Biological Control of 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

Prepared By
Gerald Michels, Jr., Erin Parks, Rachel Lange
Katie Fall, Joshua Godshall and Eric Madsen

Texas Agrilife Research
2301 Experiment Station Road
Bushland, Texas 79012

2011 Consolidated Report

Table of Contents

Introductory Notes 1

Navigating the 2011 Report 2

General Trends in 2011 4

Summary of 2011 Laboratory and Field Support Efforts 7

Air Force Academy 8

Buckley Air Force Base 18

Fort Carson Army Base 24

Rocky Flats National Wildlife Refuge 31

F. E. Warren Air Force Base 36

Appendix I: Maps 43

Appendix II: Agent Recovery for 2011 124

Appendix III: Notes on Student Participation 138

Introductory Notes

As of 2011, the biological control of noxious weeds project completes the fifteenth year at Fort Carson Military Post (FTC), twelfth year at Air Force Academy (AFA), eleventh year at Rocky Flats National Wildlife Refuge (RF), ninth year at Buckley Air Force Base (BAF), and eighth year 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, where applicable, and plant measurements that include density, height, and other variables.

The focus of the biological project in 2011 was on redistributing agents, establishing new sites with agent releases and evaluating potential new sites for agent releases next year. As in 2010, we continued our efforts to release and establish the bindweed mite *Aceria malherbae* at one installation, the U.S. Air Force Academy, to supplement a distribution previously conducted. In addition, we conducted large scale releases of several biocontrol agents for control of leafy spurge, Dalmatian toadflax, yellow toadflax and common mullein at the U.S. Air Force Academy and F. E. Warren Air Force Base.

Navigating the 2011 Report

In this report, the results for each location are described in separate sections, arranged alphabetically, beginning with the Air Force Academy and ending with F. E. Warren Air Force Base. Within each of these sections, we first provide a narrative of the important observations and activities at each site within a location for 2011, followed by tabular material with historic site data; changes in plant parameters, and biocontrol agent release and recovery records. Figures describing temporal changes of infestation area, as well as current measures of weed density and height, appear in Appendix I. A condensed summary of the biological control program is found in Appendix II, and a summary of student participation is found in Appendix III.

The sampling methods used have evolved over the course of the project and were modified in 2011. Prior to the 2011 field season, we identified a need to update our vegetation and insect mapping and monitoring protocol. The goal of the modified sampling protocol is to sample a more refined, specific area for changes in weed and insect parameters. A standardized 50 meter (m) transect with 25 meter cross transects were installed at sites where appropriate. Modified transects were installed at some sites due to size, shape or topography. Perimeter mapping was only conducted at sites where weed infestations could be reasonably included within the original site area. If the weed infestation extends beyond the original mapped area, it was not perimeter mapped. Some sites have been established and continue to be mapped using point sampling protocol only. Due to these changes, it will be difficult to flawlessly compare previous years' data to the 2011 results. At the end of the 2012 field season, we will have two consecutive years of data using this new protocol that will be able to be compared and analyzed.

The previously-established Sentinel sites were used as indicators of plant and biocontrol agent emergence and were monitored several times during the season. These sites, therefore, had a higher chance of having biological control activity detected than if only one survey was conducted per season. Upon detecting biocontrol agent emergence and activity at these Sentinel sites, surveys were begun for all other related sites. During the survey for each site, the following data were collected (with the exception of field bindweed): total area covered, density of infested patches, height of plants, seed head production and presence of biological control agents. Plant density measurements were taken from counts of individual stems or plants within a given number of $0.5m^2$ quadrat samples and height measurements were taken from the height of the tallest plant within the quadrat. These results are summarized within the respective section of the report and individual summary table for each location.

Survey transects were established at the majority of sites. We followed a standard survey procedure for most sites; the area surveyed comprised the extent of the weed infestation when the site was originally established. We installed a single primary transect along the longest axis of the infestation (50 meter long transect) with 5 (25 meter long) cross transects that intersect the primary transect line, at 5%, 25%, 50%, 75% and 95% of the primary transect's length. These span the width of the infestation, or a maximum of 50 meters along the primary transects and 25 meters along the secondary cross transects. Modified transect lengths were installed at many sites with smaller infestations. The ends of these transects were marked with wooden survey stakes and blue marking paint. We conducted weed and biocontrol agent sampling using the quadrat method at 3 meter intervals along the length of each transect. Depending on size, shape and topography of some sites, random point sampling is the preferred method of data collection. For

these sites, at least 10 random quadrat samples were surveyed within each site. If the site is very large, additional random samples were taken. In addition, this year we modified our perimeter mapping protocol. When sites were first established, the perimeter is defined by mapping around the area using a GPS unit. By mapping sites each year, we capture year-to-year changes in size and shape of the weed infestations. However, many sites are rather extensive, low density or undefined which makes it difficult to accurately represent the infestation boundaries. Frequently, non-contiguous, remnant patches of weeds are indicative of a site that has experienced successful biocontrol. To accommodate this type of satellite weed infestation (at least 10 plants but less than approximately 5m x 5m in size), we utilized point sampling to document the area. Additionally, sites were evaluated this year for final treatment or management, if no significant amount of weeds exists. These sites are listed within the appropriate section for each base. Field bindweed is the only weed species that is not perimeter mapped due to its sprawling growth pattern. Instead, random point sampling around the release locations was conducted. In addition, photopoint pictures of sites were taken to visually track changes over time.

All maps and graphs presented in our annual consolidated reports were generated from data, obtained in the field using Global Positioning System (GPS)-enabled data collectors. We upgraded our GPS units to Hemisphere Archer XF101 with ArcPad 10 to record survey data, as well as EZ Surv GNSS (Global Navigation Satellite System) post-processing software to geo-reference all of the data collected in 2011. All of the data collected on weed infestation perimeters, weed density and height, biocontrol agent release and detection from the 2011 field season were incorporated into the existing geodatabase for each location. Using this information, we analyzed data both statistically and spatially, along with converting data to visual maps, using a Geographic Information System (GIS). With the help of base personnel, we were able to include aerial imagery into our geodatabase to provide a clearer, usable representation of the data collected. As with the geodatabase from 2010 we will again make the geodatabase available on a CD or DVD to allow each installation to utilize these data to meet their own planning and analysis needs. Photopoint photos for all available years will again be incorporated into the database this year. 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 were also utilized to construct Tables 1-11.

General Trends in 2011

In 2011, we determined notable advances in biocontrol efforts to control several target weed species. Although, we saw mixed results with most weed species, we saw successful control of several diffuse knapweed, spotted knapweed, Canada thistle and musk thistle sites at various bases. We observed significant decreases in both density and size of many leafy spurge sites across the board. This year we conducted large scale releases of biocontrol agents at the U.S. Air Force Academy (for Dalmatian toadflax, leafy spurge and common mullein) and F. E. Warren Air Force Base (for Dalmatian toadflax and leafy spurge). We expect to see rapid progress towards the control of these infestations, once the biocontrol agents establish. In general, the biocontrol populations at certain sites should be augmented to ensure population maintenance, establishment and efficacy. This year, many field bindweed sites suffered drought stress and went through an early senescence, therefore mite damage was difficult to detect, though we saw successful establishment at several sites. Additional redistributions will likely be necessary at many bindweed sites across the board, since many areas infested with bindweed are highly disturbed and this contributes to their need for prolonged management.

Detailed results and information is presented within the appropriate section for each military installation. A significant addition to the program in 2011 has been the identification of several monitoring sites that are controlled; these sites require further integrated approach by base personnel for successful containment and/or eradication. Such sites will be eliminated from the Biological Control of Noxious Weeds program, enabling the direction of program resources towards new or as yet uncontrolled sites in need of additional management.

These results are likely affected by the climatic conditions suffered by much of Colorado during 2010-2011, that adversely affect biocontrol agents and the target weeds. Low moisture with little snow cover is suspected of not providing hospitable overwintering conditions for many agents. According to the National Integrated Drought Information System (NIDIS, drought.gov), El Paso County experienced abnormally dry to moderate drought conditions in 2011. Temperatures were above normal east of the Rockies and precipitation was below normal from May to October (National Oceanic and Atmospheric Administration, NOAA). This year, we continued to experience drought conditions at the U.S Air Force Academy and Fort Carson Military Post. This likely affected plant emergence, vigor, biocontrol agent establishment and productivity. The drought conditions also may have affected the quality of *Aceria malherbae* we were able to distribute this year, as our source near Trinidad, Colorado was subject to the unusually hot and dry conditions experienced throughout the region.

Alternatively, Arapahoe and Jefferson Counties, Colorado, and Laramie County, Wyoming, received average precipitation throughout the growing season in 2011. The total precipitation for May to October was above normal, as well as above normal temperatures for Arapahoe and Jefferson Counties. However, Laramie County experienced near normal temperatures in southeastern Wyoming, compared to the abnormally dry conditions in 2010. This relatively dry year, followed by a wetter year can account for changes in plant parameters and biocontrol activity at Buckley Air Force Base, Rocky Flats National Wildlife Refuge and F. E. Warren Air Force Base. The comparatively mild conditions seen at F. E. Warren Air Force Base, in 2011 will be favorable for biocontrol agent population establishment.

The population of *Larinus minutus*, a major agent for knapweed, at Rocky Flats Wildlife Refuge is plentiful, assisted by the redistribution of agents from the Academy in 2010, despite continuing collection efforts by universities and government agencies. The greatest success story

from 2011 was the spread and efficacy of the salt cedar agent *Diorhabda sp.* seen at Fort Carson Military Post. A large population of *Diorhabda sp.* was discovered at Teller Reservoir early in 2011 by Fort Carson weed management personnel. During the summer, we monitored the insect activity and observed severe defoliation induced by the beetle on the salt cedar. In addition, we are beginning to see progress at our original salt cedar monitoring site, Section36, where beetles were originally released in 2009 and augmented with *Diorhabda sp.* from Training Area 55/Beaver Creek in 2010.

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 valuable program.

Summary of 2011 Laboratory and Field Support Efforts

In addition to weed mapping and monitoring efforts on federal installations, our program performed a number of surveys to support the assessment of biological control efficacy. These included biocontrol agent surveys in the field during the summer (presented in Tables 2, 4, 6, 9 and 11). Plant materials collected from biocontrol agent release areas during the summer were dissected in the fall; this data was used to compile the biocontrol agent recovery tables. Summary tables of biocontrol agent recovery at monitored sites (Tables 2, 4, 6, 9 and 11) include:

- Knapweed seedhead and root infestations, collected in late August-September 2011
- Toadflax stem infestations, collected in May-June 2011

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

Air Force Academy

Thirty noxious weed infestations were surveyed on Air Force Academy this year. As detailed in the Navigating the Report section, we modified our sampling methodology, therefore we will not provide a total area of infestation for all sites. We surveyed 4 Canada thistle sites and 1 musk thistle site in 2011. We point sampled the infestation at CTice2,

The Canada thistle site, CTkettle, moderate density. We observed both *R. conicus* and *U. cardui* during the 2011 field season (above).

The largest infestation of Canada thistle at CTploop is visible in the center of this photo (below).

pursuant to the updated protocol, as the size has decreased from 0.08 ha (0.20 acres) mapped in 2000, subsiding at 0.02 ha (0.04 acres) this year. A single *Larinus planus* and *Urophora cardui* galls were observed during the survey. We installed and surveyed 50 m transects with 25m cross transects at CTkettle and modified versions, due to size and topography of the infestations, at CTploop and CTice1. The CTkettle site covered 0.04 ha (0.11 acres) this year, compared to 0.12 ha (0.30 acres) originally mapped in 2003 (Figure X). Currently, the Canada thistle is low to moderate density, with observations of *Rhinocyllus conicus* and both *U. cardui* adults and galls during surveys. CTploop has increased in size since the establishment of the site, although has declined from 0.02 ha (0.04 acres) mapped in 2007 to 0.01 ha (0.02 acres) in 2011 (Figure X). The infestation remains moderate density, most plants are healthy and do not show a lot of insect damage. Both *U. cardui* galls and adult *R. conicus* were detected during the modified 40 m transects.

We saw substantial improvement of the Canada thistle infestation at CTice1, which has decreased from approximately 0.11 ha (0.27 acre) in 2001 to 0.02 ha (0.04 acres) in 2011 with moderate density within the remaining occupied area. Several *R. conicus, L. planus* and *U. cardui* galls were detected during sentinel site visits and the transect surveys. Despite observing adequate biocontrol agents at some Canada thistle sites, very little insect damage was observed which should be addressed in 2012. Consideration should be made to augment existing biocontrol populations at these sites to ensure spread and establishment of agents and control of

the target weed species. We determined the musk thistle site, MTice1, to be under control, only a few plants remain and is very low density (Figure X). We highly recommend that this site receive additional attention during the spring and summer of 2012.

Four field bindweed sites were randomly point sampled in 2011 (FBferl, FBmtr1, FBmtr2 and FBstadium). The field bindweed at FBstadium and FBferl was sparse, despite no signs of biocontrol agents detected during the surveys. Both FBmtr1 and FBmtr2 sites were newly established in 2010, and the biocontrol agent, *Aceria malherbae*, was recovered in 1 of 10 samples collected at each site. On July 27, 2011, we conducted a small scale *A. malherbae* release at FBmtr2 from mite infested plant material sourced from Pinon Canyon Maneuver site (Figure X). However, though the plant material was collected from a strongly mite-infested area, the condition of both the plant material used for agent distribution and the bindweed plants to which the mites were introduced was very dry, therefore success if difficult to predict. Supplemental releases should be conducted at all bindweed sites to ensure establishment and augment existing mite populations. Generally, *A. malherbae* needs to be mowed to successfully spread and distribute the infested plants. In 2012, we will need to coordinate mowing schedules with base personnel and/or receive permission for our personnel to mow these specific infestations.

The newly established field bindweed site, MTR2, (above left) is abundant with confirmed establishment of *A. malherbae,* released in 2010. We conducted a supplemental release of the mite in July 2011 (above right).

As discussed with base personnel, due to the continuing herbicide treatments conducted on St. Johnswort throughout the base, we will no longer pursue biocontrol efforts on this weed

species. We collected over 1,000 *Chrysolina sp.* from SJkettle and SJmidkl in 2010 in anticipation of chemical treatments. This year, we visited each site and point sampled the remaining St. Johnswort infestations. The infestation at SJkettle is very small and low density, while the infestation at SJmidkl is small and low to moderate density. No biocontrol agents were recovered during the surveys confirming the remaining weeds need to be addressed with continued chemical treatments or mechanical techniques. The eradication of SJsantefe site through biocontrol has been confirmed by consecutive years of monitoring.

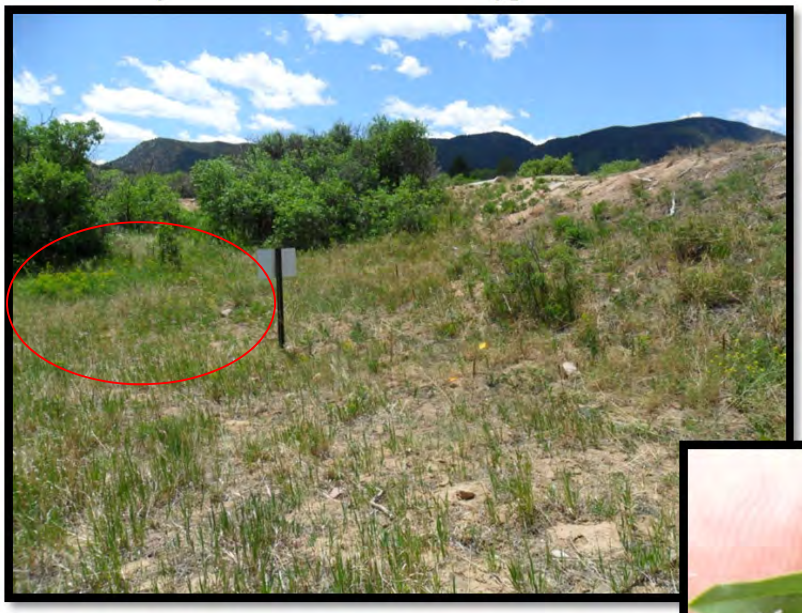
The leafy spurge site, LSDead, stunted and infested with *Aphthona sp.*

Following the objectives listed in the 2011 Statement of Work, we conducted releases of *Oberea erythrocephala* and *Spurgia esulae* at two existing leafy spurge sites, LSdead and LSferl, to augment the existing biocontrol populations. All 4 leafy spurge sites surveyed this year saw a decrease in density and size. We installed a set of modified 25 m transects at LSdead covering 0.02 ha (0.05 acres), down from the 0.08 ha (0.04 acres) mapped in 2005, and we observed that leafy spurge has been extirpated from 1 of the 2 originally mapped polygons. Progress is evident; the leafy spurge are obviously stunted and good numbers of *Aphthona sp.* were recovered during the sweep net surveys (Figure X). In July, we released 210 *O. erythrocephala* and 250 *S. esulae* galls at the LSdead site (Figure X). We expect to see continued deterioration of the leafy spurge at this site in the near future. We installed a set of small modified transects within the largest of the remaining leafy spurge infestations at LSdoug. One of the three original polygons has been controlled while the remaining two are very low density with visibly stunted plants. *Aphthona sp.* were observed during the survey.

A *S. esulae* gall released at LSdead on July 13, 2011.

The original leafy spurge infestation mapped at LSferl in 2000 has been destroyed and replaced by a parking lot and storage facility. Throughout the years, additional polygons were mapped and added to the LSferl site. This year, we installed 2 sets of small modified transects at both patches of leafy spurge, the largest infestation encompassing 0.04 ha (0.10 acres). As was done at LSdead, we released 210 *O. erythrocephala* and 250 *S. esulae* galls in July in order to satisfy an integrated biocontrol approach. The leafy spurge at LSnorthferl is fairly robust and dense within the scrub oak, with some patches throughout the open field. The original area mapped encompassed these oak stands, for ease of mapping. Since the leafy spurge

in this area is not contiguous, we utilized point sampling to indicate the presence of leafy spurge. We recovered an adequate coverage of *Aphthona sp.* during sweep net sampling, primarily located in the open areas that receive full or partial sun throughout the day. The leafy spurge in this area may not be conducive to highly successful biocontrol populations due to its proximity to the scrub oak and shaded habitat. Many of the *Aphthona sp.* prefer open sunny areas, where they will maximize density and efficacy. Research is ongoing to find insects that will successfully attack leafy spurge in forested areas. We will continue to survey and monitor these sites next year to confirm the establishment and spread of the newly released agents. In addition, we will monitor the spread of these new agents into neighboring leafy spurge sites to determine their efficacy within different habitat types.



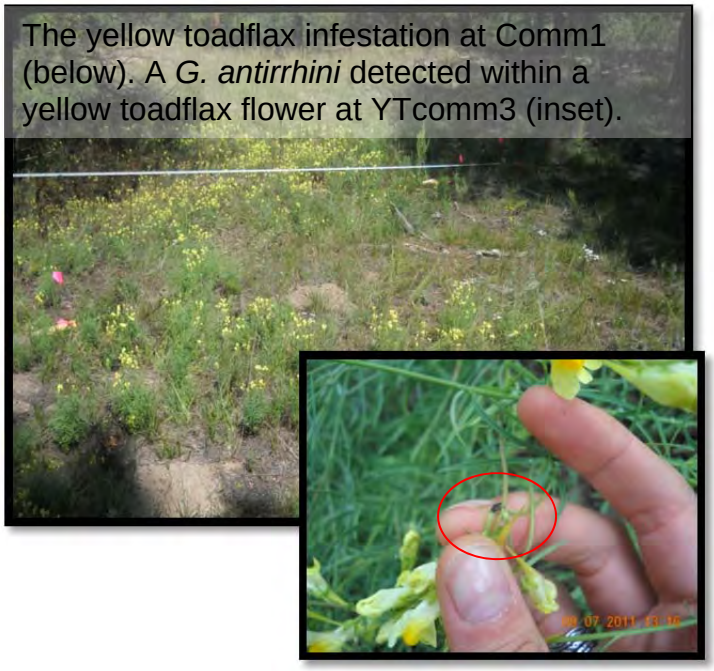
Leafy spurge infestation, LSferl, where we released 210 adult *O. erythrocephala* in July 2011 (top and bottom left).

Mating pair of *O. erythrocephala* (below).

In 2011, we surveyed all 4 yellow toadflax sites on the Air Force Academy. In late June and early July, we conducted releases of 2 biocontrol agents; 420 adult *Mecinus janthinus* and 100 caterpillar *Calophasia lunula* at YTcomm1, and 210 adult *M. janthinus* at YTice2 (Figure X and X). We will monitor and assess the establishment and spread of these agents in 2012. The yellow toadflax at all 3 YTcomm sites (YTcomm1, YTcomm2 and YTcomm3) occurs most commonly within and around the native scrub oak. We installed modified 25m with 9m cross transects at YTice1, as well as perimeter mapped the majority of the infestation, covering 0.01 ha (0.03 acres). We point sampled YTcomm2, as the toadflax infestation is small and low density with the remaining plants primarily growing under and within the scrub oak. This site is well controlled in the open, low vegetated areas, and we suggest further management be undertaken to ensure the current containment. Two small patches of yellow toadflax were discovered during our survey, located to the north of the original YTcomm2 site, which should receive management as well. No releases were conducted at YTcomm3, therefore if this site will remain the in the program, agents need to be re-distributed or released at this location. The approximate size of this infestation is 0.02 ha (0.01 acres). We installed the standard 50 m x 25 m transect at YTice2, but did not perimeter map due to the low growing yellow toadflax plants that were difficult to distinguish between other vegetation. The biocontrol agent, *Gymnetron antirrhini*, was recovered from both YTcomm1 and YTcomm3 during transect surveys.

The summer crew, releasing biocontrol agents on yellow toadflax at the YTice2 site.

In late May/early June, we collected stems from each yellow toadflax site for dissection, to look for evidence of the stem-boring weevil, *M. janthinus*, previously released at YTcomm1 and YTcomm2. The dissections did not produce any evidence of the biocontrol agent. We will perform the stem dissections next spring, to determine the successful establishment and dispersal of *M. janthinus* we released in 2011.


The yellow toadflax infestation at Comm1 (below). A *G. antirrhini* detected within a yellow toadflax flower at YTcomm3 (inset).

Releasing biocontrol agents *M. janthinus* (above left) and *C. lunula* (above right) at the yellow toadflax site, YTcomm1.

We sampled 4 diffuse knapweed sites in 2011. The diffuse knapweed site, DKbiketrail, is well controlled and has decreased substantially from 0.04 ha (0.09 acres), mapped in 2007, to a

The well-controlled diffuse knapweed site, DKbiketrail (above left) the diffuse knapweed site, DKrailroad with moderate density (above right).

size insufficient to perimeter map (Figure X). We point sampled the remaining small knapweed patches and produced 10 samples. Final management is recommended for this site, spot-herbicide treatment or hand pulling of the weeds is advisable. An adequate native vegetation community is present in the area therefore, re-seeding is not required at this time. We installed 50 m x 25 m transects at both DKhwy83 and DKrailroad. Both infestations are moderate density; DKhwy83 covers 0.14 ha (0.36 acres) and DKrailroad comprises 0.33 ha (0.82 acres), although the knapweed infestation at DKhwy83 extends beyond this mapped area (Figure X). We observed *Cyphocleonus achates, L. minutus* and *U. affinis* during the transect survey and sentinel site visit at DKhwy83, as well as *U. affinis* at DKbiketrail. No evidence of biocontrol agents was observed at DKrailroad in 2011. The DKhwy83 site encompasses more than a quarter acre and is moderate to high density, which requires control, considering over 1,000 *L. minutus* were removed from the site last season, in anticipation of a scheduled herbicide treatment that was not completed. Both diffuse knapweed and spotted knapweed are present at several knapweed sites

(dead, mtr, oldmonck, wtp). Where accessible, we point sampled KWwtp, which contains diffuse knapweed, as the site was under construction and being used as a staging area and for equipment storage. We recovered several *L. minutus*, and observed many seedhead emergence holes and root cavities during the point samples, despite the moderate to high density of the knapweed infestation.

We sampled a total of 8 spotted knapweed sites this year. Five of these sites (SKdead, SKmtr, SKnpwr, SKoldmonck and SKploop2) are well controlled and need to be managed for final eradication of the remaining knapweed . However, a large, moderate to high

The spotted knapweed infestations at SKoldmon (above left) and SKmtr (above right) have been controlled and further management of remaining knapweed plants is fundamental for success.

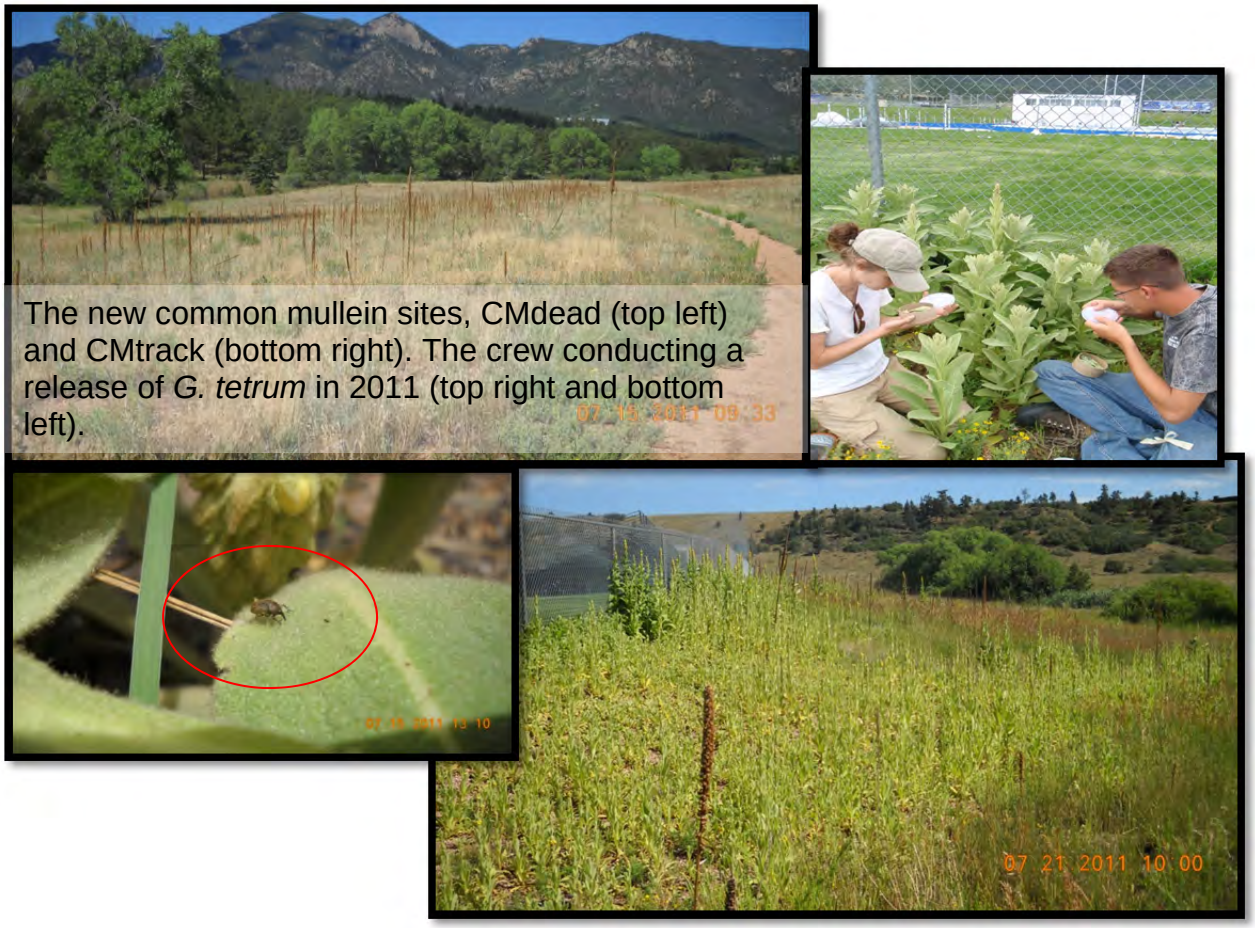
density infestation of diffuse and spotted knapweed is present in the area of SKoldmonck, and knapweed extends beyond our SKnpwr monitoring site. We installed 50 m x 25 m transects at SKmonck, SKploop1 and SKploop3. The spotted knapweed at these sites are expansive, therefore were not perimeter mapped, although the SKploop sites are low to moderate density and SKmonck consists of moderate density knapweed, extending along the hillside and Monument Creek. There is a significant limitation to the potential success of biocontrol at SKmonck and SKoldmon as a result of over 2,000 *L. minutus* removed in 2010, prior to a chemical treatment that left majority of the site uncontrolled. This year, we observed *C. achates* at SKoldmon and SKploop3 and both *L. minutus* and *U. quadrifasciata* at SKmonck, SKmtr and SKoldmon.

We collected a total of 2,122 seedheads (816 diffuse knapweed, 1,306 spotted knapweed) and a total of437 roots (180 diffuse knapweed, 257 spotted knapweed) in late August 2011 from all 12 diffuse and spotted knapweed sites. Dissections were performed during the fall, to examine the agents' successful reproduction, dispersal and damage to both diffuse and spotted knapweed plants. Seedhead dissections produced an abundance of larval *U. affinis* and *U. quadrifasciata* and both pupae and adult *L. minutus.* At least 10 % of the

An adult *C. achates* recovers after being discovered during transect survey at SKploop3.

samples contained *U. affinis* from 7 sites (DKbiketrail, SKdead, SKmtr, SKoldmon, SKploop1, SKploop2, SKploop3), and *U. quadrifasciata* from 6 sites (SKdead, SKmtr, SKnpwr, SKploop1, SKploop2, SKploop3). We discovered *L. minutus* within samples from all the sites except 3 (DKbiketrail, SKdead and DKrailroad) and the KWwtp site generated the most *L. minutus,* in 15% of samples. In addition, we recovered 109 adult *L. minutus* that were loose within the sample bags; they had left the seedheads following collection. We dissected 200 seedheads from DKbiketrail, 21% yielded *U. affinis* and 7% *U. quadrifasciata.* A total of 139 seedheads were collected from SKdead, with decent recovery rates; 17% *U. affinis* and 14% *U. quadrifasciata,* with 2 adult *L. minutus* loose in the sample bags. Biocontrol agents were much less common in the roots, we dissected; we recovered only 2 adult *C. achates* from roots collected from the SKmtr site. However, evidence of insect activity and damage in the roots was observed in samples from most sites.

This year, we added a new weed species to our monitoring efforts, common mullein. We established 2 common mullein sites, CMdead and CMtrack (Figure X). In June and July 2011, we released 840 adult *Gymnetron tetrum,* a seed-feeding weevil, at CMdead and 945 individuals at CMtrack (Figure X). The total areas of infestation were 0.06 ha (0.14 acres) at CMdead and 0.03 ha (0.07 acres) at CMtrack. Observation of this weevil on common mullein at the Academy and surrounding locations, such as Rocky Flats National Wildlife Refuge, prior to these releases indicates their successful spread onto the property from unknown releases conducted by El Paso county or other government agency. We will continue to monitor the spread, establishment and efficacy of the agents at these weed infestations.



The new common mullein sites, CMdead (top left) and CMtrack (bottom right). The crew conducting a release of *G. tetrum* in 2011 (top right and bottom left).

Recommendations for 2012:

During the fall of 2011, USFWS, Colorado State University and Texas AgriLife Research personnel discussed the focus of our noxious weed monitoring and control efforts for the upcoming year. In 2012, we will collaborate with the Colorado State University, Colorado Natural Heritage Program (CNHP) for weed monitoring and management, especially knapweeds. We will develop "shared" sites for biocontrol monitoring and exchange data and historical records to identify new potential biocontrol sites. We also discussed possibly abandoning certain weed species, such as Canada thistle, leafy spurge, yellow toadflax and St. Johnswort and put more emphasis on monitoring and controlling knapweed infestations on the Academy. Continued coordination with both entities will be essential in 2012 to successfully reach our goals.

