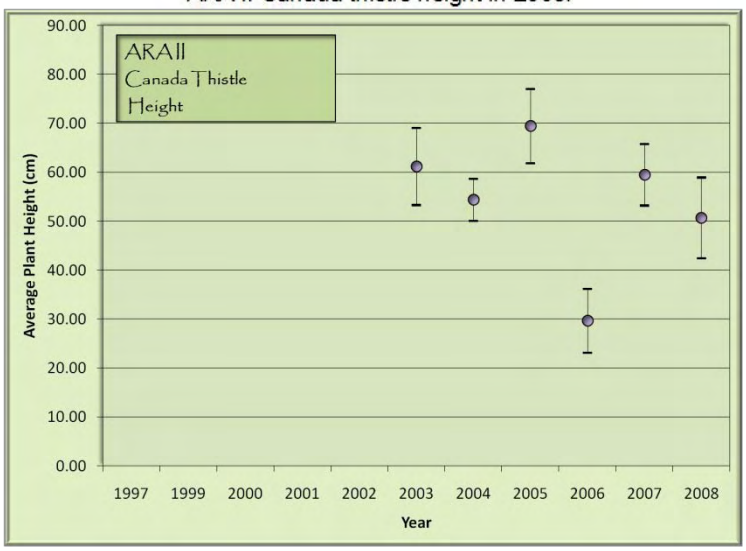


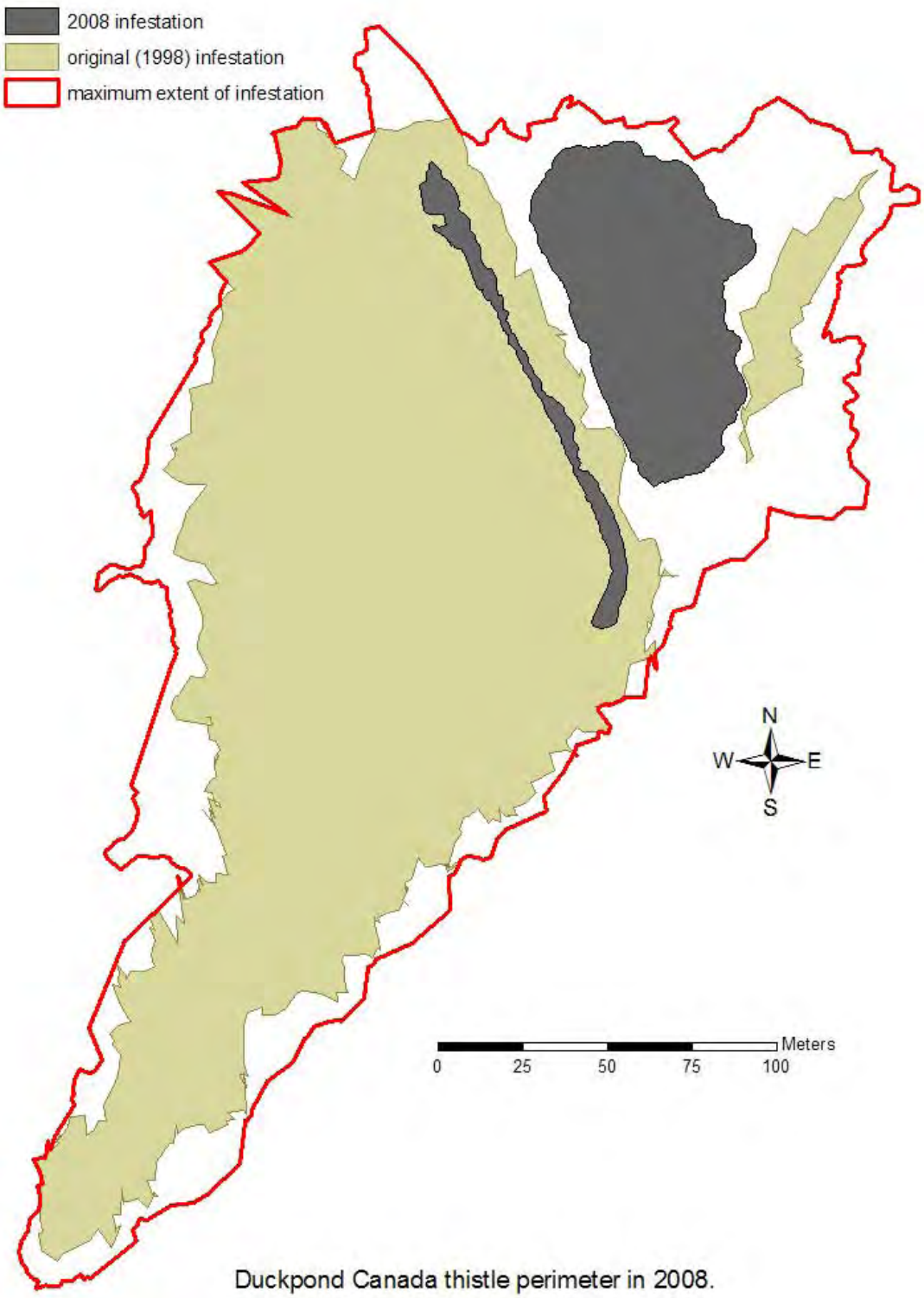
ARA II Canada thistle density in 2008.



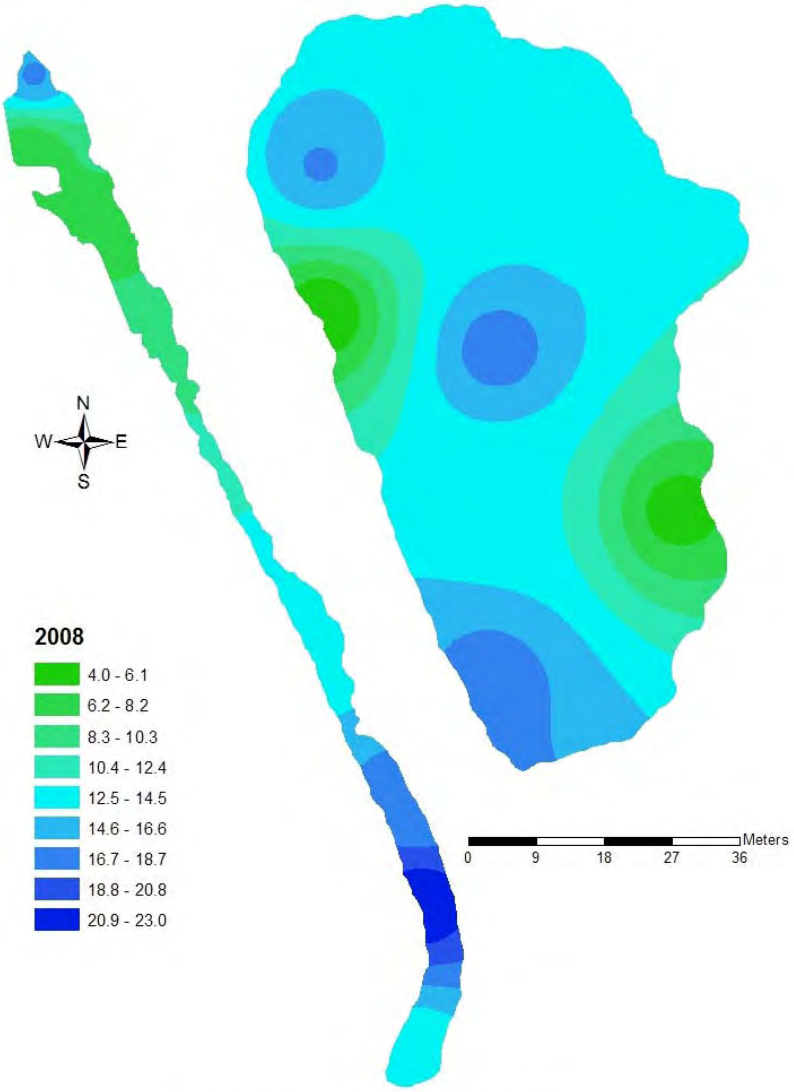


ARA II Canada thistle height in 2008.

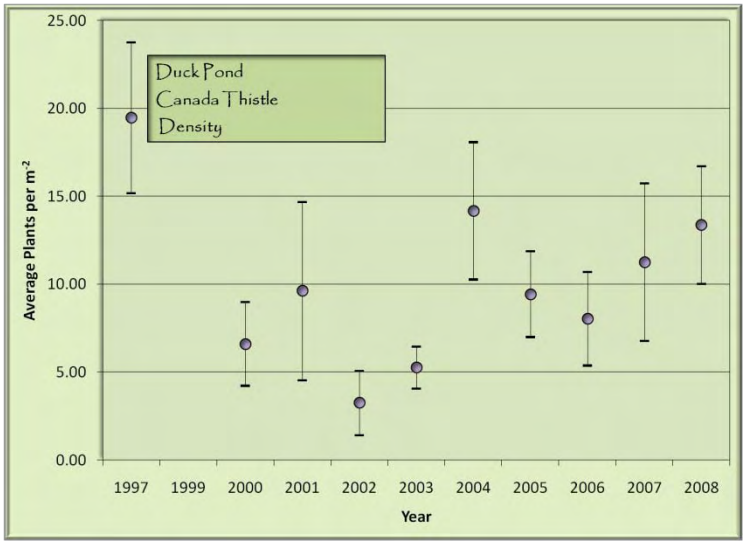


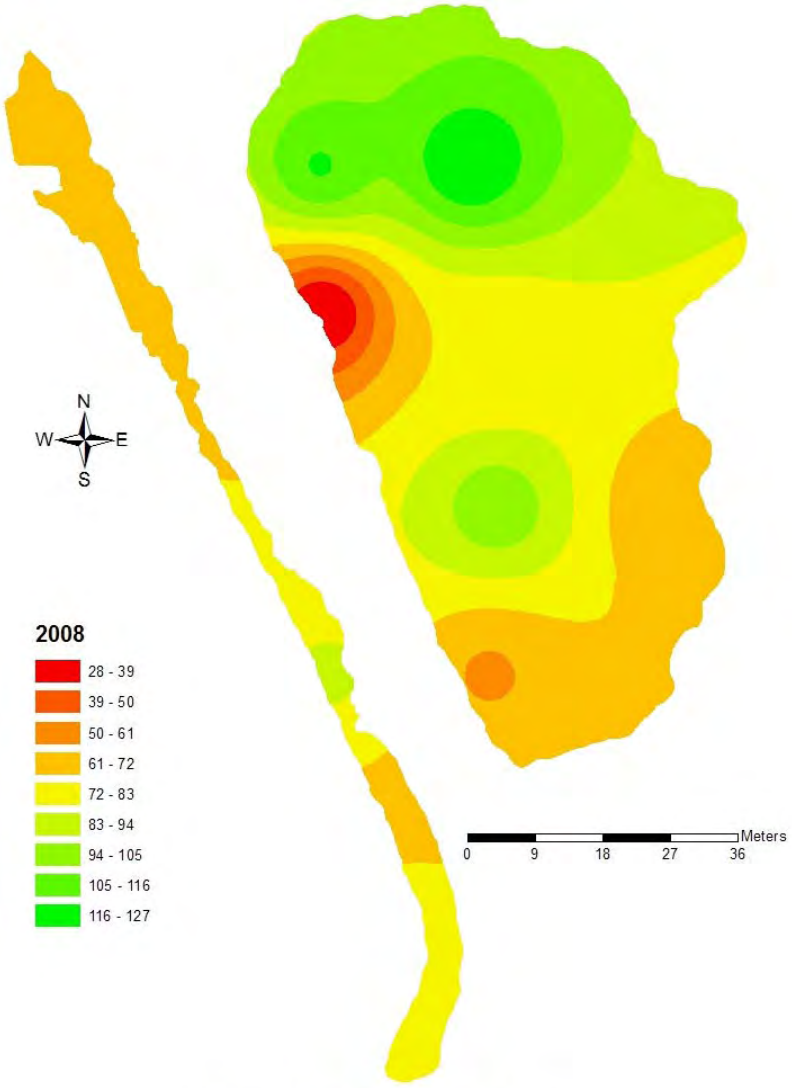


Duckpond Canada thistle perimeter in 2008.

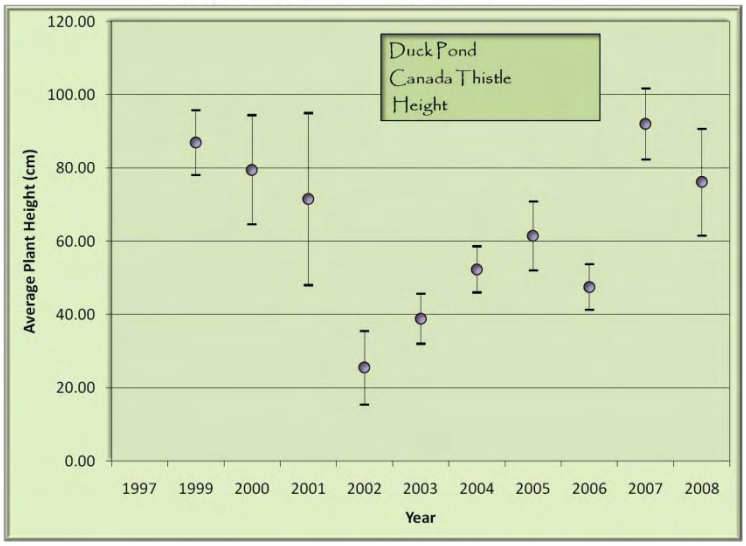


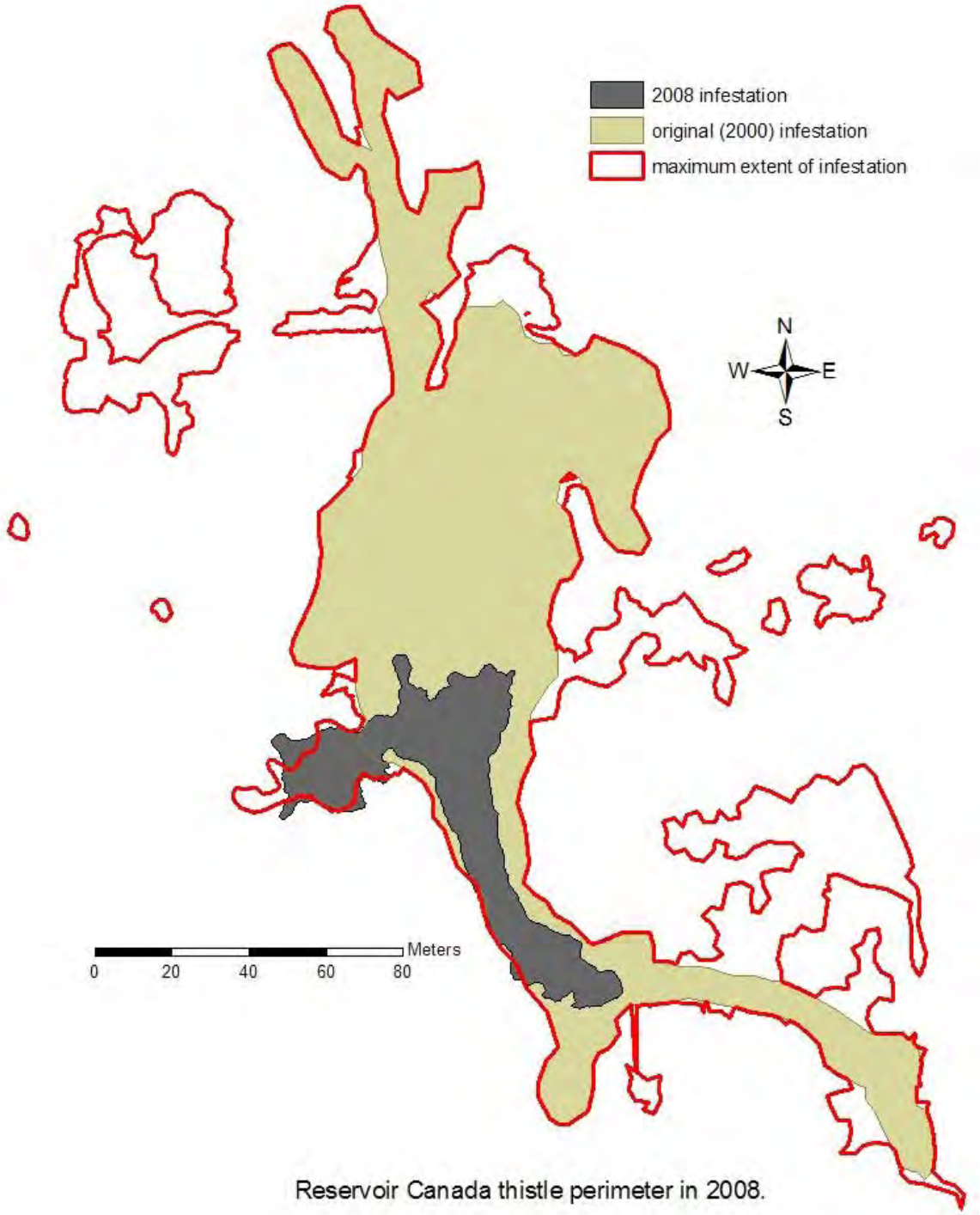
Duckpond Canada thistle density in 2008.



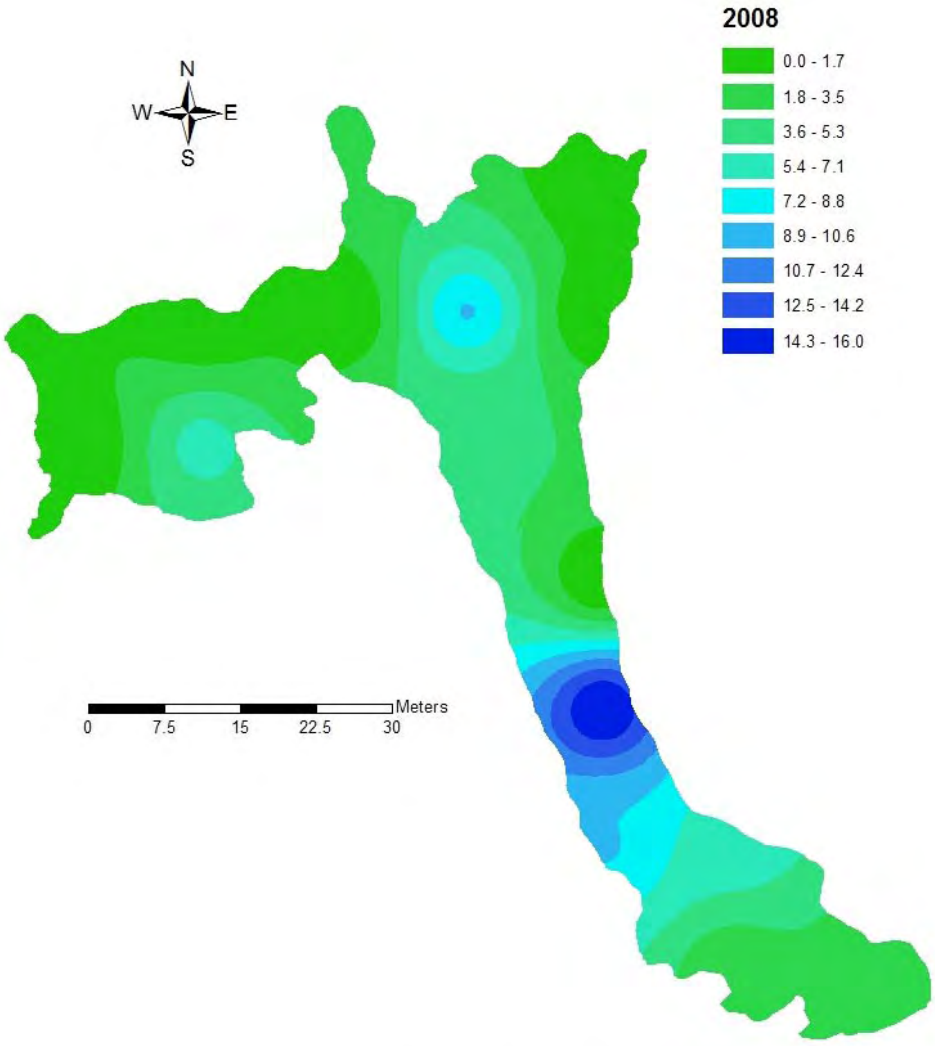


Duckpond Canada thistle height in 2008.