This year at the U.S. Air Force Academy, we saw control of several knapweed, diffuse and spotted, as well as thistle, Canada and musk, sites. We observed progress at leafy spurge and field bindweed sites, in addition to augmenting biocontrol populations with additional and new agents this summer. For 2012, we recommend that biocontrol populations at several sites (CTice2, CTkettle, CTploop, DKrailroad, DKhwy83, SKmonck, SKploop1 and SKploop3) be augmented to ensure population maintenance, establishment and efficacy. This effort will depend on the decision by USFWS for control methodology for each weed species. Supplemental releases of *A. malherbae* should be considered for all field bindweed sites, if available from other sites or projects (preferably from Pinon Canyon). We should investigate alternative biocontrol agents and/or alternative methods of control for some sites, where existing biocontrol agents have not shown establishment, due to habitat specificity. Coordination of base mowing personnel/contractors to institute a mowing schedule for sites that are not currently mowed is encouraged.

In the future, once we reach successful control of a site, we will provide any information needed for final management of the remaining weeds. The intent of biocontrol is not to eradicate weed infestations entirely, but to knock down large, dense stands to manageable levels that can be easily remedied using other control methods, if needed. Some sites have some existing native vegetation, however, some are disturbed, along roadsides and inundated with other noxious weeds. Re-vegetation with native grasses and forbs would be ideal in many areas that have been disturbed, to prevent resurgence of weeds and provide a healthy plant community and habitat. This paired with mechanical (hand-pulling) or precise spot herbicide treatment to handle the remaining plants would be the best management plan for most sites on the installation. Care should be taken to avoid disturbing the seed bank in these areas. These sites should be monitored to ensure successful natural re-generation of the native plants and displacement of noxious weeds. Some sites that have been successfully controlled and require follow-up have existing native plant communities and may not necessitate re-vegetation at this time. These sites should be monitored to ensure successful natural re-generation of native plants and displacement of the remaining noxious weeds.

Table 1. Sites to be discontinued from monitoring by the Biological Control of Noxious Weeds program. Terminal management for remaining weeds is recommended.

Weed	Site
common mullein*	none
field bindweed*	none
knapweed	DKbiketrail, SKdead, SKmtr, SKnpwr, SKoldmon, SKploop2
leafy spurge*	none
Saint Johnswort*	SJkettle, SJmidkl, SJsantafe**
thistle*	MTice1
yellow toadflax*	none

*Per discussions in late 2011, all non-knapweed sites may be eliminated from the Biological Control of Noxious Weeds program, depending on objectives decided upon by Academy personnel.
**no infestation remains

Buckley Air Force Base

The Canada thistle infestation at CTwake growing along the dam.

A total of 28 sites were monitored in 2011 at Buckley Air Force Base. As detailed in the Navigating the Report section, we modified our sampling methodology, therefore we will not provide a total area of infestation, as only a few sites were perimeter mapped. Two Canada thistle and one musk thistle sites were surveyed and perimeter mapped this year. Due to the small size and topography of the infestation at CTwlake, the Canada thistle was both point sampled and perimeter mapped, encompassing 0.12 ha (0.30 acres). The majority of the Canada thistle at this site is located within the rip rap boulders that support the dam for Williams Lake and the size has remained somewhat stable since the sites' establishment in 2003 (Figure X). Within the larger patch of Canada thistle, we observed adult *Cassida rubignosa a*s well as foliage damage caused by the beetles. We installed 50 m x 25 m transects at both CTaspen and MTaspen, within the original mapped areas. Both sites are very dense with healthy, robust plants. The thistles coexist in a majority of the area and cannot successfully be perimeter mapped as two separate sites. We attempted to perimeter map only the musk thistle at MTaspen, resulting in 0.78 ha (1.90 acres) of infestation, however, the musk thistle extends far beyond this mapped area. We observed adult and larval *C. rubignosa* on musk thistle and *Urophora cardui* galls on Canada thistle plants however, additional biocontrol agents are recommended for all thistle sites. For clarification, the reason CTmissgate site was established in 2008 is unknown, as no biocontrol agent releases were actually conducted; we will no longer monitor this site, however control measures are recommended for this region.

The Canada thistle site CTaspen and musk thistle site MTaspen on the top and bottom, respectively.

A total of 7 leafy spurge sites were surveyed this year. Both LSrunway and LSsfence have steady, successful populations

of *Aphthona sp.* beetles and the weed infestations have greatly decreased over the last few years (Figure X). In June, we observed heavy foliage damage at the LSrunway site, many leafy spurge plants were extremely stunted, defoliated, covered in actively feeding flea beetles. Similarly, we discovered a large amount of *Aphthona sp.* at the LSsfence site, a single sweep net sample recovered 95 *Aphthona czwalinae.* We point sampled the small, isolated patch of leafy spurge surrounding a stagnant pond of water at LSsfence. In 2011, the total area of leafy spurge infestation at LSrunway was 0.02 ha (0.04 acres) down from 0.11 ha (0.26 acres) in 2007. The original LSrunway site, established in 2004, has been successfully controlled, no leafy spurge remains in this area. This year, we installed and sampled a modified transect due to the small size and perimeter mapped the remaining small infestation. Generally, we have seen that control is effective at these sites.

We observed excellent defoliation at the leafy spurge infestations at Runway (above left) and Sfence (above right) in mid-June along with an abundance of flea beetles (*Aphthona sp.)* and several *O. erythrocephala.* Unfortunately, Canada thistle is thriving within the Sfence area.

We installed 2 modified transects due to the size of the leafy spurge infestations within 2 of the 5 patches at the LSnorthfence site. The total area of infestation is 0.13 ha (0.30 acres), which has remained stable since its establishment in 2009. All 5 infestations at LSnorthfence are high density; we recovered both *Aphthona sp.* and *Oberea erythrocephala*.

We installed a modified transect at this patch of leafy spurge located at the southwest side of Northfence. Both *Aphthona sp.* and *O. erythrocephala* were observed during transect surveys in 2011 (left).

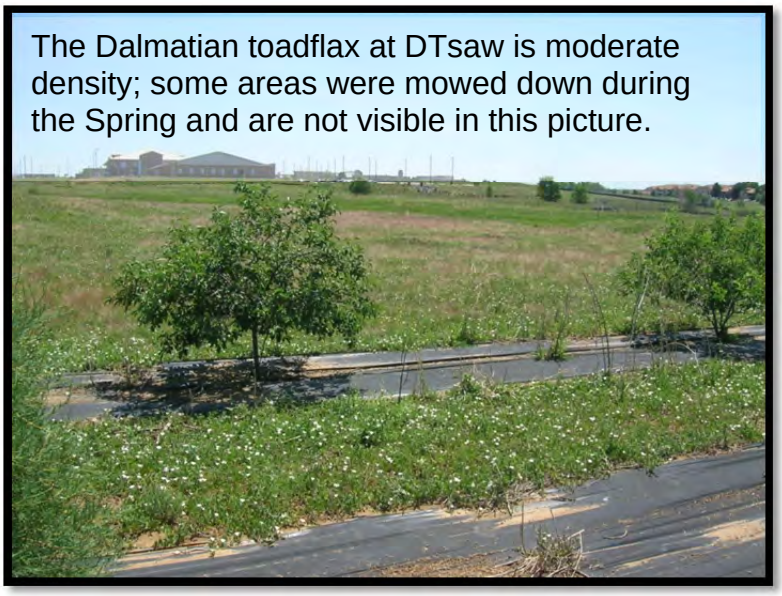
Leafy spurge at Wlake saw some success in 2011, with decreases in overall size of infestation and density since 2003 (left). In the background, you can see evidence of the construction underway for the new FAM Camp in the background, removing our SouthWL leafy spurge site.

We point sampled and perimeter mapped the leafy spurge infestation at LSwlake (Figure X). The most densely infested patches of the site covers 0.02 ha (0.04 acres) this year, compared to 0.38 ha (0.94 acres) in 2003. This site consists of sparse patches of leafy spurge throughout the historically mapped area, ranging from low to high density. We did detect minimal quantity of *Aphthona sp.* during the sweep samples. A new observation was made this year, with the discovery of a single leafy spurge hawk moth caterpillar, *Hyles euphorbiae*. The biocontrol agent was observed on a heavily defoliated small leafy spurge plant near LSwlake, despite no releases of the agent conducted by our program. The source of the biocontrol agents' distribution is unknown, likely conducted by a local government agency.

Three additional leafy spurge sites, LSnorthrun1, LSnorthrun2 and LSnorthrun3 are traditionally only randomly point sampled for the *Aphthona spp.* flea beetles. Random sampling was conducted to estimate weed abundance, density, height, and seed production, as well as insect data. Although, both biocontrol agents, *Aphthona sp.* and *O. erythrocephala,* were observed at LSnorthrun3, and *Aphthona. sp.* observed at LSnorthrun1, the leafy spurge remains dense and vigorous. LSnorthfence, LSnorthrun1, LSnorthrun2, LSnorthrun3 and LSwlake should receive additional biocontrol agents to augment the existing small populations, to ensure success. We will no longer monitor the leafy spurge site, LSinterior; we currently do not and likely will

never receive permission to access this area, per Laurie Fisher. The leafy spurge site LSsouthwl has been destroyed by construction of a new Fam Camp during the summer of 2011.

This year, 1 Dalmatian toadflax site was surveyed and perimeter mapped. We installed 2 50 m x 25 m transects to cover the large, linear infestation at DTsaw . The total area of infestation in 2011 was 0.15 ha (0.38 acres) compared to 0.32 ha (0.79 acres) in 2003. We saw moderate density and overall healthy Dalmatian toadflax plants throughout the area. This spring, we were unable to collect toadflax stems from this site, in order to look for evidence of *Mecinus janthinus* infestations from 2010. During our early site visit to collect stems, it appeared that portions of the site were recently mowed and no stems were left standing. Over the last two years, no successful biocontrol establishment has been observed at this site. Additional biocontrol releases of *M. janthinus* or other available agents, if available through a commercial source or field collecting from other sites, are recommended. In the 2010 report, we mentioned the potential establishment of a new Dalmatian toadflax site, DTsilver, identified by former USFWS employee. We were unable to conduct releases of biocontrol agents on this infestation, therefore it will no longer be considered at this time, for inclusion into the program. In addition, we will abandon the DTsfence site, as the area is restricted and it will not be accessible in the future.


The Dalmatian toadflax at DTsaw is moderate density; some areas were mowed down during the Spring and are not visible in this picture.

Eighteen field bindweed sites were monitored using the random point sampling technique to determine changes in plant parameters and checked for presence of the mite *Aceria malherbae.* The field bindweed was widespread and rather dense at most sites. Various levels of established of the biocontrol agent, *A. malherbae* were observed. Due to the relatively dry spring and early summer, the field bindweed was slow to emerge with an early senescence, which can negatively affect the biocontrol agents' lifecycle. No signs of biocontrol agents were detected during the random samples at 11 sites (FBaspen, FBbreckenridge, FBnegate1-5, FBsaw1, FBsaw2, FBsfence2, FBsteamboat) with 3 sites containing minimal signs of the mite (Fw1, Fw2, RV); re-distribution of the mite, *A. malherbae,* is recommended in to ensure establishment. This will be a priority for 2012, given availability of mites from other sites or commercial sources. Ground disturbance due to new


Mowing during the growing season is recommended for sites including FBaspen, to help distribute the bicontrol agent *A. malherbae.*

construction and landscaping is the cause for the lack of biocontrol agents at 3 sites (FBnegate1-5, Fbsaw1, FBsaw2). Generally, *A. malherbae* is successfully spread by mowing which distributes the infested plants; many of the sites we monitor are located along frequently mowed roadsides, promoting establishment of the biocontrol agents (Figure X). There are two sites that will no longer be monitored by our program. FBsteamboat is located in a temporary parking lot, and is used if needed for events, the bindweed is sparse and biocontrol agents do not have success in this high traffic area. The field bindweed at FBfw3 is extremely dense and healthy, growing within a large stand of Canada thistle; unfortunately this site cannot be reasonably mapped by our personnel. Alternative weed control measures should be considered for these sites.

Both field bindweed and Canada thistle intertwined in a dense patch at FBfw3 (left). Mowing operations currently underway along the roadside, at the Breckenridge site; you can see the un-mowed flowering bindweed plants on the far right (right).

Recommendations for 2012:

This year, we primarily saw successfully establishment and control of several leafy spurge sites at Buckley Air Force Base. Consideration should be made for additional biocontrol efforts for majority of Canada and musk thistle, Dalmatian toadflax, and field bindweed sites. The biocontrol populations at CTaspen, MTaspen and DTsaw should be augmented to ensure population maintenance, establishment and efficacy. Supplemental releases of *A. malherbae* are recommended for all field bindweed sites, if available from other sites or projects. Coordination of base mowing personnel to institute a mowing schedule for sites that are not currently mowed is encouraged. In the future, once we reach successful control of a site, we will provide any information needed for final management of the remaining weeds. The intent of biocontrol is not to eradicate weed infestations entirely, but to knock down large, dense stands to manageable levels that can be easily remedied using other control methods, if needed. Some sites have some existing native vegetation however, most are disturbed, along roadsides and inundated with other noxious weeds. Re-vegetation with native grasses and forbs would be ideal in many areas that have been disturbed, to prevent resurgence of weeds and provide a healthy plant community and habitat. This paired with mechanical (hand-pulling) or precise spot herbicide treatment to handle the remaining weeds would be the best management plan for most sites on the installation. Care should be taken to avoid disturbing the seed bank in these areas as well. These sites should be

monitored to ensure successful natural re-generation of the native plants and displacement of noxious weeds.

Table 2. Sites to be discontinued from monitoring by the Biological Control of Noxious Weeds program. Terminal management for remaining weeds is recommended.

Weed	Site
Dalmatian toadflax	DTsilver, DTsfence
field bindweed	FBsteamboat, FBfw3
leafy spurge	LSinterior, LSsouthwl
thistle	none

Fort Carson Army Base

During the 2011 season, 37 sites were surveyed and monitored at Fort Carson Military Post. A number of historical sites that have been monitored since the beginning of the program have been altered and will be removed from our program. This will be discussed further in this section. Twenty-six field bindweed sites were randomly point sampled to estimate weed abundance, density, length, seed production and biocontrol agent establishment. Varying levels of successful biocontrol was observed at each site . No biocontrol agents were observed at 9 sites this year. Redistribution of the mite, *Aceria malherbae*, ideally sourced from Pinon Canyon Maneuver Site or locations in Texas, paired with coordinated mowing operations to stimulate the spread and establishment of the agent is recommended for all sites. Ten of the sites were mowed in 2011 (FBballfield1-3, and 5-7, FBgolfcourse, FBharr, FBhospital and FBwildlife). We visited an additional 14 historical field bindweed sites that were eliminated by construction that we will no longer monitor (see Table 3.).

A. malherbae damage on field bindweed at the FBhazmat site.

This year, we saw success at our spotted knapweed sites. We surveyed 4 spotted knapweed sites, with 2 under control, SKturkey and SKfuel . Construction was currently underway during our survey at SKfuel, majority of the site has been replaced by parking lots, buildings and a drainage ditch. Despite the construction, we detected *Larinus minutus* adults and emergence holes in the knapweed seedheads in the few plants that remain within the ditch. A majority of the spotted knapweed at SKturkey is located along a two-track road that has eroded following recent heavy rain events. This site should be carefully managed to avoid spreading noxious weed seeds during erosion control efforts. Due to the sensitivity of this area and progress made, immediate spot herbicide treatment or mechanical control efforts are advisable. In addition, we point sampled SKhazmat and SKsouthturkey, although these sites will

The successfully controlled SKturkey, we marked small patches of knapweed with pink flags, as seen in the photo (left). Despite SKfuel being located in cantonment and replaced by new construction (below), biocontrol agents were

no longer be included in the program. SKsouthturkey recei
treatment during the summer of 2011, manual vegetation a
in Spring or Summer 2011 and was scheduled for a prescribed burn in October/early November 2011. During discussions with Chris Caris, Fort Carson weed manager, we were informed that SKhazmat inadvertently received an herbicide treatment this summer, unaware it was a Texas AgriLife Research biocontrol site. Two diffuse knapweed sites were visited and evaluated this summer. DKgunclub received an herbicide treatment during the spring of 2011 and DKroute1 is routinely mowed by various Fort Carson contractors, due to its proximity to heavily traveled Route 1. Due to the very small size of the infestation and recently mowed weeds at DKroute1, we only collected 3 point samples and detected both adult *Cyphocleonus achates* and *L. minutus* adults and pupae (*L. minutus* also recovered during seedhead dissections).

After discussions with Chris Caris about future management plans, we will no longer survey or monitor any knapweed biocontrol sites on Fort Carson. Instead, Chris proposed an in-house effort to eradicate the weed from the base using chemical and/or mechanical weed control methods. We recommend these sites continue to be monitored to ensure the best management of the weeds, especially

The small diffuse knapweed infestation at DKroute1, mowed prior to our survey. The *C. achates* recovered during the point sample survey (right).

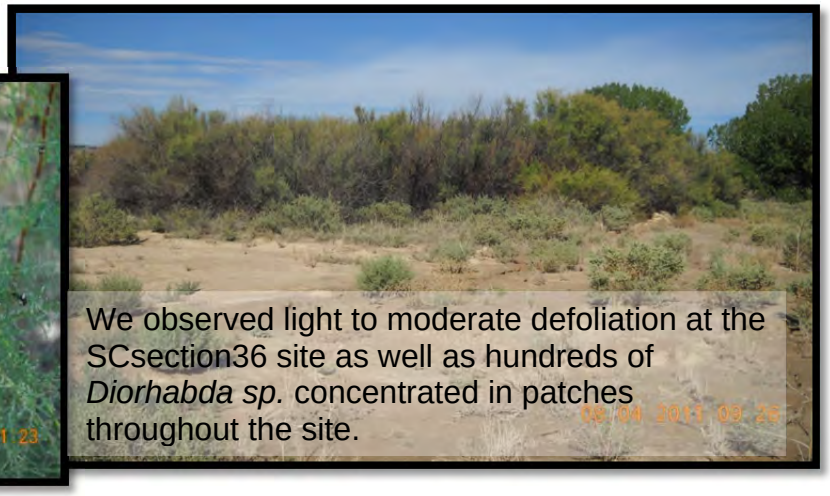
sites that have been knocked back to manageable size and density

by biocontrol.

We collected knapweed seedheads and roots in August from DKroute1, SKfuel, SKhazmat, SKsouthturkey and SKturkey. Dissections were performed during the fall, to examine the agents' successful reproduction, dispersal and damage to both diffuse and spotted knapweed plants. Seedhead dissections produced larval *Urophora affinis,* both larval and adult stage *U. quadrifasciata* as well as pupae and adult *L. minutus.* A total of 59 seedheads were collected from DKroute1, only producing a single biocontrol agent, *L. minutus* in 8% of the samples. Thirty-nine seedheads were dissected from SKfuel, with decent recovery rates, 8% *U. affinis,* 10% *U. quadrifasciata* and 10% *L. minutus,* with 4 adult *L. minutus* loose in the sample bag. Of the 199 seedheads dissected from SKhazmat, 8% contained *U. affinis,* 25% *U. quadrifasciata* and 1% *L. minutus,* in addition to 9 adult *L. minutus* and 5 adult *U. quadrifasciata* loose in the sample bag. We dissected 184 knapweed seedheads from SKsouthturkey, with visible blue herbicide residue on some seedhead samples. Both *U. affinis* and *U. quadrifasciata* comprised 1% of the samples, in addition to 7 loose adult *L. minutus* loose in the sample bags. Lastly, we dissected 174 seedheads from SKturkey, 2% contained *L. minutus,* as well as 23 adult *L. minutus* in the sample bags. This year, biocontrol agents were less common in the roots. A total of 98 roots were dissected and only evidence of *Cyphocleonus achates* was detected in a couple of roots collected from SKturkey.

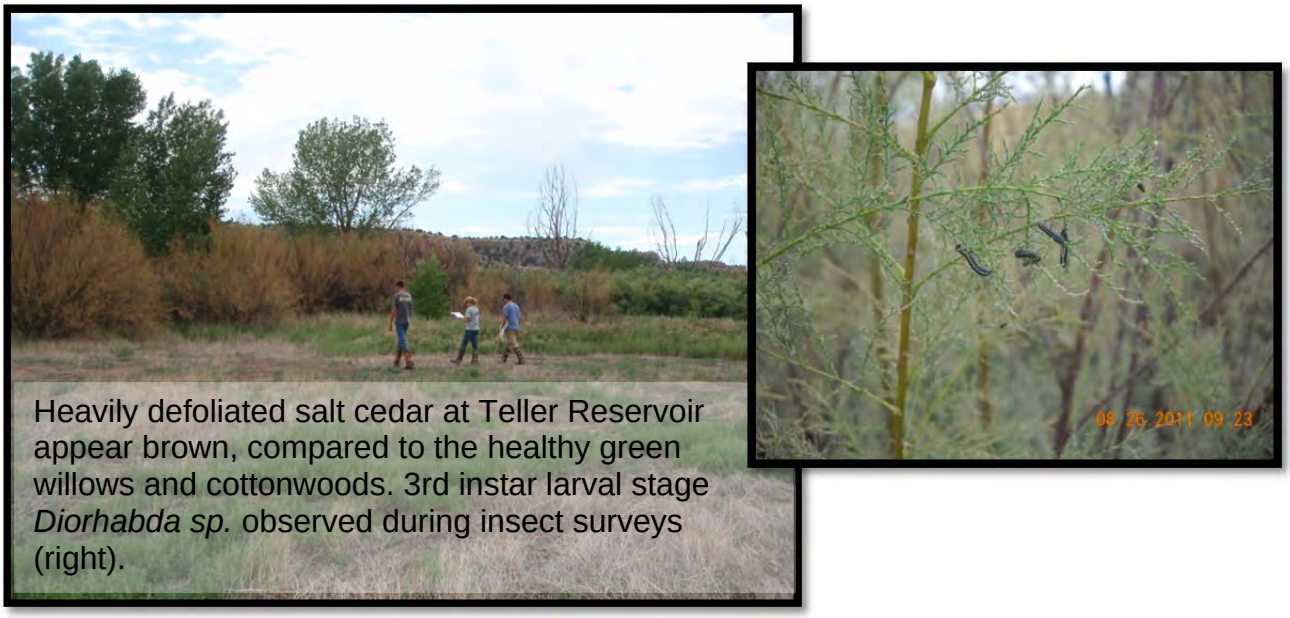
Biocontrol agents were recovered during seedhead dissections for SKhazmat.

The salt cedar in Training Area 36 and in Teller Reservoir was surveyed for *Diorhabda sp.* using a combination of timed insect counts and insect sweeps using Tamarisk Coalition protocol. At SCsection36, we collected 4 GPS location data points, 25 sweeps each (100 total sweeps) and observed *Diorhabda sp.* adults, eggs, and 1st-3rd instars larvae. We followed the same protocol at Teller Reservoir with the


We observed light to moderate defoliation at the SCsection36 site as well as hundreds of *Diorhabda sp.* concentrated in patches throughout the site.

Photos taken in August 2010 (left) and in August 2011 (below).

4 GPS location data points but, added 4 timed 5 minute insect counts. Thousands of adult and late instar larvae *Diorhabda sp.* were detected. In addition to the large numbers of *Diorhabda sp.* at both locations, we saw severe defoliation throughout Teller Reservoir, specifically (Figure X). Establishment of the beetles at Teller Reservoir was discovered this spring by Fort Carson personnel; the beetles naturally spread, likely from Beaver Creek. Many areas surveyed were 90-100% defoliated, often with an abundance of active beetles in both larval and adult life stages. We recommend continued monitoring of the status of the salt cedar and spread of the *Diorhabda sp.* in 2012. The raw data was submitted to Chris Caris in September 2011 to share with the Tamarisk Coalition.



Heavily defoliated salt cedar at Teller Reservoir appear brown, compared to the healthy green willows and cottonwoods. 3rd instar larval stage *Diorhabda sp.* observed during insect surveys (right).

Although some weed populations do not have sustained biocontrol agent populations, many of the infestations are showing a steady decline in area and/or density. Six thistle sites were surveyed and/or assessed during the 2011 field season. Three thistles sites have shown significant declines, CTara1, CT/MTreservoir and CTduck. We point sampled the Canada thistle at CTara1, due to minimal remaining thistle plants. During 2011, we collected 10 points that covered each patch of plants, compared to the over 700 points we collected to identify individual plants and small patches of plants last year. No biocontrol agents were detected during the survey and the thistle plants appeared healthy, therefore this site should quickly be evaluated in 2012 for final management of the remaining weeds to maintain the success we have reached. Re-vegetation with grasses and forbs would be ideal as there is an abundance of visible bare ground susceptible to another attack of noxious weeds and very little existing native vegetation. Our continued monitoring of CTara1 will depend on the decision of base personnel to either pursue the recommended terminal management or to have the site remain under biocontrol only. The Canada thistle and musk thistle sites CTreservoir and MTreservoir are under control; this year only a few plants were observed in the area. There is enough existing native vegetation within the CT/MTreservoir site not to warrant further re-seeding however, the remaining thistle plants should be spot treated to curb future re-infestation and to maintain the success we have seen. The Canada thistle infestation at CTduck has decreased substantially since its establishment in 1998, covering 0.35 ha (0.86 acres) down from approximately 1.58 ha (3.9 acres). Although, this year we did not detect any biocontrol agents or damage to the Canada thistle plants during the 50mx25m transect survey. This year, the Canada and musk thistle infestations at Highway115 encompasses 0.18 ha (0.44 acres), the area is roughly unchanged since its establishment in 2000.

Sparse Canada thistle plants that remain at CTara1.


The CT/MTreservoir sites have been successfully controlled.

Like CTduck, no biocontrol agents were observed during the point sample survey at CT/MThwy115 this year. We recommend re-distribution of agents from other sites or projects, or from a commercial source to augment any existing biocontrol populations at these thistle sites. The MTwildlife site was point sampled due to the shape, topography and size of the infestation around Womack Reservoir. We observed many *Rhinocyllus conicus* on thistle flowerheads. However, as discovered in 2010, ant predation seems to be a problem at this site, potentially causing a number of weevil mortalities or restricting their ability to become a stable population. Mid-summer, the CTara2 infestation incidentally received a large scale broad spectrum herbicide treatment, intended to control the teasel and houndstongue within the area. Fort Carson personnel conducted this treatment and anticipate further using chemical control methods therefore, we will abandon this site.

Recommendations for 2012:

This year at Fort Carson Military Post, we saw control of several Canada and musk thistle, knapweed and salt cedar sites. We recommend that biocontrol populations at several sites (CTduck, CT/MThwy115, MTwildlife) be augmented to ensure population maintenance, establishment and efficacy. Supplemental releases of *A. malherbae* should be considered for all field bindweed sites, if available from other sites or projects (preferably from Pinon Canyon). Coordination of base mowing personnel/contractors to institute a mowing schedule for sites that are not currently mowed is encouraged. In the future, once we reach successful control of a site, we will provide any information needed for final management of the remaining weeds. The intent of biocontrol is not to eradicate weed infestations entirely, but to knock down large, dense stands to manageable levels that can be easily remedied using other control methods, if needed. Some sites have some existing native vegetation however, most are disturbed, along roadsides and inundated with other noxious weeds. Re-vegetation with native grasses and forbs would be ideal in many areas that have been disturbed, to prevent resurgence of weeds and provide a healthy plant community and habitat. This paired with mechanical (hand-pulling) or precise spot herbicide treatment to handle the remaining weeds would be the best management plan for most sites on the installation. Care should be taken to avoid disturbing the seed bank in these areas. These sites should be monitored to ensure successful natural re-generation of the native plants and displacement of noxious weeds. Some sites that have been successfully controlled and require follow-up have existing native plant communities and may not necessitate re-vegetation at this time. These sites should be monitored to ensure successful natural re-generation of native plants and displacement of the remaining noxious weeds.

Evidence of herbicide treatment on Canada thistle at CTara2.

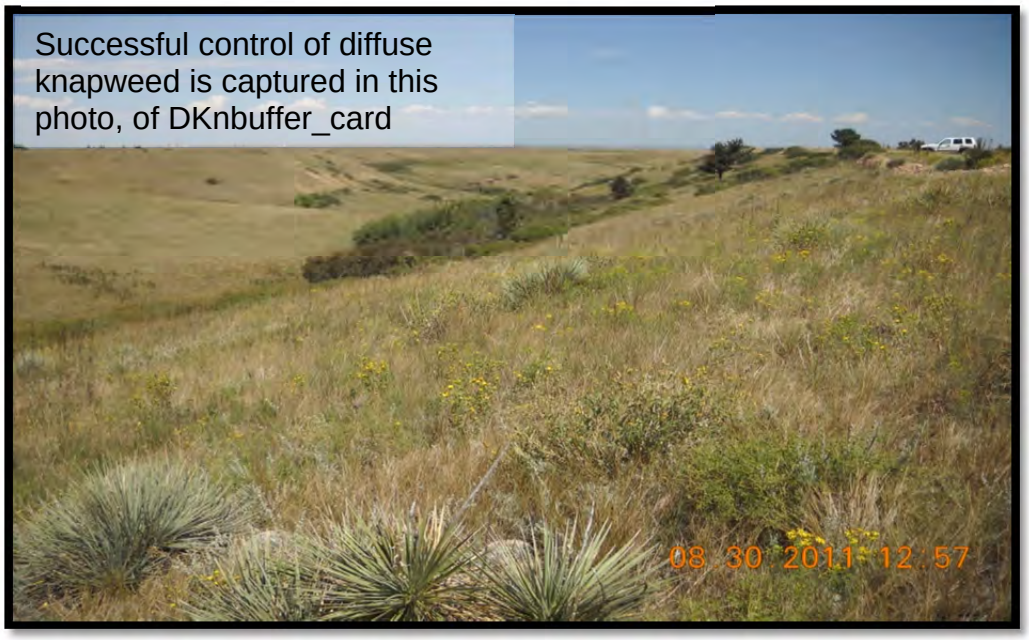
Table 3. Sites to be discontinued from monitoring by the Biological Control of Noxious Weeds program. Terminal management for remaining weeds is recommended.

Weed	Site
field bindweed	none
knapweed	DKgunclub, DKroute1, SKhazmat, SKturkey, SKsouthturkey, SKfuel
salt cedar	none
thistle	CTara1*, CTara2, CTreservoir*, MTreservoir*

*Management objectives of base personnel will determine the elimination or maintenance of the site in our program.

Rocky Flats National Wildlife Refuge

Twenty-four noxious weed infestations were sampled at Rocky Flats National Wildlife Refuge in 2011. We continue to observe successful agent establishment and control of diffuse knapweed within and near release locations. Over the last few years, thousands of agents, primarily *Cyphocleonus achates* and *Larinus minutus* have been collected from various knapweed infestations on Rocky Flats by various state and local agencies as well as universities, for redistribution and/or studies. This year, *C. achates* was collected by students from the University of Arkansas (approximately 2,000 insects), and technicians from the Colorado Department of Agriculture (unknown amount of insects). Since 2007, we continue to perform



Successful control of diffuse knapweed is captured in this photo, of DKnbuffer_card

the transect surveys over 4.2 km of diffuse knapweed in the North Buffer area as well as 1.4 km of Dalmatian toadflax along the South Fence. These two diffuse knapweed sites, DKnbuffer_card and DKnbuffer_line were surveyed along multiple 300-500 m transect lines, which resulted in 11 of 123 points and 2 of 126 points, respectively, containing knapweed. Very little knapweed is present within these areas however, knapweed occurs in the surrounding areas, primarily near the south fence, west gate entrance and along roadsides. Both DKsite1 and DKsite2 were very low density with just a few plants remaining in small patches. We observed several biocontrol agents at each site, including *C. achates, L. minutus, Urophora affinis* and *Urophora quadrifasciata.* This area is within the Central Operable Unit (COU), and has been successfully re-seeded with native vegetation. It is of note that our insect surveys may not accurately reflect the knapweed agents' establishment and spread, because of large collections and re-distributions over the years. However, the data collected this year shows significant control of the diffuse knapweed at our monitoring sites. In order to successfully control the entire diffuse knapweed infestation at Rocky Flats, only minimal collections of agents from the refuge is recommended, as well as augmenting or redistributing agent populations.

We collected diffuse knapweed seedheads and roots in late August from DKnbuffer_line and DKnbuffer_card. The dissections were performed during the fall, to examine the agents' successful reproduction, dispersal and damage to the knapweed plants. A total of 116 seedheads were collected from DKnbuffer_card. The samples produced small numbers of seedhead agents, only 1% of samples contained *U. affinis,* 2% *U. quadrifasciata,* and 7% *L. minutus,* in addition to 5 adult *L. minutus* loose in the sample bag. Of the 40 seedheads dissected from DKnbuffer_line, 5% contained *U. affinis,* 3% *U. quadrifasciata,* and 5% *L. minutus.* A total of 44 roots were dissected from both sites. Some *C. achates* damage (cavities and tunnels) was observed in the roots collected from DKnbuffer_card. One knapweed root revealed a significant occurrence of a *Sphenoptera jugoslavica* larva. *L. minutus, U. affinis* and *U. quadrifasciata* were all recovered from the dissected seedheads.

Two adult *C. achates* detected at DKnbuffer_card.

This year, all 5 of our established Dalmatian toadflax sites were surveyed. Adult *Mecinus janthinus* were detected at all 5 sites during sampling in 2011. Four sites were point sampled, and one, DTsfence continued to be point sampled at pre-determined survey points along transect lines. Very little toadflax was observed during the transect survey, only 24 of the 74 sampled quadrat points contained toadflax. The density was very low as well; only 5 of the quadrats had more than 10% canopy cover by weeds. During the survey, we did observe healthy toadflax plants in patches surrounding the sample points. The Dalmatian toadflax infestations at DTsite1, DTsite2 and DTweather have decreased substantially and only small to medium sized patches remain (Figure X). In 2004, the DTweather site was perimeter mapped and encompassed more than 1.42 ha (3.5 acres), this year the majority of the infestation covered 0.02 ha (0.05 acres) within small patches (we did not include the area outside the COU fence). This year, we point sampled the DToriginal site, and very low density within several patches remaining throughout the field. The best strategy for these sites may be to receive more biocontrol agents to augment existing populations. Although, we will likely continue to see decreases in density and size of these Dalmatian toadflax sites, since the *M. janthinus* populations have been somewhat stable.

Only a few patches of Dalmatian toadflax remain at DTsite1 (left). On the right is a quadrat containing a few toadflax plants, during point sampling.

In late May/early June, we collected a total of 30 stems from each Dalmatian toadflax sites for dissection to look for evidence of the stem-boring weevil. We found an abundance of *M. janthinus* adults, pupae, some larvae as well as many oviposition holes in stems collected from all 5 sites at Rocky Flats. Adult *M. janthinus* were recovered from at least 80-90% of all stems collected and many contained multiple insects (one stem collected from DToriginal contained 29 adults). Populations of *M. janthinus* have proven to be high and self-sustaining at many sites. In addition, we incidentally observed adult *M. janthinus* on Dalmatian toadflax infestations that we do not monitor, during surveys for other noxious weeds.

One Canada thistle site, CT Lindsay, was surveyed at Rocky Flats in 2011. We installed 50 m x 25 m transects through the original infestation, as previously described in the Navigating the 2011 Report section. Canada thistle is present in abundance in the Lindsay Ranch area, particularly close to and surrounding the pond, therefore we did not perimeter map the site this year. An abundance of *U. cardui* galls and *Cassida rubignosa* foliage damage was observed during the transect survey. Only biocontrol agent presence is checked at the musk thistle site, MTnbuffer. This year, we observed both adult and larval stages of *Rhinocyllus conicus* in the

Musk thistle site, MTnbuffer (right). Adult *R. conicus* and damage within a musk thistle seedhead (left).

musk thistle seedheads, as well as several empty emergence holes and cavities . This agent has been successfully established in this area, significant decreases in weed density and vigor should be obvious in the future.

All 16 field bindweed sites were sampled this year. Evidence of the biocontrol agent *Aceria malherbae* was observed at 12 of the sites, and in abundance at some sites (FBhighroad1, FBnbuffer2 and FBsite1). The field bindweed infestations at 7of the sites were considered patchy to sparse (FBsite1-4, FBhighroad1-2 and FBnbuffer4). Re-distribution of the agent is recommended if available from other sites or commercial sources (Pinon Canyon Maneuver Site is a preferred source).

Field bindweed with extensive *A. malherbae* damage at FB Site1 (above). Photopoint for Site1, patchy bindweed was reported this year (left).

Recommendations for 2012:

Overall, we observed successful biocontrol underway at many of our sites this year. Consideration should be made for additional biocontrol efforts for several existing sites. The biocontrol populations at or near CTlindsay, DTsite1, DTsite2, DTsfence and DTweather should be augmented to ensure establishment and efficacy. In addition, supplemental releases of *A. malherbae* are recommended for many of the field bindweed sites, if available from other sites or projects. All 4 of our diffuse knapweed sites (DKnbuffer_card, DKnbuffer_line, DKsite1 and DKsite2) have been successfully controlled by biocontrol agents, though other areas of Rocky Flats are affected by this weed. The majority of the sites have existing native vegetation and may not need re-vegetation at this time, as re-vegetation efforts have been undertaken by Rocky Flats in the recent years. The best management practice would be mechanical (hand-pulling) or precise spot herbicide treatment to handle the few remaining weeds found within the sites. These sites should be monitored to ensure successful natural re-generation of the native plants and displacement of noxious weeds.

Table 4. Sites to be discontinued from monitoring by the Biological Control of Noxious Weeds program. Terminal management for remaining weeds is recommended.

Weed	Site
Dalmatian toadflax	none
field bindweed	none
knapweed	none
thistle	none

F. E. Warren Air Force Base

In 2011, we monitored a total of 21 noxious weed sites at F.E. Warren Air Force Base. Five Dalmatian toadflax sites were mapped, including 2 new sites established with biocontrol releases. On June 30, 2011, we released a total of 630 adult *Mecinus janthinus* on Dalmatian toadflax at two new locations (Figure X). We released half along the north side of Central Avenue (DTcentral) and the remaining 315 agents on the south side of Central Avenue next to the Peace Keeper Railroad (DTpkrr). Following our newly implemented protocol, as described earlier in this report, we surveyed 50mx25m transects at DTcentral, but did not perimeter map due to the large extent of the infestation. We point sampled DTpkrr due to the linear toadflax infestation along both sides of the active railroad tracks, which likely extends several miles. During the surveys in July, we recovered minimal amount of the released agent, *M. janthinus* at both sites however, establishment may be confirmed with our toadflax stem dissection surveys that will be conducted next spring.

New Dalmatian toadflax site, DTcentral.

The newly established Dalmatian toadflax site, DTpkrr, established on June 30, 2011 with the release of 315 adult *M. janthinus* (top). Releasing biocontrol agents and collecting data with GPS at release location (left bottom). Student workers, Fall and Godshall installing a Texas AgriLife biocontrol of noxious weeds sign at the new site (right bottom).

Dalmatian toadflax made a slight resurgence this year, compared to 2010, although control efforts have proven successful. This comeback is likely due to above normal precipitation between May and October in Laramie County, following a relatively dry year. One of the three existing toadflax sites, DTcontrol, saw containment for two consecutive years (Figure X). Last year, only a single Dalmatian toadflax plant was discovered throughout the site area; this year, we found just a few plants, although the area is dense with both native vegetation and other noxious weeds including Canada thistle and leafy spurge. The recommendation for this site is mechanical or chemical spot treatment for the 2012 growing season. DTmissile was point sampled and perimeter mapped, the majority of the site encompassing 0.0006 ha (0.0016 acres) compared to 2.04 ha (5.04 acres) originally mapped in 2004 (Figure X). The site has seen dramatic decreases in size and density and is considered under control however, no biocontrol agents, *M. janthinus* were observed this year. Additional biocontrol measures or final treatment, chemical and/or mechanical should be executed. Our continued monitoring of DTmissile will depend on a decision by base personnel to either administer final control measures, or to leave

the site within our biocontrol program. We surveyed 50mx25m transects and perimeter mapped the infestation at DTnature, which rebounded somewhat from 2010 (Figure X). The size of DTnature has decreased substantially from 4.55 ha (11.2 acres) in 2004 to 0.007 ha (0.02 acres) in 2011. No *M. janthinus* was observed during the surveys, therefore, additional biocontrol releases or chemical and/or mechanical control measures for final treatment, since the site is a manageable size, is recommended. DTnursery was established as a nursery for biocontrol agents but has been replaced by leafy spurge in the last few years. We will no longer monitor the success of biocontrol for Dalmatian toadflax at this site, and may consider it for additional leafy spurge agent re-distribution. This spring, we were unable to gain access onto the base until mid June and did not collect Dalmatian toadflax stems for dissection. This will be a priority in 2012, to determine *M. janthinus* reproduction, dispersal and establishment from 2011. The results from the spring stem dissection surveys will provide essential information needed to assess the proper treatment of these sites.

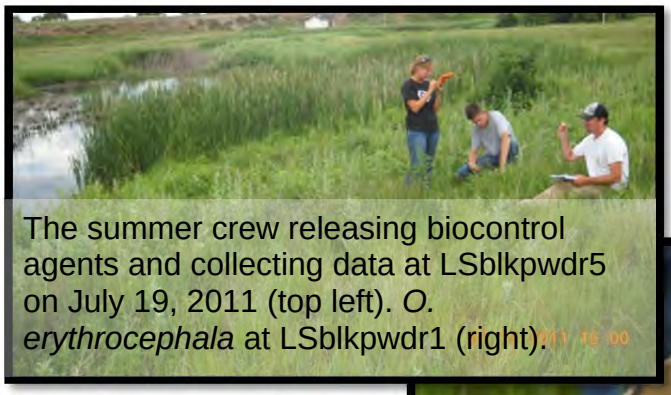
We have seen success at all 3 established Dalmatian toadflax sites. The infestation at Missile is very sparse and patchy (top left). The remaining few toadflax plants are visible in the middle of the picture at DTcontrol (top right). Dalmatian toadflax making a slight comeback from last year at DTnature, low to medium density covering approximately 0.007 ha (bottom left).

We monitored and surveyed 16 leafy spurge sites, including 1 new site, LScontrol2, founded by bicontrol agent releases. Since their establishment, 11 of these sites are randomly point sampled. In addition to sampling weed infestations, approximately 25,000 *Aphthona sp.* flea beetles, 420 *Oberea erythrocephala* and 500 *Spurgia esulae* galls were released among 5 sites (LSblkpwdr1, LSblkpwdr5, LScontrol, LScontrol2 and LSnature1). Four species of *Aphthona* , including *A. cyparrissiae, A. czwalinae, A. lacertosa* and *A. nigriscutis,* comprising the flea beetle mix from our supplier were distributed. These large scale releases conducted this year should effectively augment existing agent populations that we observed during our surveys this year. Three biocontrol agents, *Aphthona sp., O. erythrocephala,* and *Hyles euphorbiae* were

recovered from 11 of the 15 established leafy spurge sites. A new observation was made this year, with the leafy spurge hawk moth caterpillar, *H. euphorbiae*, observed at LScontrol, LSnature1 and on leafy spurge near DTcontrol (Figure X). Biocontrol releases of this agent were not conducted by our program, so it likely was distributed by the County or other local agency, as the existing *O. erythrocephala* populations, prior to releases this summer.

H. euphorbiae, leafy spurge hawk moth caterpillar, discovered on leafy spurge at DTcontrol on July 19, 2011.

This year, we found the leafy spurge to be fairly stunted and late to bloom at some sites, albeit dense and robust at other sites, such as LSbridge1, 2 and the LSnature sites. We randomly point sampled LSblkpwdr1-6, LSbridge1-2, LSnature3-4 and LSpropane. There are varying levels of density, size and biocontrol establishment at these 11 sites. The leafy spurge at LSpropane is rather sparse, low to medium density and due to the proximity to propane tanks and an access road; this area is mowed during the growing season. The other 10 sites remain medium to high density with low numbers of the biocontrol agents *Aphthona sp.* and *O. erythrocephala* detected. On July 19, 2011 we released a total of 9,600 *Aphthona sp.* mix and 420 *O. erythrocephala* at LSblkpwdr1 and LSblkpwdr5. Although we did not release agents at all of the suitable sites, the intent is that the agents will become established at the release locations and be strong enough to re-distribute to these infestations naturally. We will continue to survey and monitor these sites next year to confirm the establishment and spread of the newly released agents.



The summer crew releasing biocontrol agents and collecting data at LSblkpwdr5 on July 19, 2011 (top left). *O. erythrocephala* at LSblkpwdr1 (right).

Pursuant to our updated sampling methodology detailed earlier in this report, we installed 50 m x 25 m transects at 5 leafy spurge sites, to survey and estimate weed abundance, height, density and biocontrol agent populations. We did not perimeter map these sites as the extent of the infestations is too large to successfully map. We surveyed 50 m x 25 m transects at LSblkpwdr, LScontrol and the newly established LScontrol2;

the majority of the leafy spurge within these areas was new growth and very few plants reached the flowering stage this year. However, all 3 sites were medium to high density. In addition to the sampling, we released 9,600 *Aphthona sp.* mix at LScontrol, and 4,800 *Aphthona sp.* mix and 250 *S. esulae* galls at LScontrol2. We installed modified transects at LSnature1 and LSnature2 (50 m x 15 m and 40 m x 20 m, respectively) due to the size and topography of the sites. These sites are very high density with healthy, robust leafy spurge. Although during the surveys, we recovered both *Aphthona sp., O. erythrocephala* as well as 2 individual *H. euphorbiae.* The supplemental releases of 6,000 *Aphthona sp.* mix and 250 *S. esulae* galls conducted on July 19, 2011, should move toward control of these leafy spurge infestations in the upcoming years.

Aphthona sp. mix released at LScontrol2.

New site, LScontrol2 (left). *S. esulae* gall released at LScontrol2 (below).

The leafy spurge at LSnature1 is very dense, and the existing biocontrol agent population was supplemented with 4,800 *Aphthona sp.* mix and 210 *O. erythrocephala* on July 19, 2011 (left).

Recommendations for 2012:

This year at F. E. Warren Air Force Base, we saw control of existing Dalmatian toadflax sites as well as continued implementation of biocontrol efforts for success of leafy spurge in the future. There were discussions this year about introducing Canada thistle into the program at Warren; this should be seriously considered for 2012. We will continue to monitor these sites to look for evidence of establishment and spread of the biocontrol releases conducted this summer. In the future, once we reach successful control of a site, we will provide any information needed for final management of the remaining weeds. The intent of biocontrol is not to eradicate weed infestations entirely, but to knock down large, dense stands to manageable levels that can be easily remedied using other control methods, if needed. Some sites have some existing native vegetation however, most are disturbed, along roadsides and inundated with other noxious weeds. Re-vegetation with native grasses and forbs would be ideal in many areas that have been disturbed, to prevent resurgence of weeds and provide a healthy plant community and habitat. This paired with mechanical (hand-pulling) or precise spot herbicide treatment to handle the remaining weeds would be the best management plan for most sites on the installation. Care should be taken to avoid disturbing the seed bank in these areas. These sites should be monitored to ensure successful natural re-generation of the native plants and displacement of noxious weeds. The Dalmatian toadflax site, DTcontrol has been successfully controlled using biocontrol methods and we recommend further management be taken to completely eradicate toadflax from this site and to prevent the spread or a resurgence.

Table 5. Sites to be discontinued from monitoring by the Biological Control of Noxious Weeds program. Terminal management for remaining weeds is recommended.

Weed	Site
Dalmatian toadflax	DTcontrol, DTmissile*
leafy spurge	none

*Management objectives of base personnel will determine the elimination or maintenance of the site in our program.

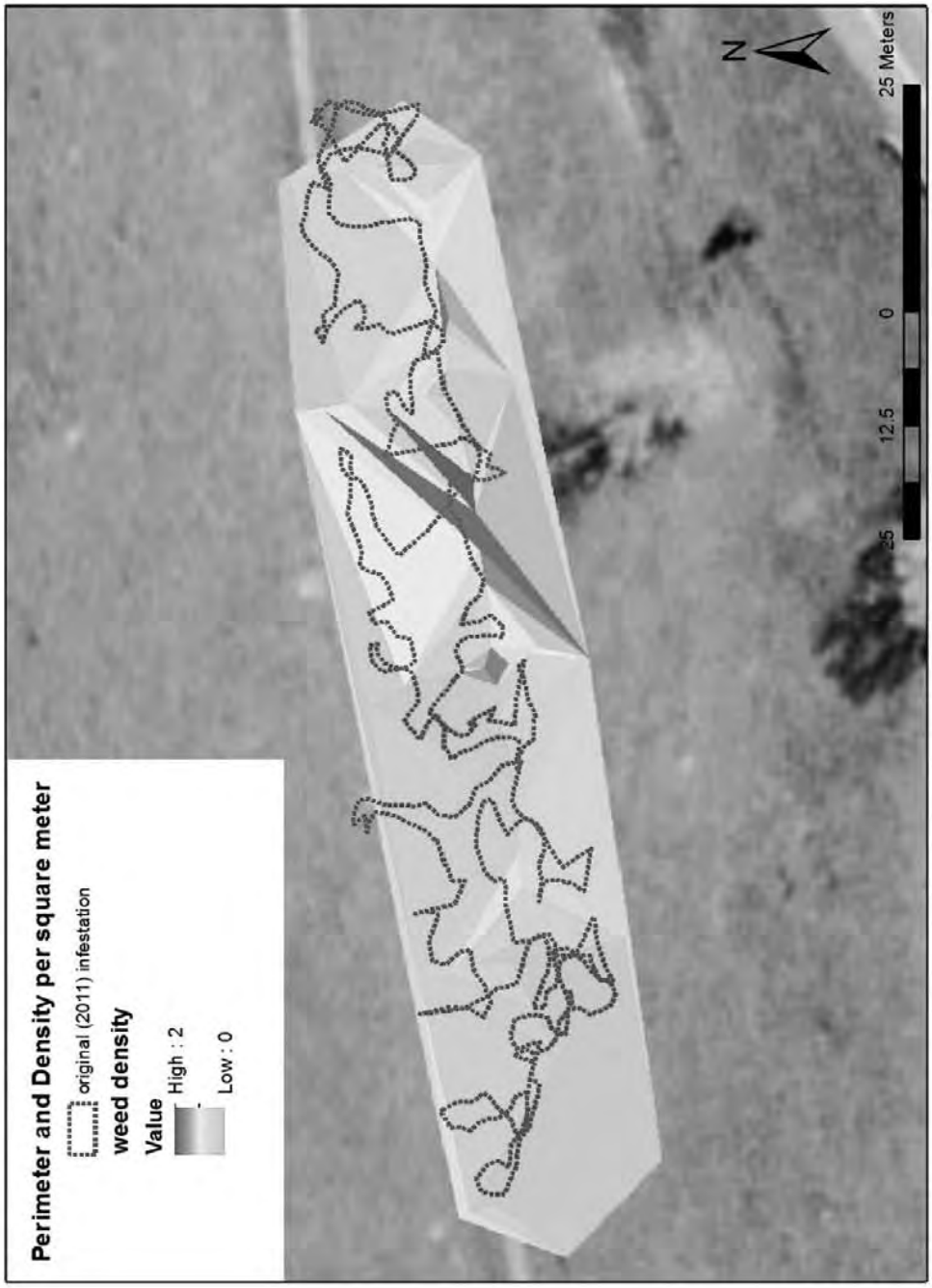
Appendix I: Maps

The Appendix contains maps illustrating changes in site perimeter and density. The information is arranged by installation, and then by weed species. A single map is presented for each site, except for those sites which have either decreased significantly in size or have shifted away from the original extent by a large degree. For such sites, the full extent of the original and current infestation is displayed, followed by one or more maps detailing the specific areas where the current infestation exists and from which data was collected during 2011.

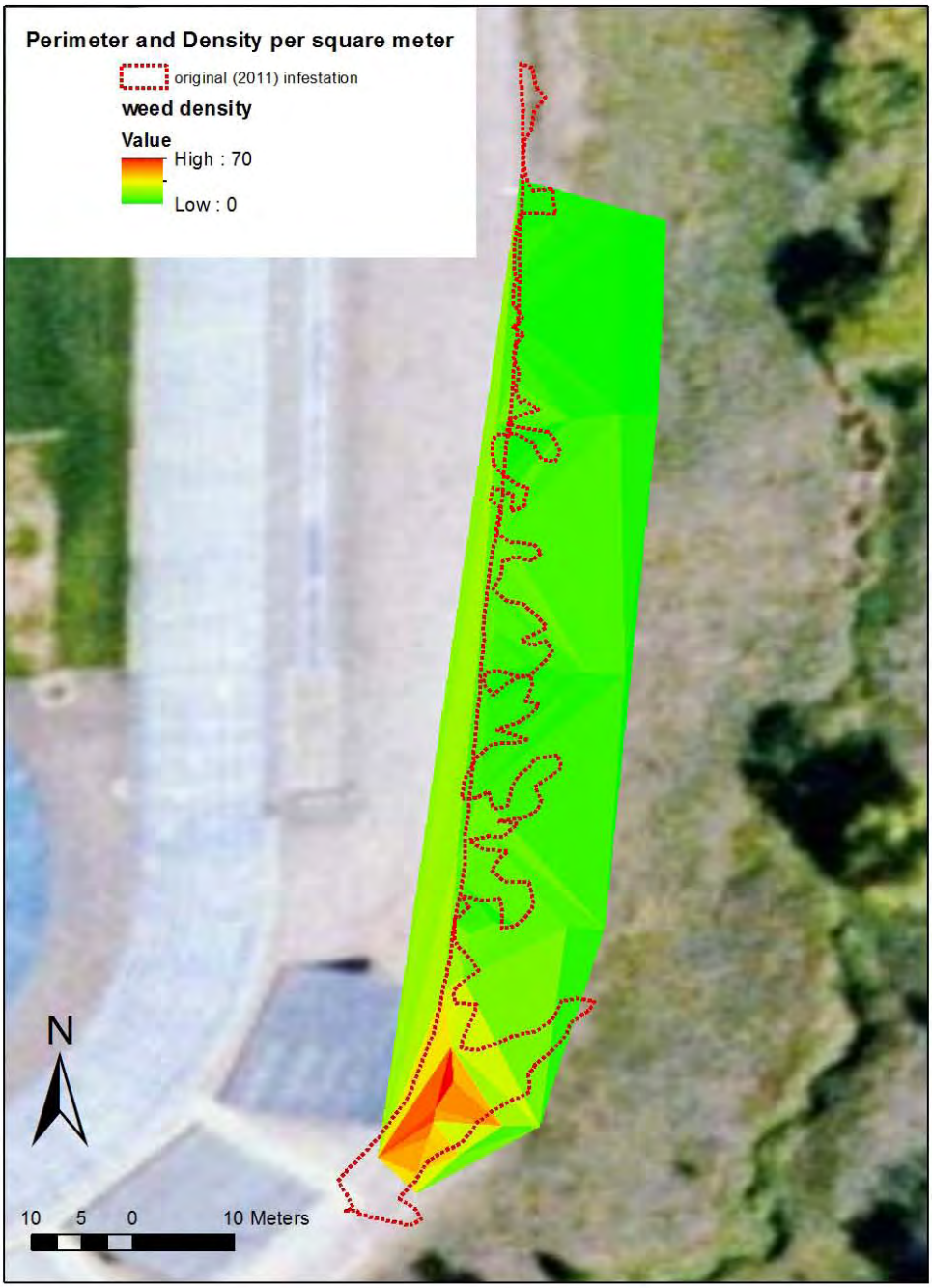
Symbologies utilized in the maps reflect the changes made in sampling protocol during 2011, described earlier in this report. A color gradient appears on most maps, and reflects weed density as extrapolated from survey points utilized this year. This gradient was generated within ESRI ArcGIS software. High and low density values of the color gradient are unique for each site, and appear within the figure legend. In some cases, these relationships were found to be more accurately represented by graduated symbols instead of the color gradient method; density data for these sites are represented by graduated symbols color-coded for 2011 density data and "original" density data collected upon the sites' establishment. As mentioned regarding the high and low density values corresponding to color gradient symbology, values corresponding to the graduated symbols are unique to each site and appear in the figure legend. Perimeters are displayed on the figures and, where applicable, distinct symbology is used to distinguish current and "original" site boundaries.

When viewing the information presented in the Appendix, it is important to remember that area and density are often interrelated. Though, for a given year, these parameters do not necessarily respond in the same way. Sites with a large area of a weed infestation may have low density, or small areas may have high density. Fluctuations in the parameters can indicate effectiveness of biocontrol or may be influenced by climatic conditions; especially rainfall and temperature. This season, through fine tuning our perimeter mapping efforts, we achieved more well-defined areas of infestation for sites where these mapping efforts were deemed necessary.