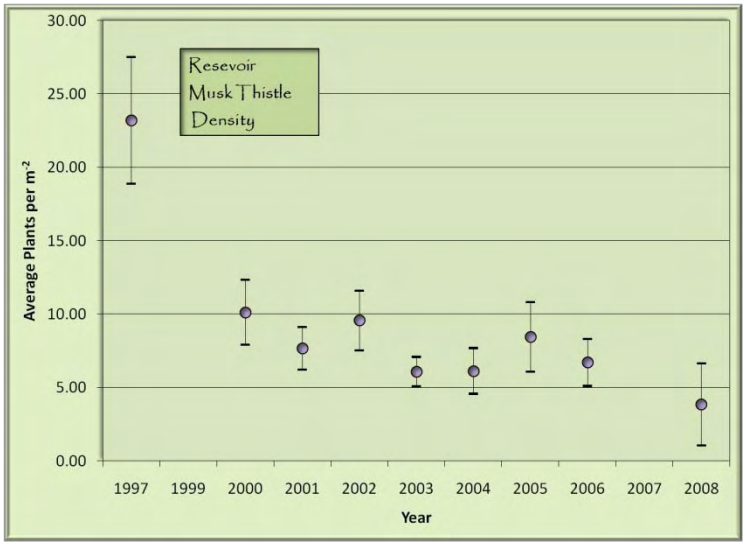


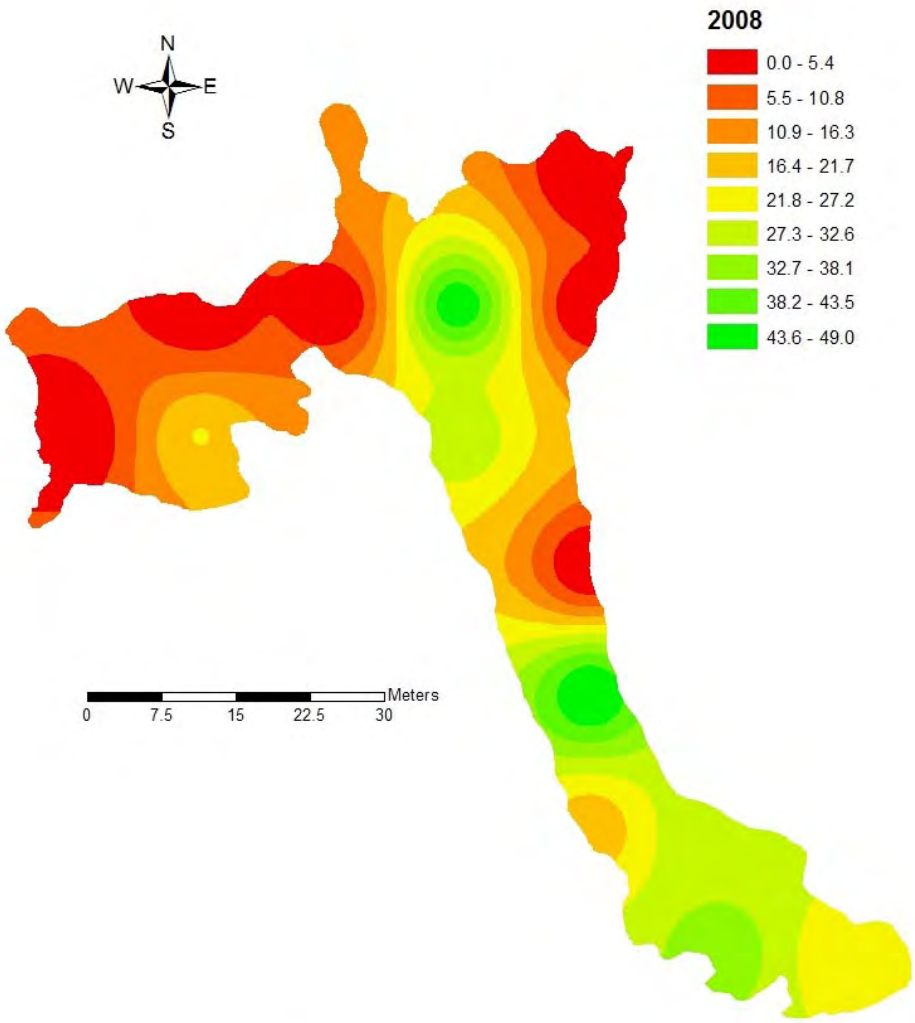


Reservoir Canada thistle perimeter in 2008.

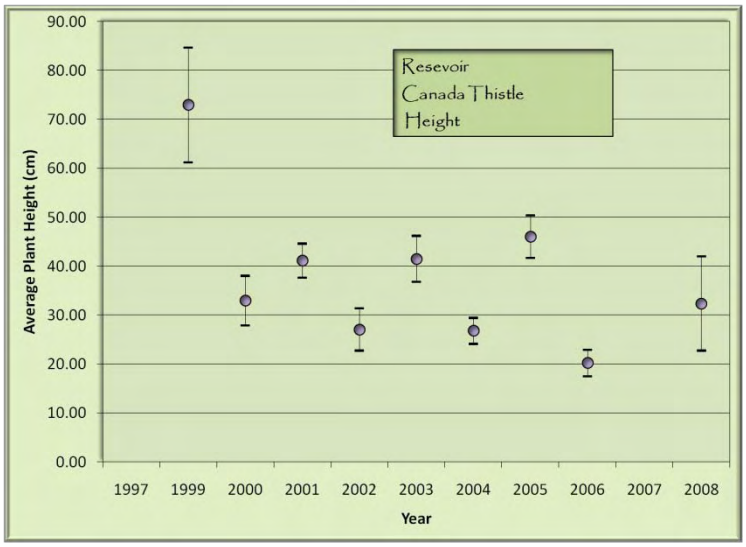


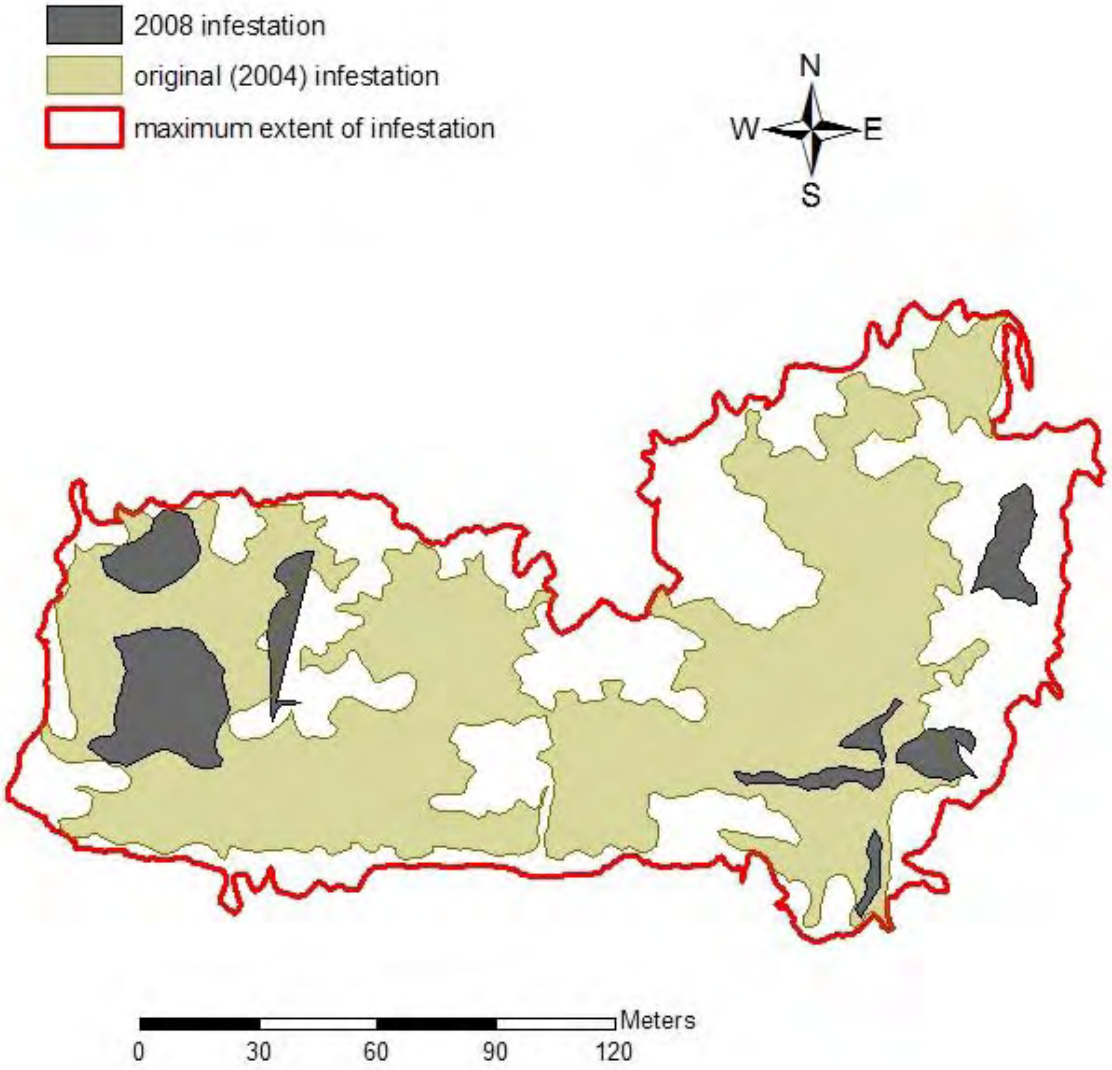
Reservoir Canada thistle density in 2008.



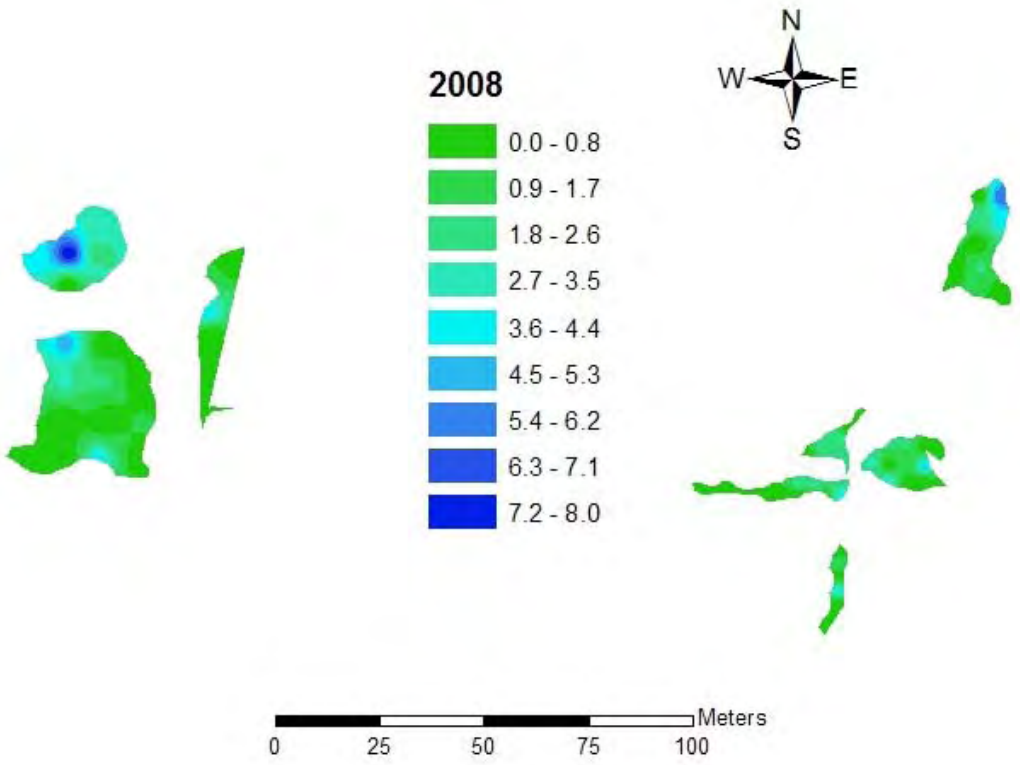


Reservoir Canada thistle height in 2008.

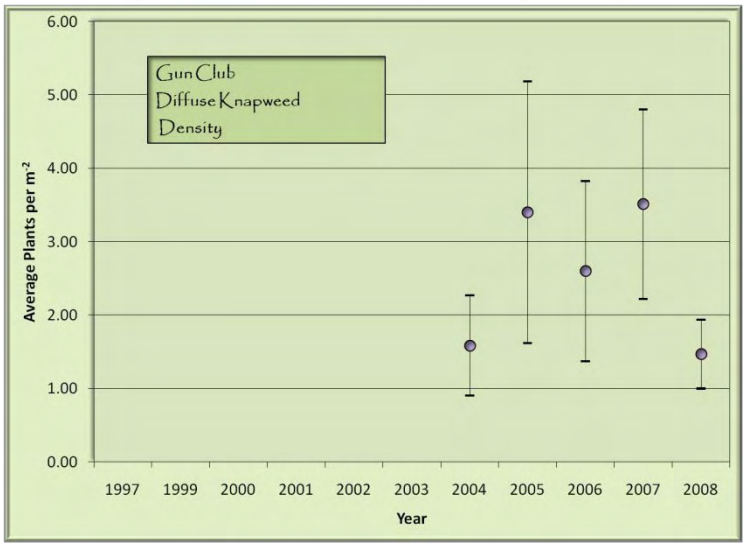


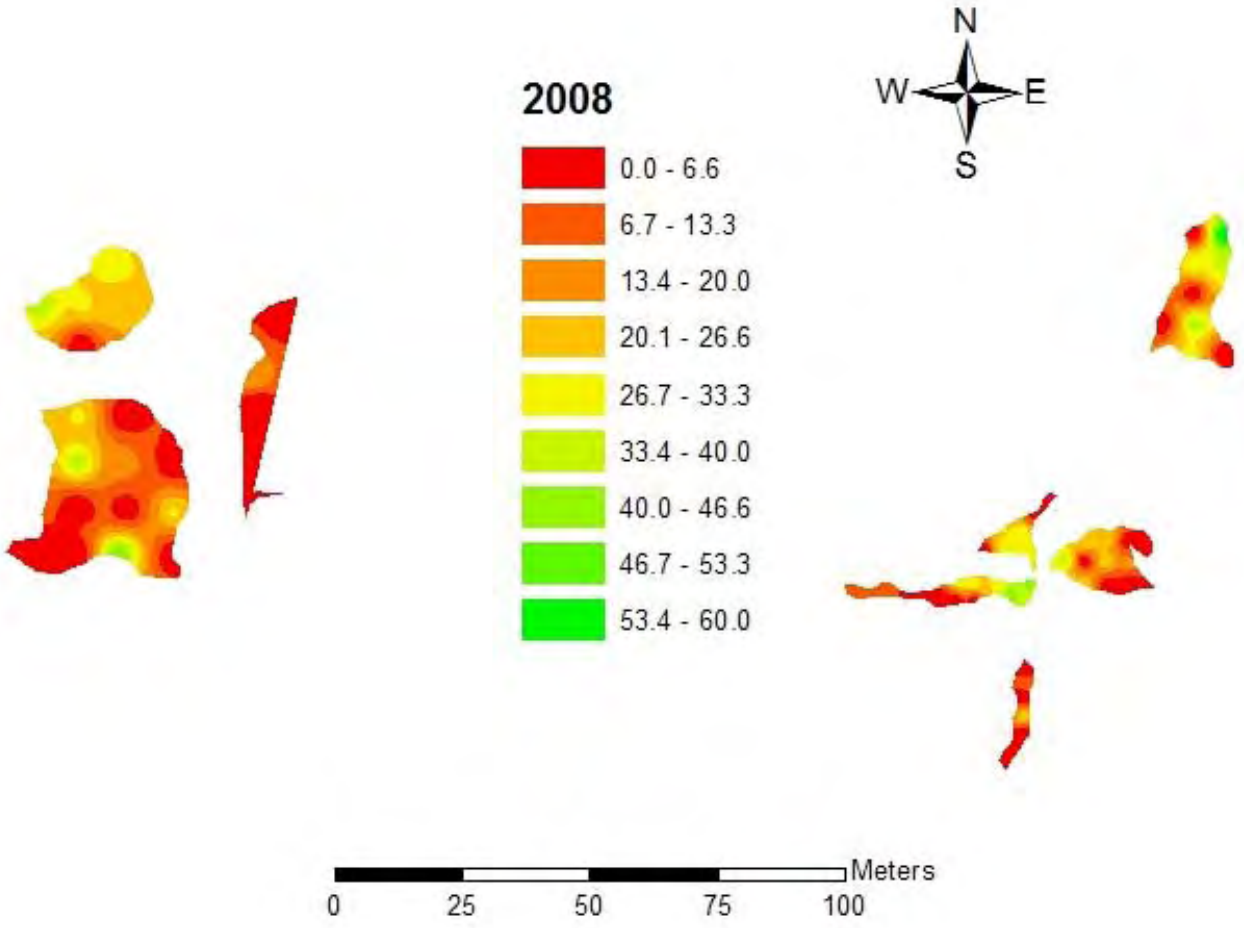


Gun Club diffuse knapweed perimeter in 2008.

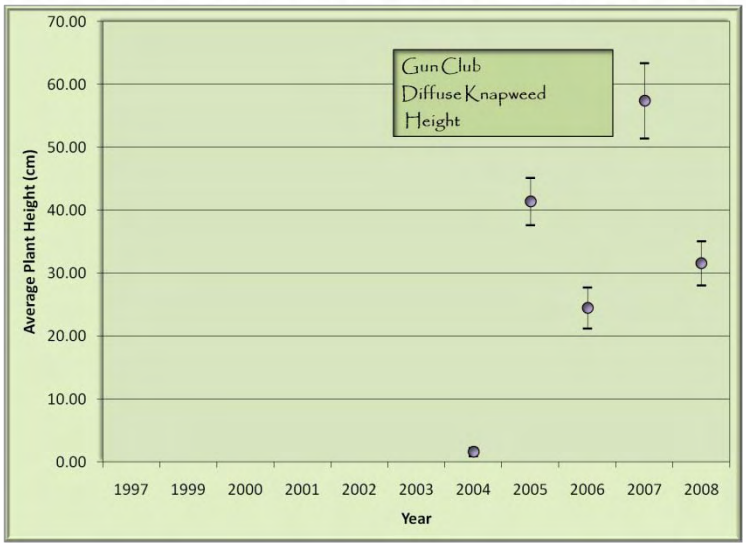


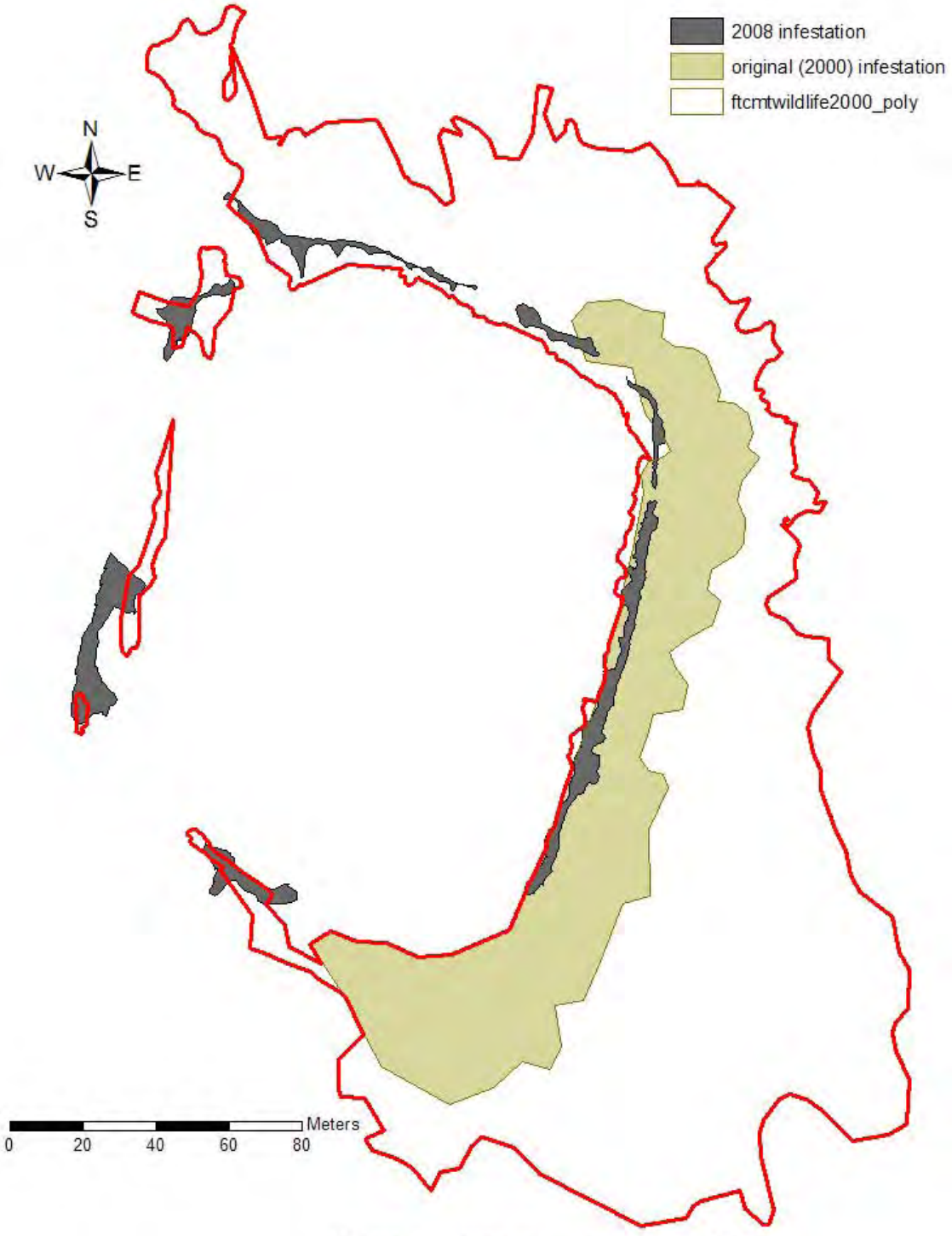
Gun Club diffuse knapweed density in 2008.



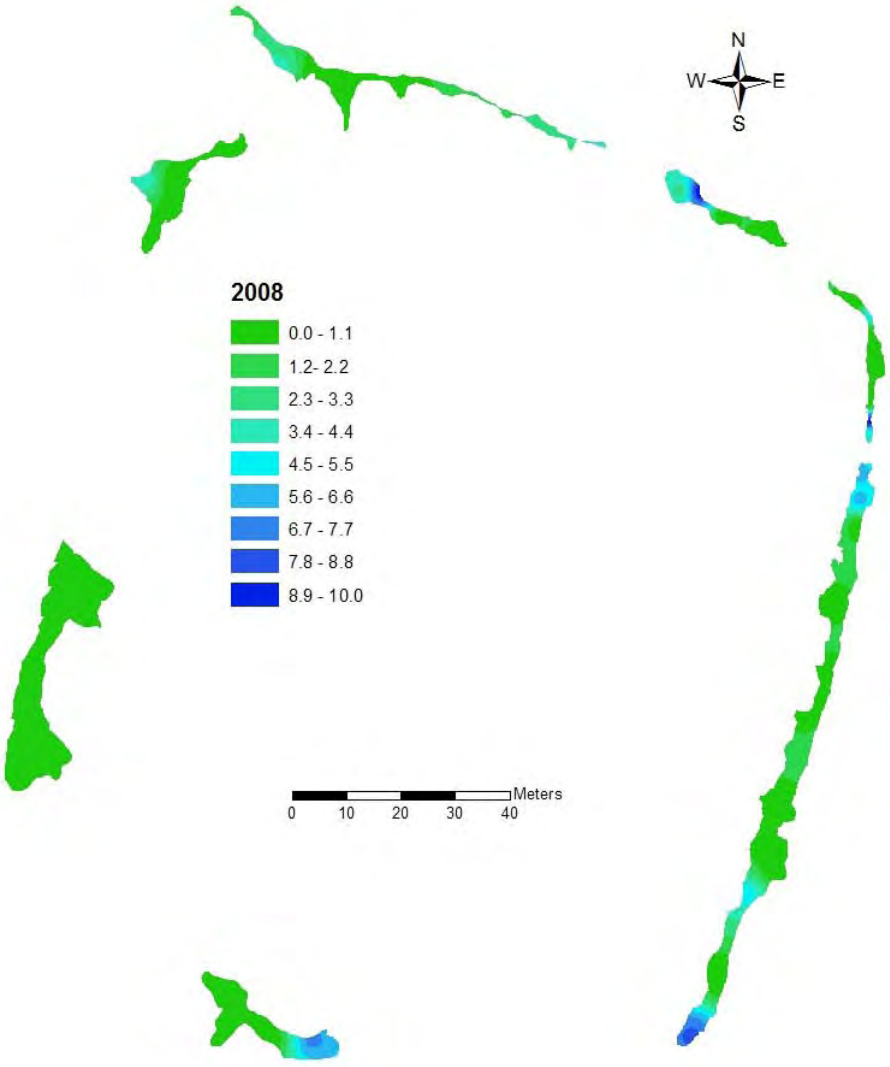


Gun Club diffuse knapweed height in 2008.

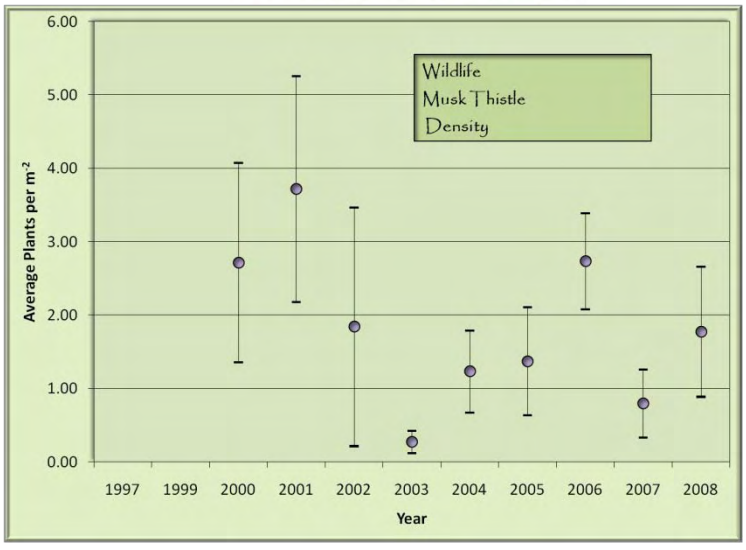


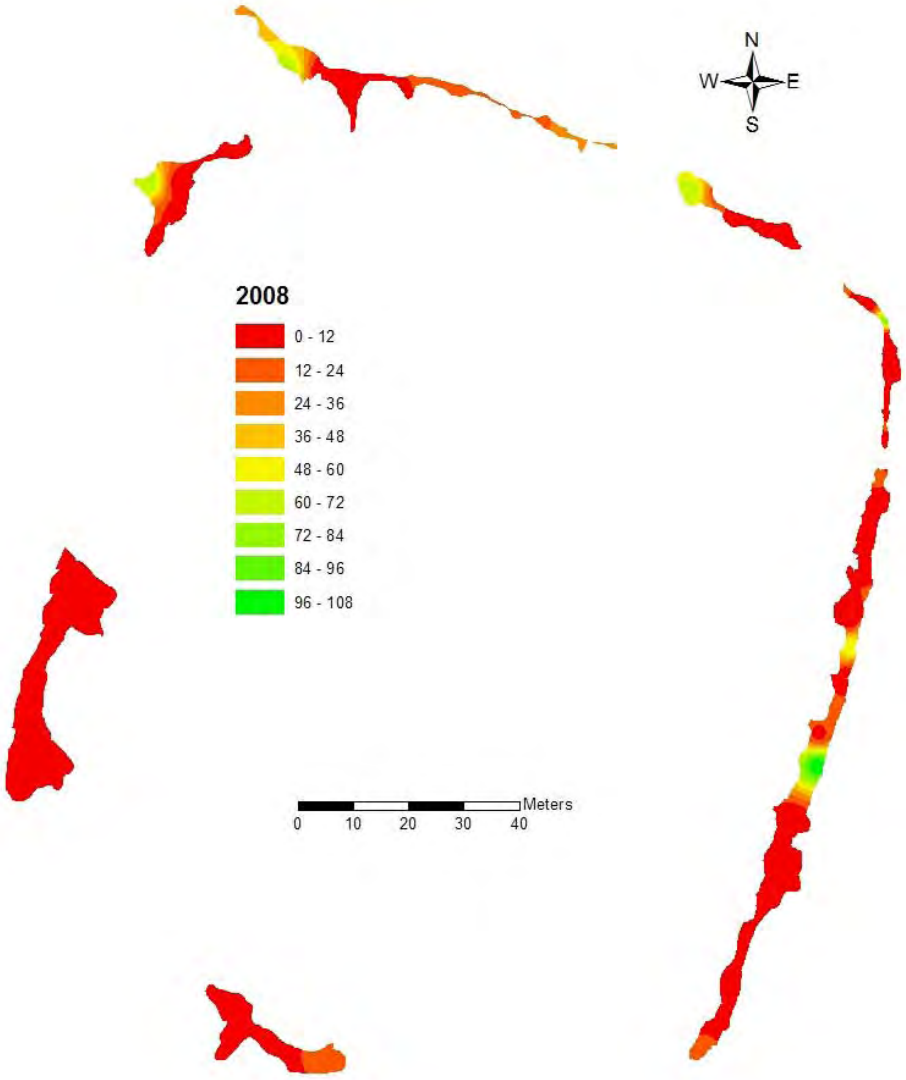


Wildlife musk thistle perimeter in 2008.

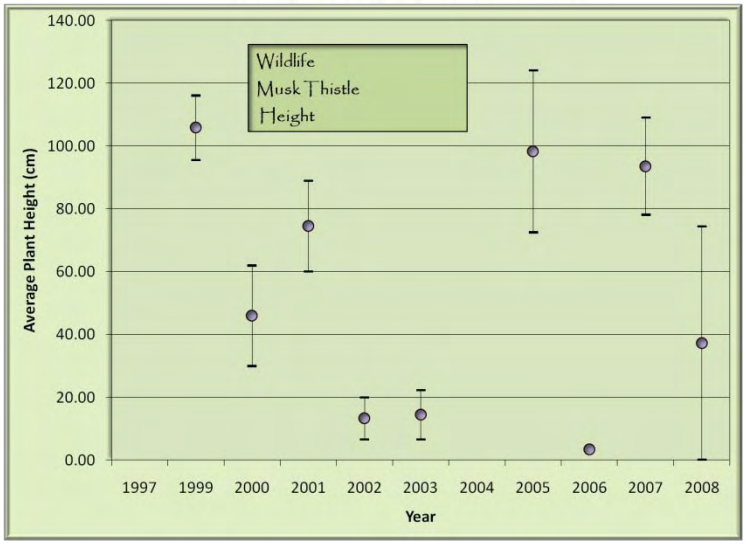


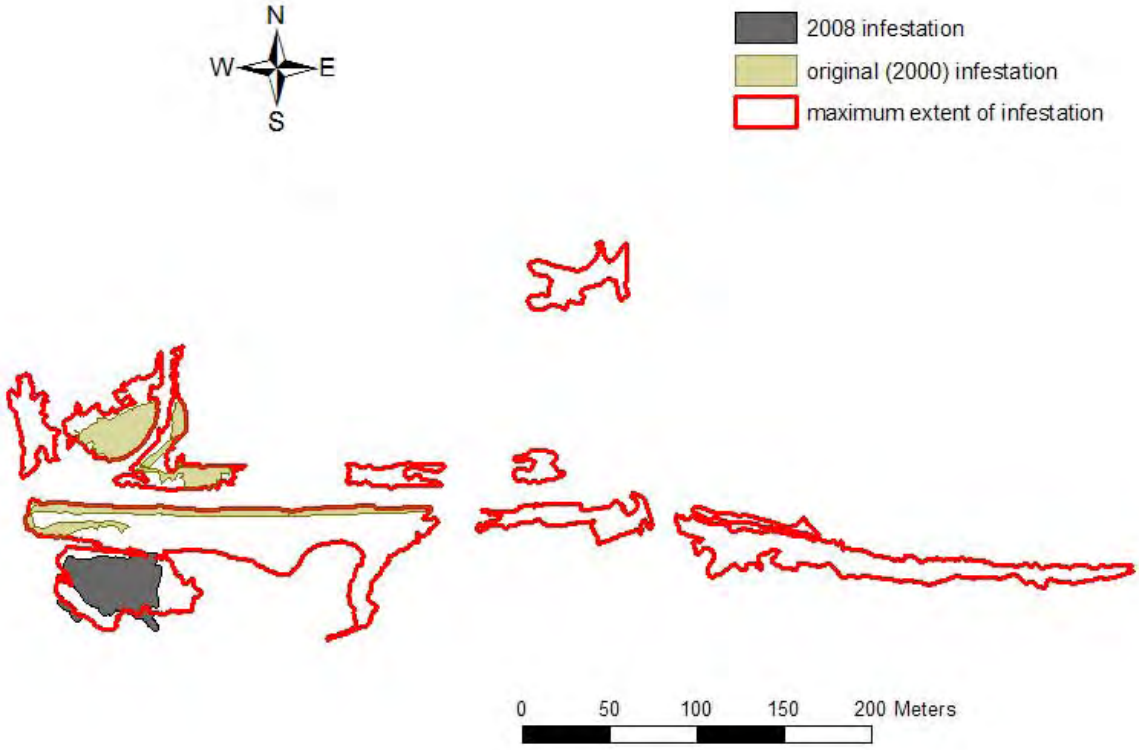
Wildlife musk thistle density in 2008.



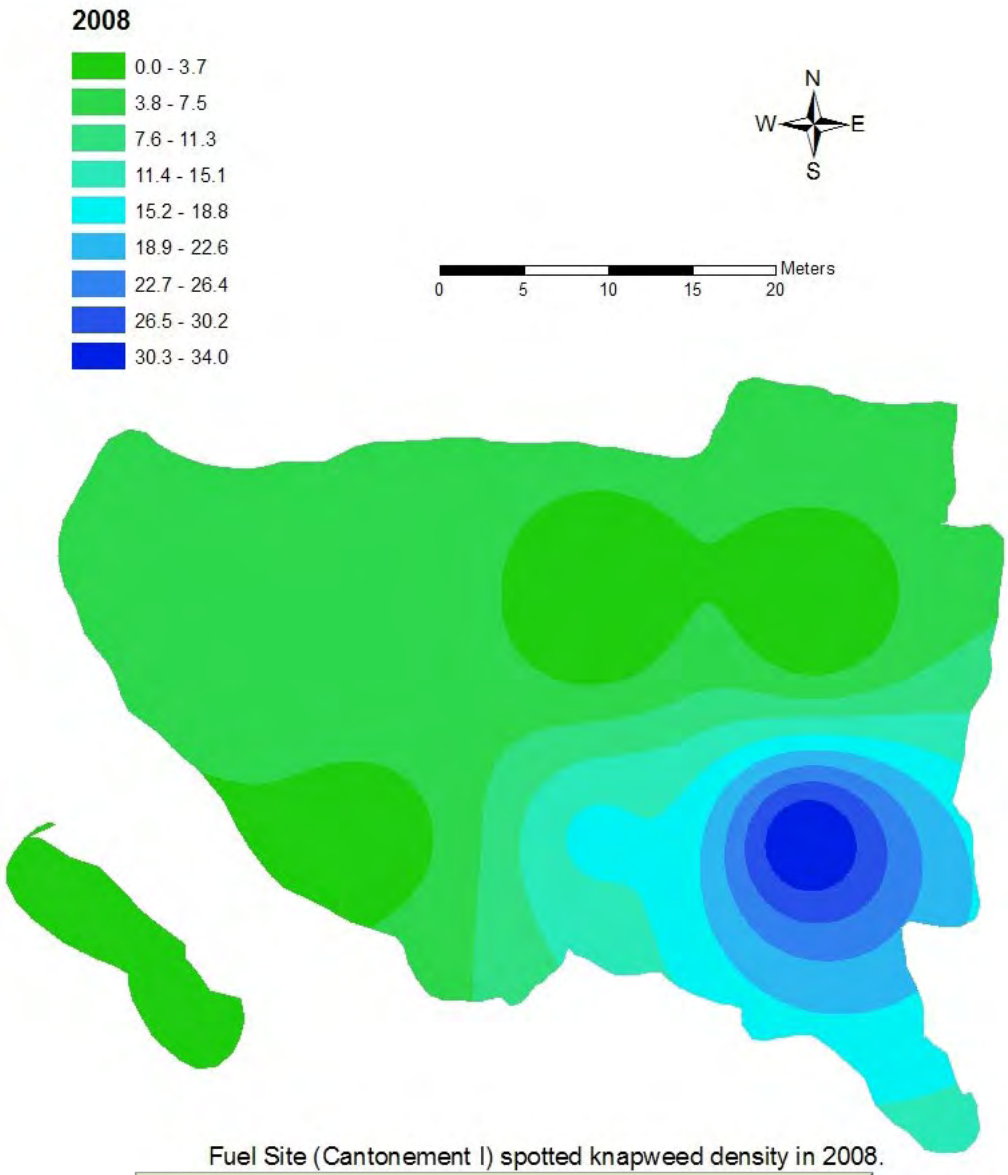


Wildlife musk thistle height in 2008.