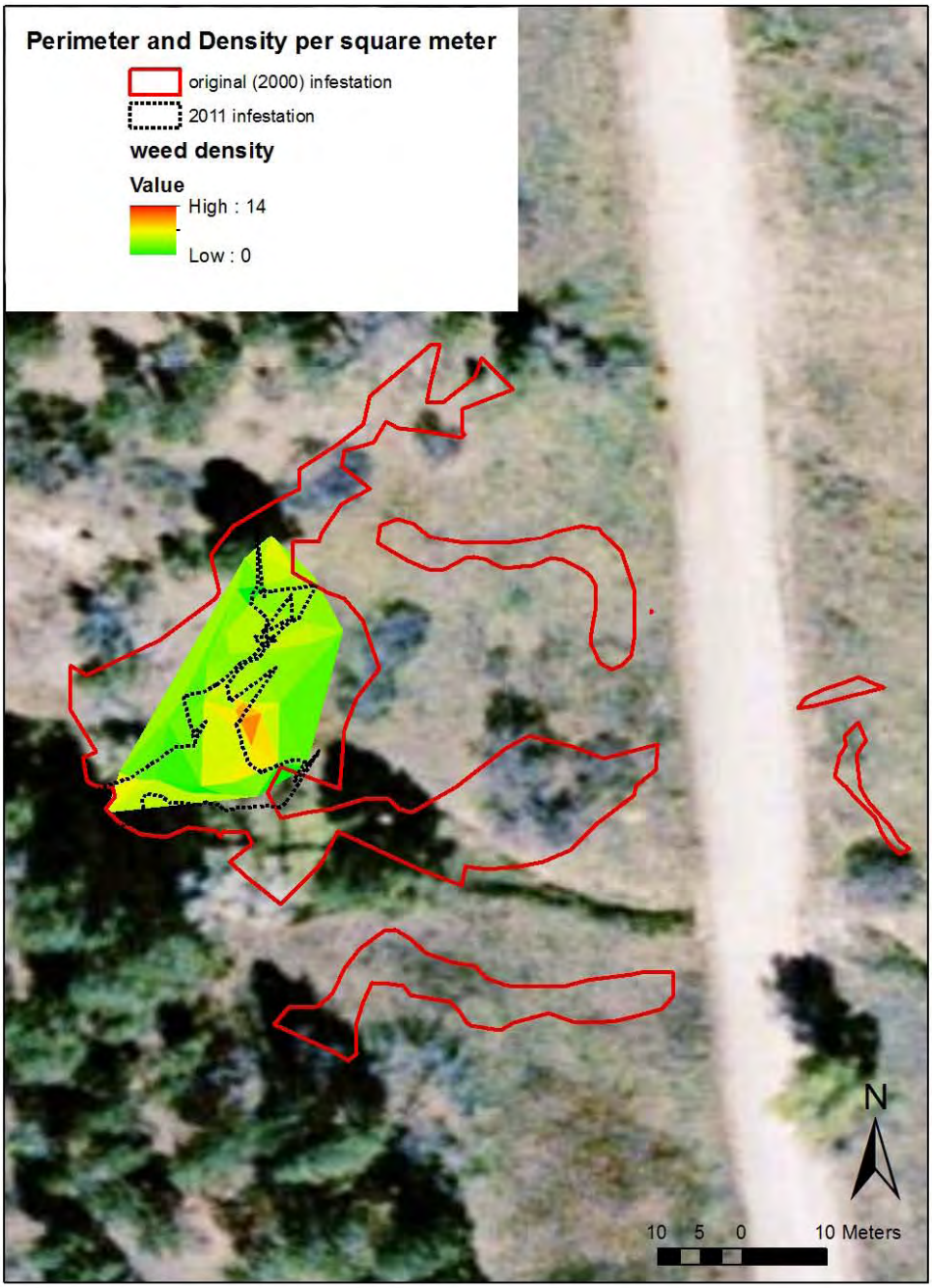
Air Force Academy



Deadman's Trail Common Mullien 2011

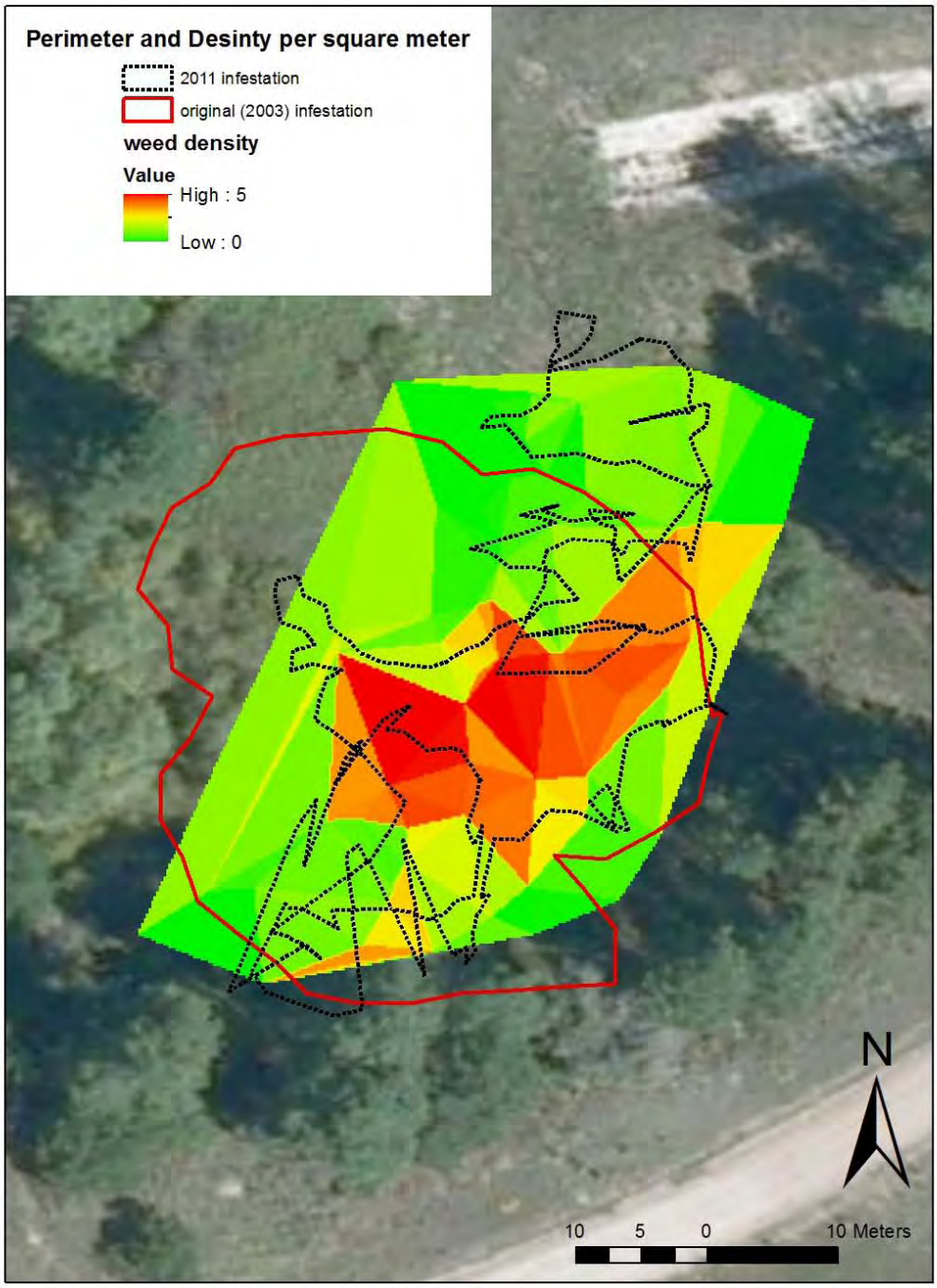


Track Common Mullien 2011

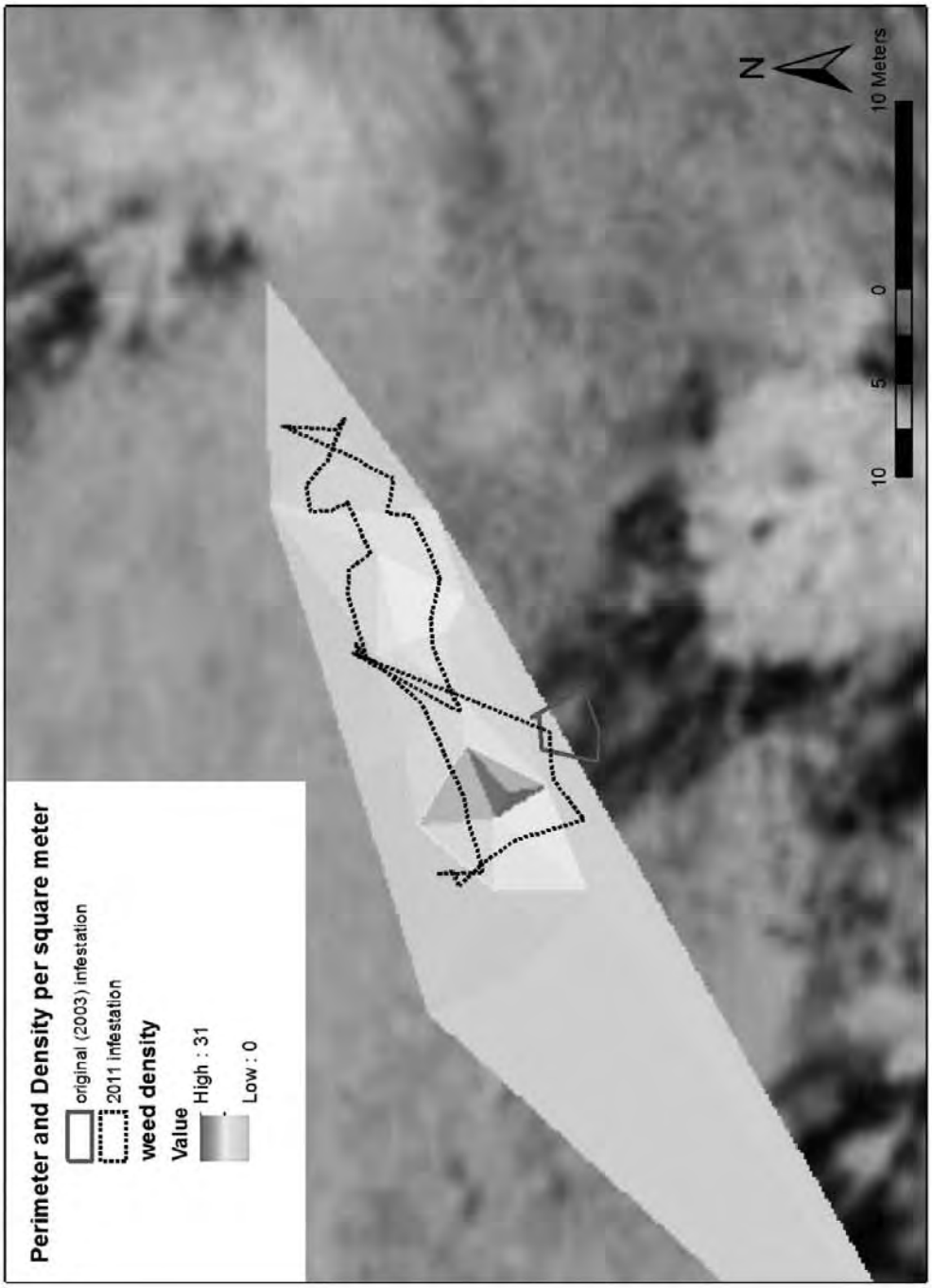


Ice Lake Road 1 Canada Thistle 2011

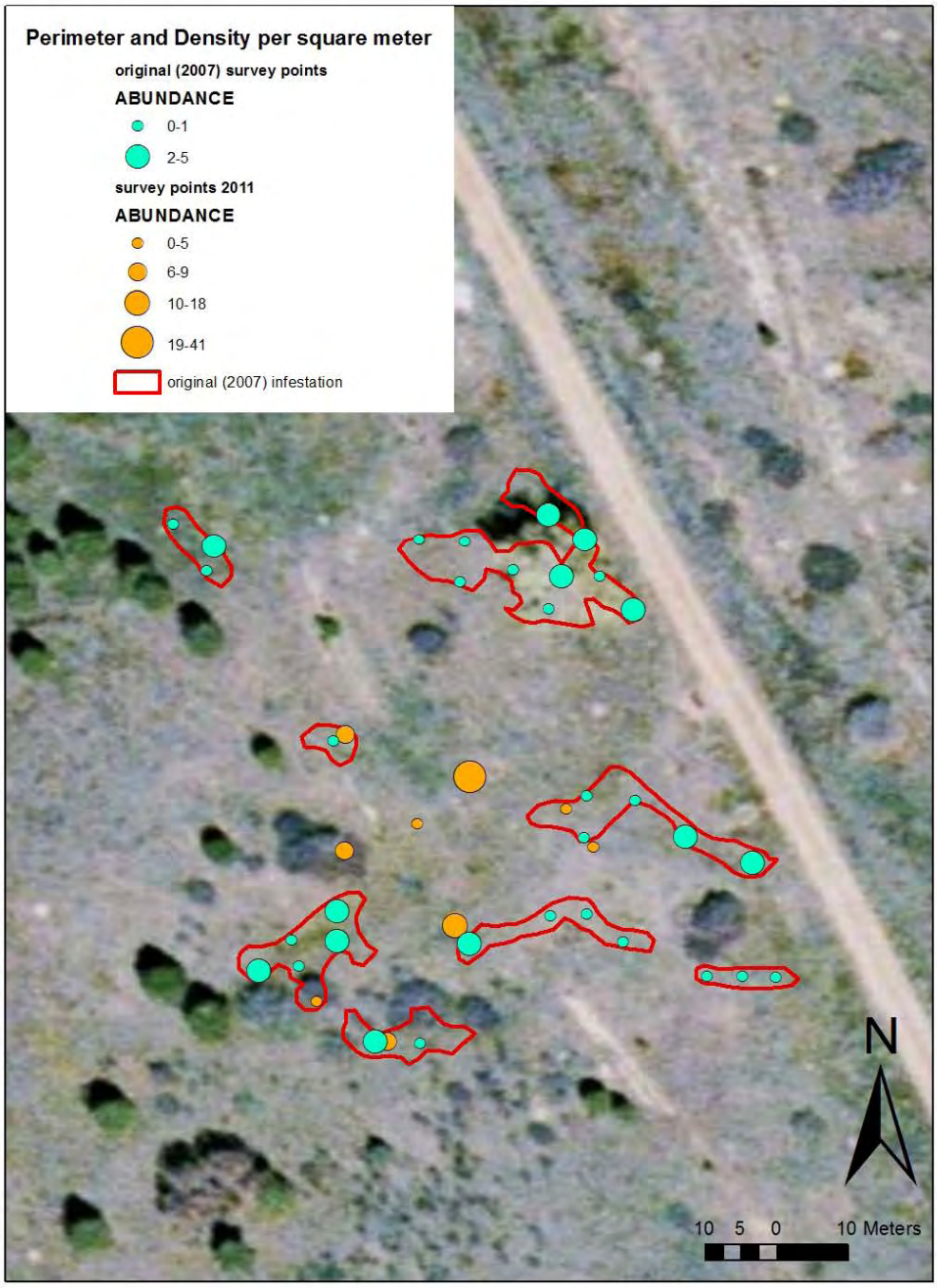
Ice Lake Road 2 Canada Thistle 2011



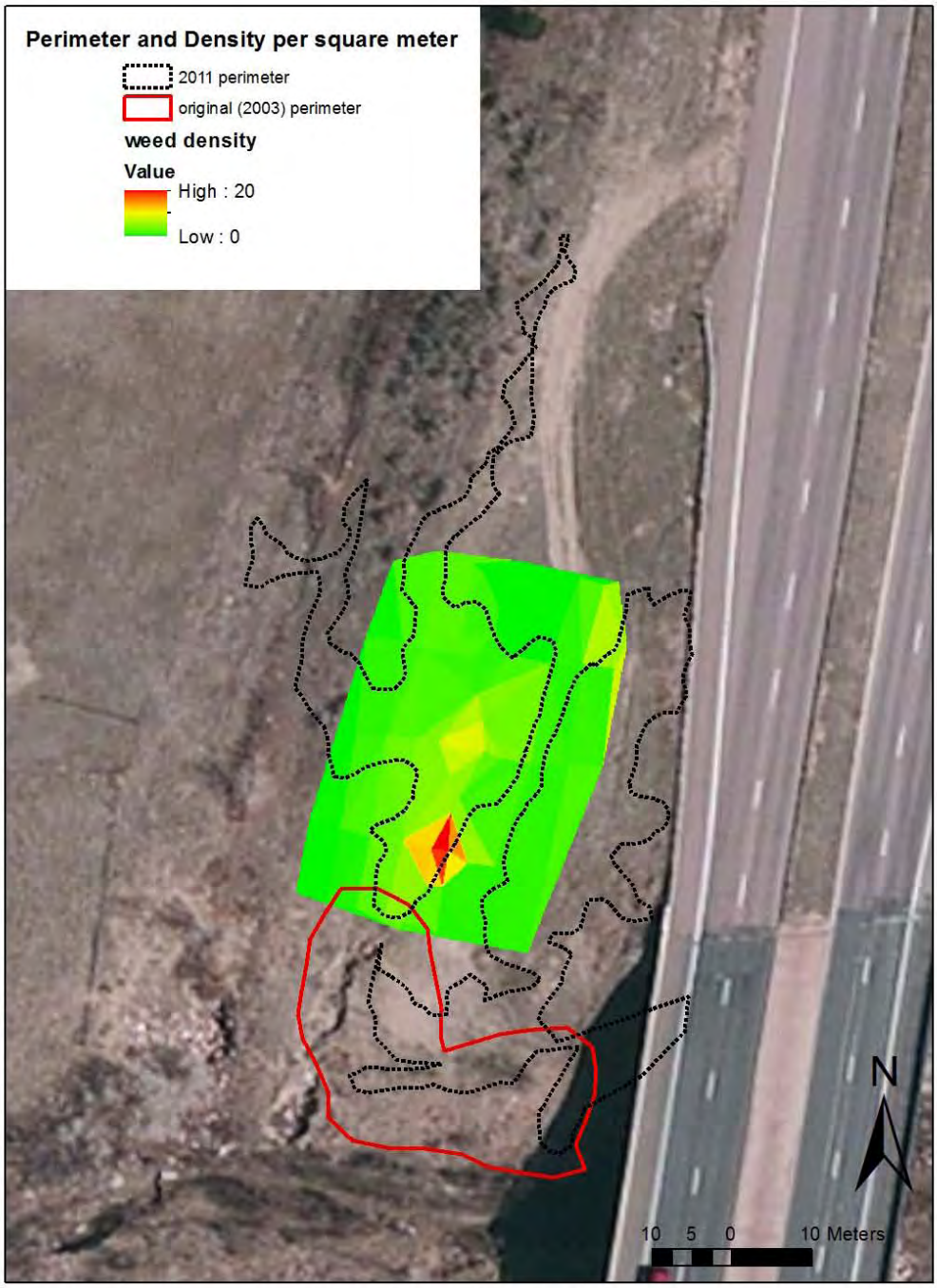
Kettle Lake Canada Thistle 2011



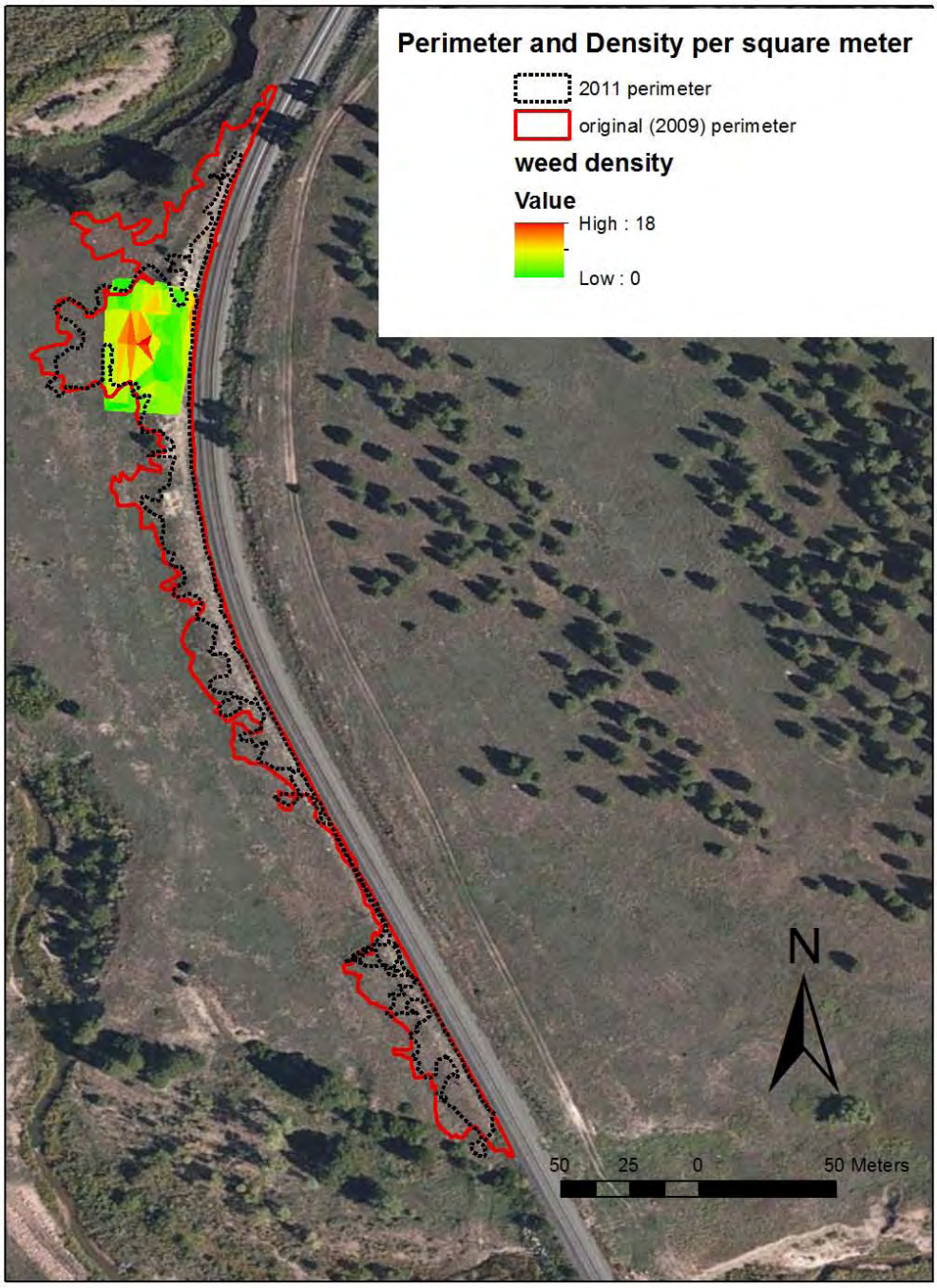
Parade Loop Canada Thistle 2011



Biketrail Diffuse Knapweed 2011

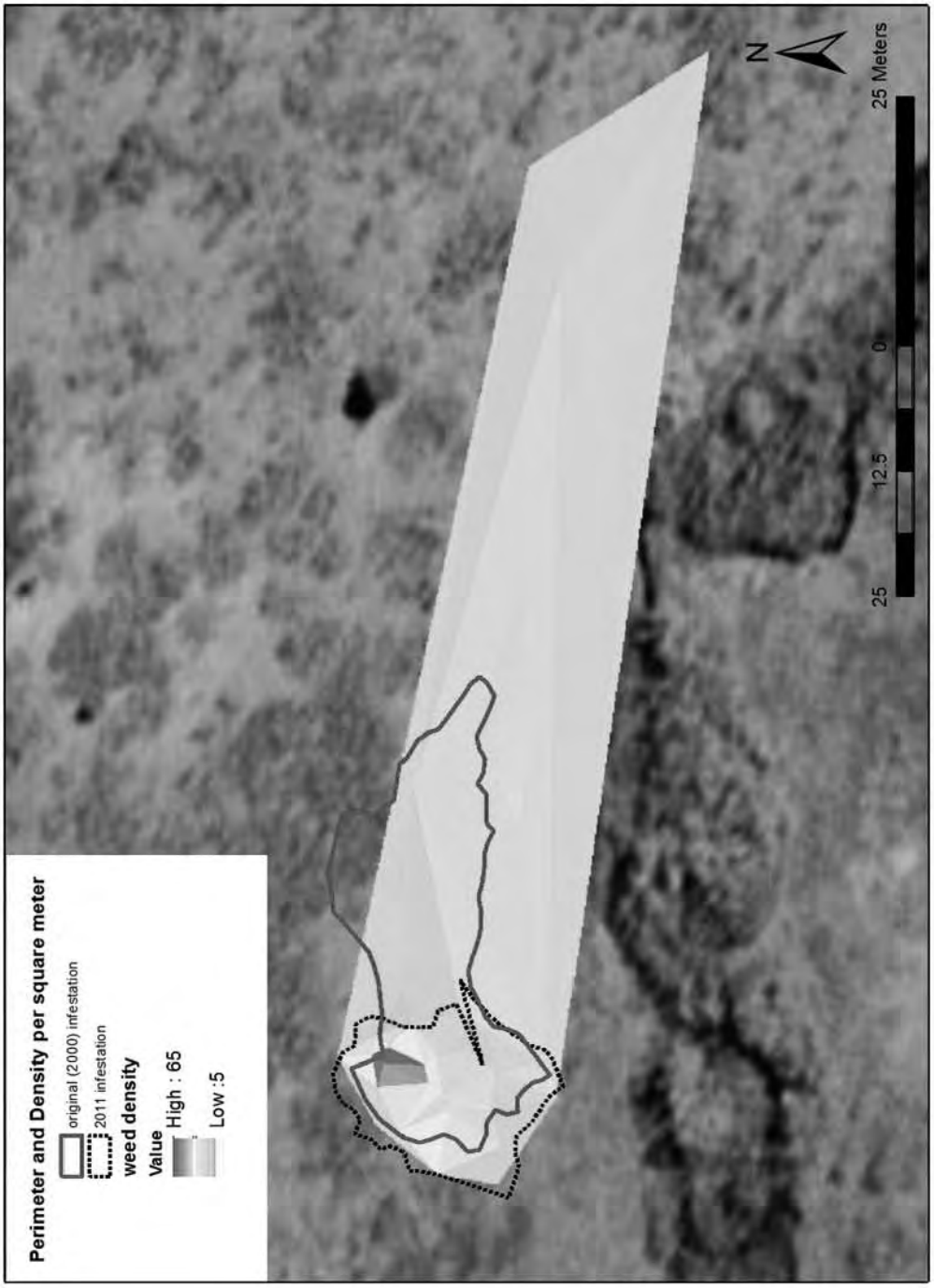


Highway 83 Diffuse Knapweed 2011

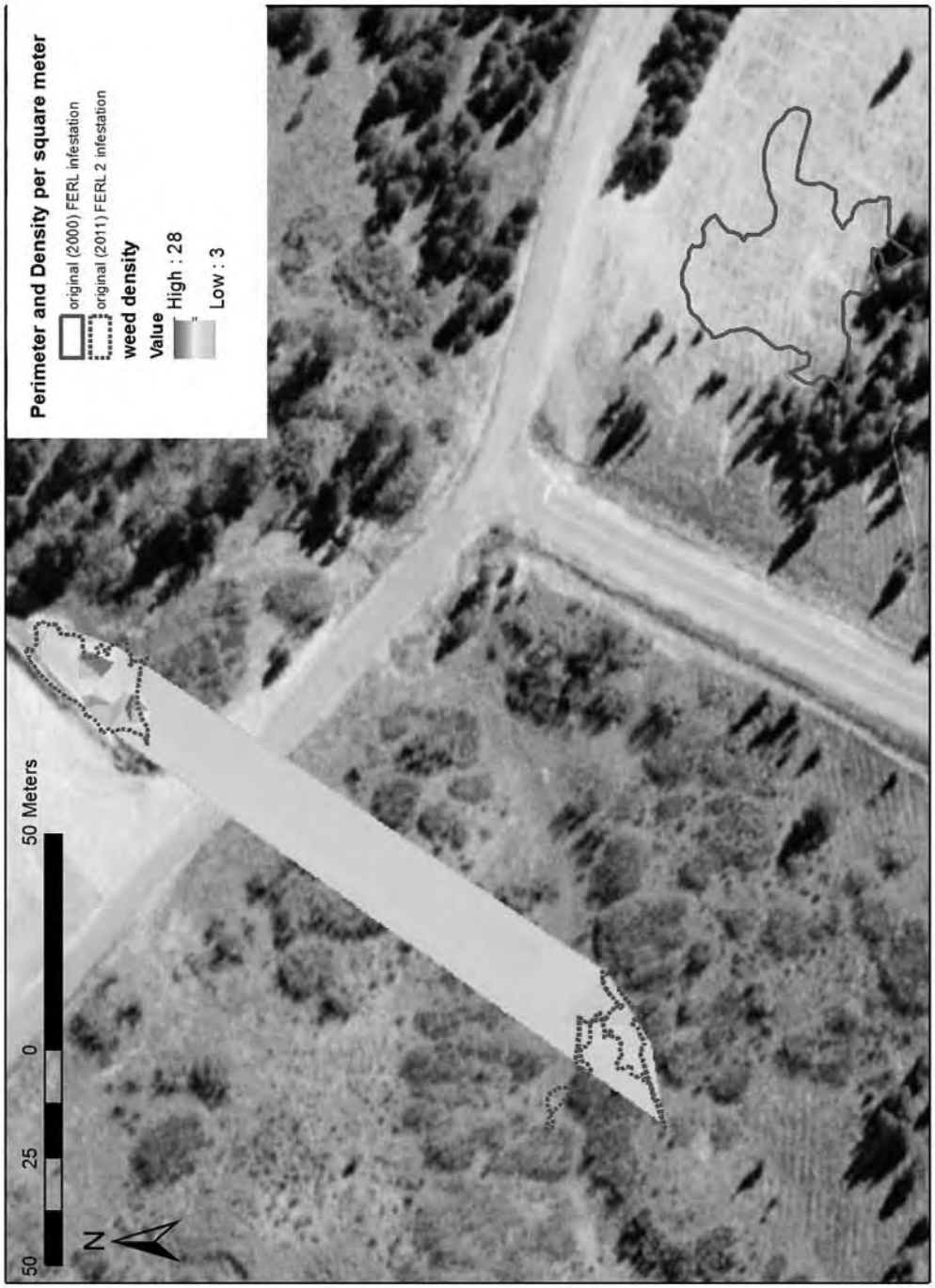


Railroad Diffuse Knapweed 2011

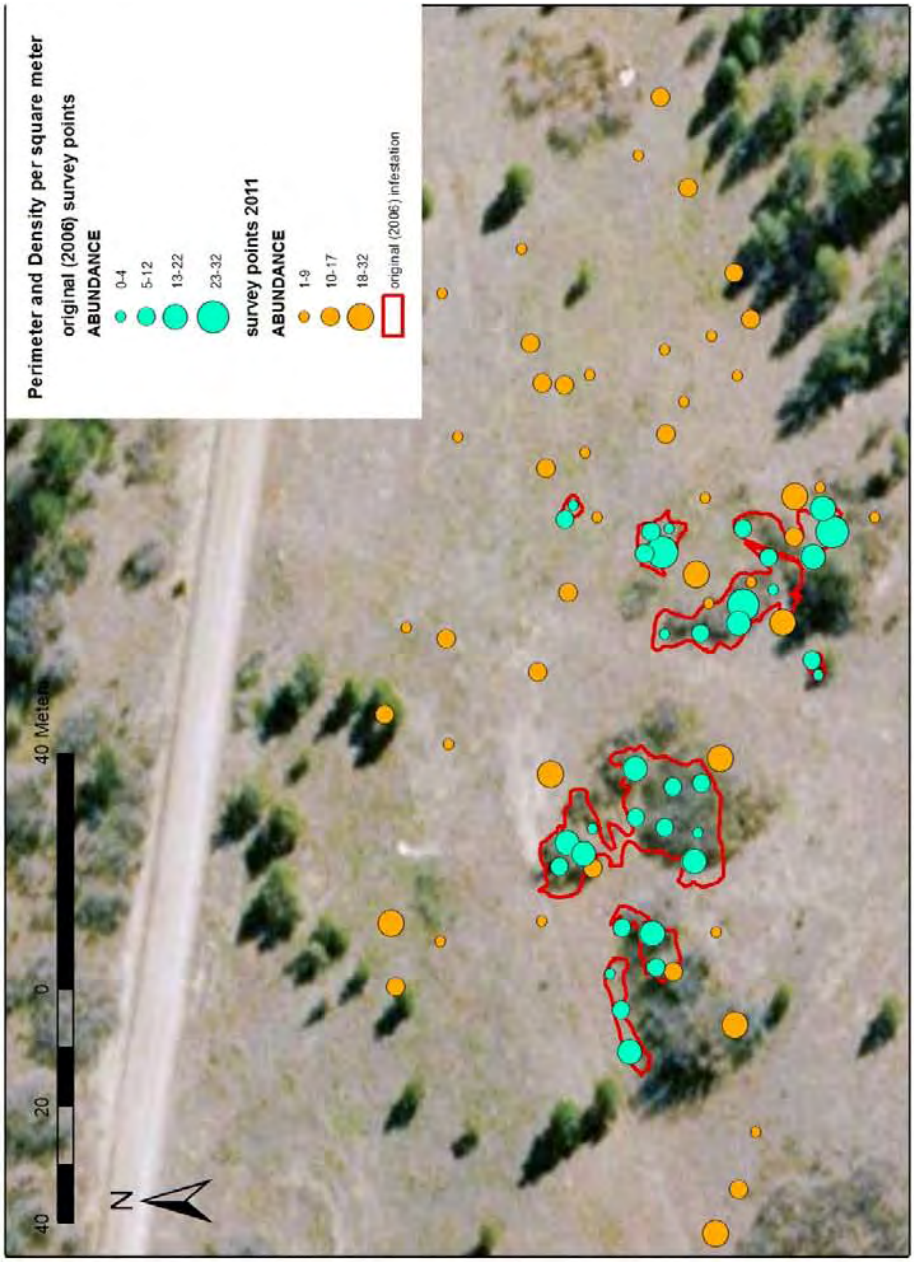
Water Treatment Plant Knapweed 2011