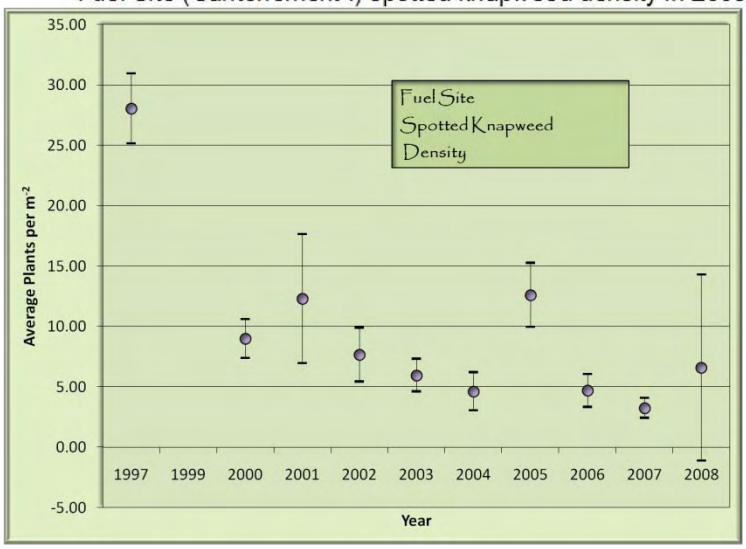


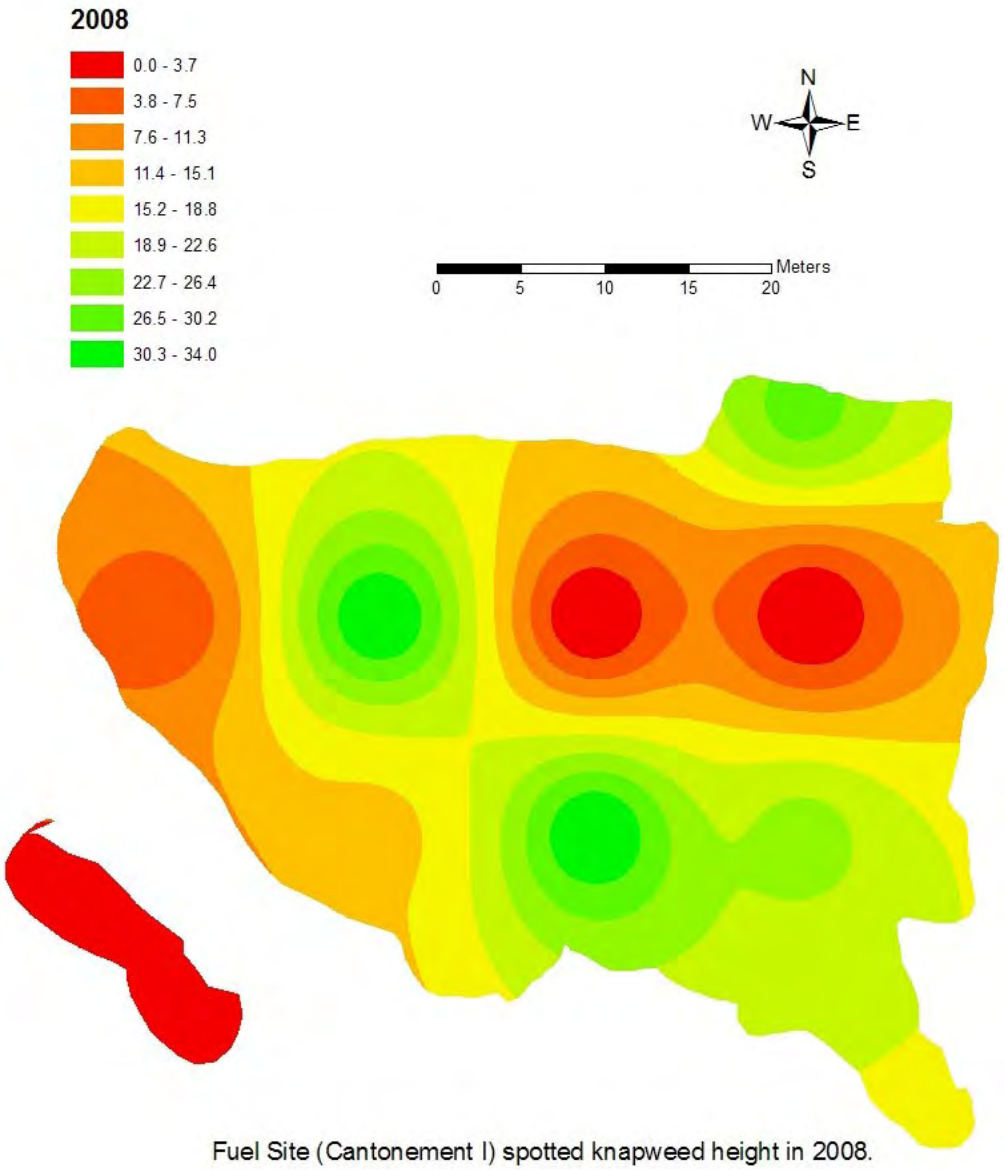


Fuel Site (Cantonement I) spotted knapweed perimeter in 2008.

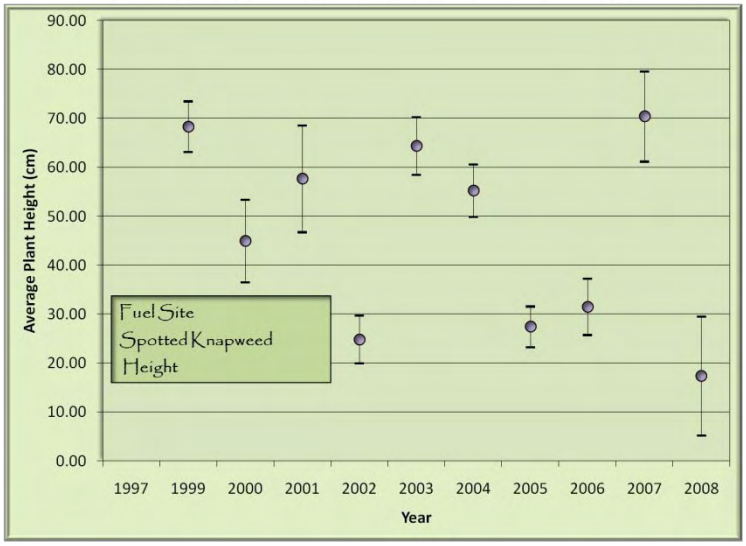


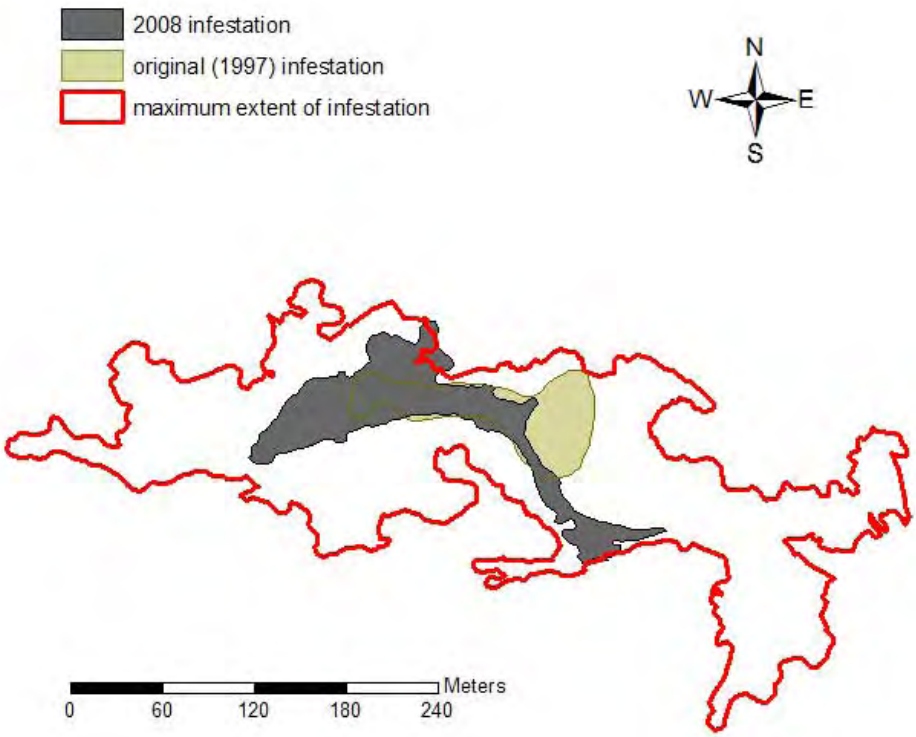
Fuel Site (Cantonement I) spotted knapweed density in 2008.



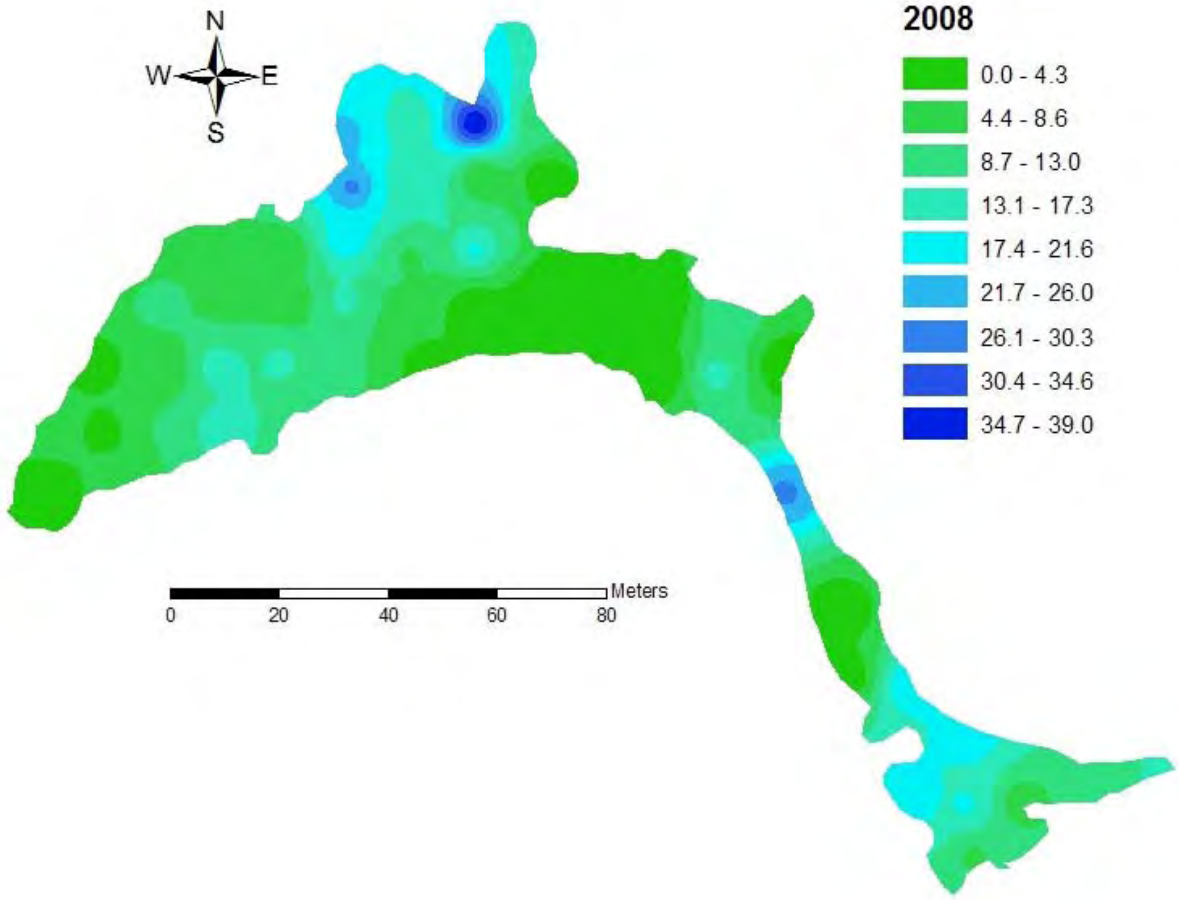


Fuel Site (Cantonement I) spotted knapweed height in 2008.

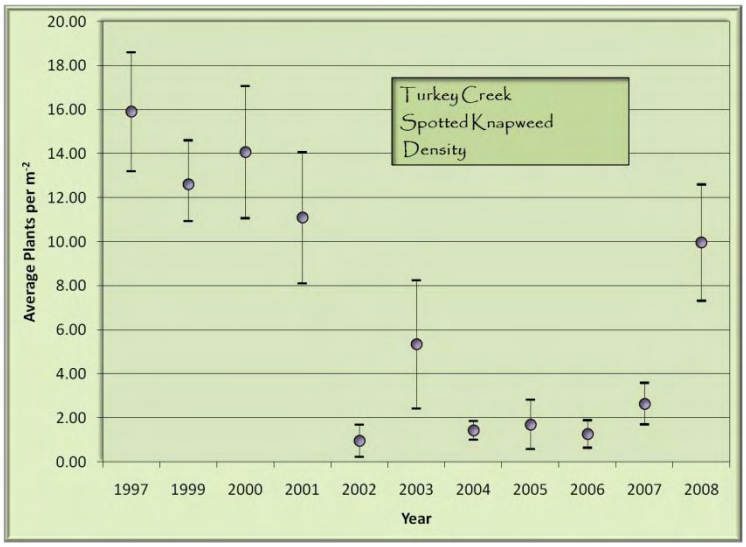


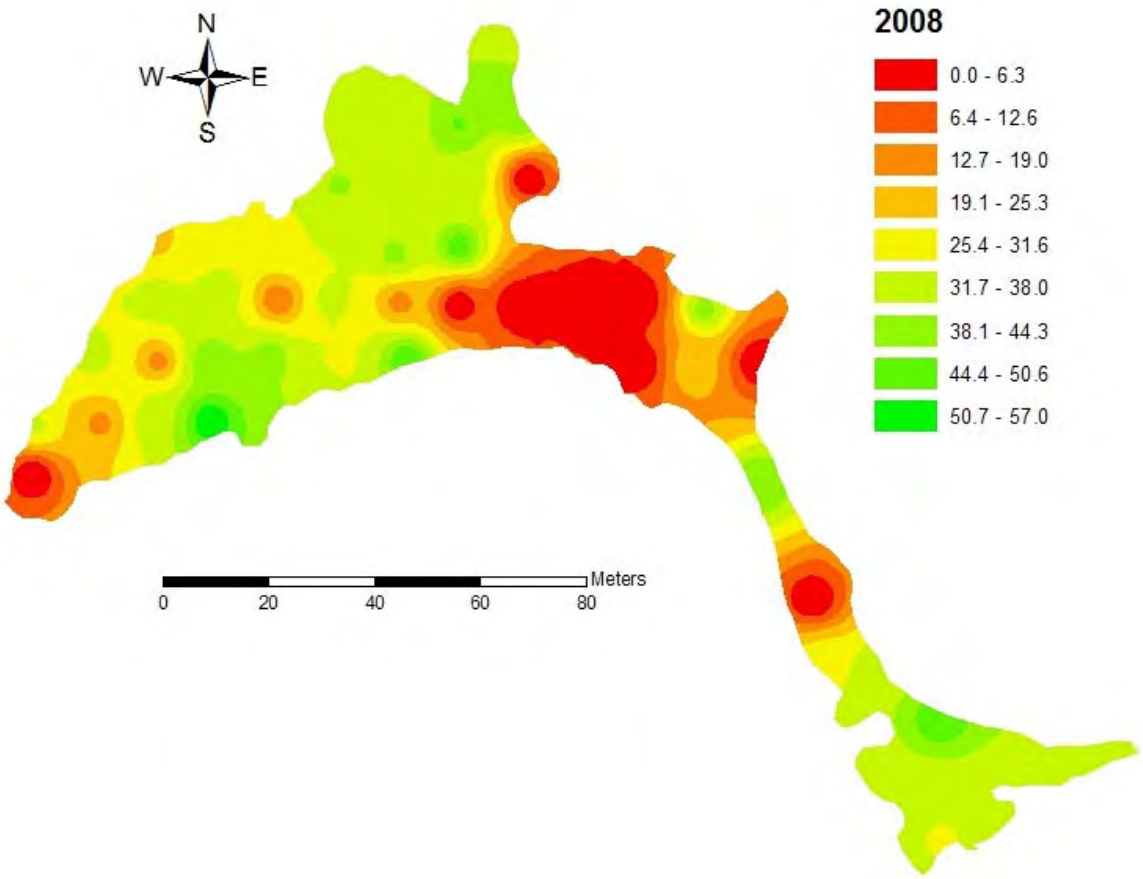


Turkey Creek spotted knapweed perimeter in 2008.

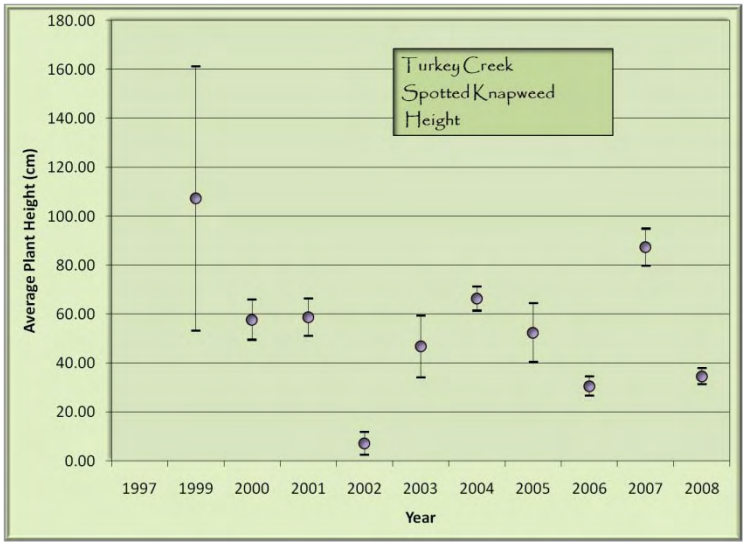


Turkey Creek spotted knapweed density in 2008.





Turkey Creek spotted knapweed height in 2008.



Rocky Flats National Wildlife Refuge

Four invasive plant sites were mapped at Rocky Flats National Wildlife Refuge this year. The Dalmatian toadflax Original (Figure 19) and North Buffer musk thistle sites did not have enough plants to map, however, the Weather site, which had not been mapped since 2004, came back strong with 0.15 ha (0.37 acres) of weeds. Additionally, four field bindweed sites were randomly sampled to assess the establishment of the mite *Aceria malherbae*. The two sites that were fully mapped (Lindsay Ranch Canada thistle and Weather Dalmatian toadflax) covered a total area of 0.79 ha (1.95 acres) (Table 15). Just as last year, the Dalmatian toadflax South Fence and diffuse knapweed North Buffer sites were surveyed as transects. No significant changes occurred in either height or density at any of the four sites sampled.

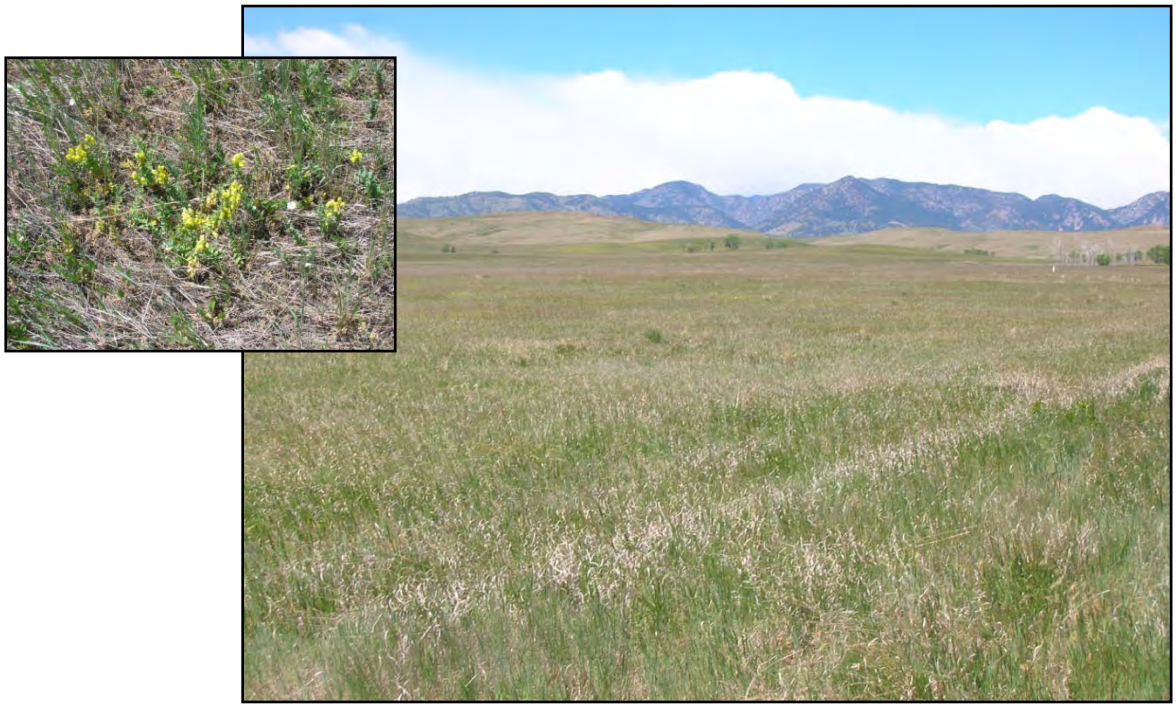


Figure 19. The Original Dalmatian toadflax site, showing only a few scattered populations of toadflax in the background.