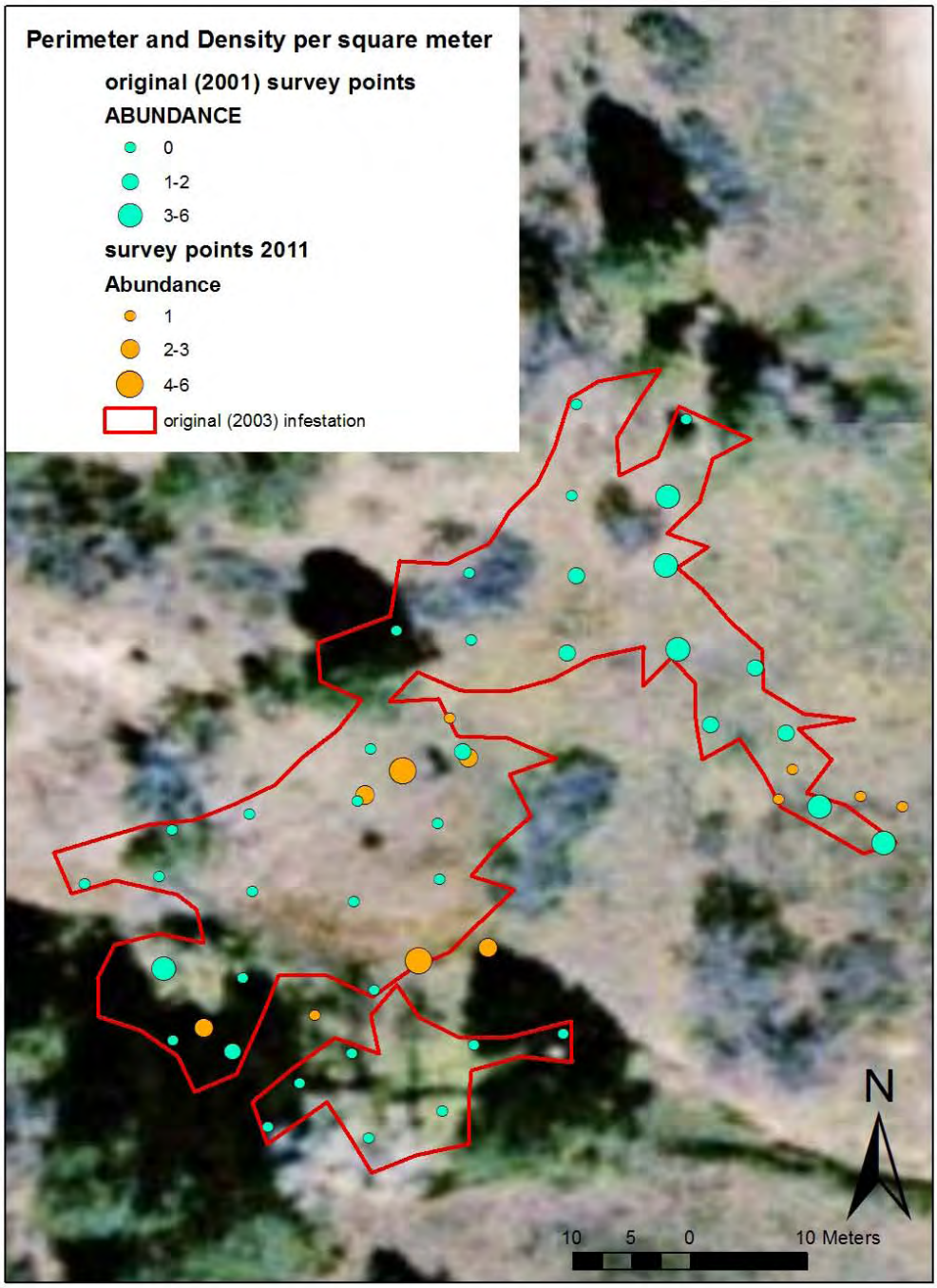
Deadman's Trail Leafy Spurge 2011



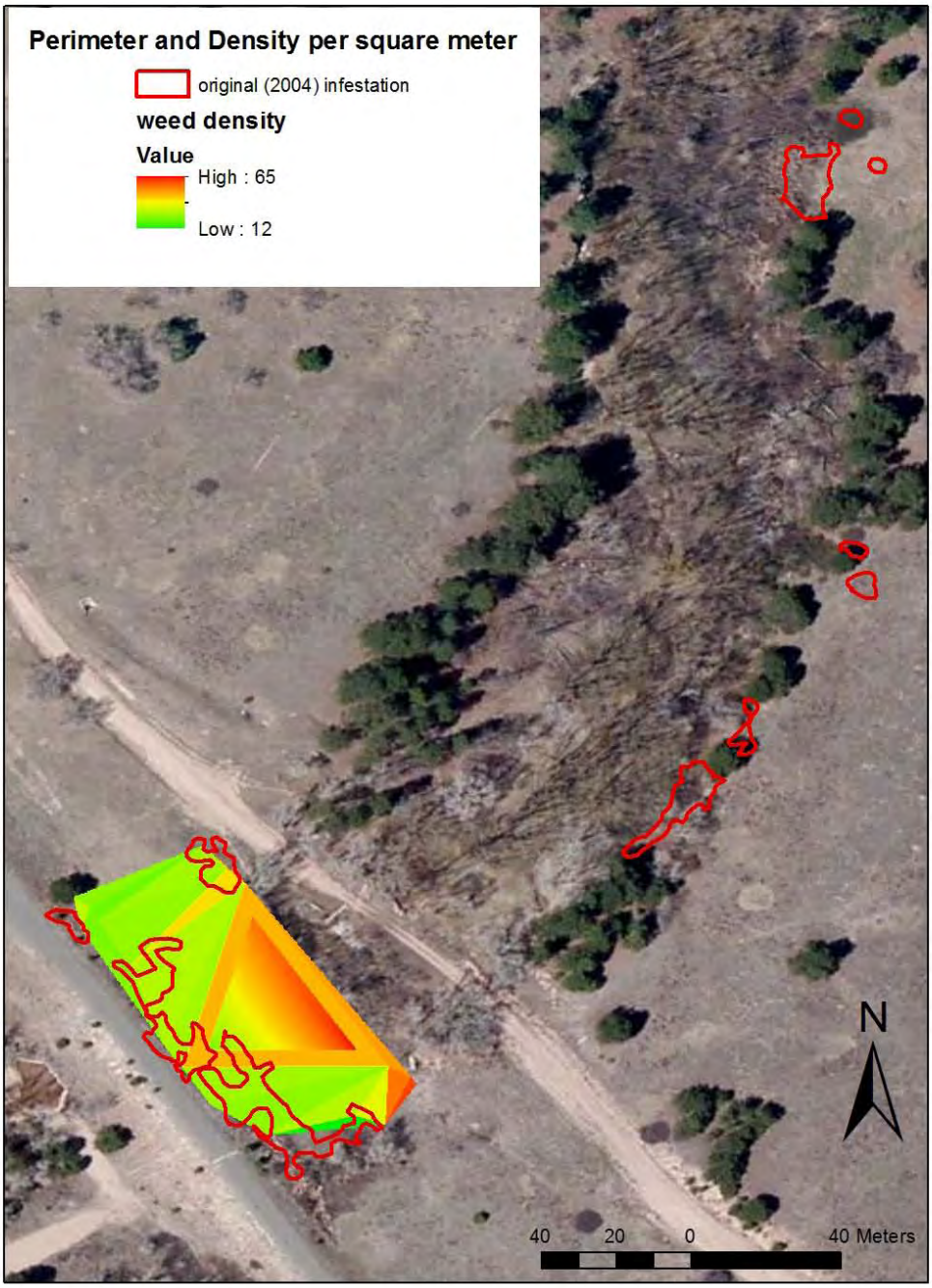
FERL and FERL 2 Leafy Spurge 2011



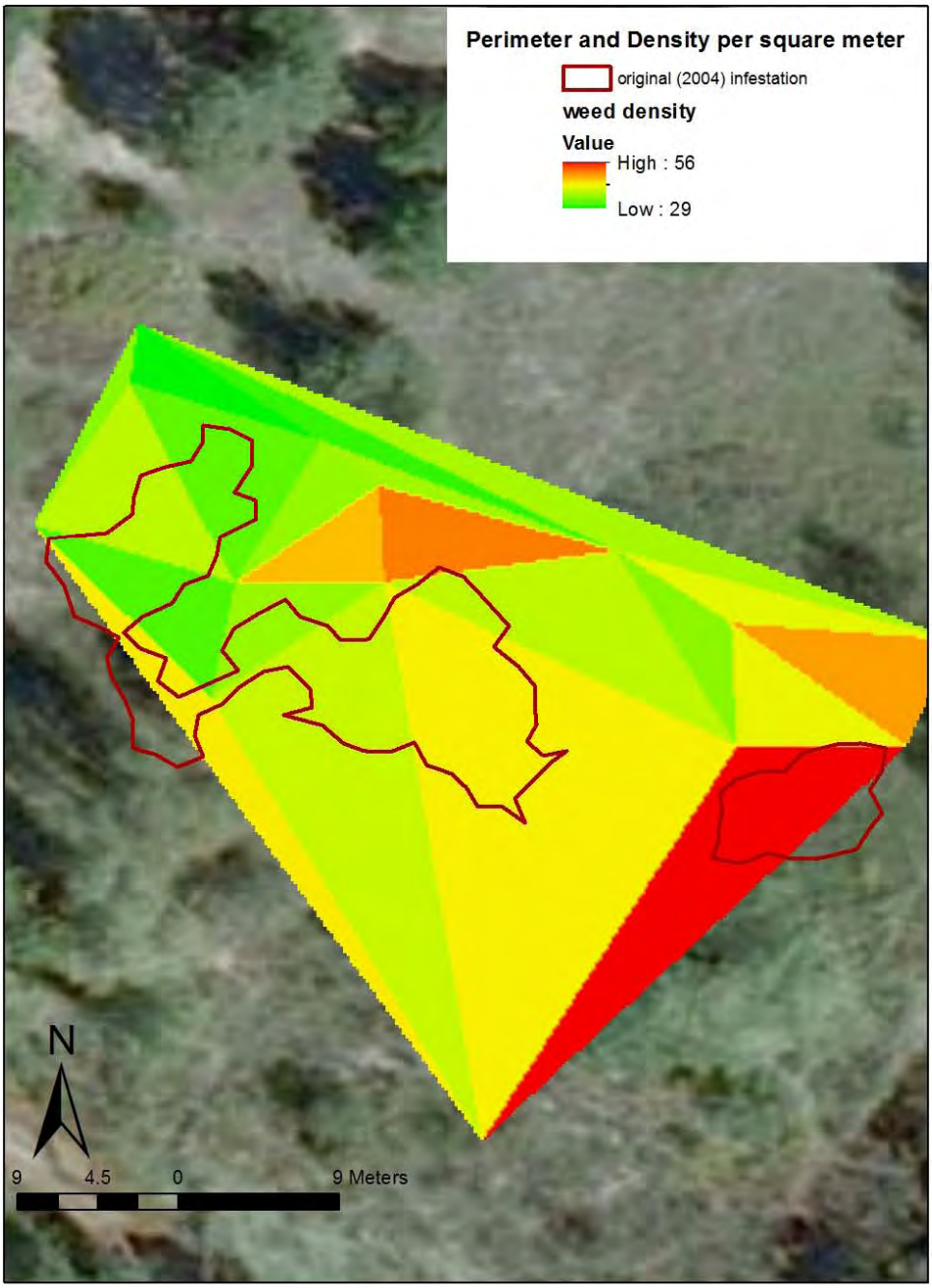
FERL North Leafy Spurge 2011



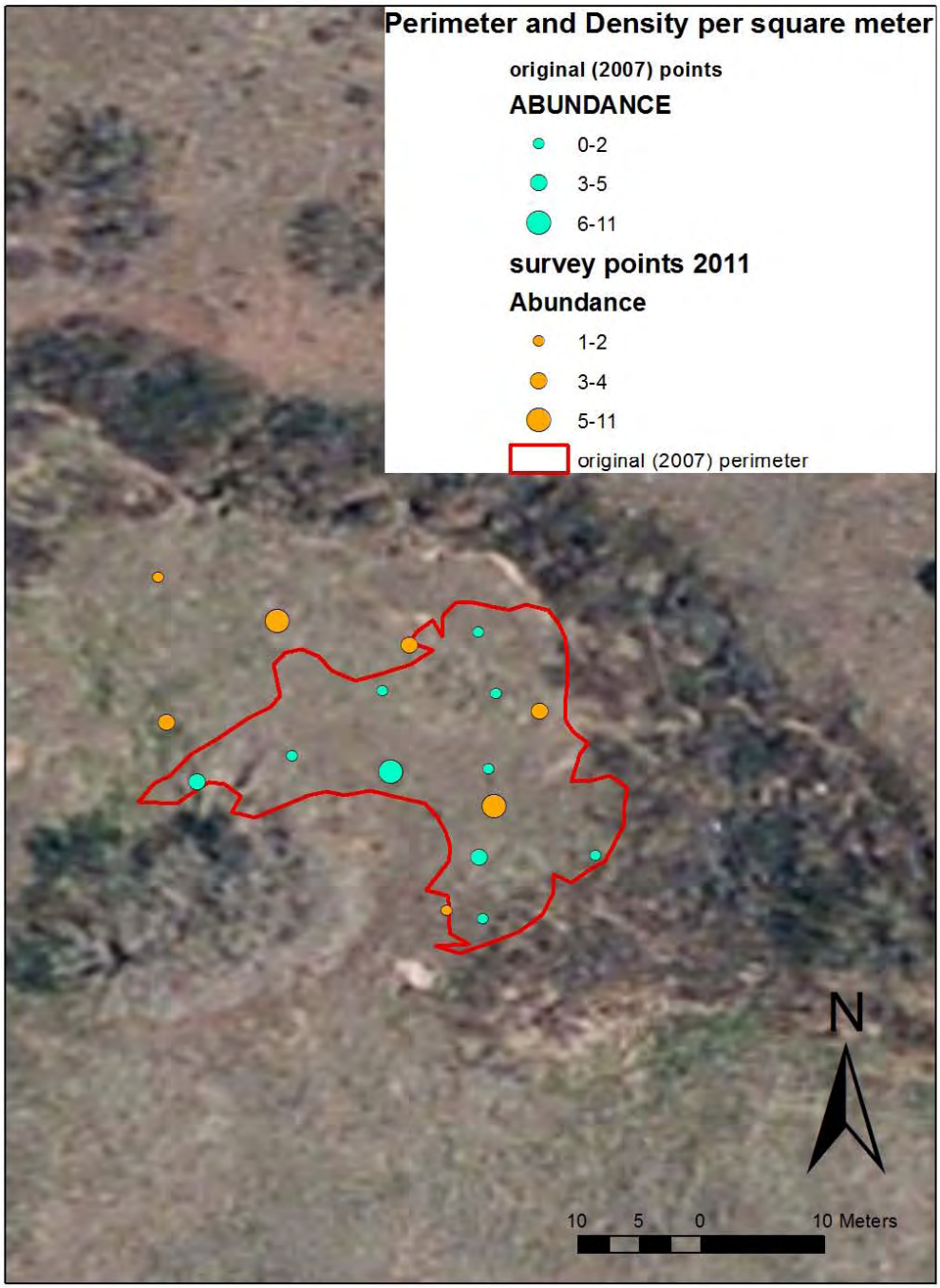
Ice Lake Road 1 Musk Thistle 2011



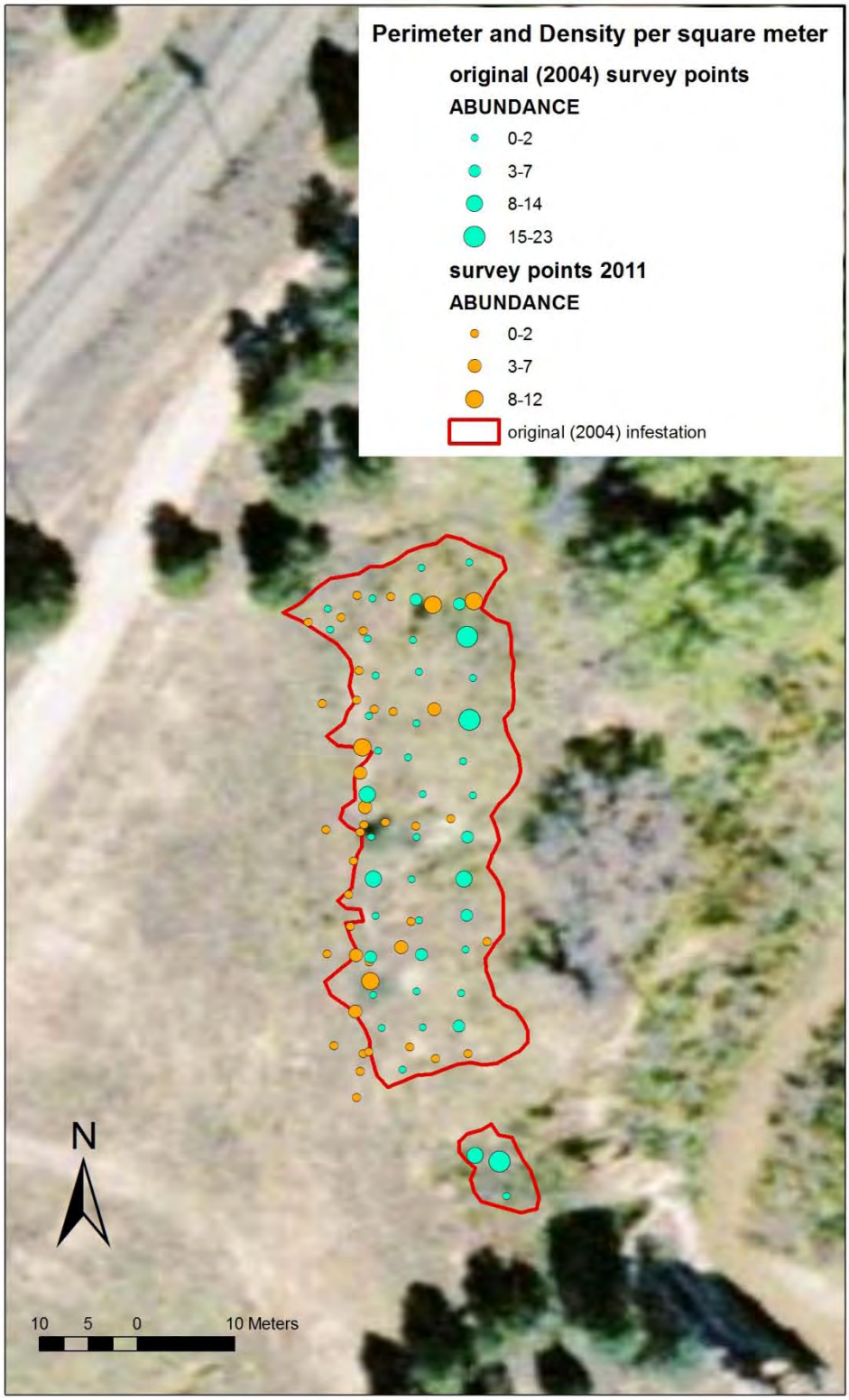
Kettle Creek St. Johnswort 2011



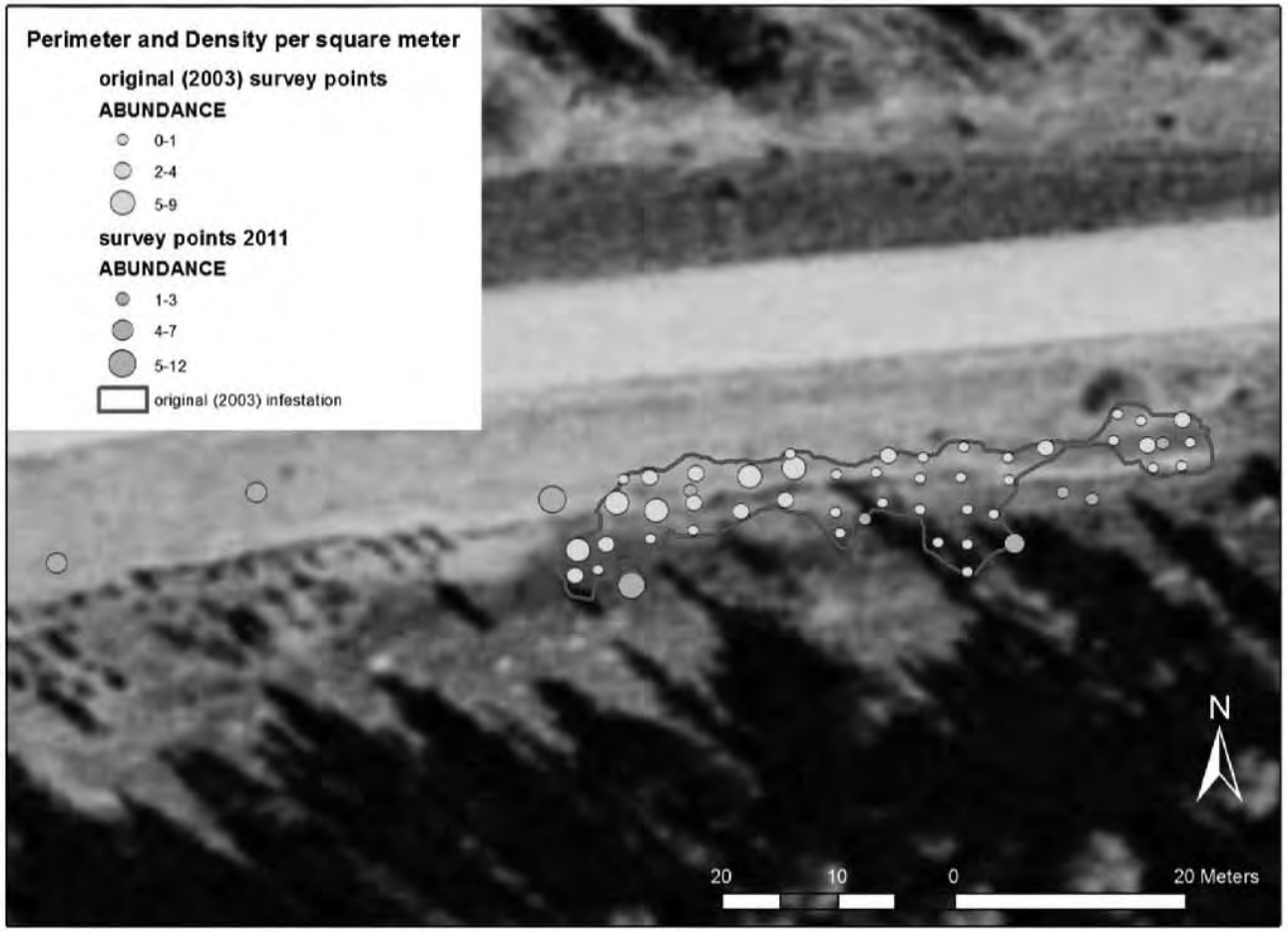
Mid Kettle Creek St. Johnswort 2011



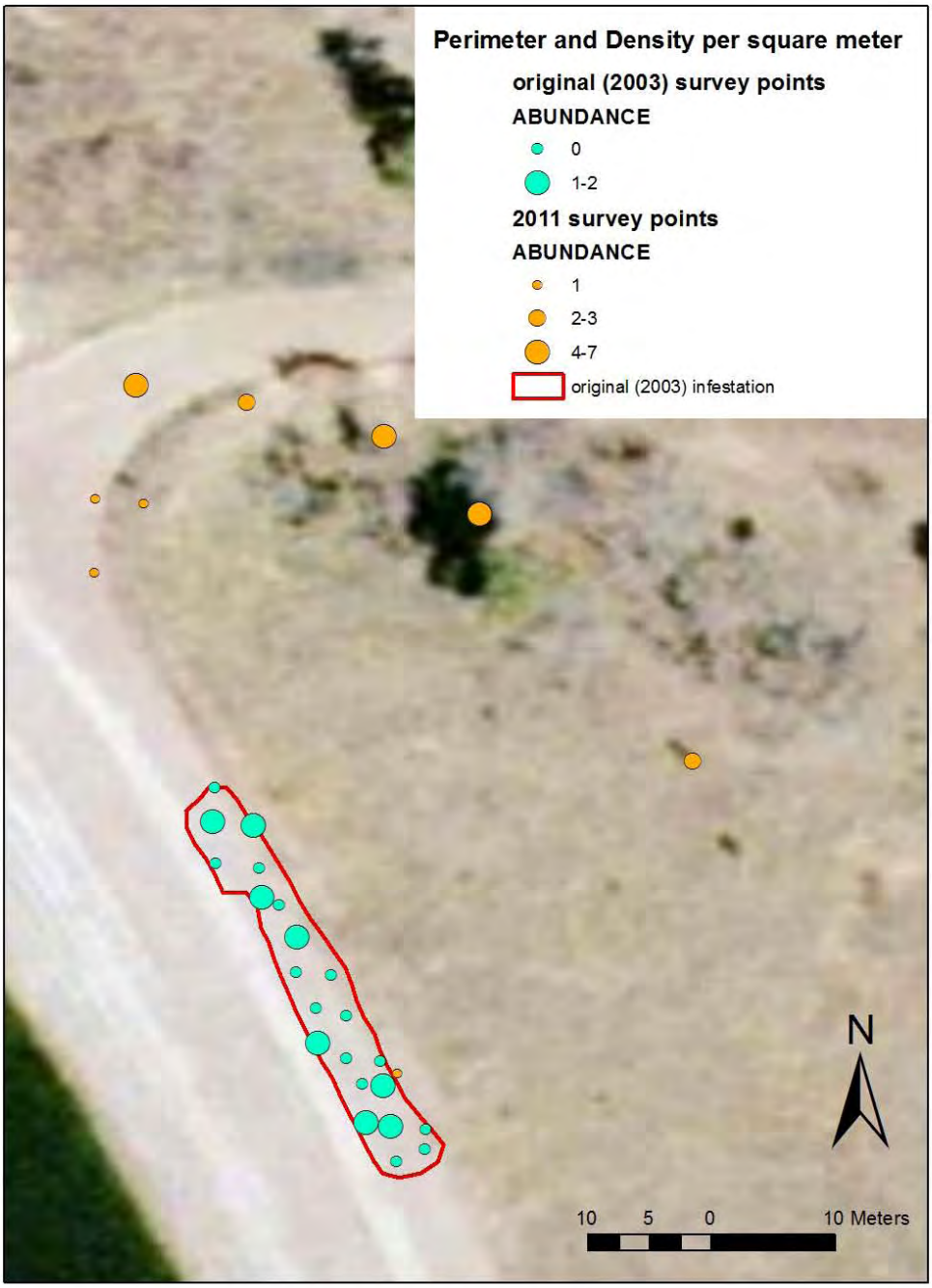
Deadman's Trail Spotted Knapweed 2011



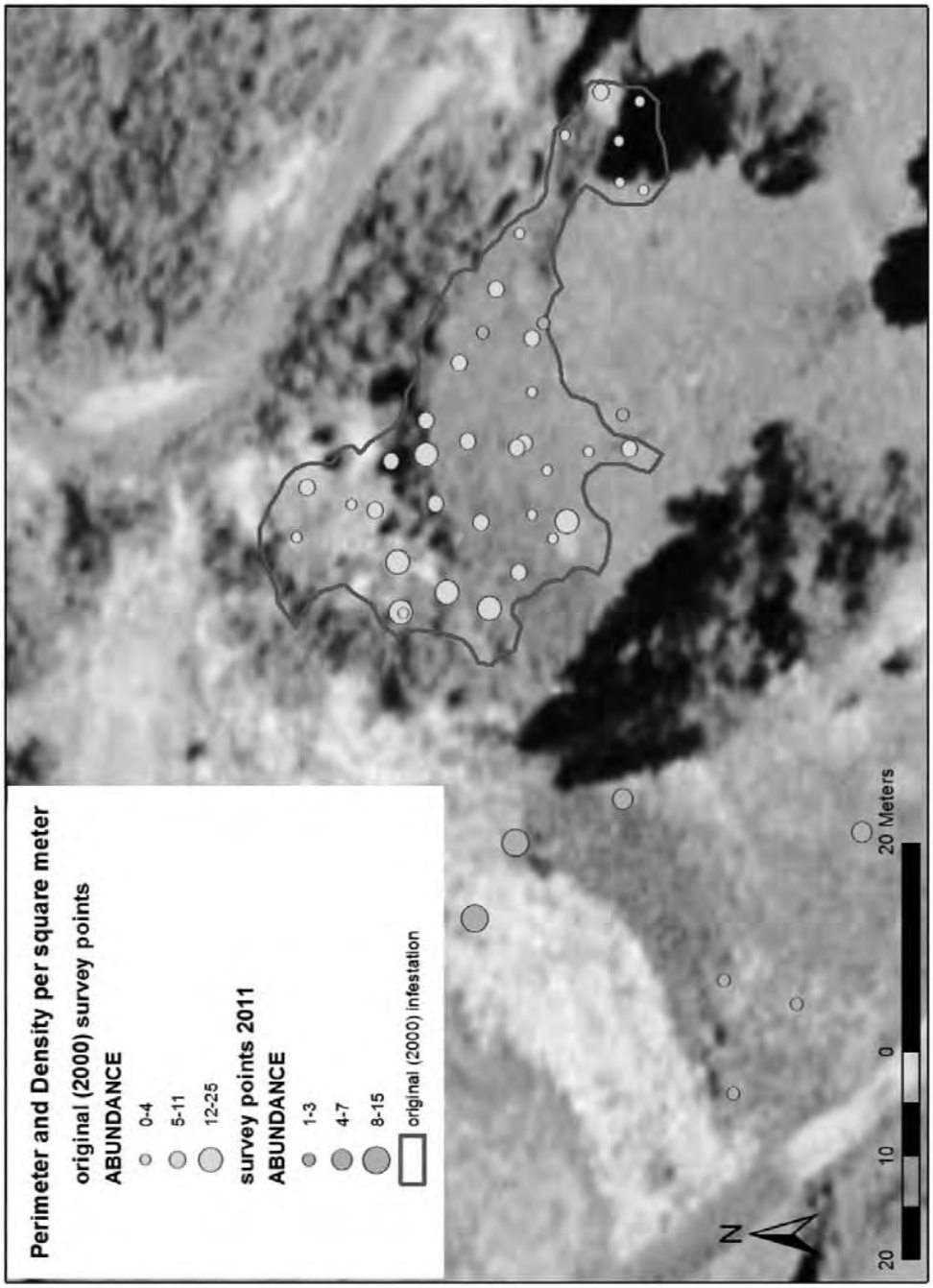
New Monument Creek Spotted Knapweed



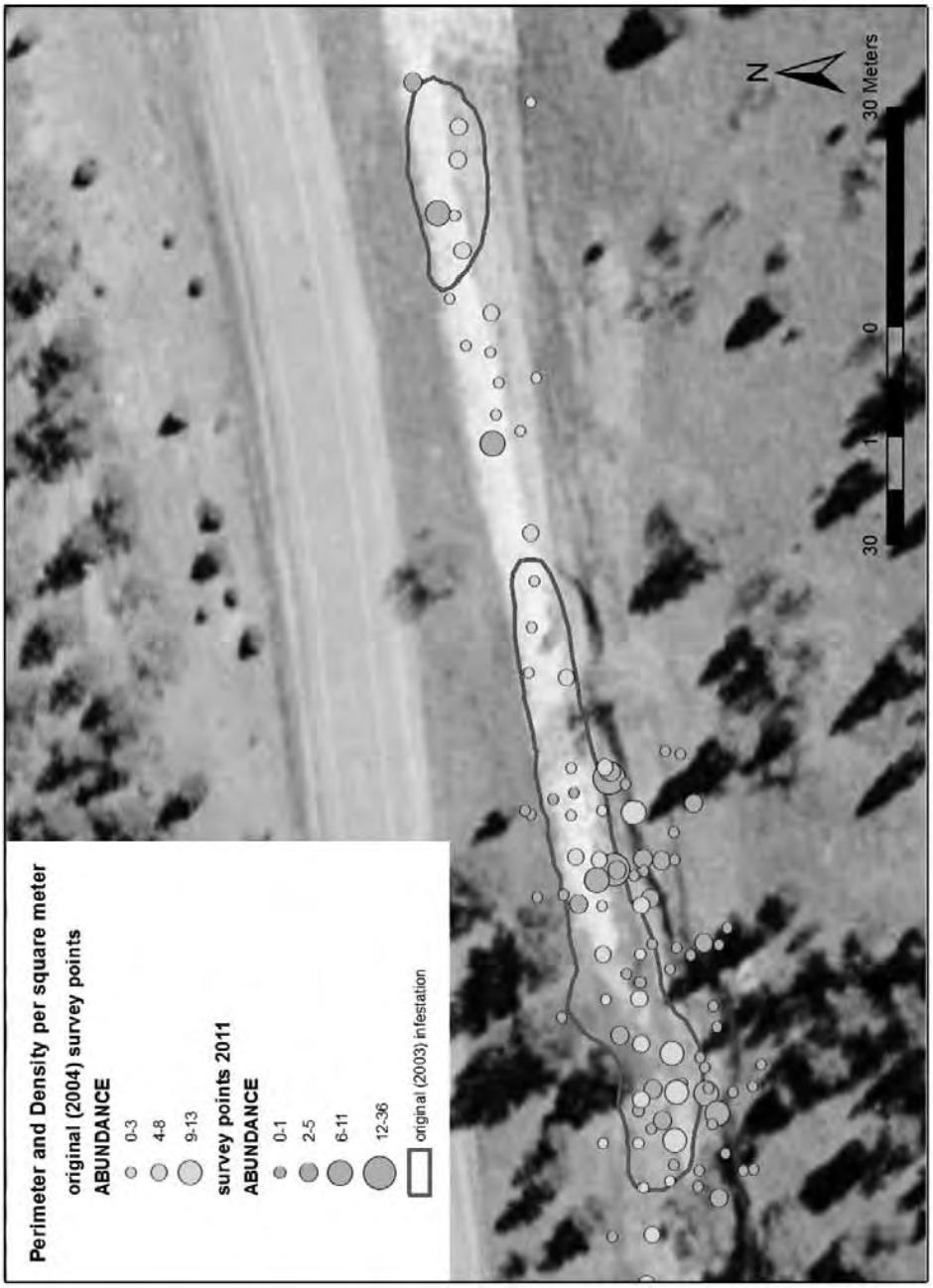
Monument Trail Road Spotted Knapweed 2011