This year was conducive to several species of bio-agents at the Lindsey Ranch Canada thistle site (Figure 20). Eleven of the 75 quadrats surveyed when the site was mapped had at least one gall caused by *Urophora cardui*, and 15 galls were counted in all. *Cassida rubiginosa* also flourished at this site, on one insect survey alone 216 *C. rubiginosa* were detected in 10 quadrats. No other site at any of the other participating installations had counts of the insect above five, and most recoveries of *C. rubiginosa* recovery were incidental observations. Similar to Buckley Air Force Base and Fort Carson Military Post, the Canada thistle biocontrol agent *Rhinocyllus conicus* was found to have self-dispersed to the Lindsey Ranch site at Rocky Flats, despite never having been released there. *Larinus planus*, another thistle feeder, was also detected on the site this year, though it was not released on this installation.

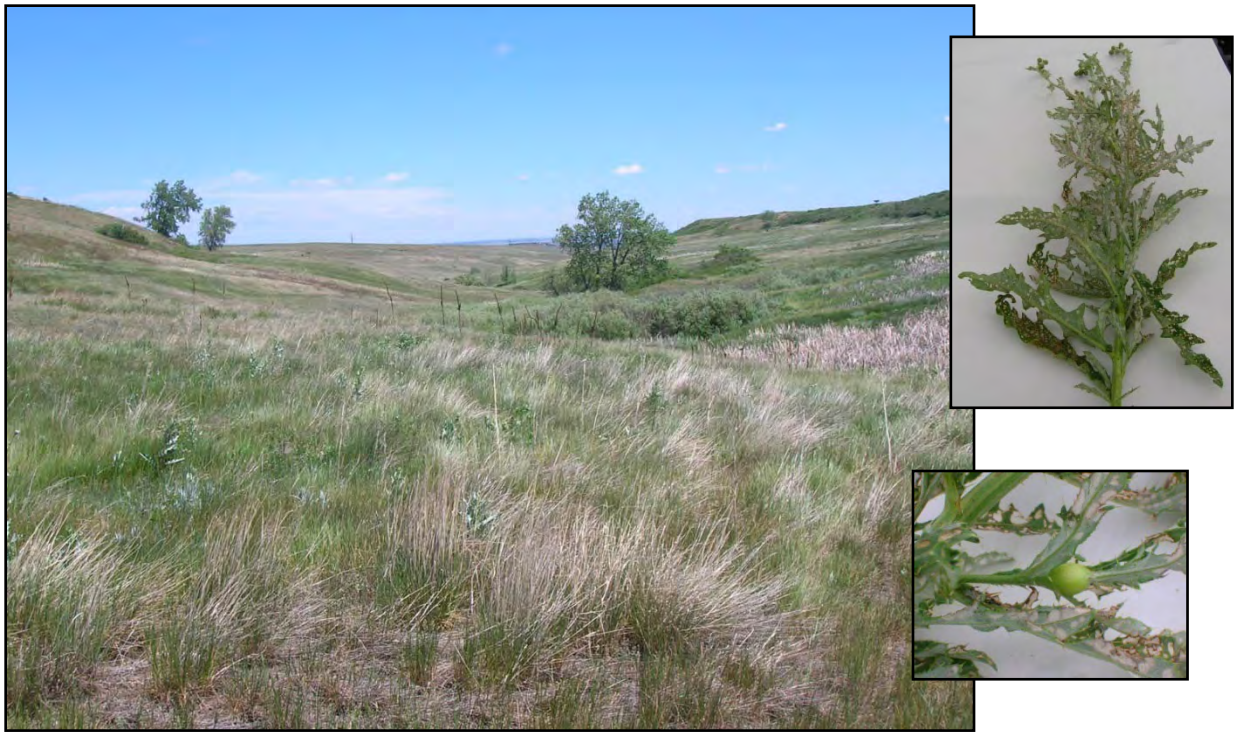


Figure 20. The scenic and pastoral Lindsey Ranch Canada thistle site. High levels of *Cassida rubiginosa* (cause of the window-paneing, upper inset) and *Urophora cardui* (bottom inset) were detected at this site this summer.

The toadflax and knapweed sites did not show any trends this year with regards to plant parameters or insect recoveries compared to last year's numbers. Dissections were carried out on seedheads and roots of plants sampled from the Cardinal transect knapweed site (Table 16). All seedhead and root feeding insects were recovered except for *Agapeta zoegana*. Information regarding the stem feeding insect *Mecinus janthinus* will be obtained from stem dissections conducted in the spring of 2009.

Figure 21. Root tunneling larvae munching on knapweeds at the field bindweed sites 8 and 9, near Lindsay Ranch.

Field bindweed sites Highroad 1, Highroad 2, Site 8 and Site 9 were randomly sampled for the mite *A. malherbae.* Only the Highroad1site appeared to have a well established mite colony with 60% of quadrats having infested runners. Releases of mites on infested runners collected in Amarillo, Texas, were made at the Highroad site, Site 6, Site 7 and Site 8. More releases are planned for next year if necessary; we also plan to incorporate mowing with our releases as has been done in previous years. Experience has shown that mowing bindweed sites approximately two weeks after the release of *A. malherbae* can increase the distribution and infection rates.

Figure 22. Student worker Brian Mulhern shows a field bindweed runner heavily infested by the leaf gall mite *Aceria malherbae*. The runner was collected at the field bindweed Site 8.

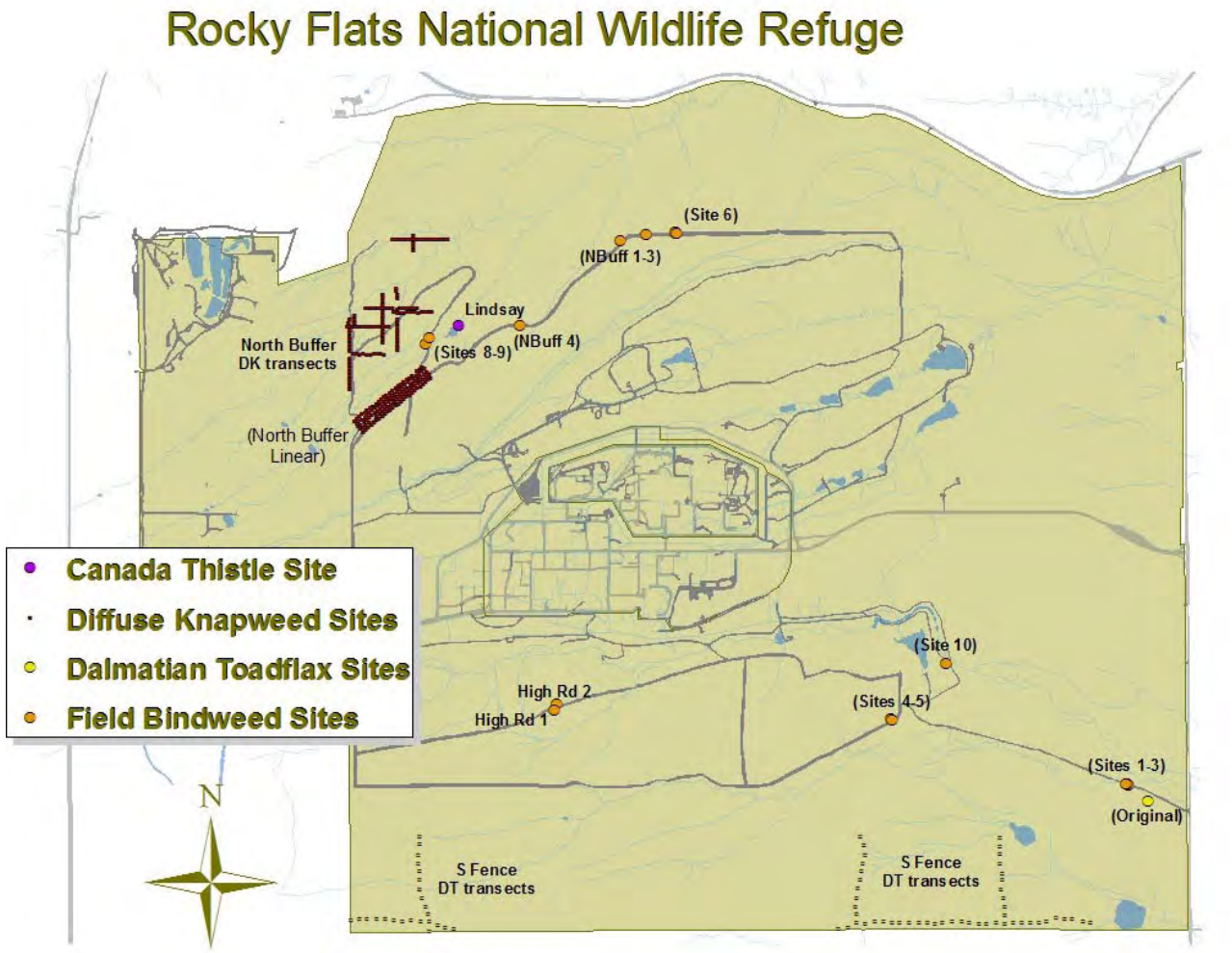


Figure 23: Schematic diagram of Rocky Flats National Wildlife Refuge with weed biological control study areas superimposed. Sites listed in parentheses were not surveyed in 2008.

Table 15. Historic noxious weed infestation parameters, Rocky Flats National Wildlife Refuge, Golden, Colorado, 2001-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Canada thistle – Lindsay Ranch													
2004	692	43	7.84	34	56.05	104	1.64	0.30					
2005	2,205	30	5.93	16	94.23	165	18.14	0.72	218.64	-24.36	68.12		
2006	5,617	47	5.89	19	46.07	100	9.28	0.51	154.74	-0.67	-51.11		
2007	2,560	36	4.53	45	58.45	98	8.09	5.68	-54.42	-23.09	26.87		
2008	6,355	75	4.15	18	46.97	86	5.97	3.27	148.24	-8.39	-19.64	818.35	-47.07
Dalmatian toadflax – Original Site													
2001	1,688	48	22.43	64	52.94	84							
2002	7,913	93	3.81	23	12.90	55			368.78	-83.01	-75.63		
2003	*(see Note)*												
2004	*(see Note)*												
2005	2,216	69	8.21	26	43.40	66	16.81						
2006	1,686	90	1.16	19	12.15	20			-23.91	-85.87	-72.00		
2007	26,077	44	1.45	17	46.23	62			1446.68	25.00	280.49	1444.85	-93.54
2008	*(see Note)*												
Dalmatian toadflax – South Fence *													
2005		71	3.04	29	47.94	74	9.76	1.12					
2006		74	1.31	12	26.50	57	1.40			-56.91	-44.72		
2007		74	2.05	21	49.25	79				56.48	85.84		
2008		24	3.96	20	48.57	74				93.17	-1.38		30.26
Dalmatian toadflax - Weather													
2003			3.24		68.92								
2004			4.97		46.92					53.40	-31.92		
2005													
2006													
2007													
2008	1516	10	1.50	5	23.17	27				-69.82**	-50.92**		-53.70

Table 15. Historic noxious weed infestation parameters, Rocky Flats National Wildlife Refuge, Golden, Colorado, 2001-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
Diffuse knapweed – North Buffer *													
2004		249	0.85	12	17.72	72	21.37	0.18					
2005		250	1.13	21	52.95	120	49.72	0.53		32.94	198.81		
2006		249	0.59	22	34.43	188	53.00	0.42		-47.79	-34.98		
2007		123	0.44	11	46.17	73	117.21	3.75		-25.42	34.10		
2008		122	0.67	28	40.61	81	158.89	3.83		52.27	-12.04		-21.18

n – number of samples or observations
* - infestation was not mapped (a linear transect method was utilized to survey the weed population)
** - values given in the year-to-year change column reflect 2- or 3-year changes, as sampling was not done at all sites all years
Note - site was not mapped, as toadflax infestation had been reduced to a few scattered plants

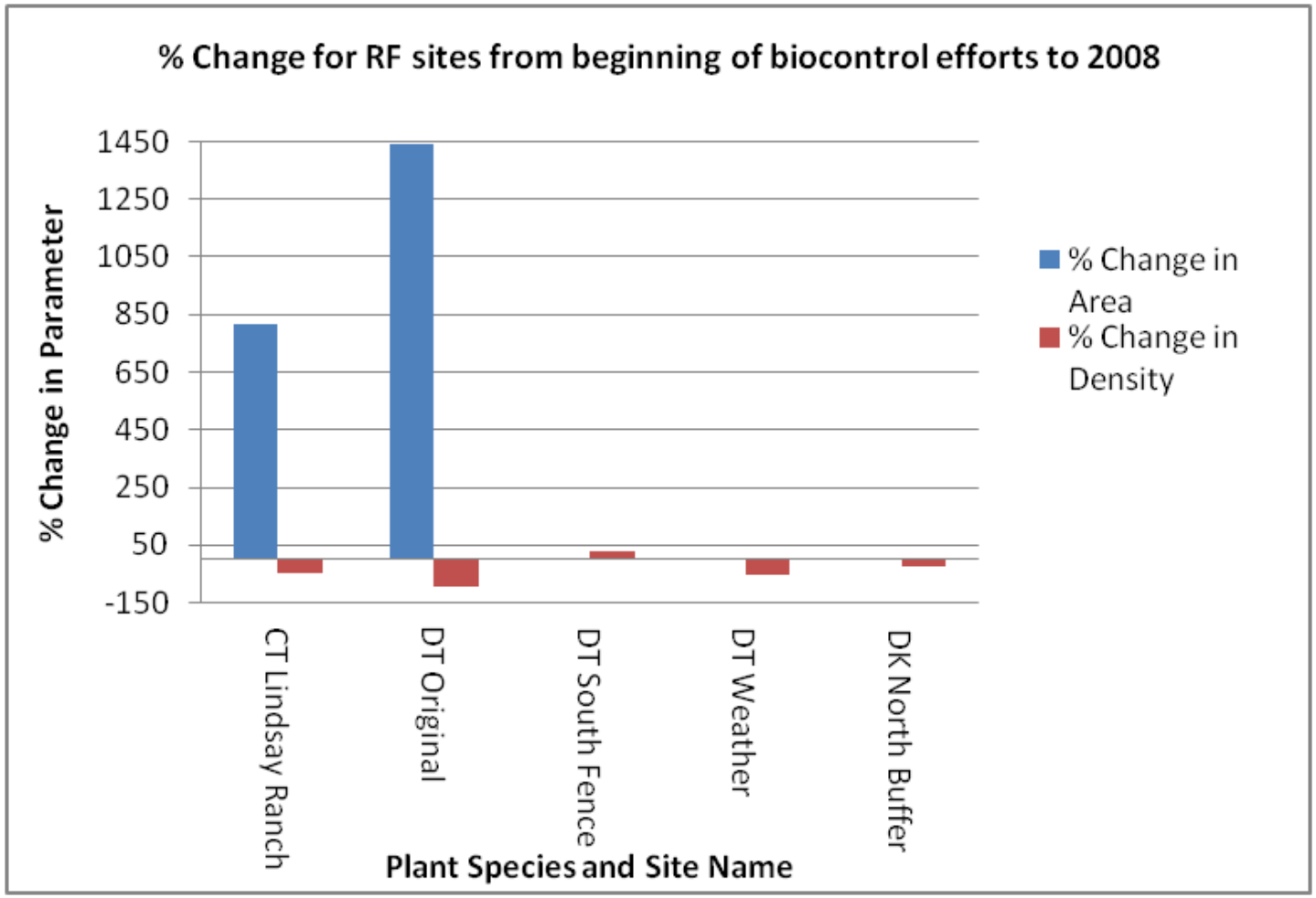


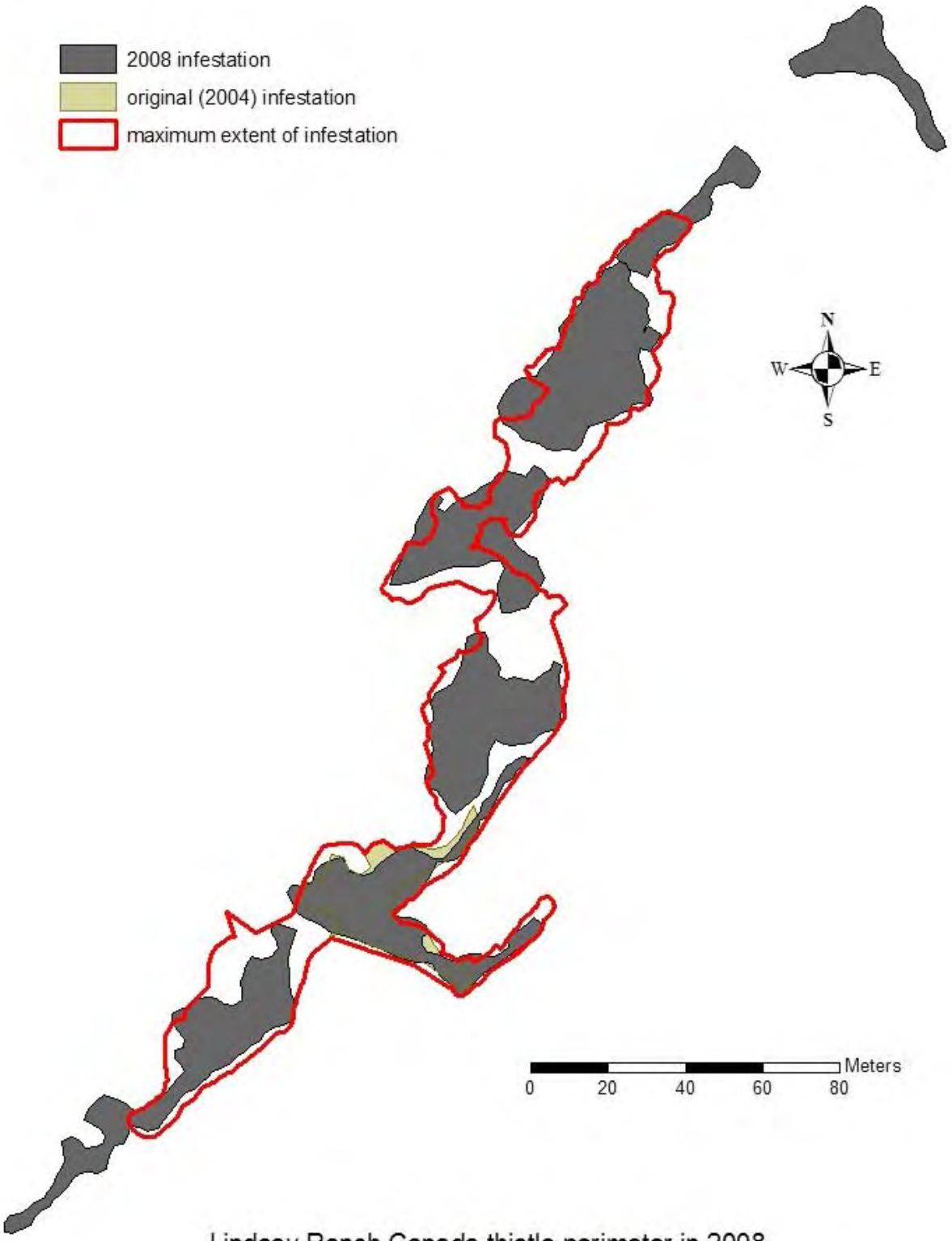
Figure 24. Percent change in area and density of all sites at Rocky Flats. The percent change is calculated by dividing the difference in the parameters between the first year they were monitored and this year's data by the area or density from this year. The number of years represented vary and depend on when the sites were established. The South Fence and North Buffer sites have no area data; the Weather site has area data only for this year.

Table 16. Noxious weed biological control sites, target weeds, species released and recoveries at Rocky Flats National Wildlife Refuge, Golden, Colorado, 2008.

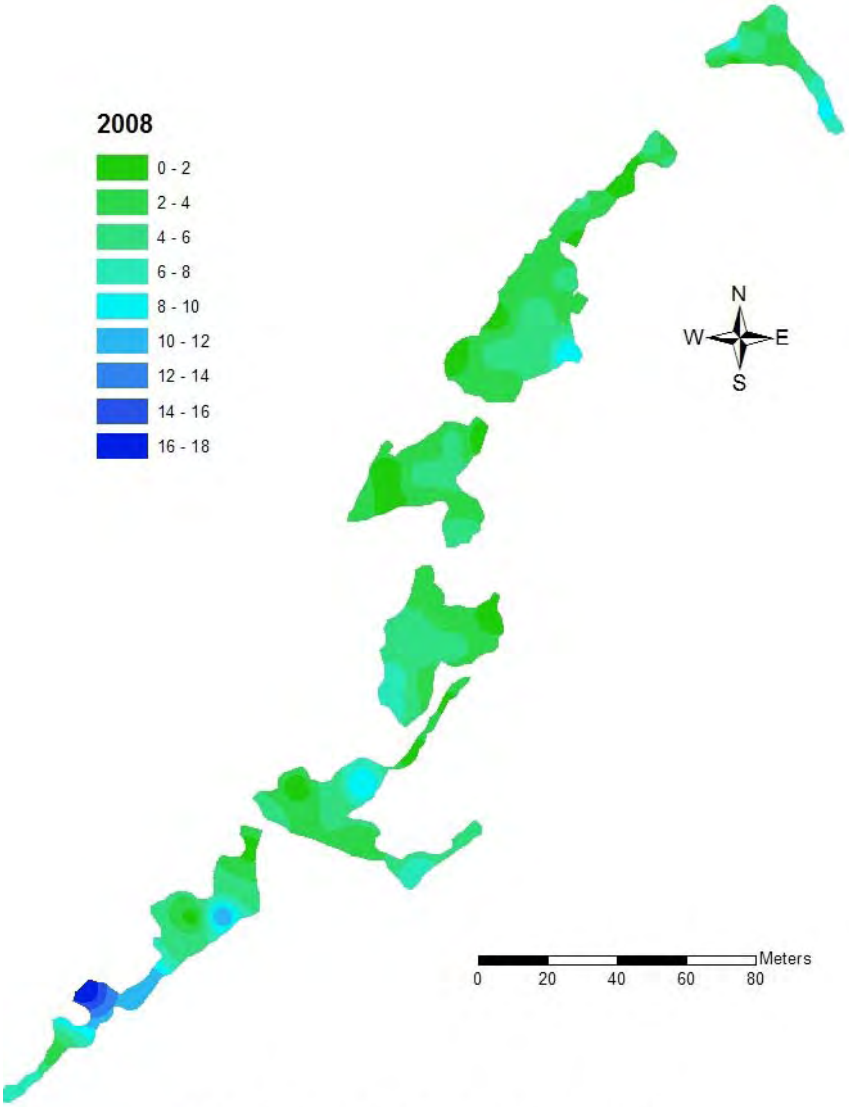
Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
RF	Canada thistle	Lindsay Ranch	*Cassida rubiginosa*	X		
RF	Canada thistle	Lindsay Ranch	*Larinus planus*	X[1]		
RF	Canada thistle	Lindsay Ranch	*Rhinocyllus conicus*	X[1]		
RF	Canada thistle	Lindsay Ranch	*Urophora cardui*	X		
RF	Musk thistle	North Buffer	*Trichosirocalus horridus*			
RF	Diffuse knapweed	Northwest Buffer Zone	*Agapeta zoegana*			
RF	Diffuse knapweed	Northwest Buffer Zone	*Cyphocleonus achates*	X		
RF	Diffuse knapweed	Northwest Buffer Zone	*Larinus minutus*	X		
RF	Diffuse knapweed	Northwest Buffer Zone	*Metzneria paucipunctella*	X		
RF	Diffuse knapweed	Northwest Buffer Zone	*Sphenoptera jugoslavica*	X		
RF	Diffuse knapweed	Northwest Buffer Zone	*Urophora affinis*	X		
RF	Diffuse knapweed	Northwest Buffer Zone	*Urophora quadrifasciata*	X[1,2]		
RF	Dalmatian toadflax	Original Site	*Mecinus janthinus*	X		
RF	Dalmatian toadflax	Southeast Buffer Zone	*Mecinus janthinus*			
RF	Dalmatian toadflax	Sites III & IV	*Mecinus janthinus*			
RF	Dalmatian toadflax	South Fence	*Mecinus janthinus*			
RF	Dalmatian toadflax	Weather	*Mecinus janthinus*	X[2]		
RF	Field bindweed	Multiple sites	*Aceria malherbae*	X	X	

[1] Adventitious recovery, this species not released at this site

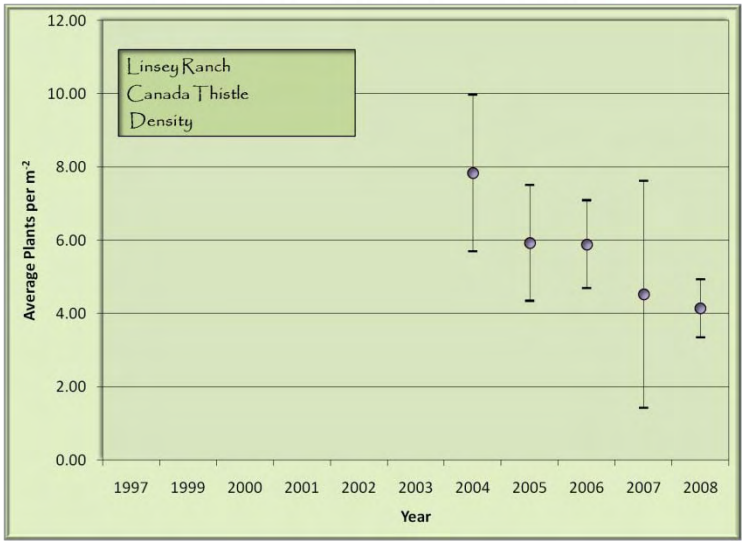
[2] New recovery in 2008

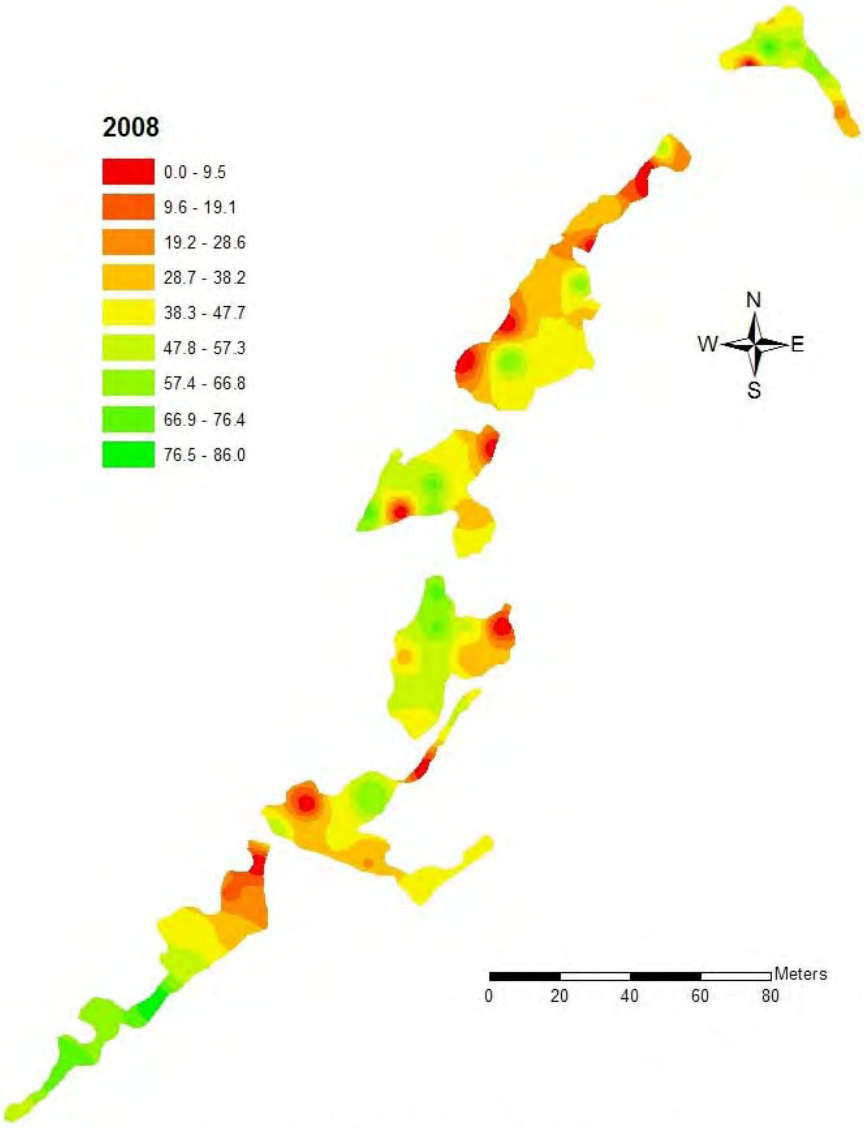


Lindsay Ranch Canada thistle perimeter in 2008.

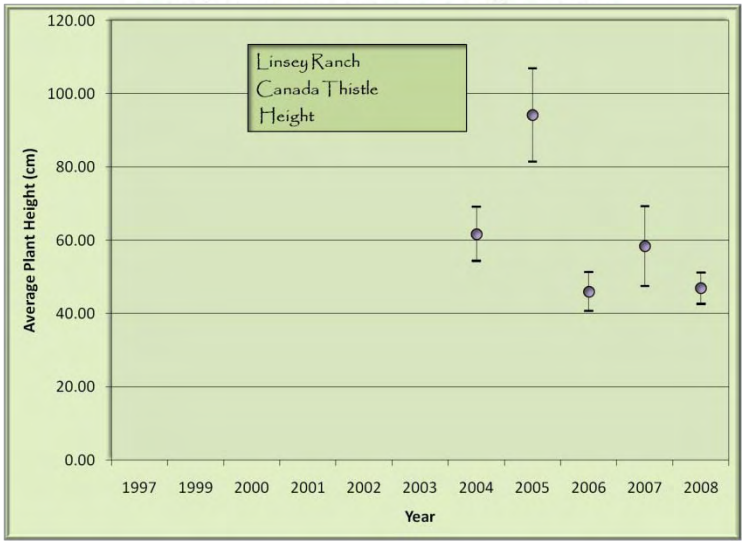


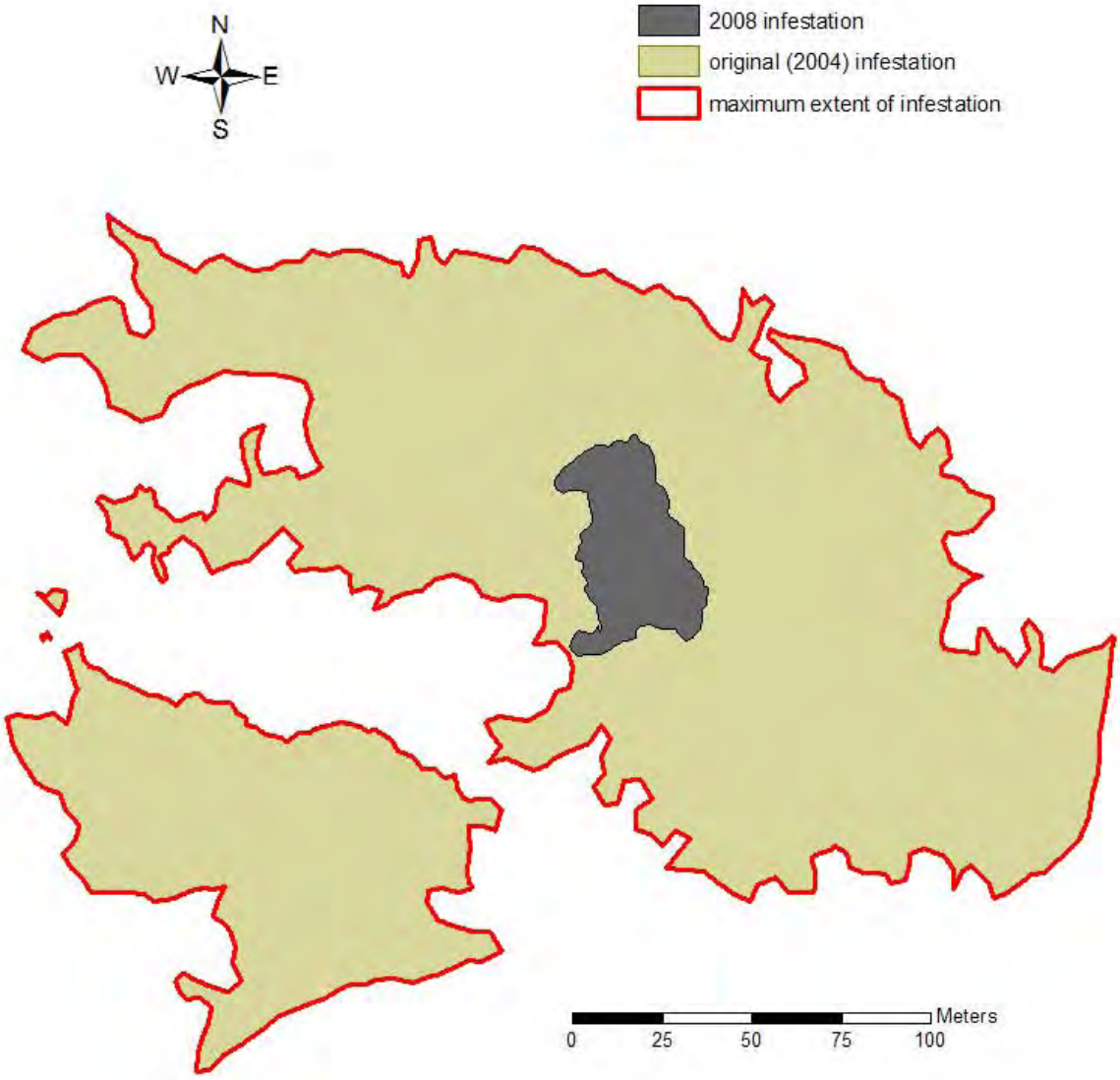
Lindsay Ranch Canada thistle density in 2008.



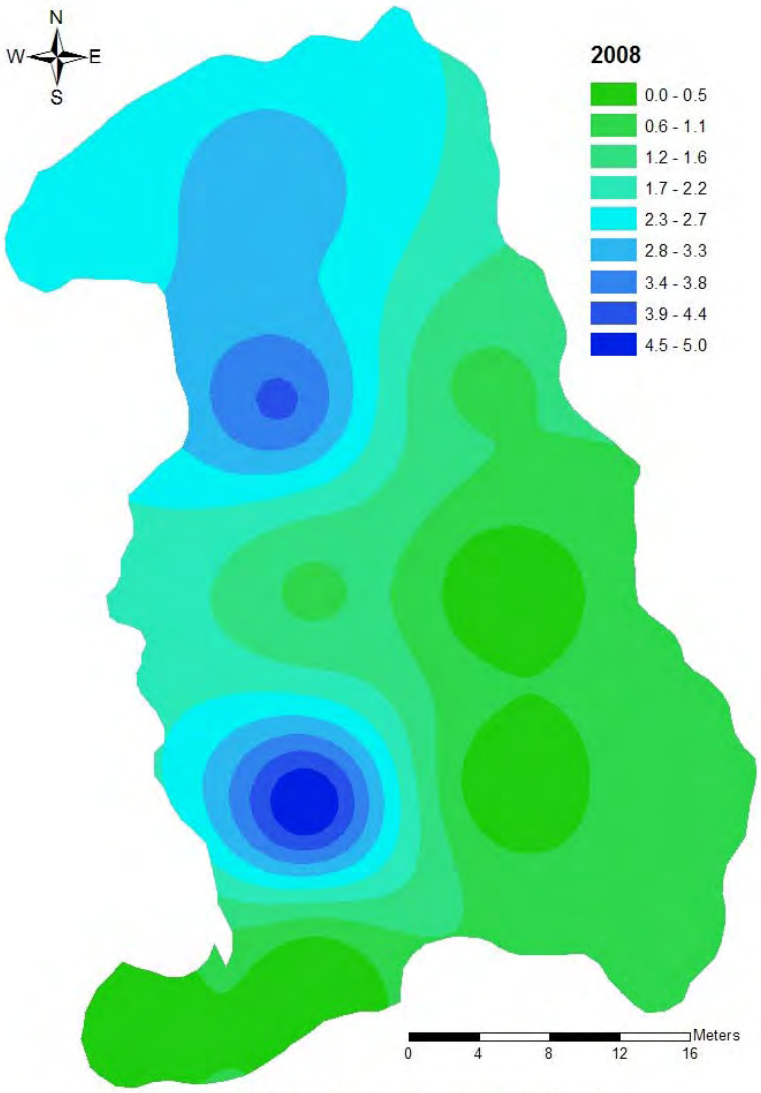


Lindsay Ranch Canada thistle height in 2008.

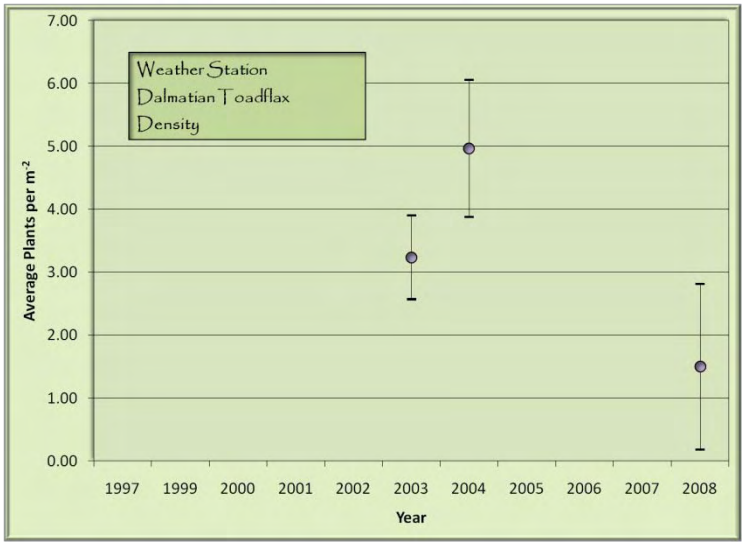


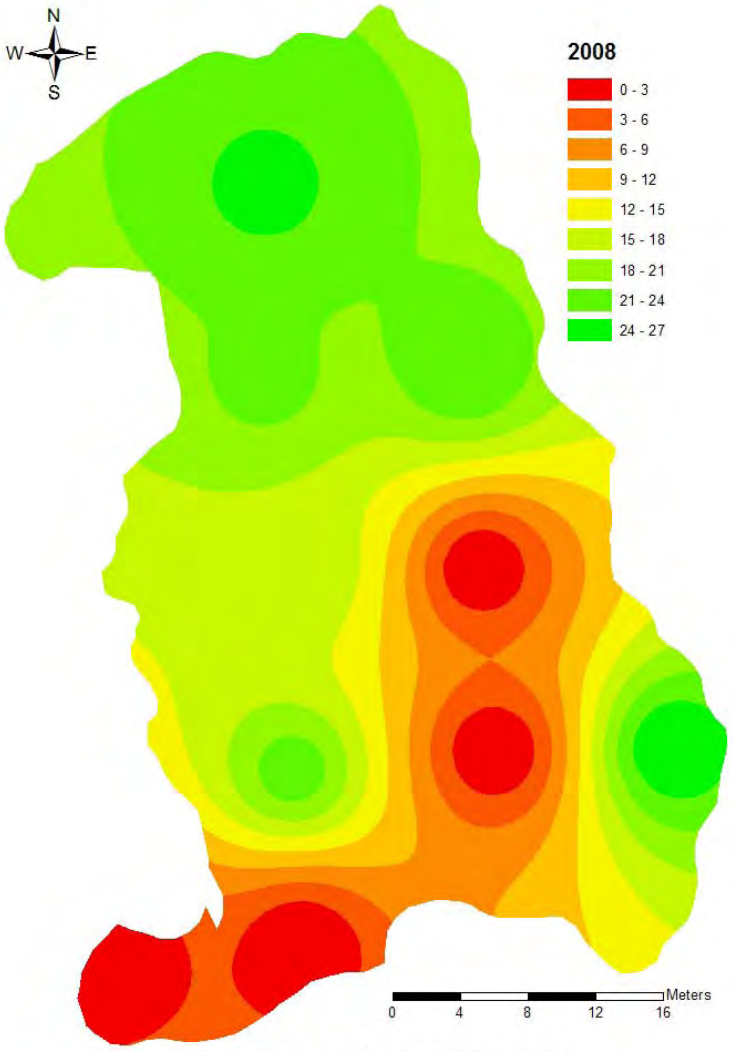


Weather Dalmatian toadflax perimeter in 2008.