NPWR Spotted Knapweed 2011

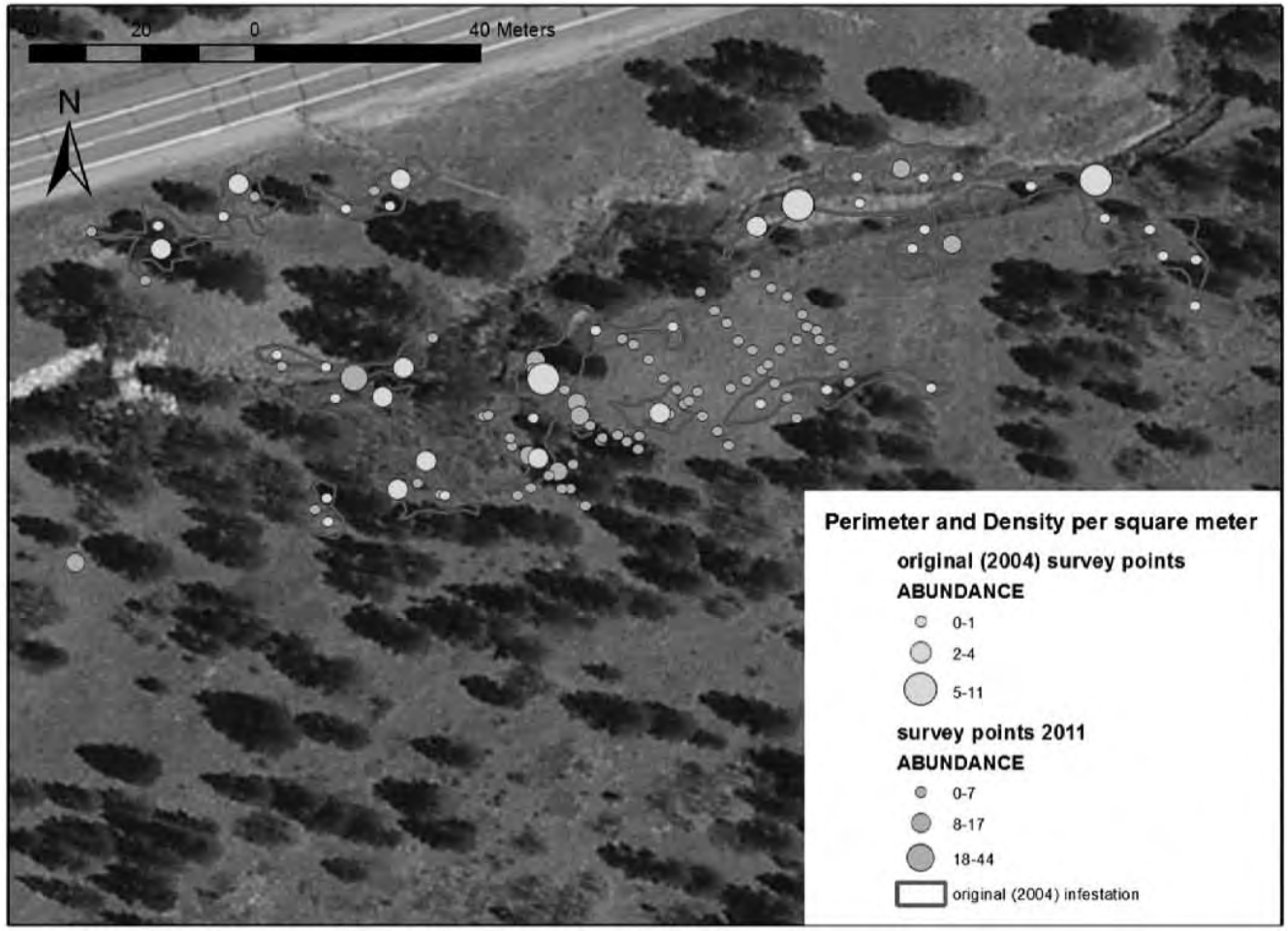


Old Monument Creek Spotted Knapweed 2011

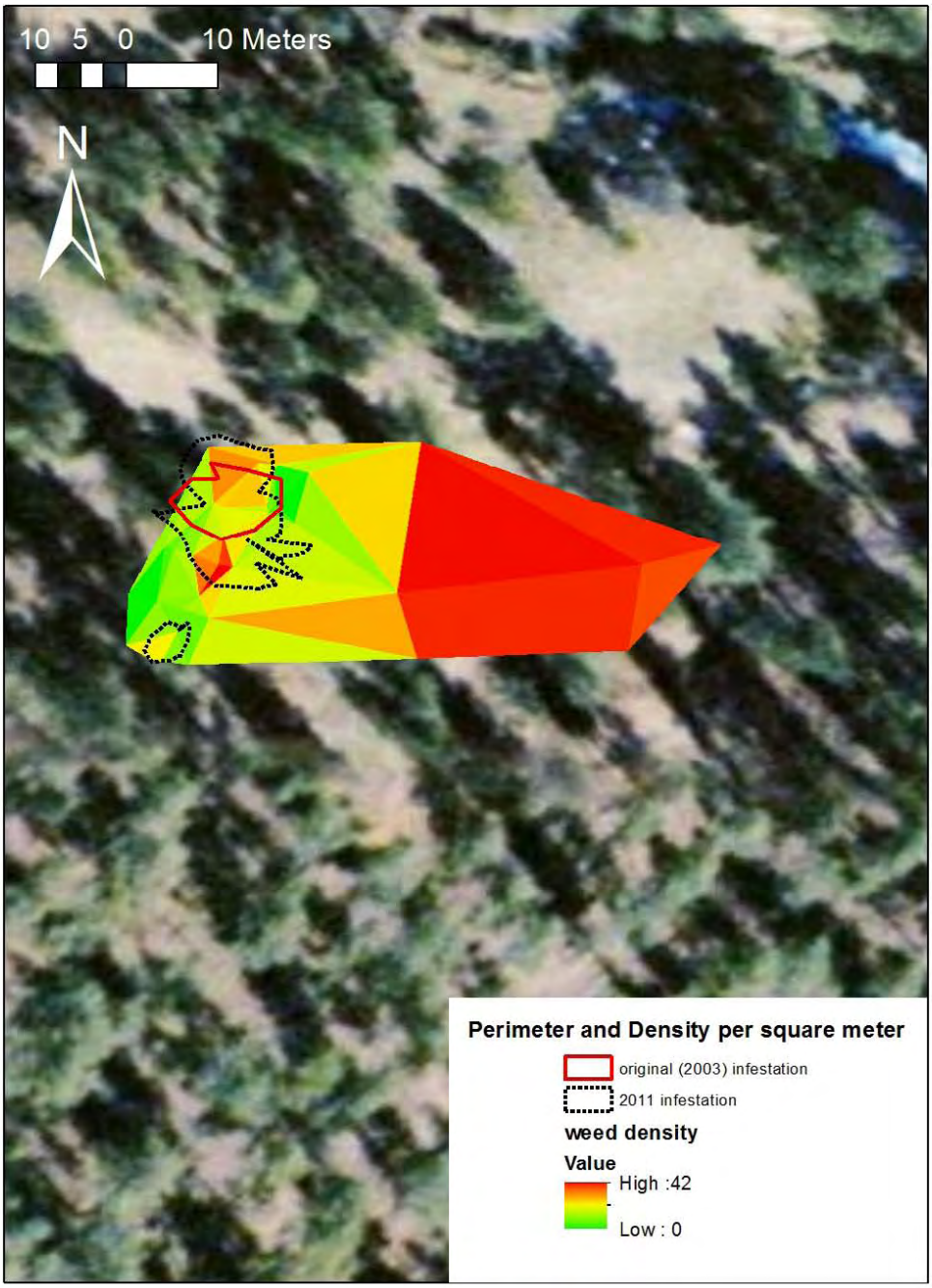


Parade Loop 1 Spotted Kanpweed 2011

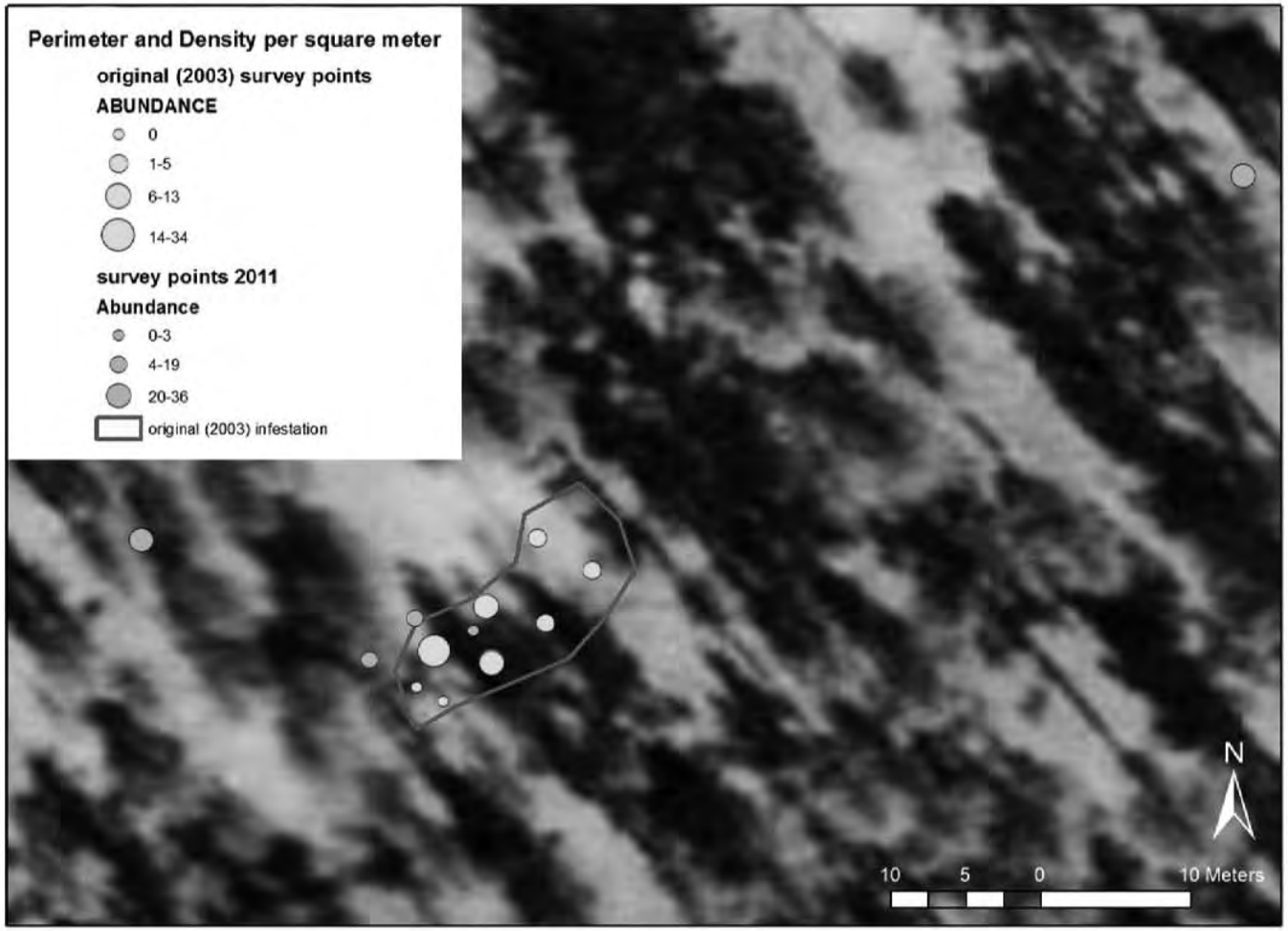
Parade Loop 2 Spotted Knapweed 2011



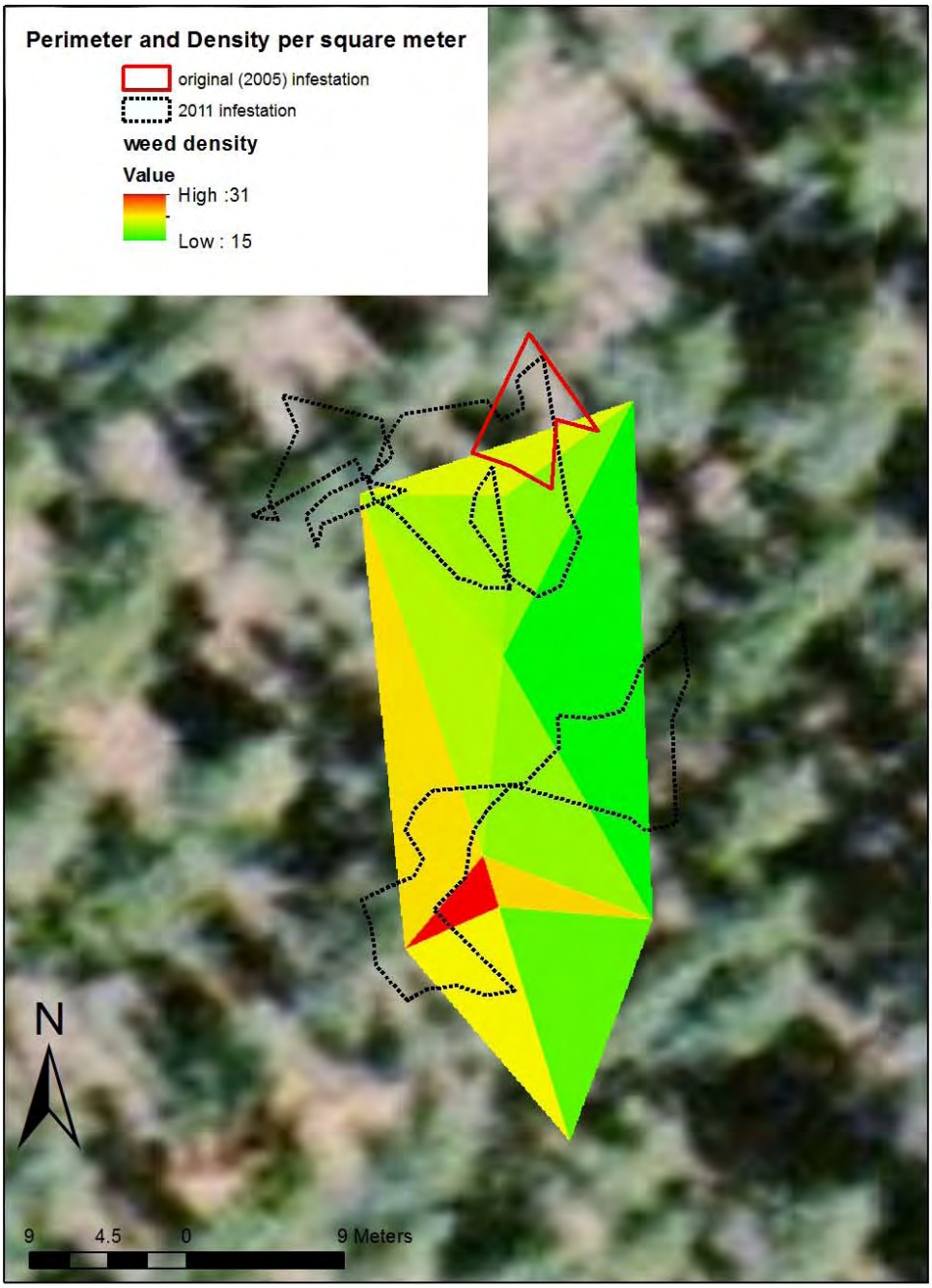
Parade Loop 3 Spotted Knapweed 2011



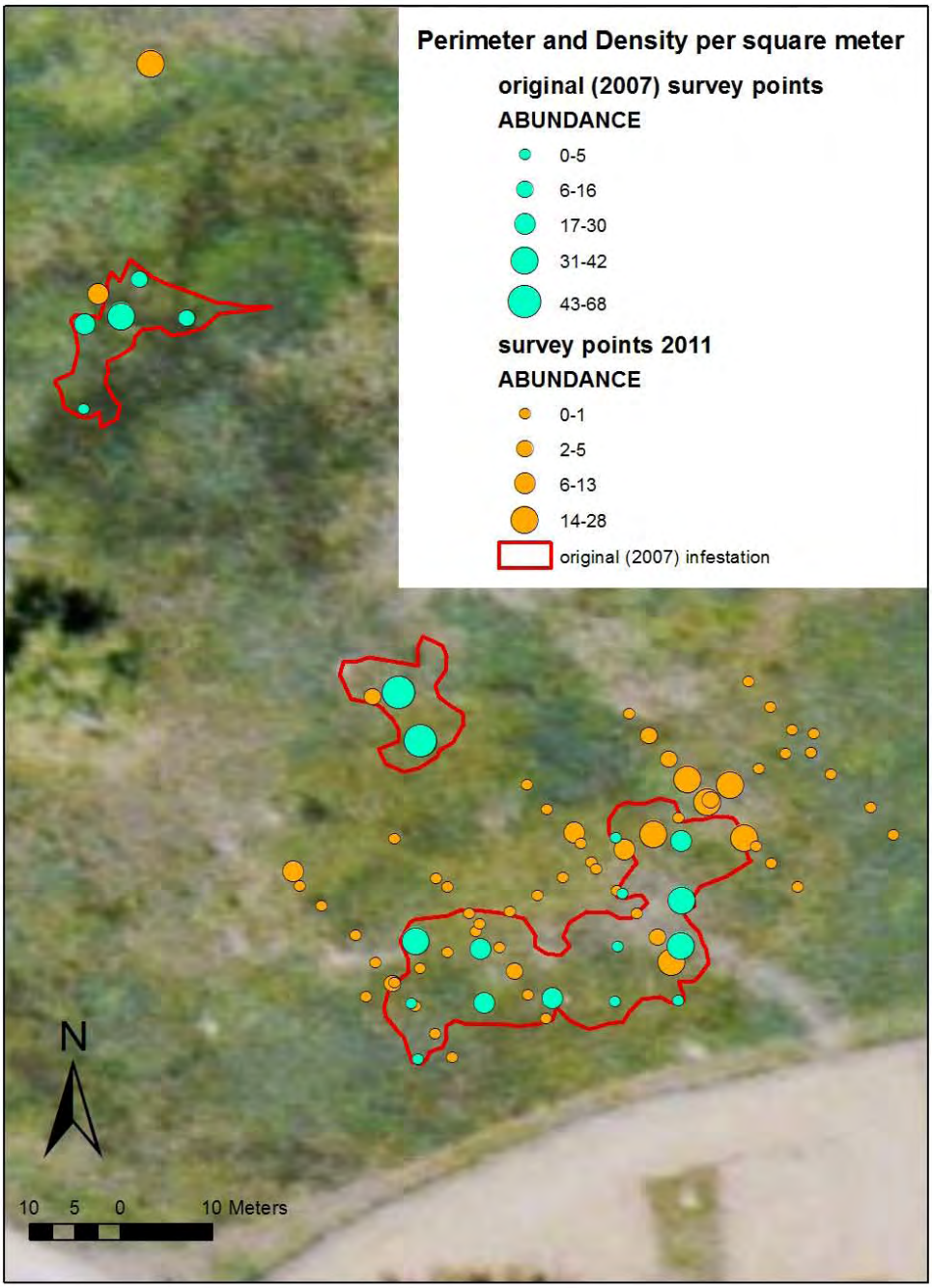
Communication Drive 1 Yellow Toadflax 2011