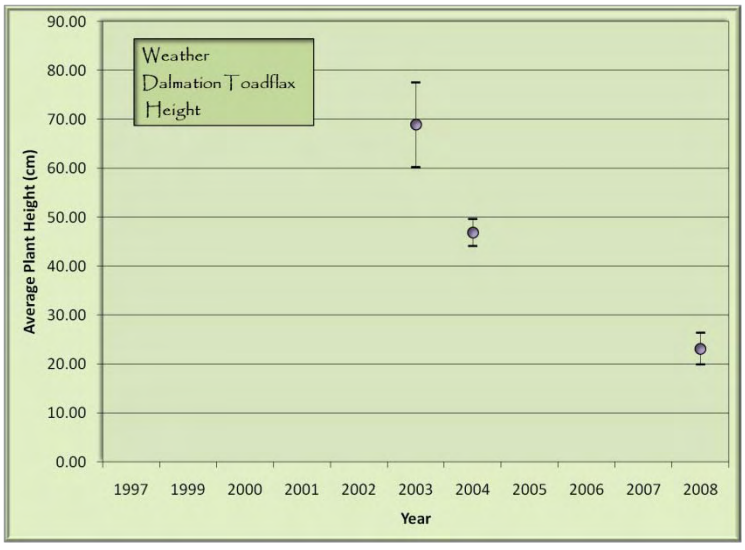


Weather Dalmatian toadflax density in 2008.





Weather Dalmatian toadflax height in 2008.



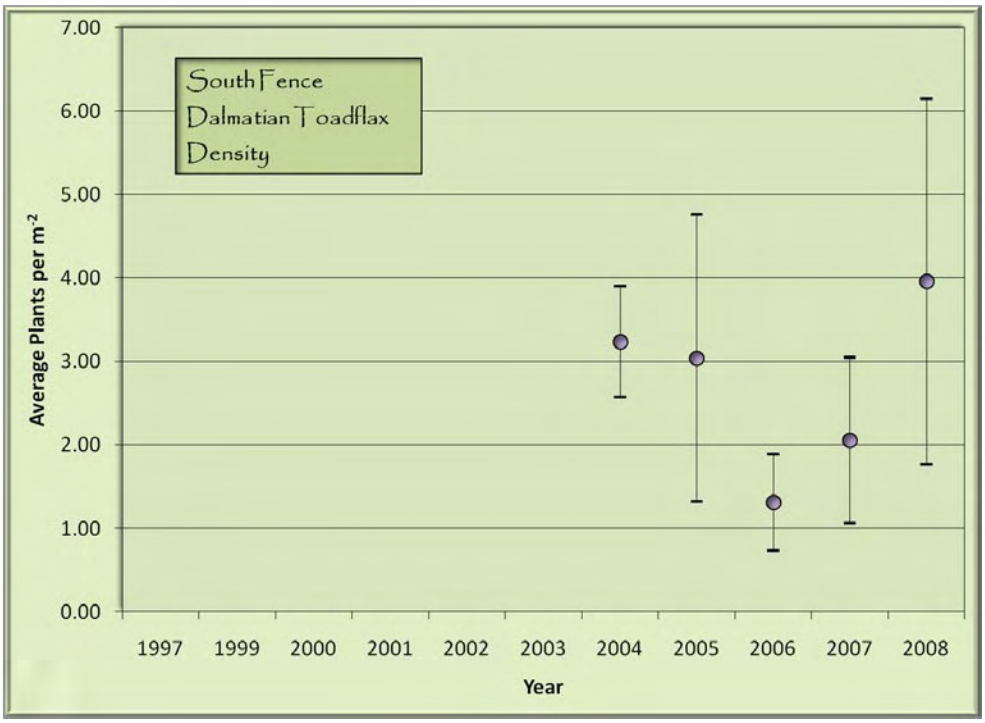
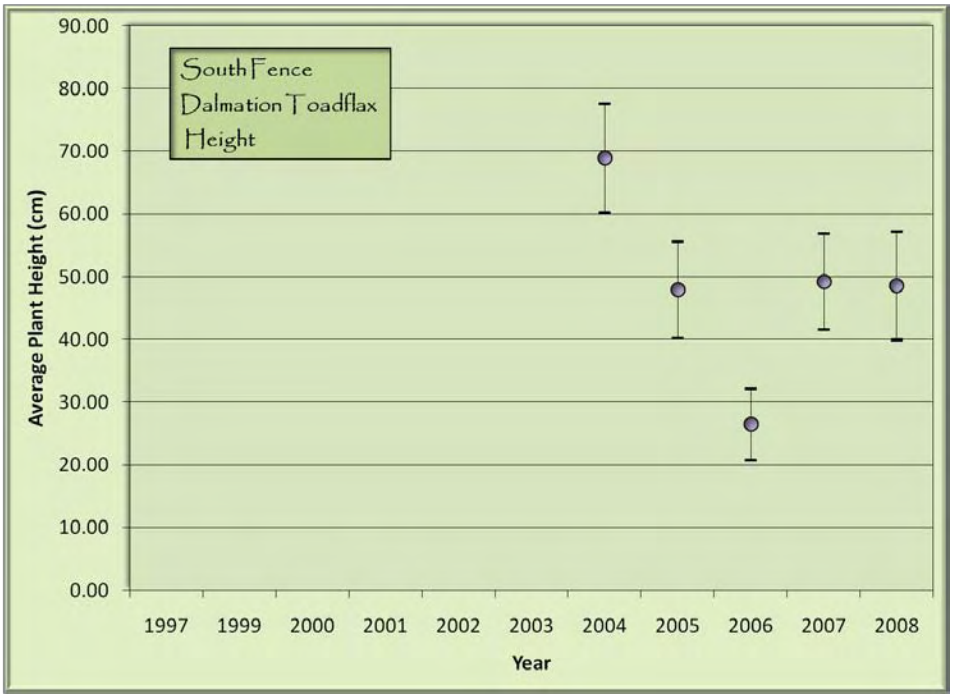


Figure 25. History of the South Fence Dalmatian toadflax densities (above) and height (below), sampled between 2005 and 2008.



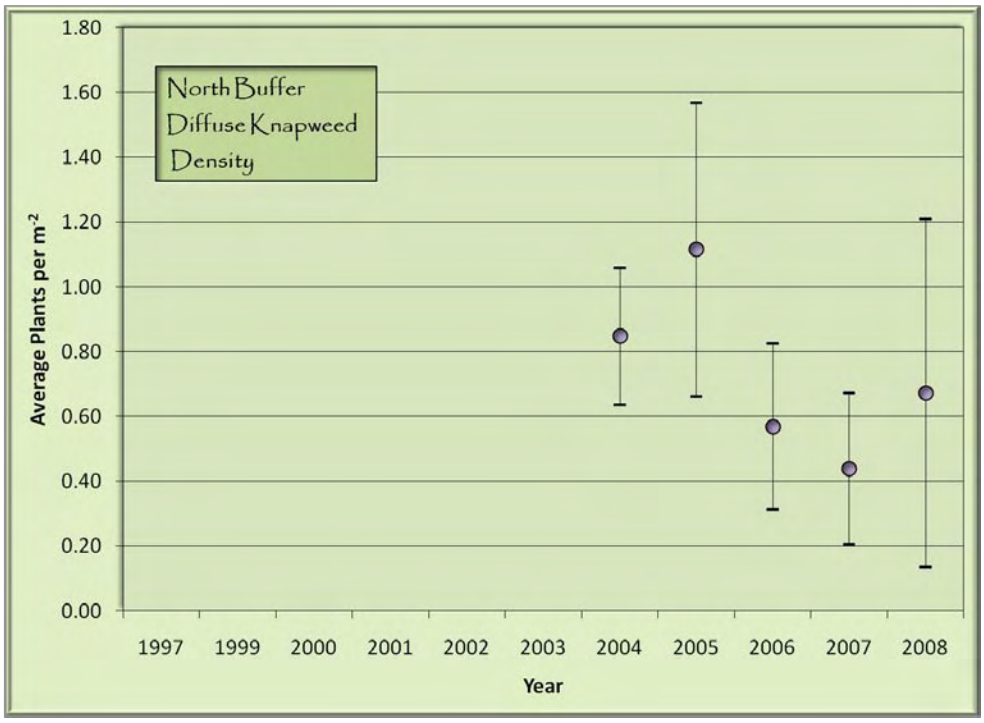
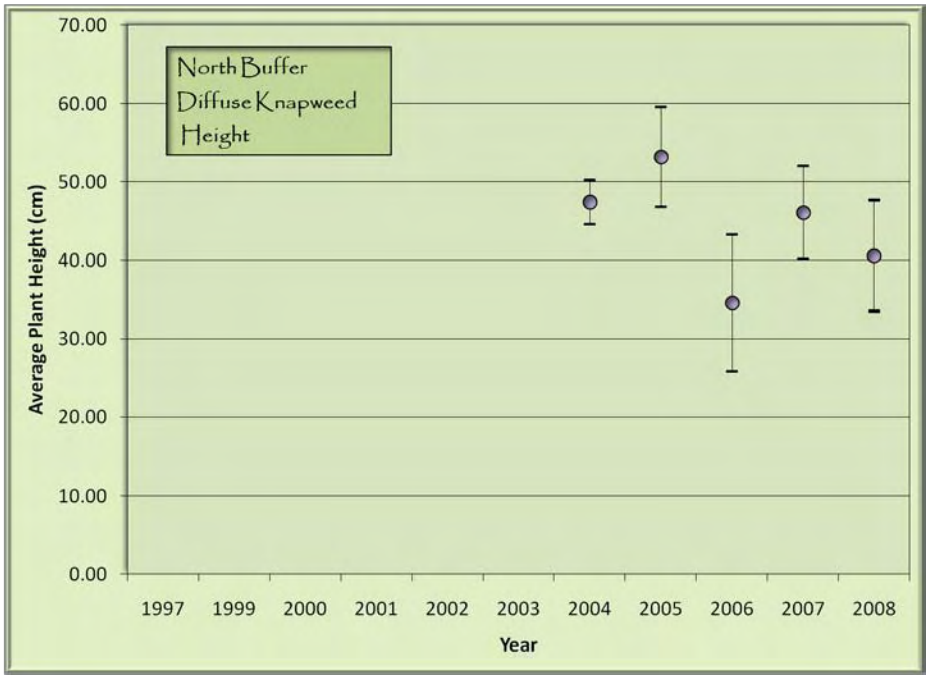


Figure 26. History of the North Buffer diffuse knapweed densities (above) and height (below), sampled between 2005 and 2008.



Warren Air Force Base

Only one site at Warren Air Force Base, Black Powder Road leafy spurge (0.73 ha; 1.8 acres), was mapped this year. The plants at the remaining sites that have been mapped in the past were too few and scattered to adequately survey. Eleven leafy spurge sites were randomly sampled for establishment of species in the *Aphthona* sp. complex (see Table 18) from a release made in 2005.

Figure 27. This year's Dalmatian toadflax Control site. There were not enough toadflax plants to map this year, only a small patch is visible in this photos (red circle).

This year seemed to be particularly bad for Dalmatian toadflax (Figure 21); toadflax plants at all four toadflax sites (Control, Nature Trail, Missile Drive, and Nursery) were short and did not form the dense yellow stands seen in earlier photopoints. The Dalmatian toadflax infestation at the Nursery site is virtually eliminated and instead has been replaced by an infestation of leafy spurge. The Nursery site is a good candidate for release of the *Aphthona* sp. complex next summer (if enough insects are available) as this mix of beetles has been successful at controlling leafy spurge at other sites around the base.

Leafy spurge did not appear to have a favorable growing season either. The Black Powder leafy spurge site had an 80% decline in area and a significant decrease in density despite the presence of a single quadrat with over 144 plants. Plant height was also lower, but not significantly so. All *Aphthona* beetles except *A. czwalinae* were recovered at the Black Powder site during the sentinel site surveys, though none were recorded during the site mapping (Figure 22). The leafy spurge sites randomly surveyed for *Aphthona* sp. beetles also appeared to have a lower plant density, though height and density data was not recorded for these sites this year. The only *Aphthona* species that was found during these random sweeps was *A. nigriscutis*.

Figure 28. Top left, leafy spurge at Black Powder 3 in 2007 is much denser and taller than the same site in 2008 (top right). Below, student worker Sundhya Solanki peers into a sweepnet searching for *Aphthona* sp. at the Black Powder 4 site.

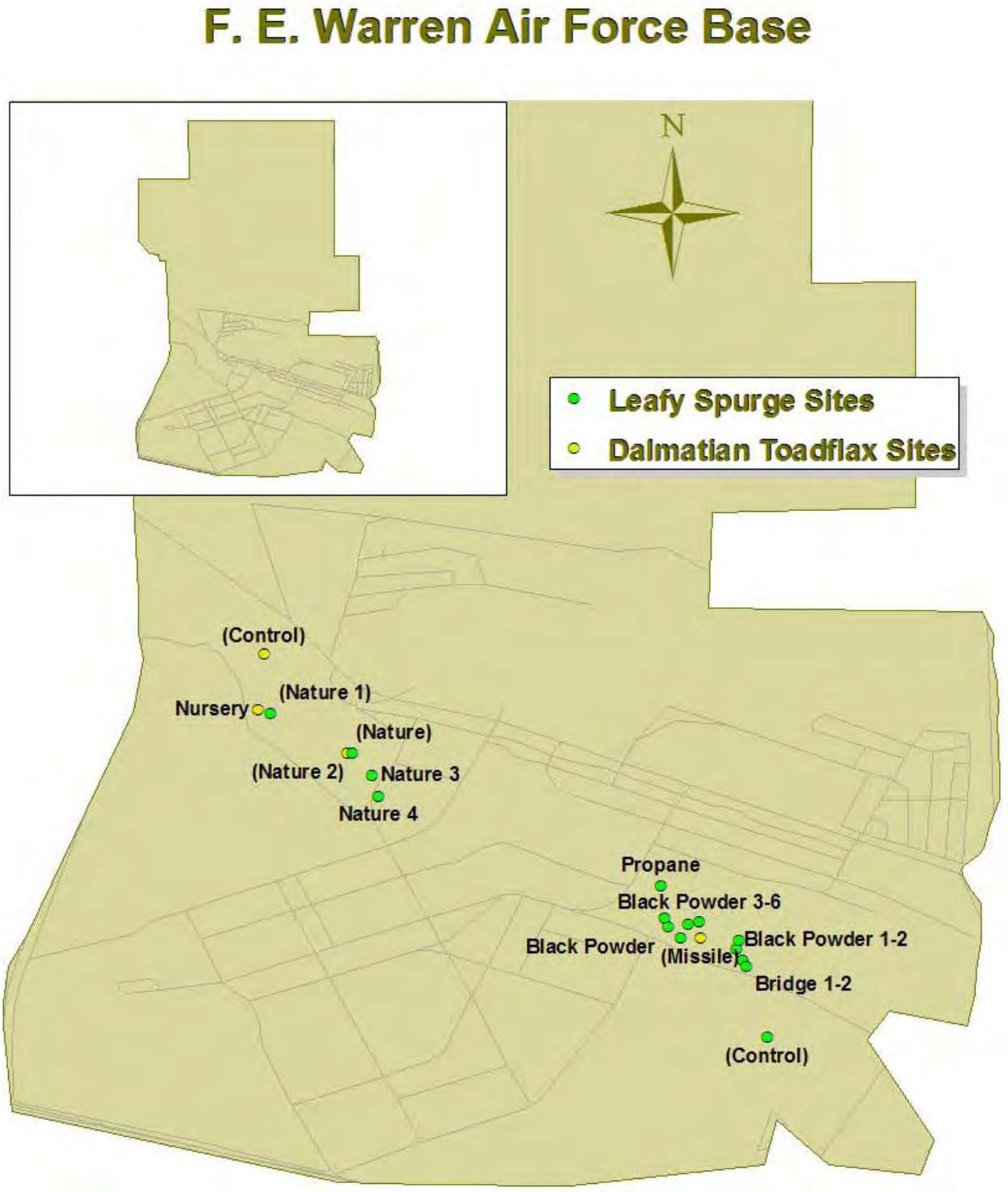


Figure 29. Schematic diagram of F. E. Warren Air Force Base with weed biological control study areas superimposed. Sites listed in parentheses were not surveyed in 2008.

Table 17. Historic noxious weed infestation parameters, F. E. Warren Air Force Base, Cheyenne, Wyoming, 2004-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
						Dalmatian toadflax - Control							
2004	18,424	45	2.67	21	32.73	91							
2005	23,234	44	3.66	25	49.36	74	13.57		26.11	37.08	50.81		
2006	10,540	37	0.35	6	43.13	60	4.25		-54.64	-90.44	-12.62		
2007	*(see Note a)*												
2008	*(see Note b)*												
						Dalmatian toadflax – Missile							
2004	20,356	49	0.63	3	24.14	80							
2005	27,247	54	4.35	54	53.52	91	10.22		33.85	590.48	121.71		
2006	9,601	41	0.30	9	53.50	58	16.00		-64.76	-93.10	-0.04		
2007	19,406	110	0.68	16	57.96	84			102.12	126.67	8.34	-4.67	7.94
2008	*(see Note b)*												
						Dalmatian toadflax – Nature							
2004	45,471	80	1.16	8	25.01	84							
2005	49,471	63	4.61	29	55.15	98	14.26		8.80	297.41	120.51		
2006	49,727	84	2.28	49	33.26	76	3.66		0.52	-50.54	-39.69		
2007	51,205	130	1.48	43	42.78	76			2.97	-35.09	28.62	12.61	27.59
2008	*(see Note b)*												
						Leafy spurge – Black Powder Road							
2005	2,797	28	48.82	127	64.93	91							
2006	32,077	96	35.80	178	45.80	91			1046.84	-26.67	-29.46		
2007	36,874	129	69.35	534	47.79	110			14.95	93.71	4.34		
2008	7,310	27	31.26	144	41.79	87			-80.18	-54.92	-12.55	161.35	-35.97
						Leafy spurge – Control							
2004	5,526	31	41.70	98	48.71	69							
2005	60,606	50	59.80	362	63.03	94			996.74	43.41	29.40		
2006	55,476	64	35.97	118	48.86	81			-8.46	-39.85	-22.48		
2007	*(see Note a)*												
2008	*(see Note c)*												

Table 17. Historic noxious weed infestation parameters, F. E. Warren Air Force Base, Cheyenne, Wyoming, 2004-2008.

Year	Area (m^2)	n	Density ($1/2m^2$)		Height (cm)		Avg. Seedheads per plant	Avg. Head size (mm)	Year to year % change			% Change to date	
			Avg.	Max	Avg.	Max			Area (m^2)	Avg. density	Avg. height	Area	Avg. Density
						Leafy spurge – Nature I							
2004	1,849	44	36.95	88	67.14	95							
2005	1,547	35	45.77	250	68.35	97			-16.33	23.87	1.80		
2006	2,120	54	23.41	59	66.98	105				-48.85	-2.00		
2007	2,382	60	63.68	217	57.55	93			12.36	172.02	-14.08	28.83	72.34
2008	*(see Note b)*												
						Leafy spurge – Nature II							
2004	1,703	42	66.19	129	55.98	81							
2005	1,463	38	85.30	184	62.35	80			-14.09	28.87	11.38		
2006	2,071	54	48.30	125	53.87	90			41.56	-43.38	-13.60		
2007	1,940	62	68.55	211	52.68	92			-6.33	41.93	-2.21	13.92	3.57
2008	*(see Note b)*												

n – number of samples or observations

Note: site was not mapped, as a) goat grazing prevented an accurate survey b) infestation had been reduced to a few scattered plants c) site was destroyed

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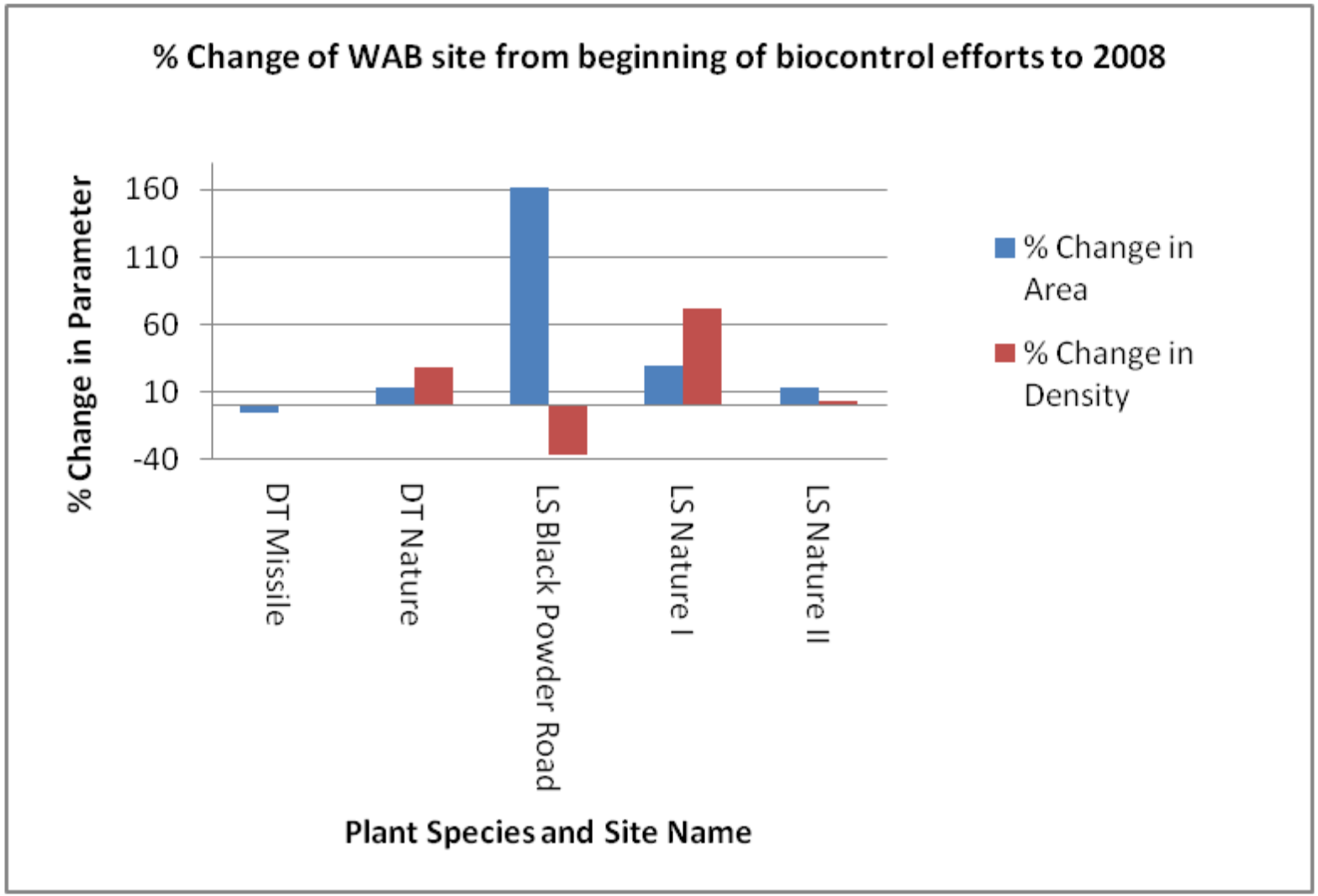


Figure 30. Percent change in area and density of all sites at Rocky Flats. The percent change is calculated by dividing the difference in the parameters between the first year they were monitored and this year's data by the area or density from this year. The number of years represented vary and depend on when the sites were established. The South Fence and North Buffer sites have no area data; the Weather site has area data only for this year.

Table 18. Noxious weed biological control sites, target weeds, species released and recoveries at, F. E. Warren Air Force Base, Cheyenne, Wyoming, 2008.

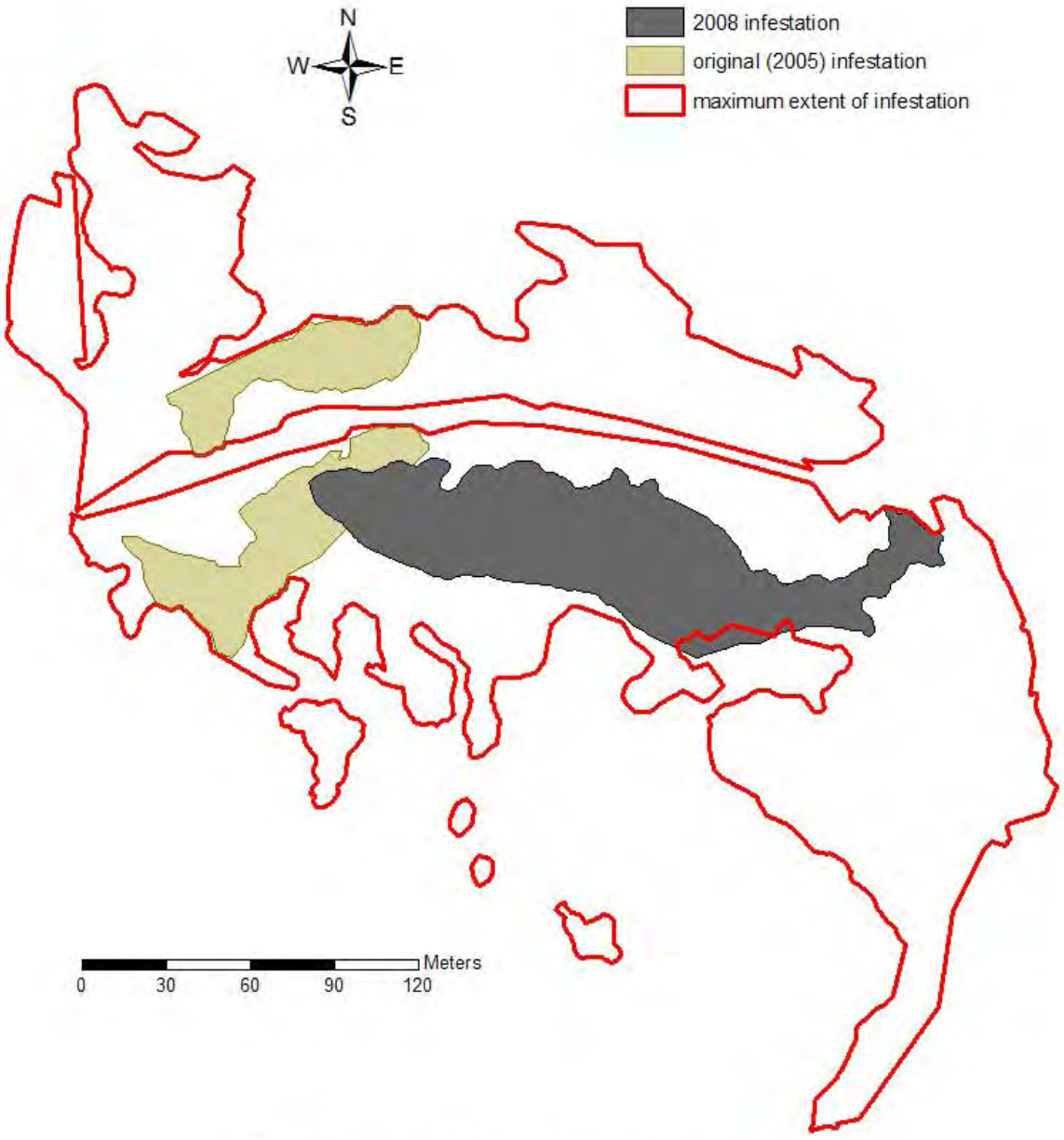
Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
WAB	Leafy spurge	Black Powder	*Aphthona* sp. complex[2]	X		
WAB	Leafy spurge	Black Powder I[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Black Powder II[1]	*Aphthona* sp. complex[2]	X[4]		
WAB	Leafy spurge	Black Powder III[1]	*Aphthona* sp. complex[2]	X[4]		
WAB	Leafy spurge	Black Powder IV[1]	*Aphthona* sp. complex[2]	X[4]		
WAB	Leafy spurge	Black Powder V[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Black Powder VI[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Bridge I[1]	*Aphthona* sp. complex[2]	X[4]		
WAB	Leafy spurge	Bridge II[1]	*Aphthona* sp. complex[2]	X[4]		
WAB	Leafy spurge	Control	*Aphthona czwalinae*			
WAB	Leafy spurge	Control	*Aphthona lacertosa*			
WAB	Leafy spurge	Control	*Aphthona nigriscutis*			
WAB	Leafy spurge	Nature I	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Nature Ib[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Nature II	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Nature IIa[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Nature III[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Nature IV[1]	*Aphthona* sp. complex[2]			
WAB	Leafy spurge	Propane[1]	*Aphthona* sp. complex[2]			
WAB	Dalmatian toadflax	Control	*Mecinus janthinus*			
WAB	Dalmatian toadflax	Nature	*Mecinus janthinus*			
WAB	Dalmatian toadflax	Nursery [1]	*Mecinus janthinus*	X		
WAB	Dalmatian toadflax	Missile	*Mecinus janthinus*	X		

[1] Area not mapped, release only

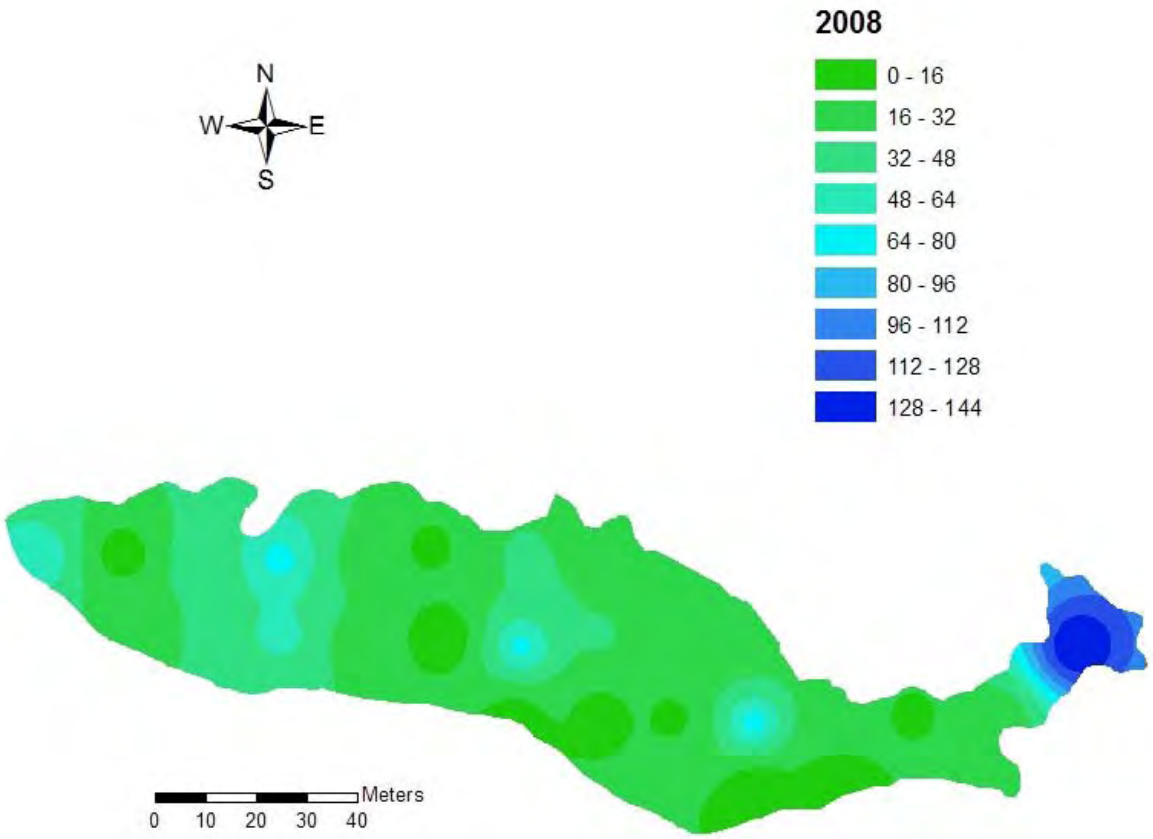
[2] *Aphthona* sp. complex is composed of varying proportions of *A. cyparissiae, A. czwalinae, A. lacertosa,* and *A. nigriscutis*, though no *A. czwalinae* were recovered this year.

[3]Adventitious recovery, no release made at this site

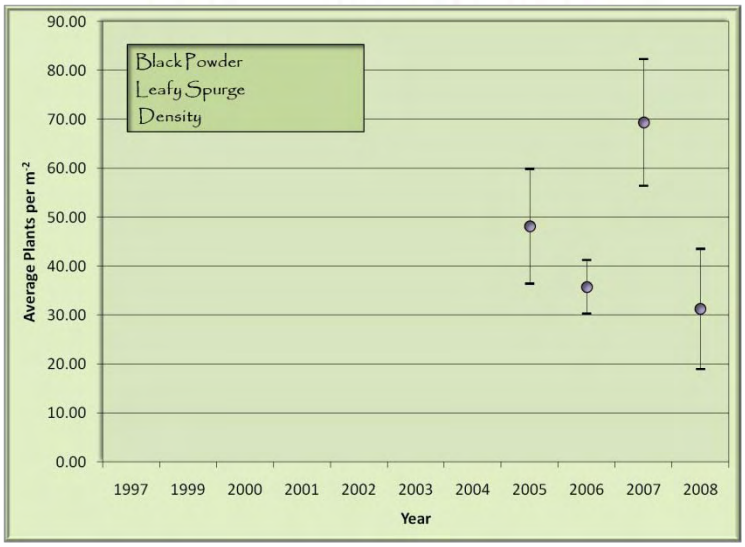
[4]Only *Aphthona nigriscutis* recovered out of all the *Aphthona* species released.

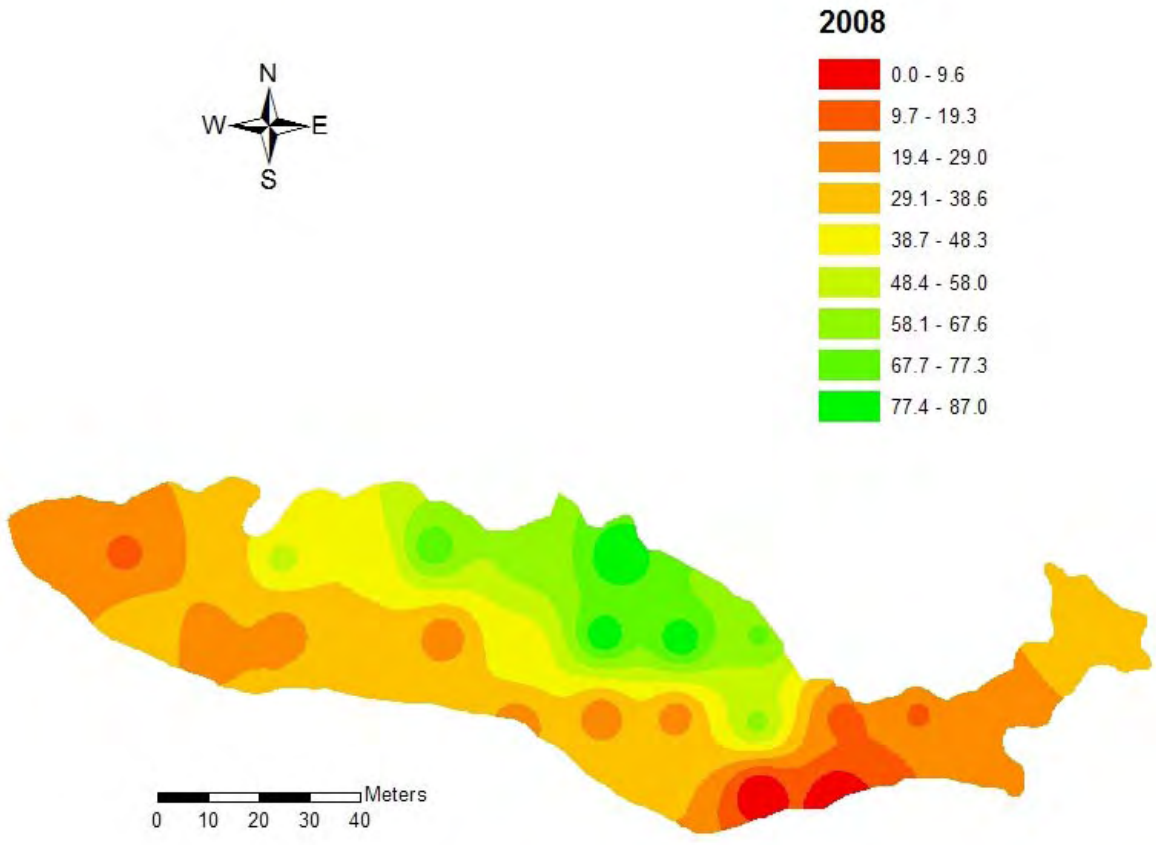


Black Powder leafy spurge perimeter in 2008.

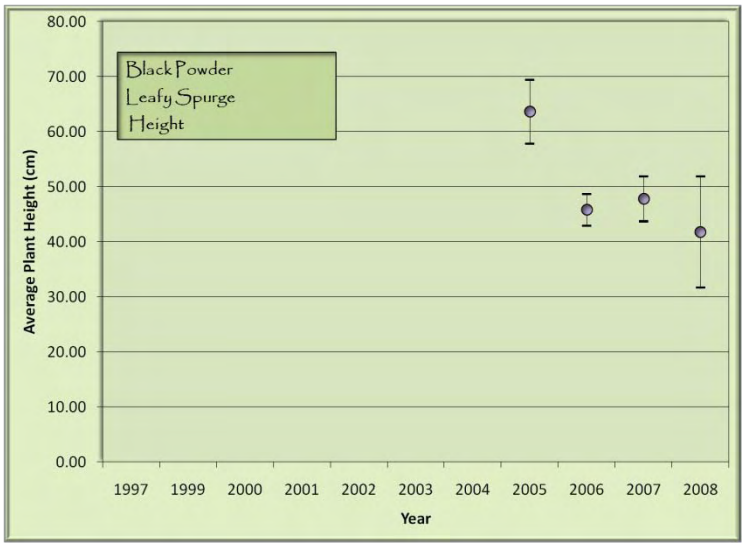


Black Powder leafy spurge density in 2008.





Black Powder leafy spurge height in 2008.



Apendix 1. Table showing size of study areas by species and by installation.

Species	Air Force Academy		Buckley Air Force Base		Fort Carson[1]		Rocky Flats		Warren Air Base[2]	
	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares	Acres	Hectares
Thistle	0.47	0.19	6.35	2.57	58.6	23.7	1.58	0.64	--	--
Knapweeds	4.67	1.89	--		2.52	1.02	--	--	--	--
Leafy Spurge	0.91	0.37	0.49	0.20	--		--	--	1.80	0.73
Toadflax	0.29	0.12	1.16	0.47	--		0.37	0.15	--	--
St. John's wort	0.33	0.13	--		--		--	--	--	--
Total acres (ha)	6.66	2.70	8.01	3.24	61.1	24.7	1.95	0.79	1.80	0.73

[1] Total does not include area of salt cedar in Section 36 (4.61 acres; 1.87 ha).
[2] Total does not include area of sites monitored by transects