Communication Drive 2 Yellow Toadflax 2011

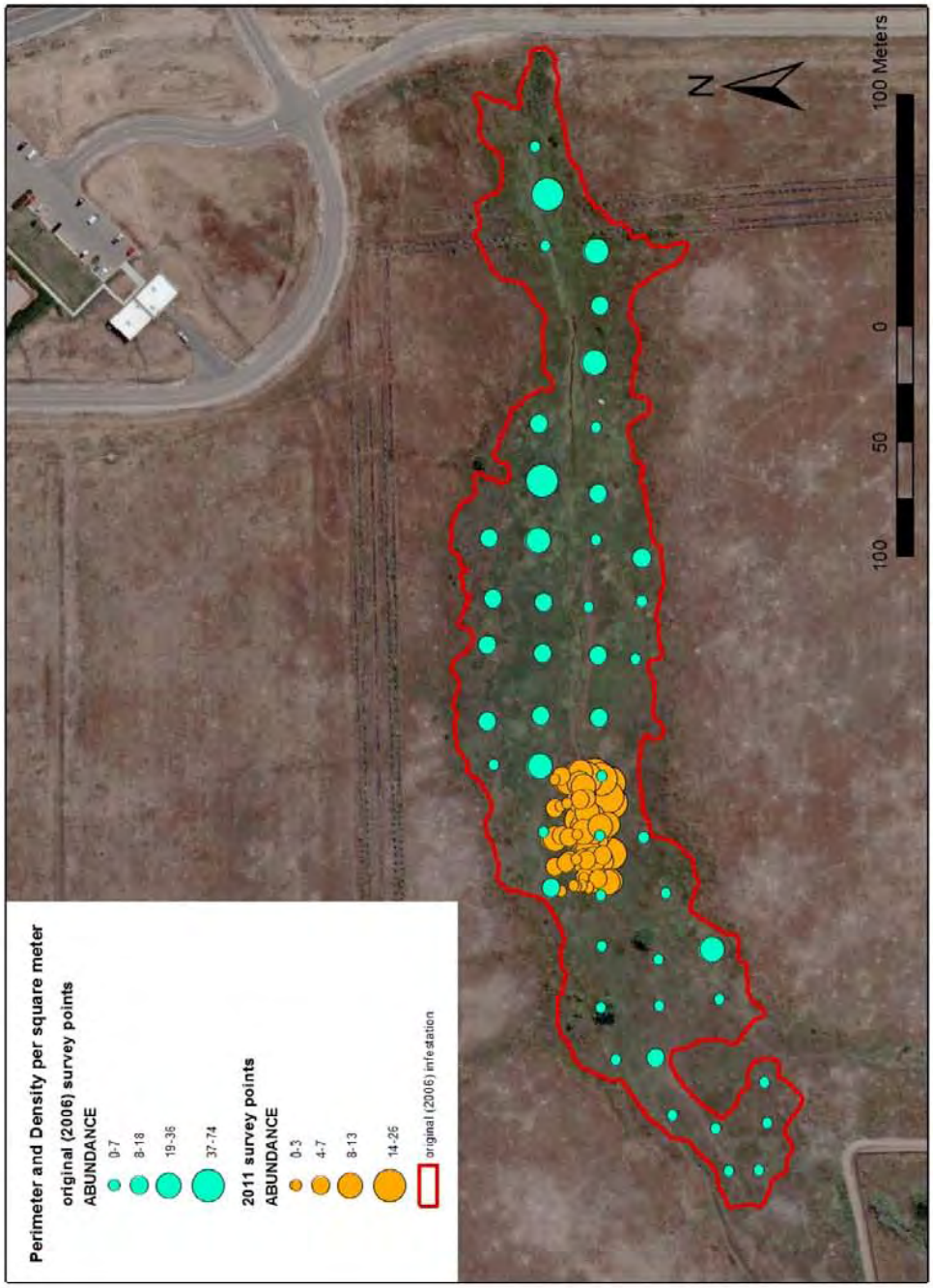


Communication Drive 3 Yellow Toadflax 2011

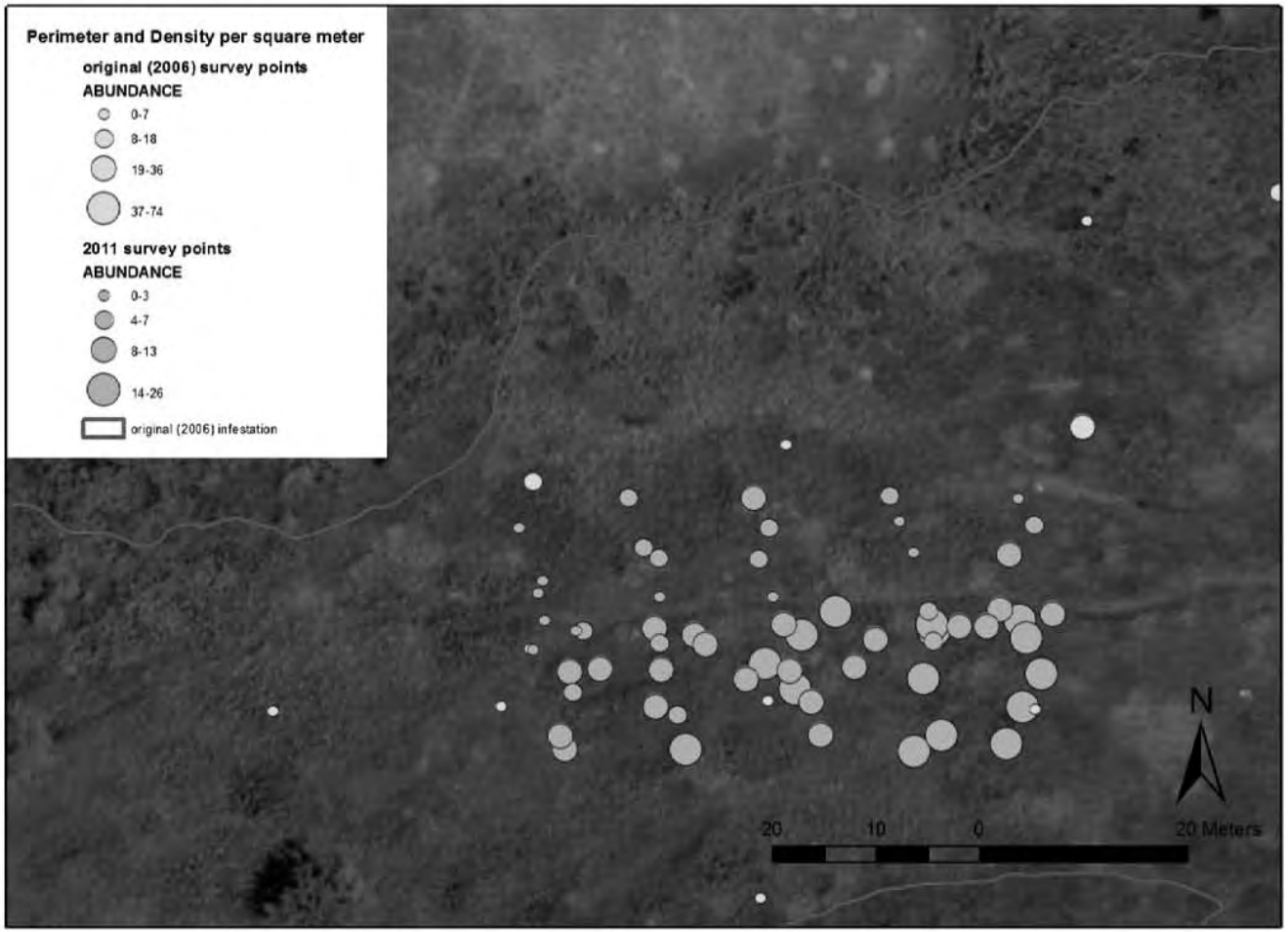


Ice Lake Road Yellow Toadflax 2011

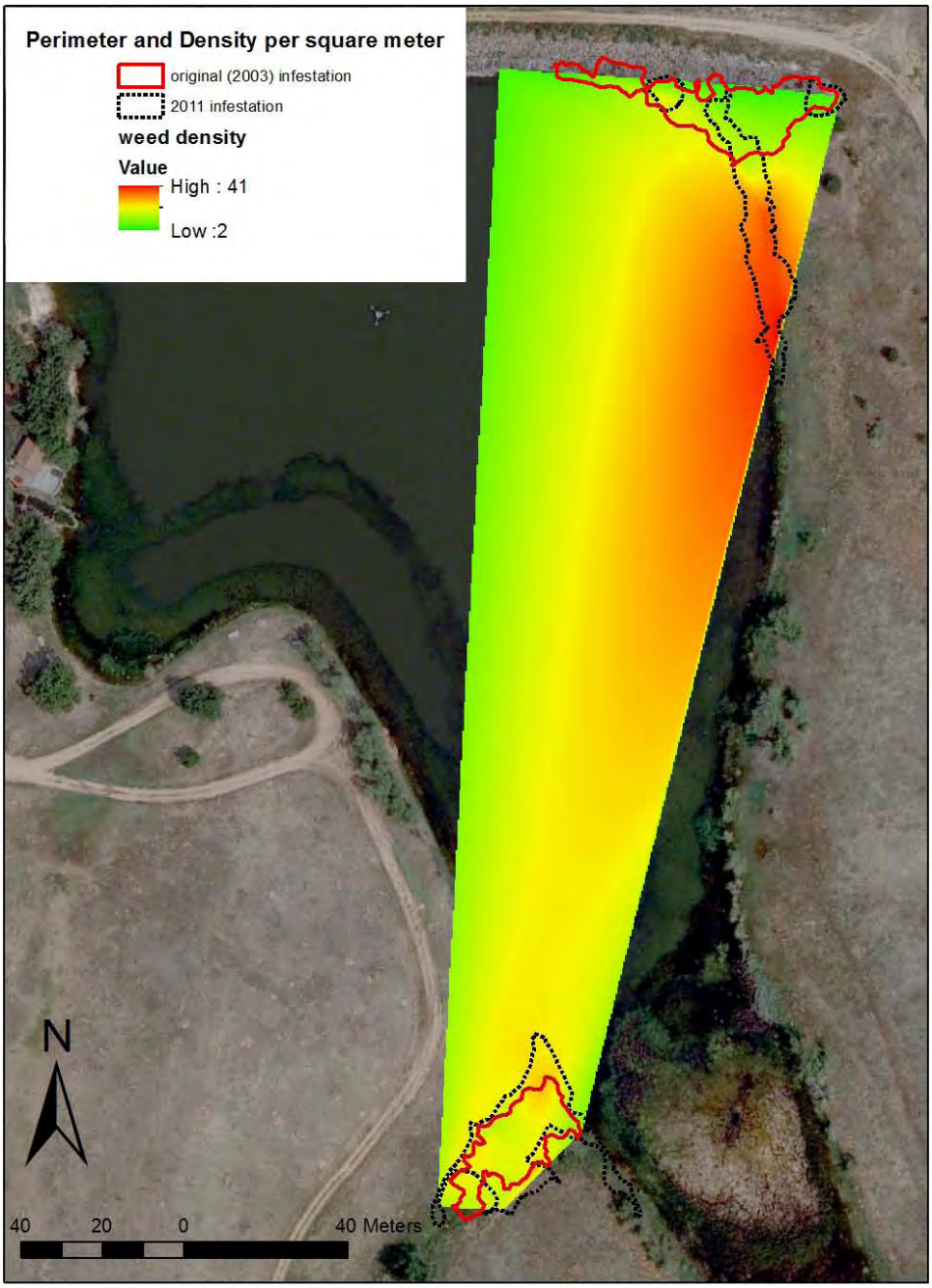
Buckley Air Force Base



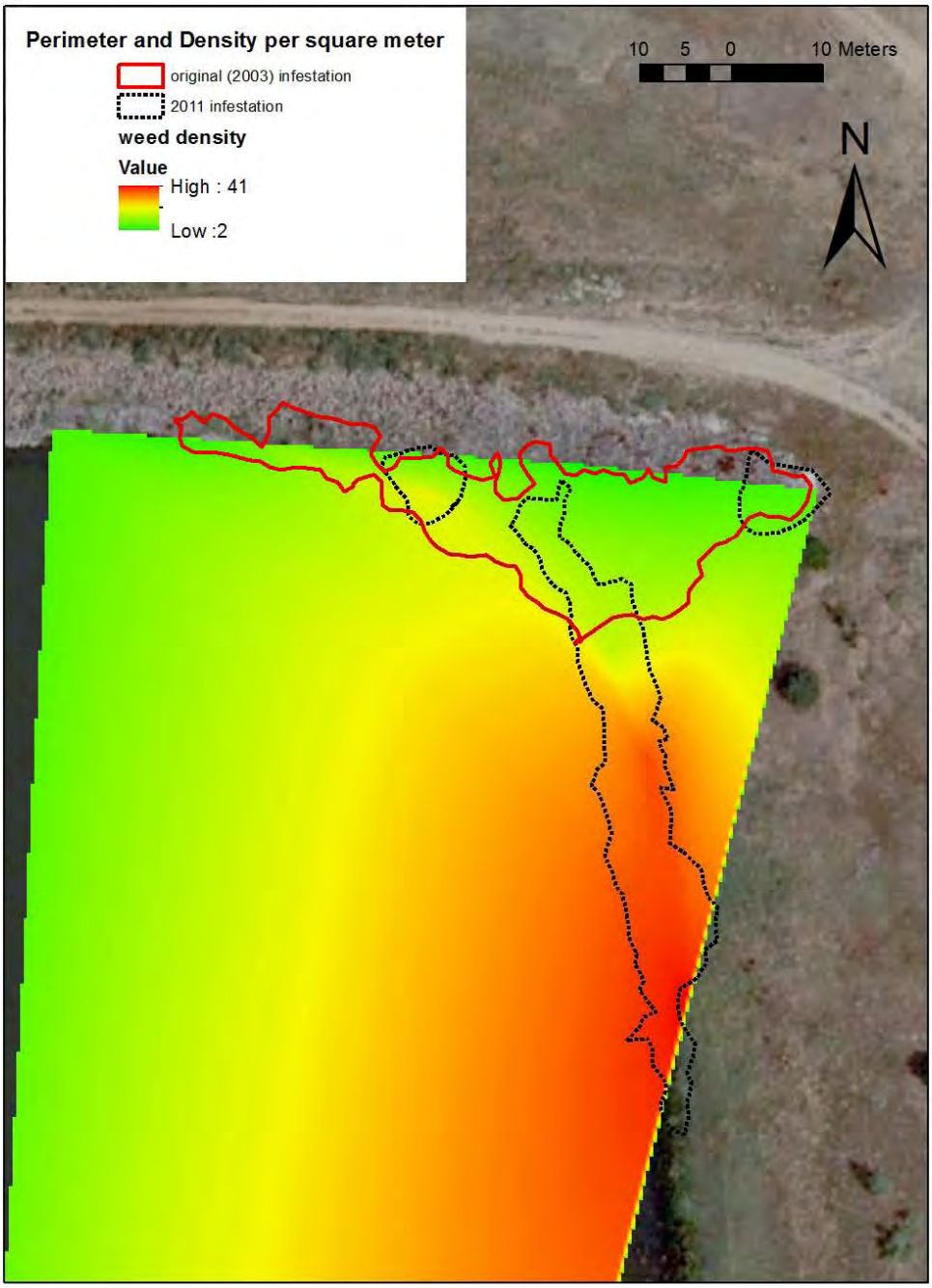
Aspen Canada Thistle 2011a



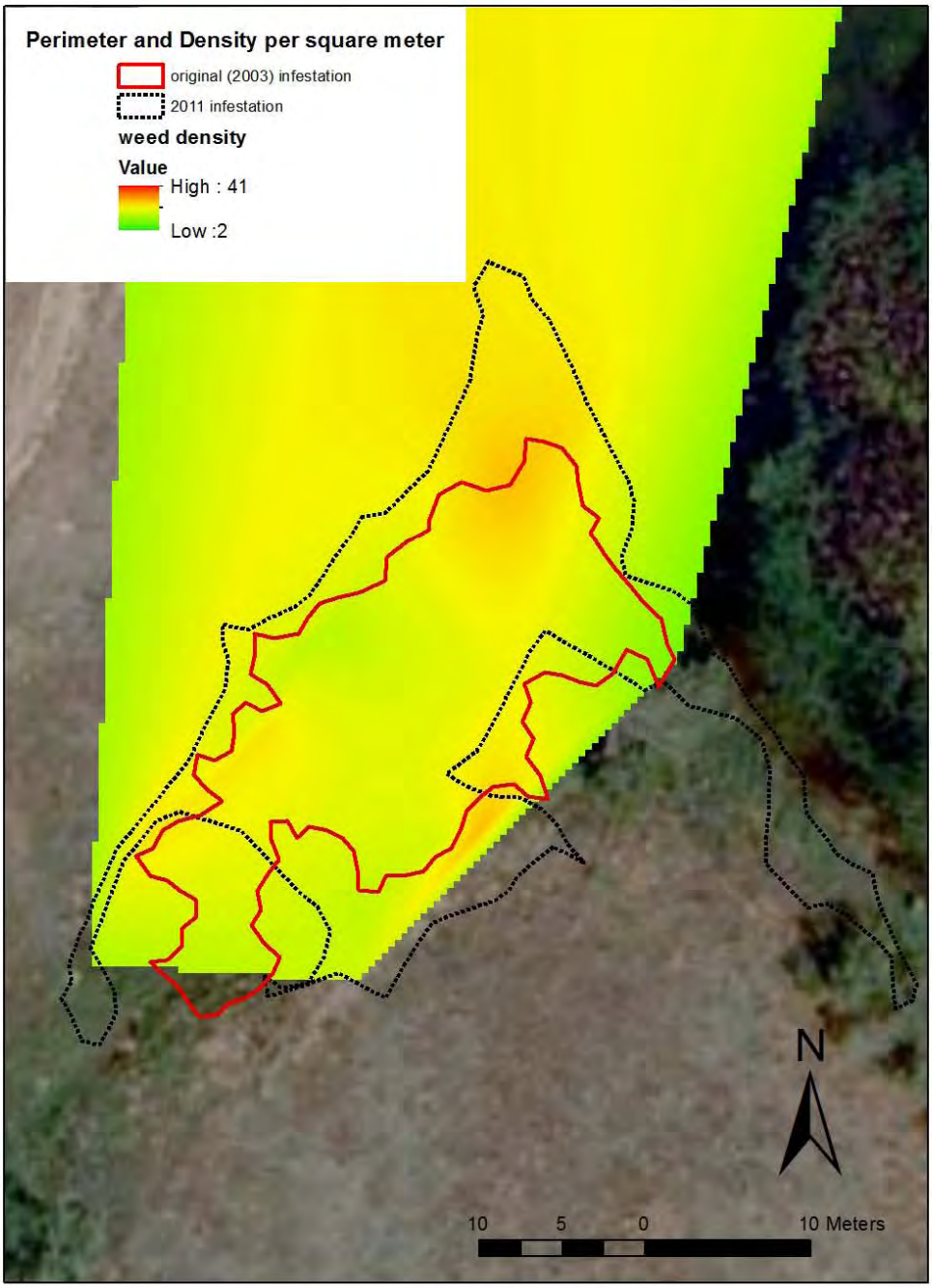
Aspen Canada Thistle 2011b



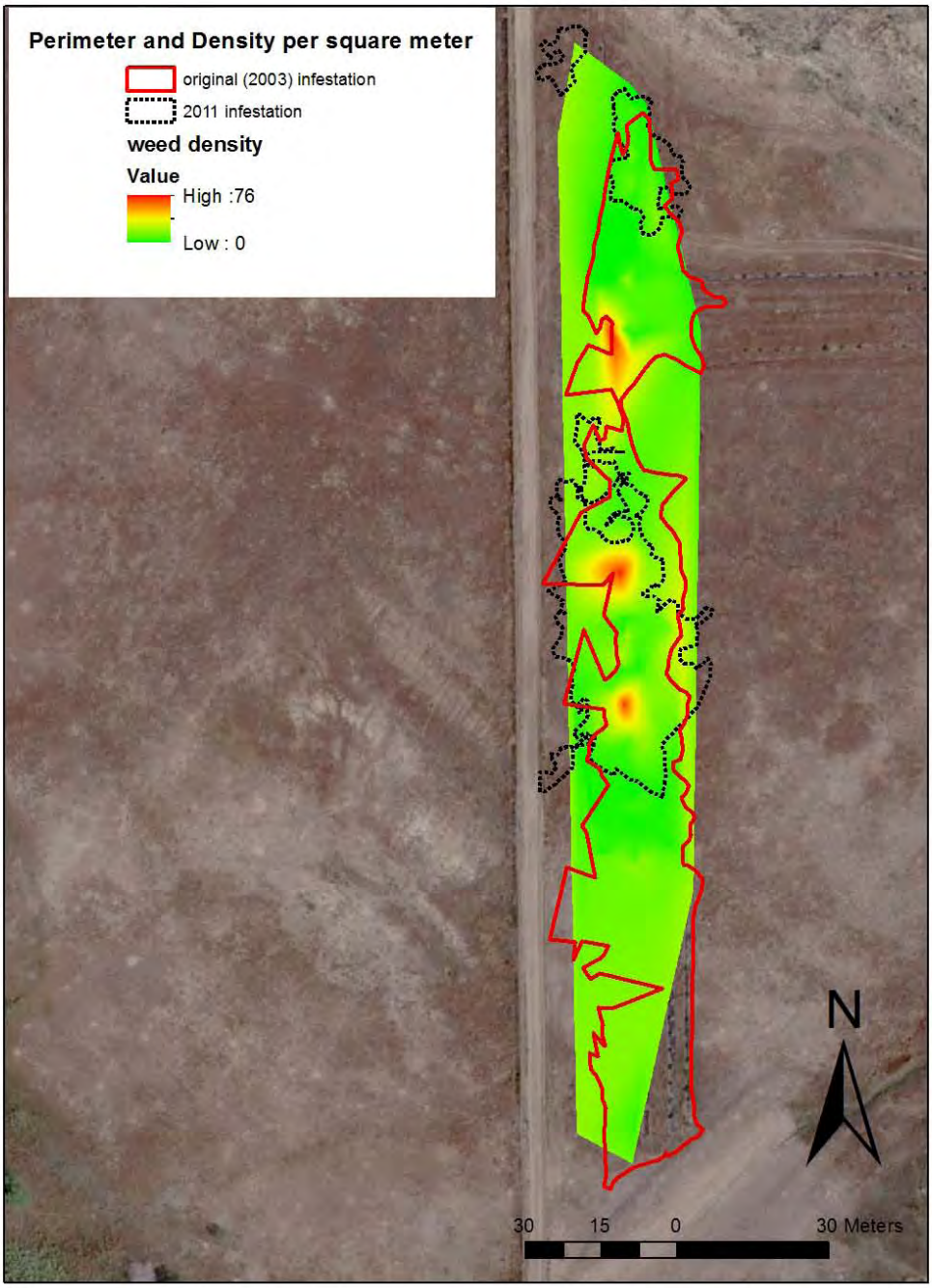
Williams Lake Canada Thistle 2011a



Williams Lake Canada Thistle 2011b

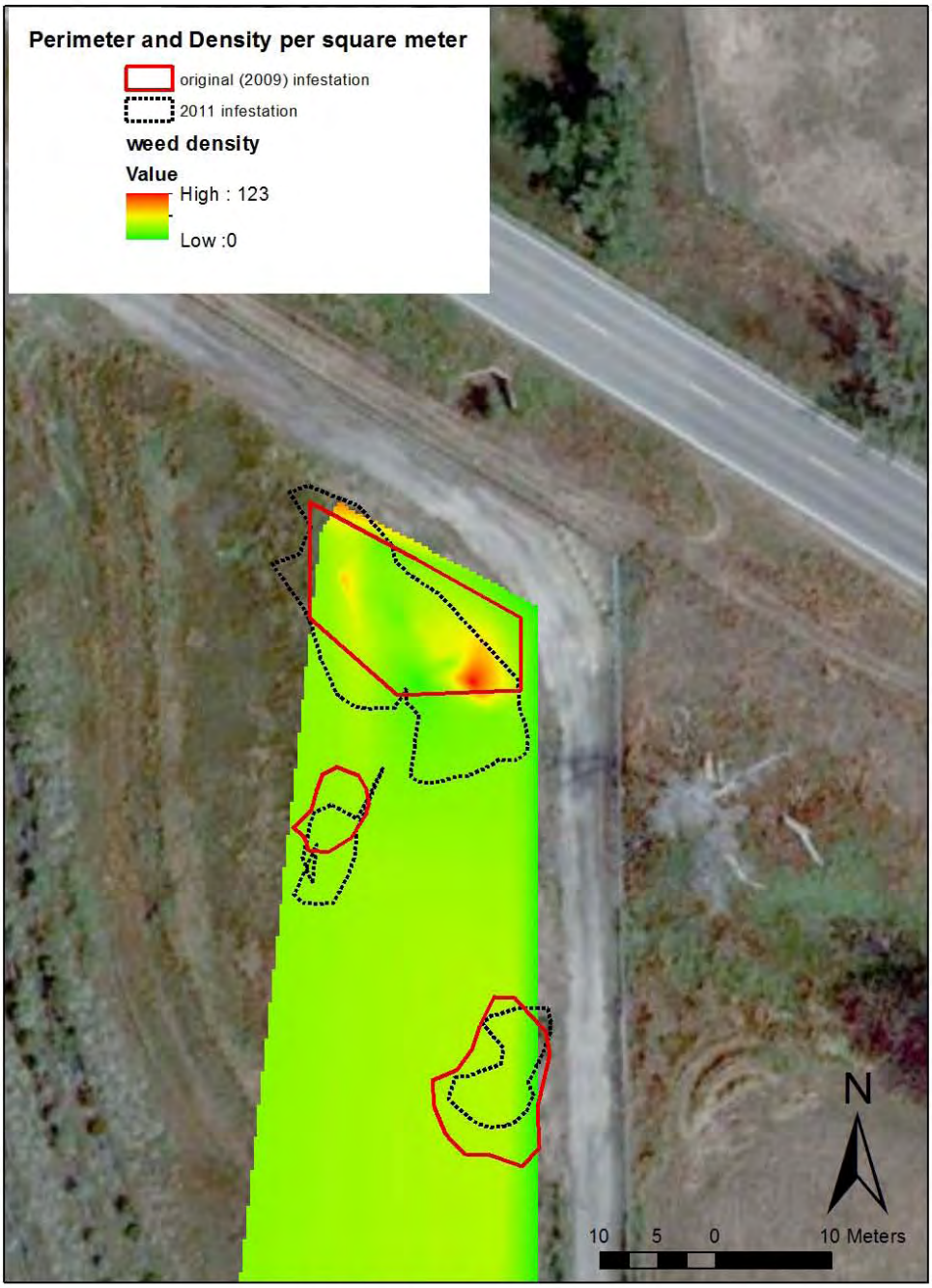


Williams Lake Canada Thistle 2011c



South Aspen Way Dalmatian Toadflax 2011

North Fence Leafy Spurge 2011a



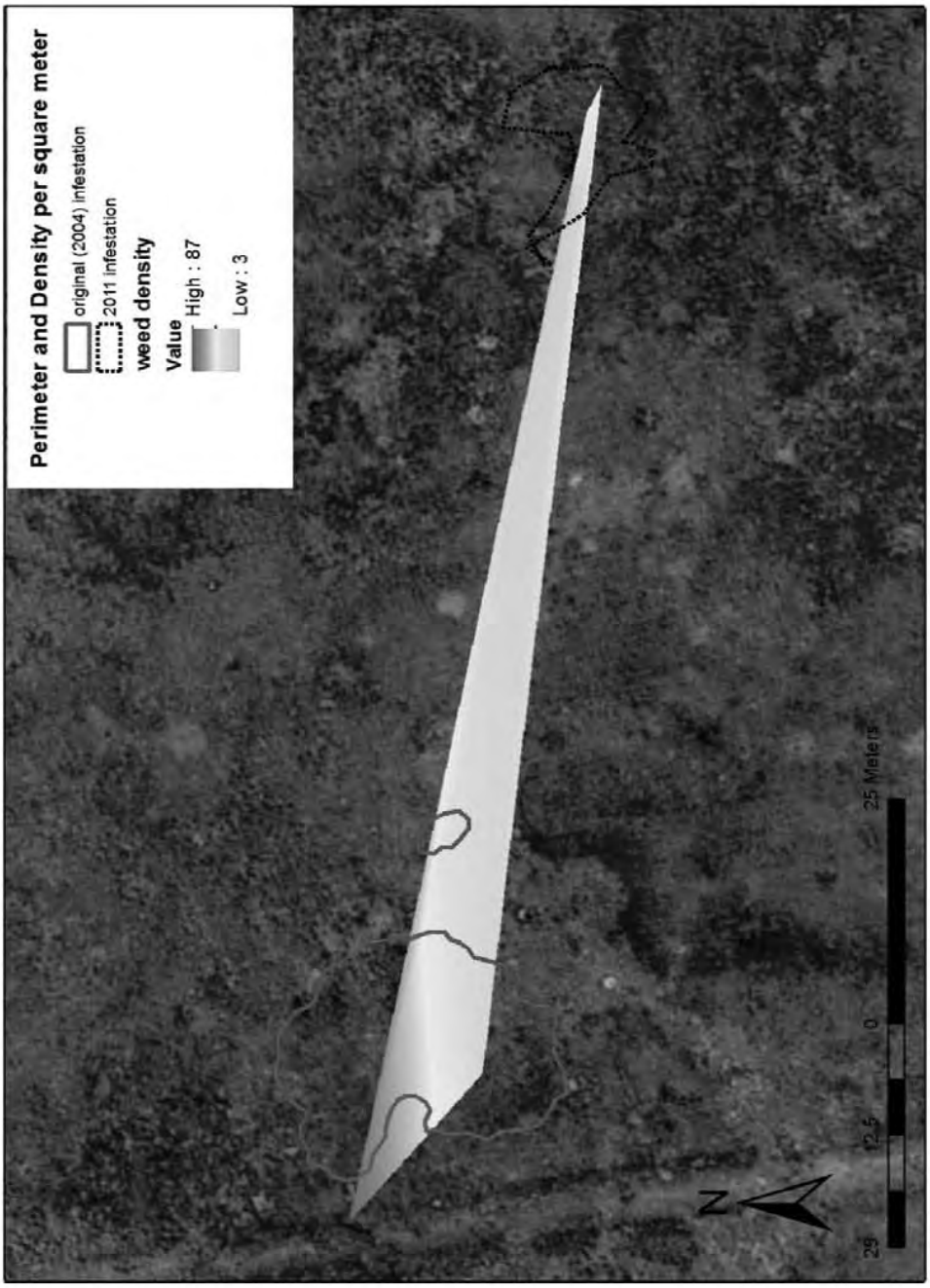
North Fence Leafy Spurge 2011b

North Fence Leafy Spurge 2011c

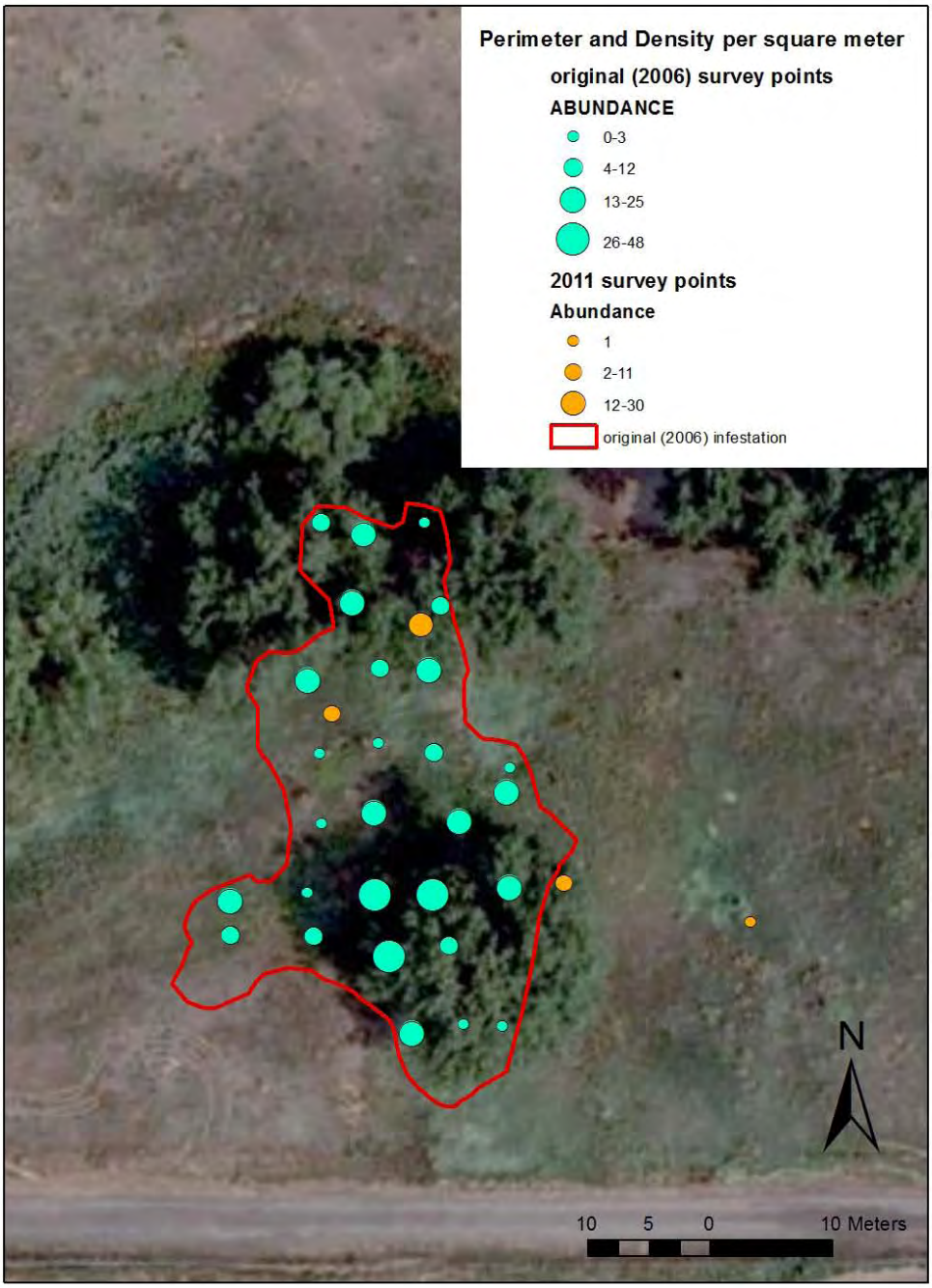
North Run 1 Leafy Spurge 2011

North Run 2 Leafy Spurge 2011

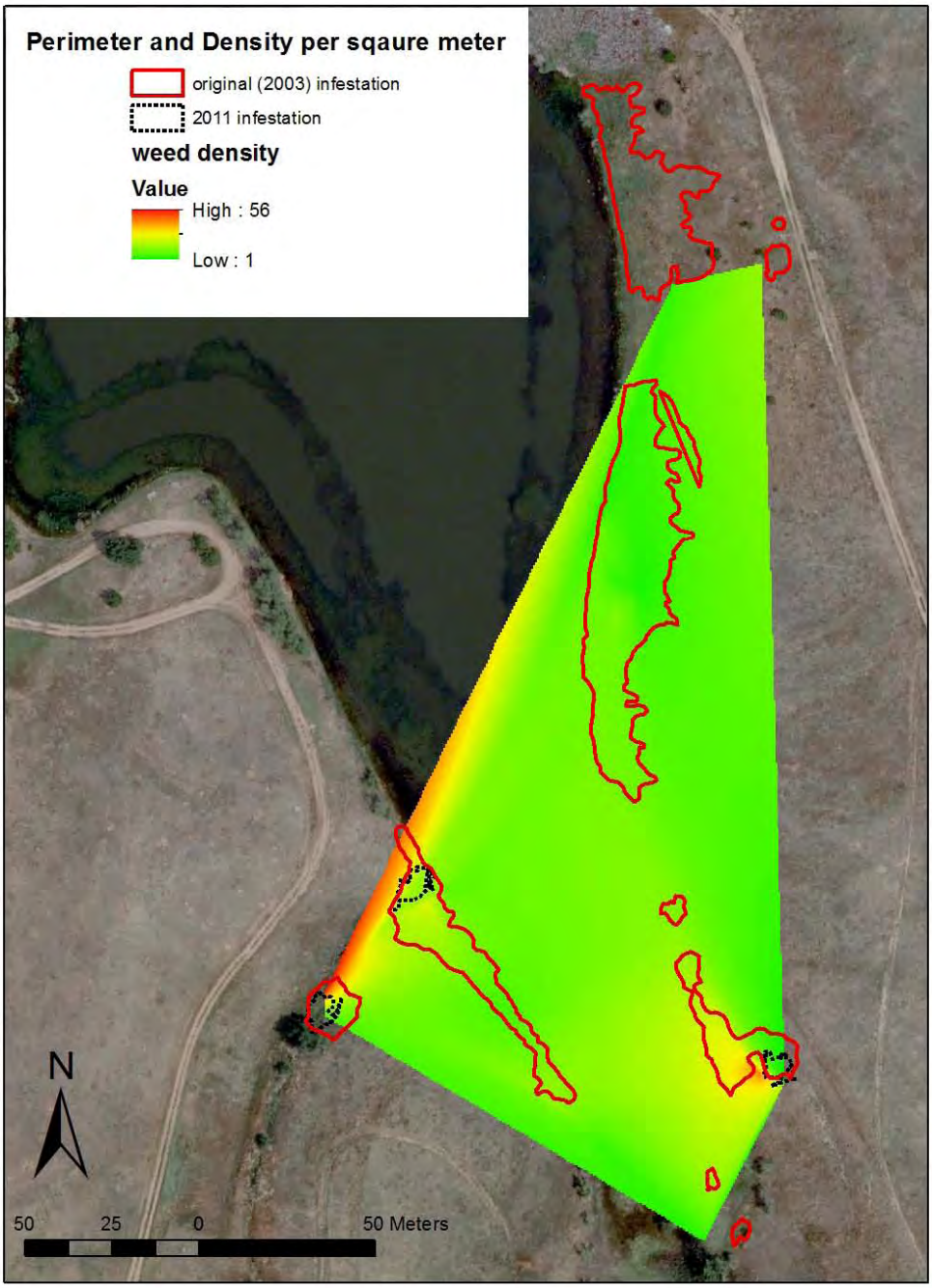
North Run 3 Leafy Spurge 2011



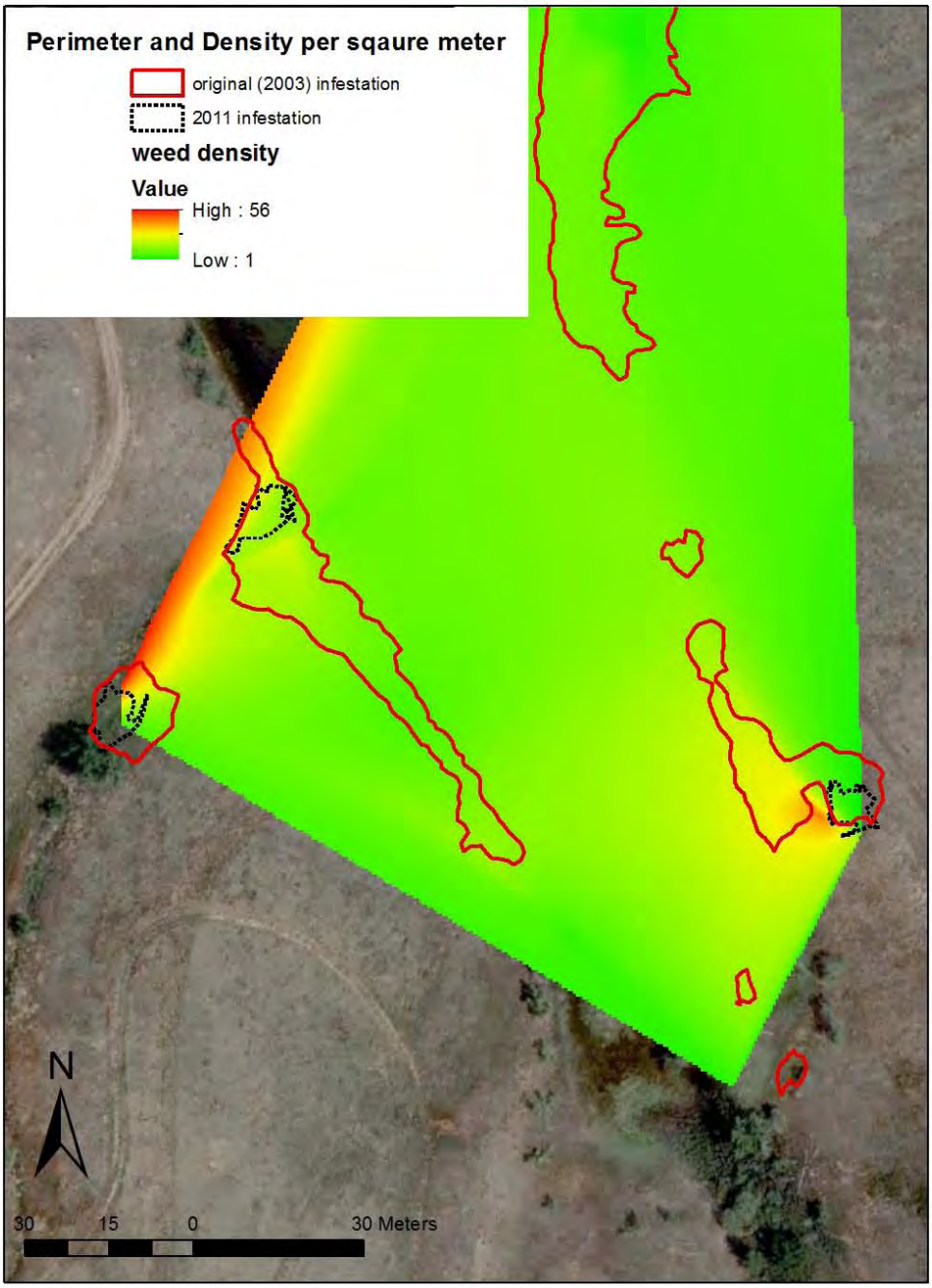
Runway Leafy Spurge 2011



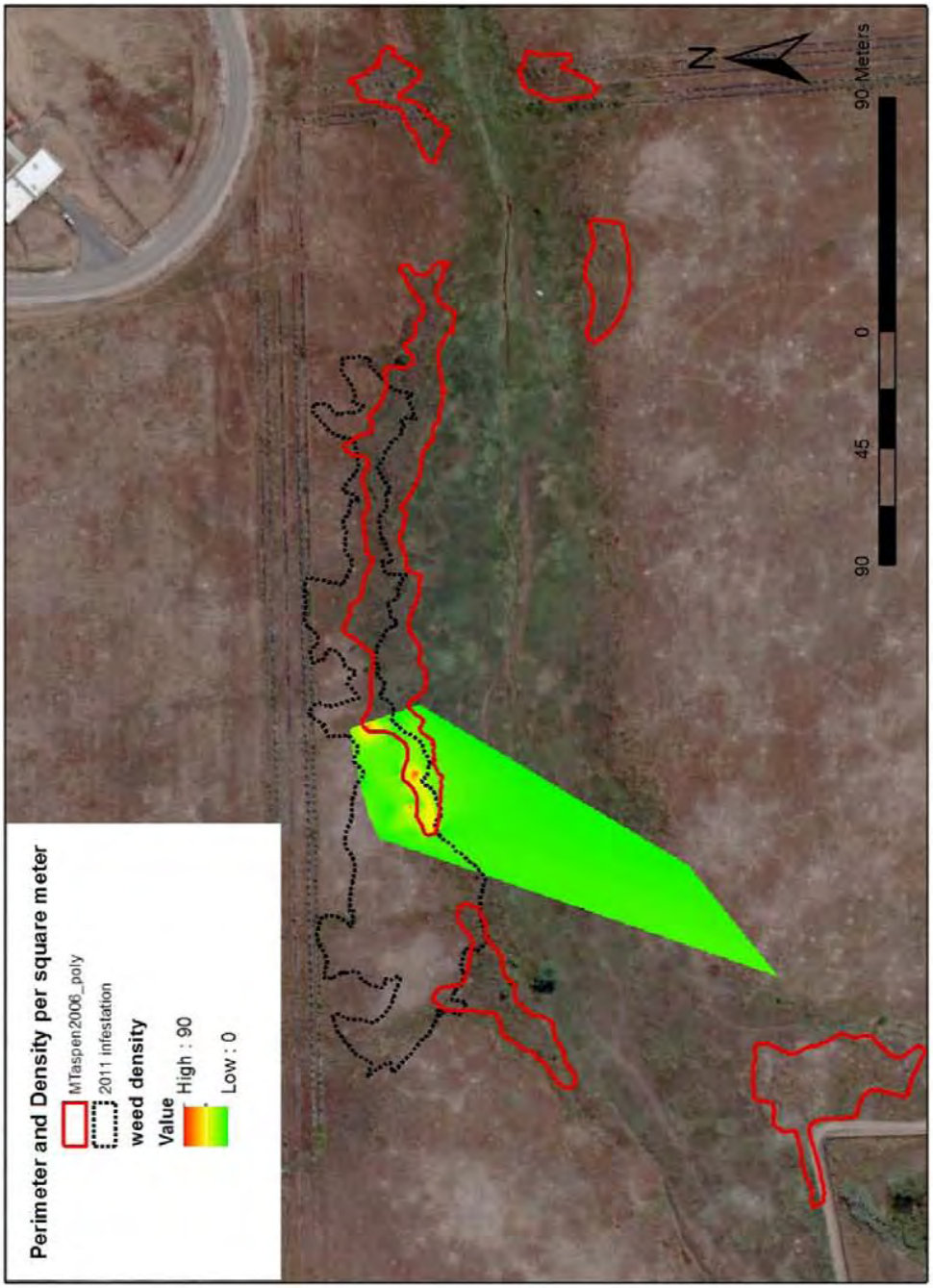
South Fence Leafy Spurge 2011



Williams Lake Leafy Spurge 2011a

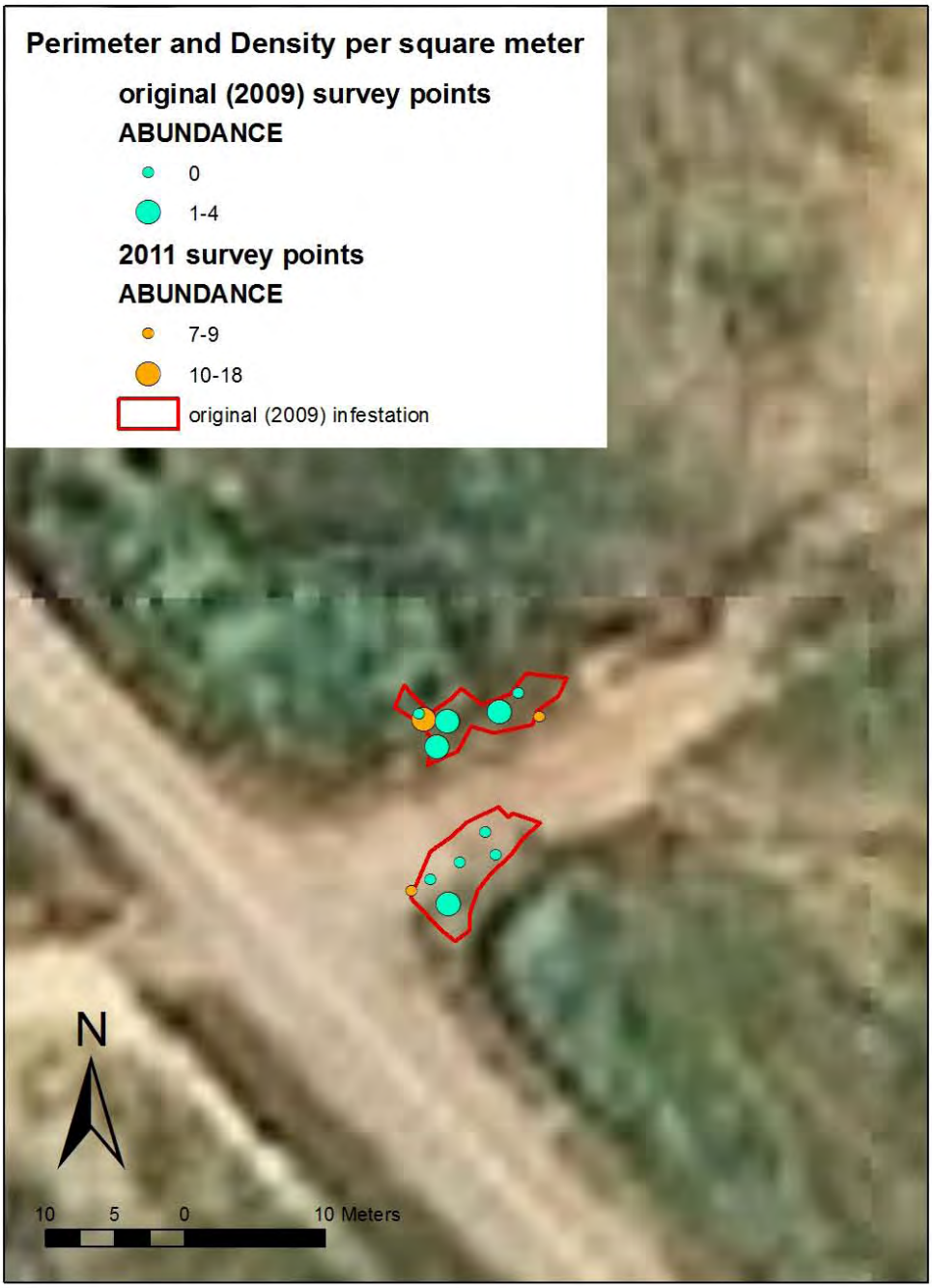


Williams Lake Leafy Spurge 2011b

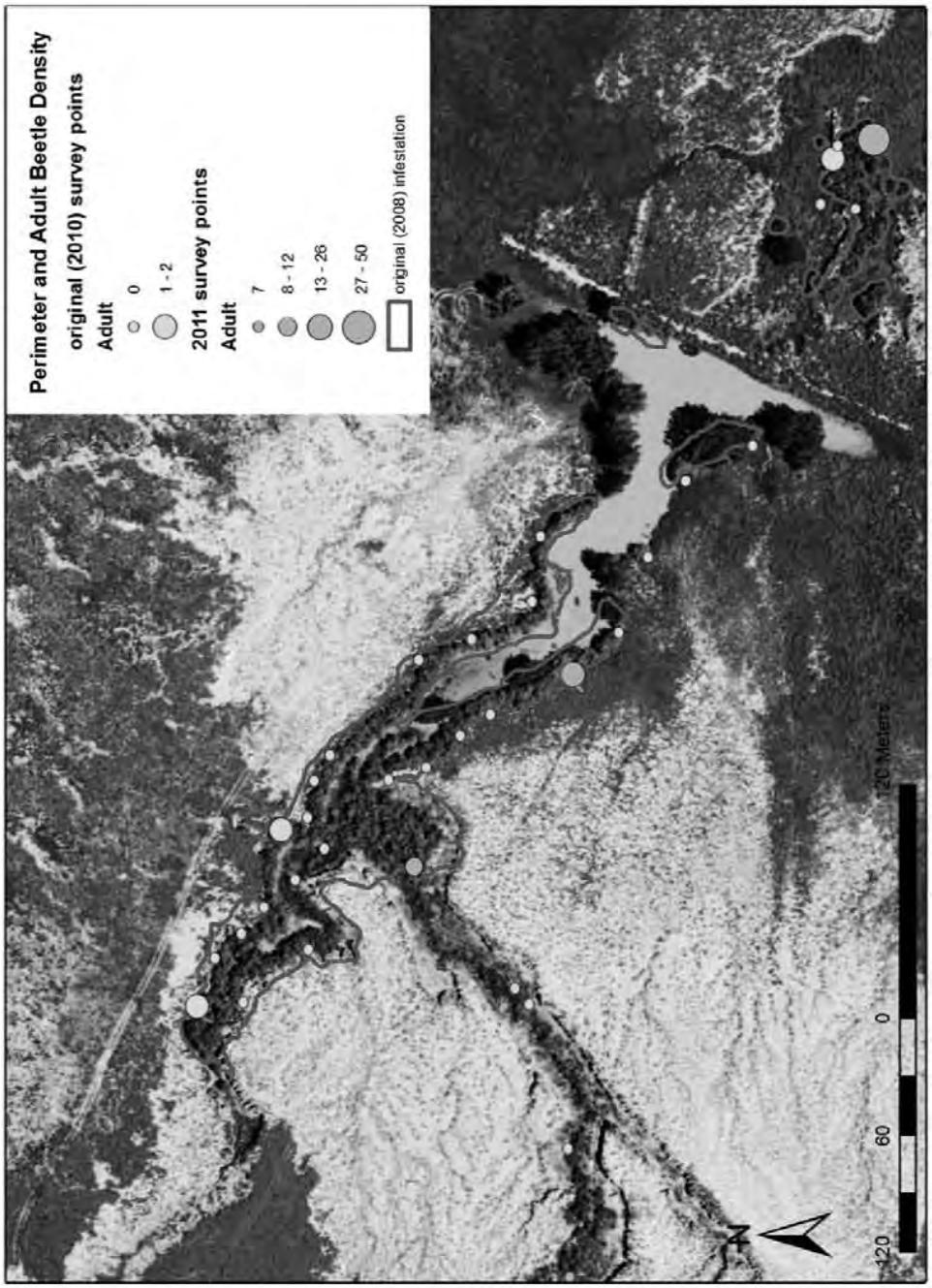


Aspen Musk Thistle 2011

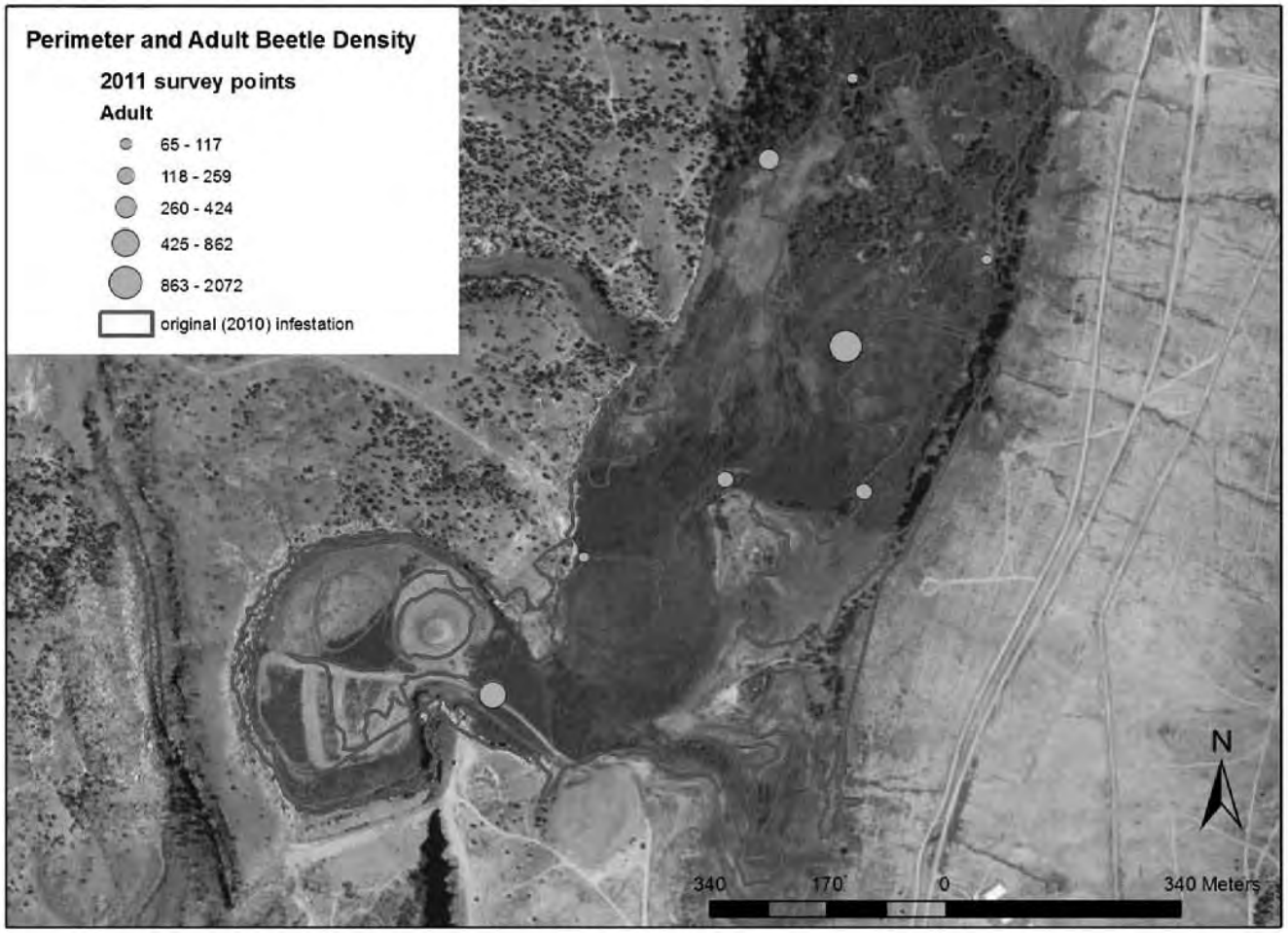
Fort Carson Military Post



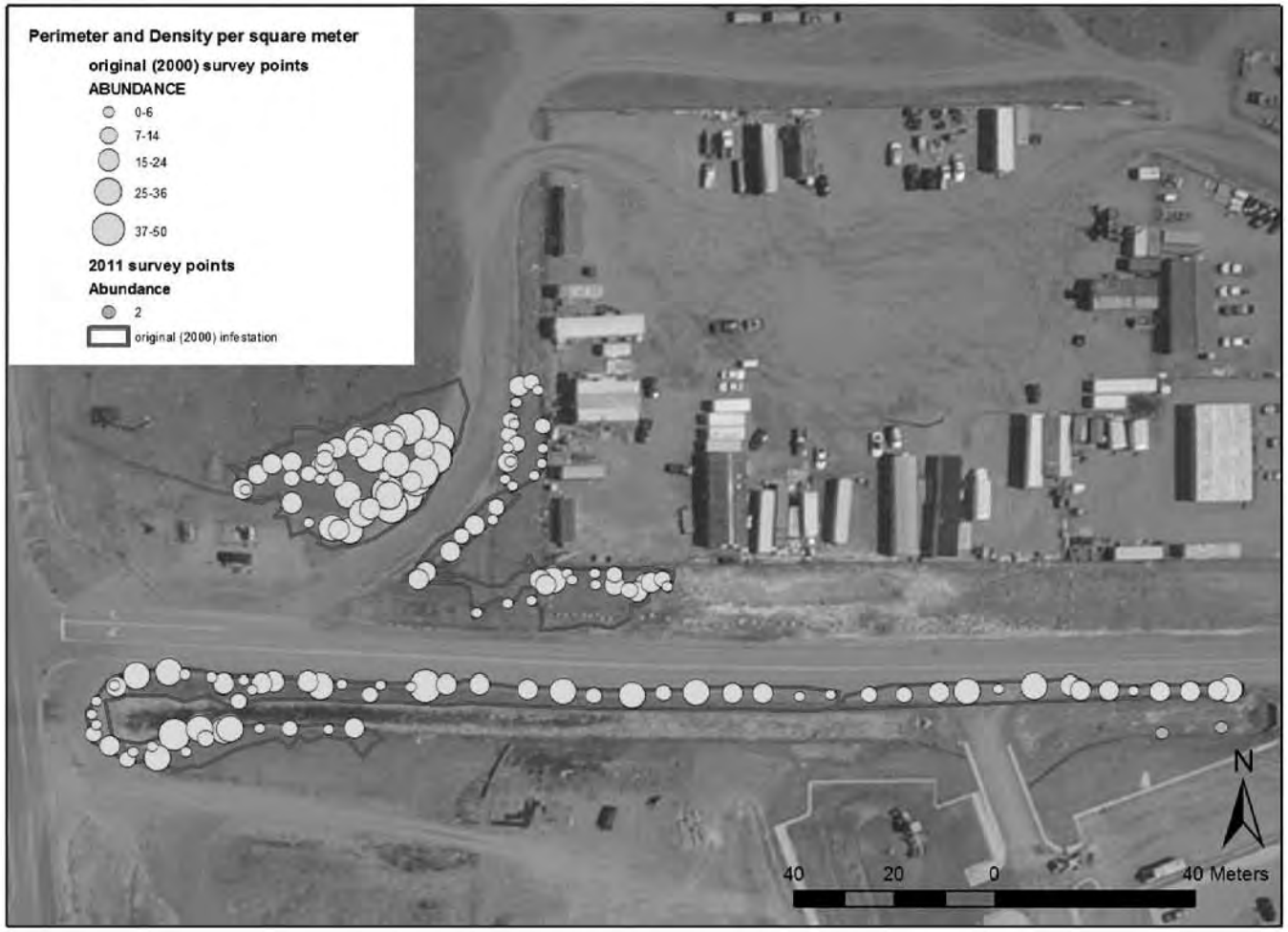
Route 1 Diffuse Knapweed 2011



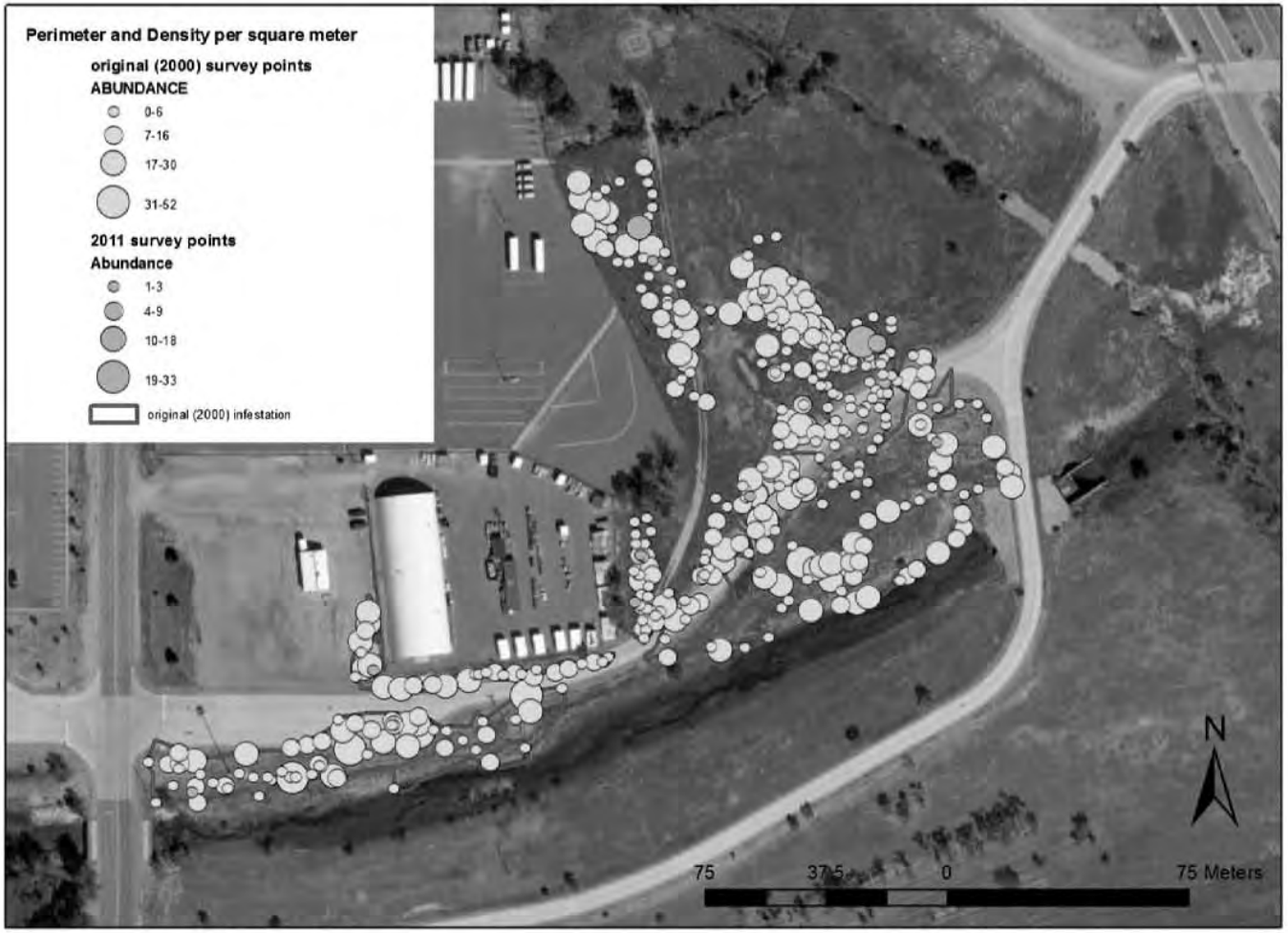
Section 36 Saltcedar 2011



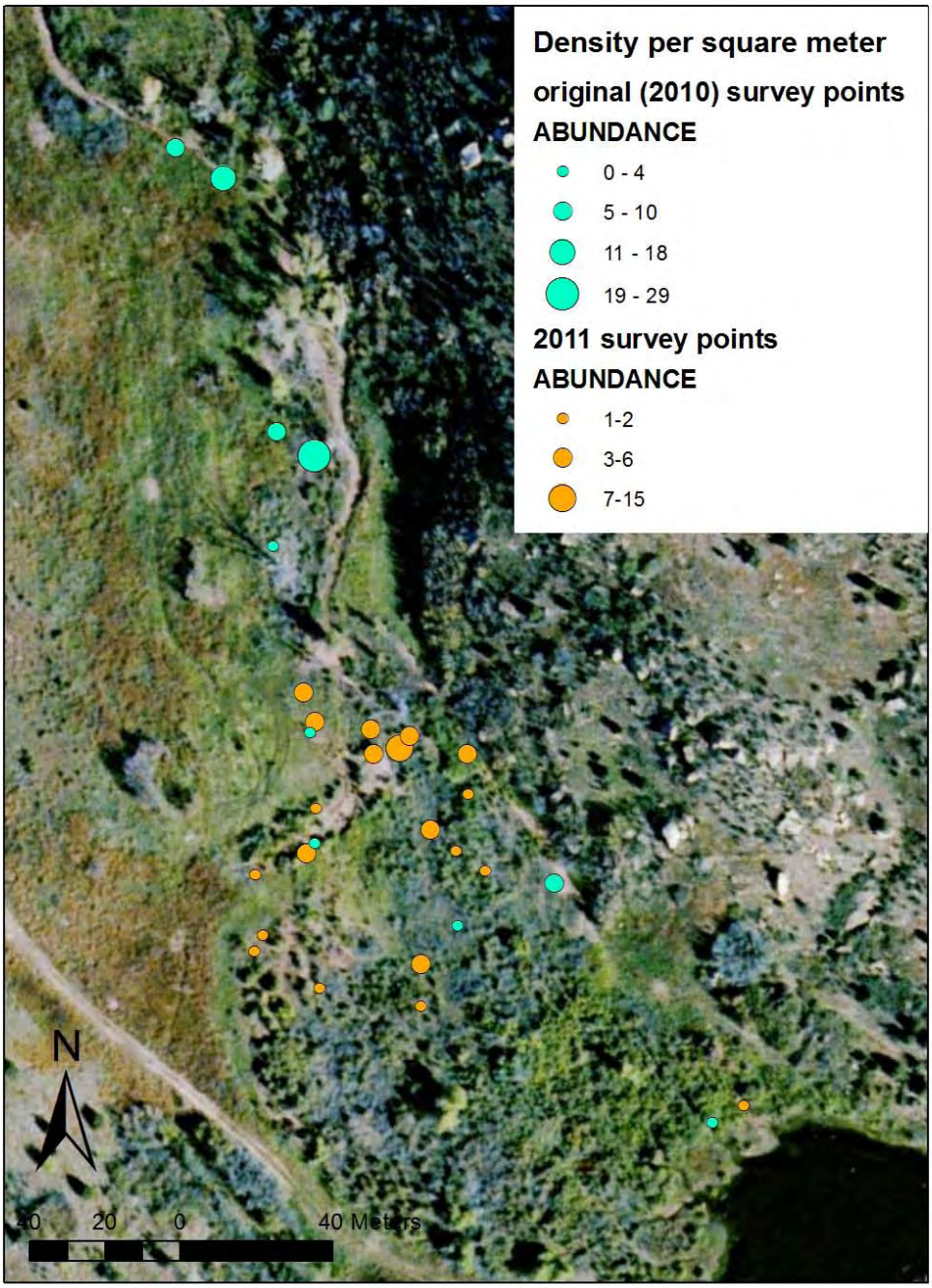
Teller Reservoir Saltcedar 2011



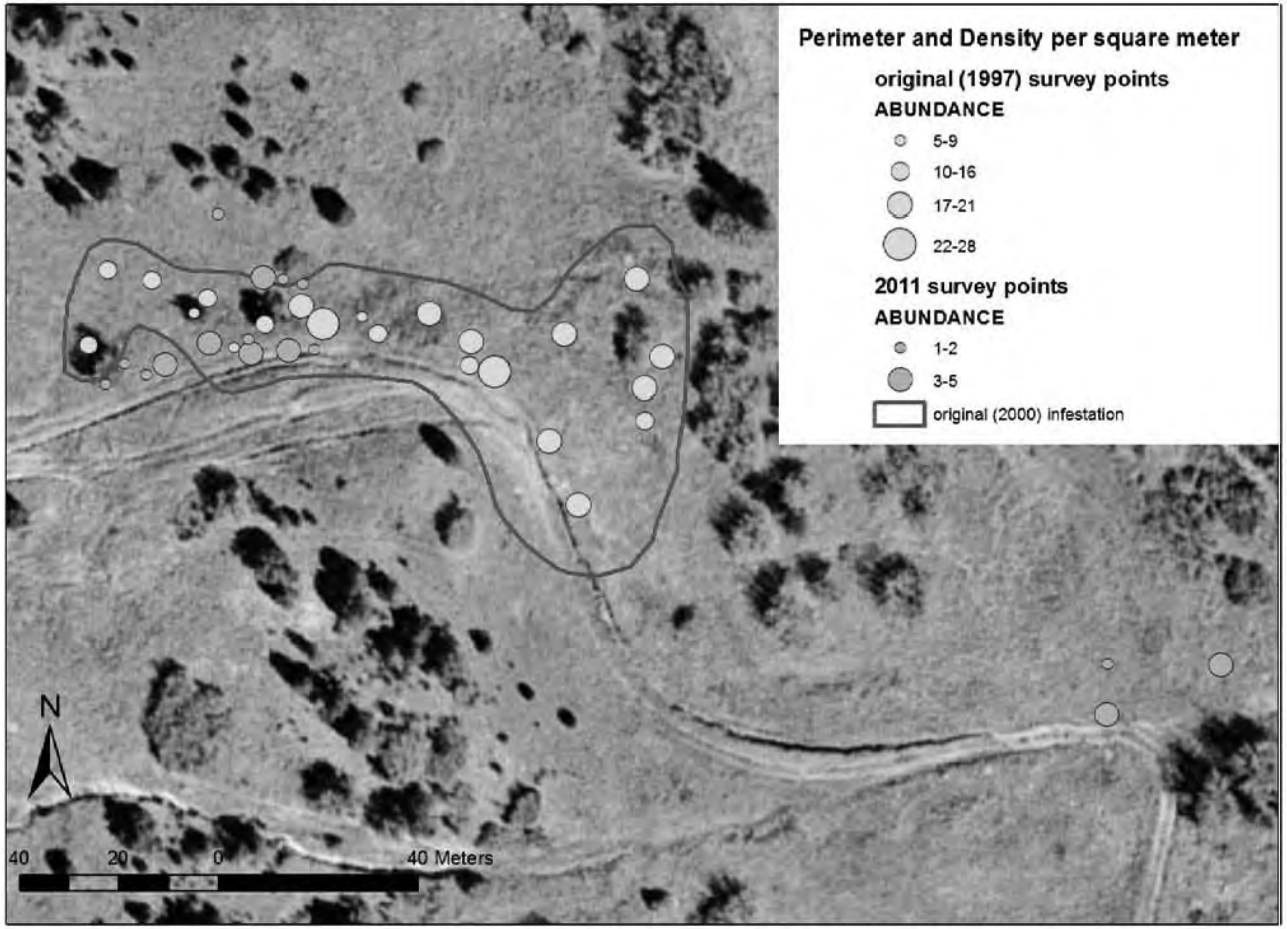
Fuel Site Spotted Knapweed 2011



Hazmat Spotted Knapweed 2011

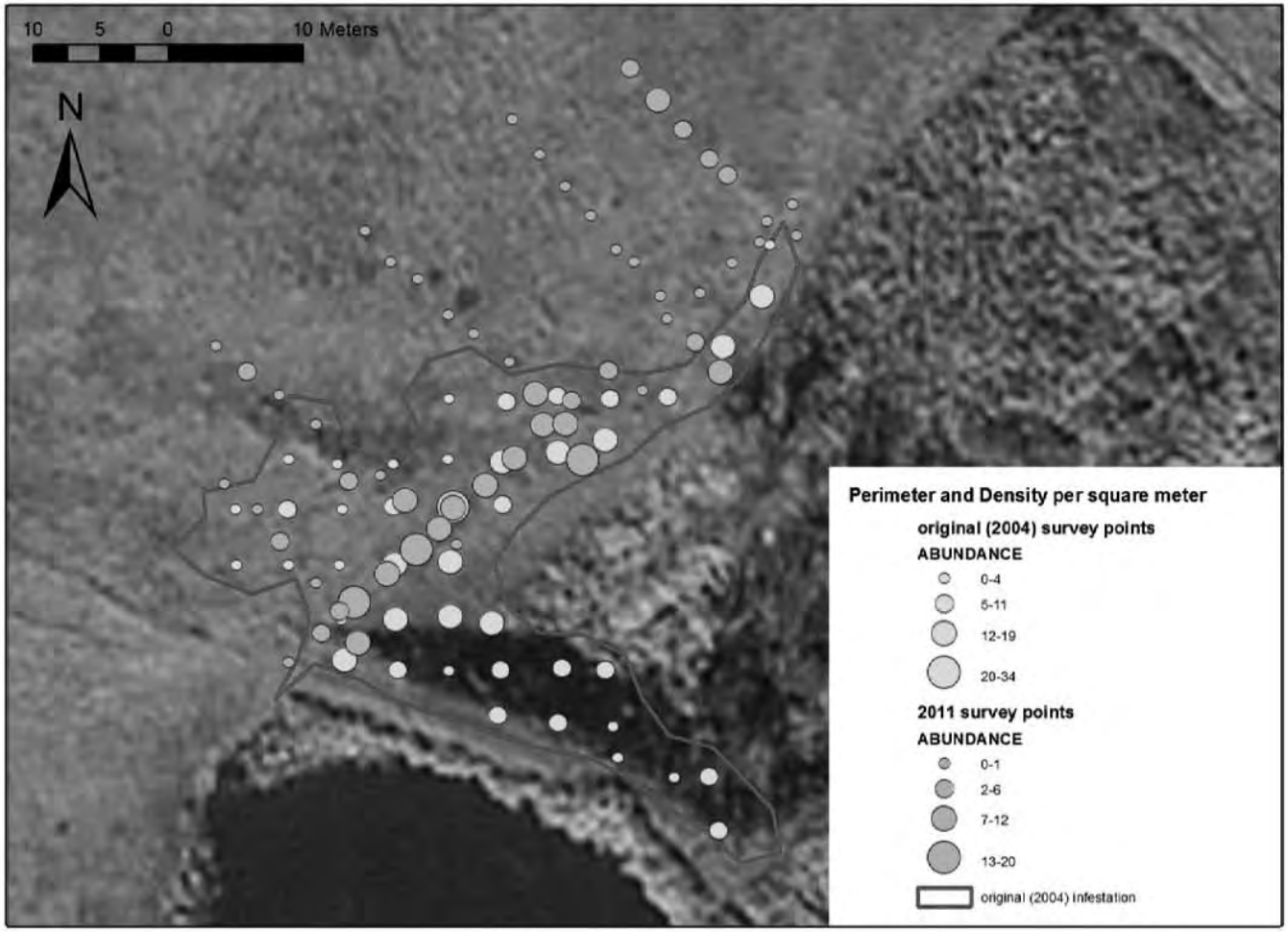


South Turkey Creek Spotted Knapweed 2011

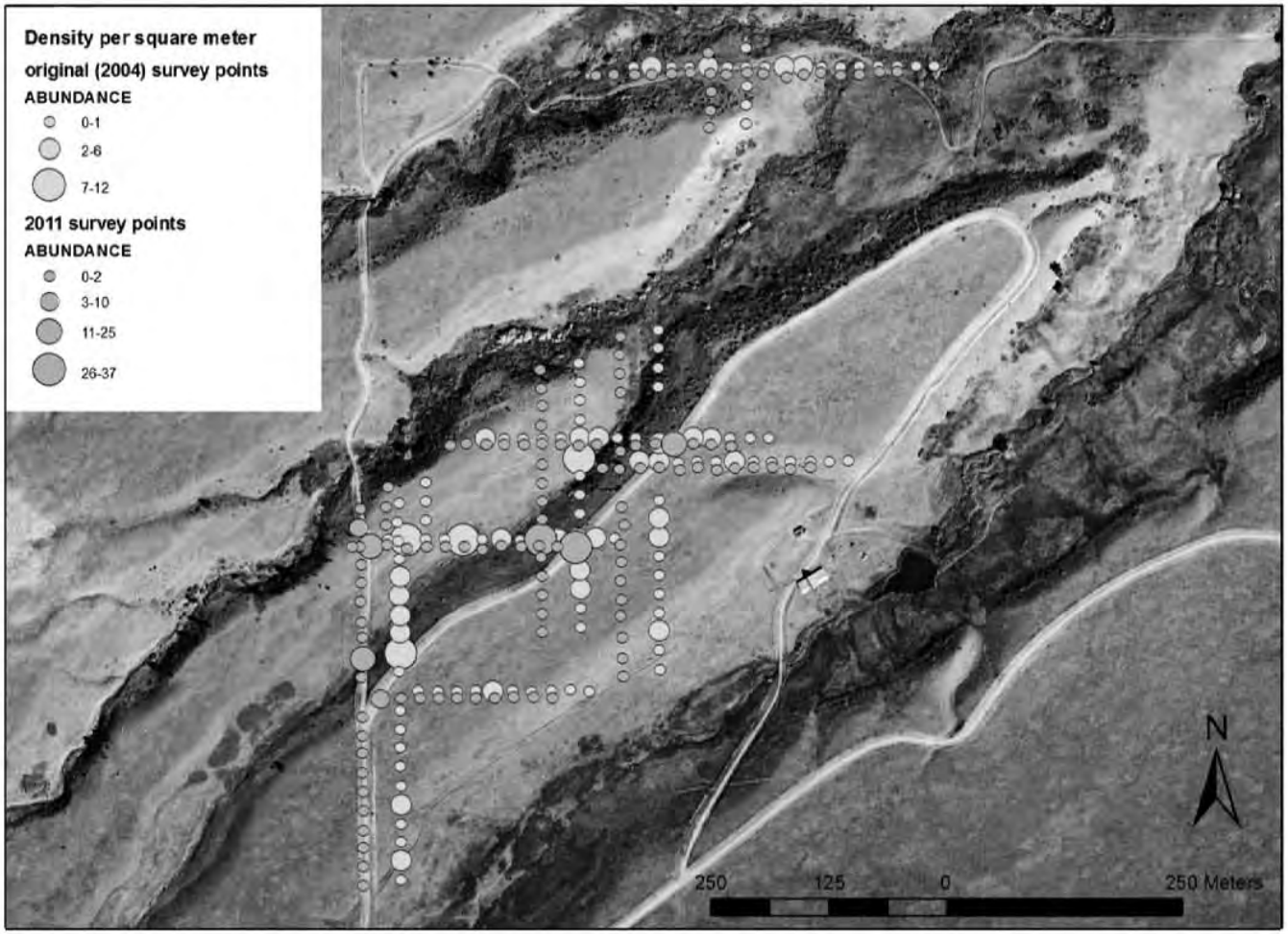


Turkey Creek Spotted Knapweed 2011

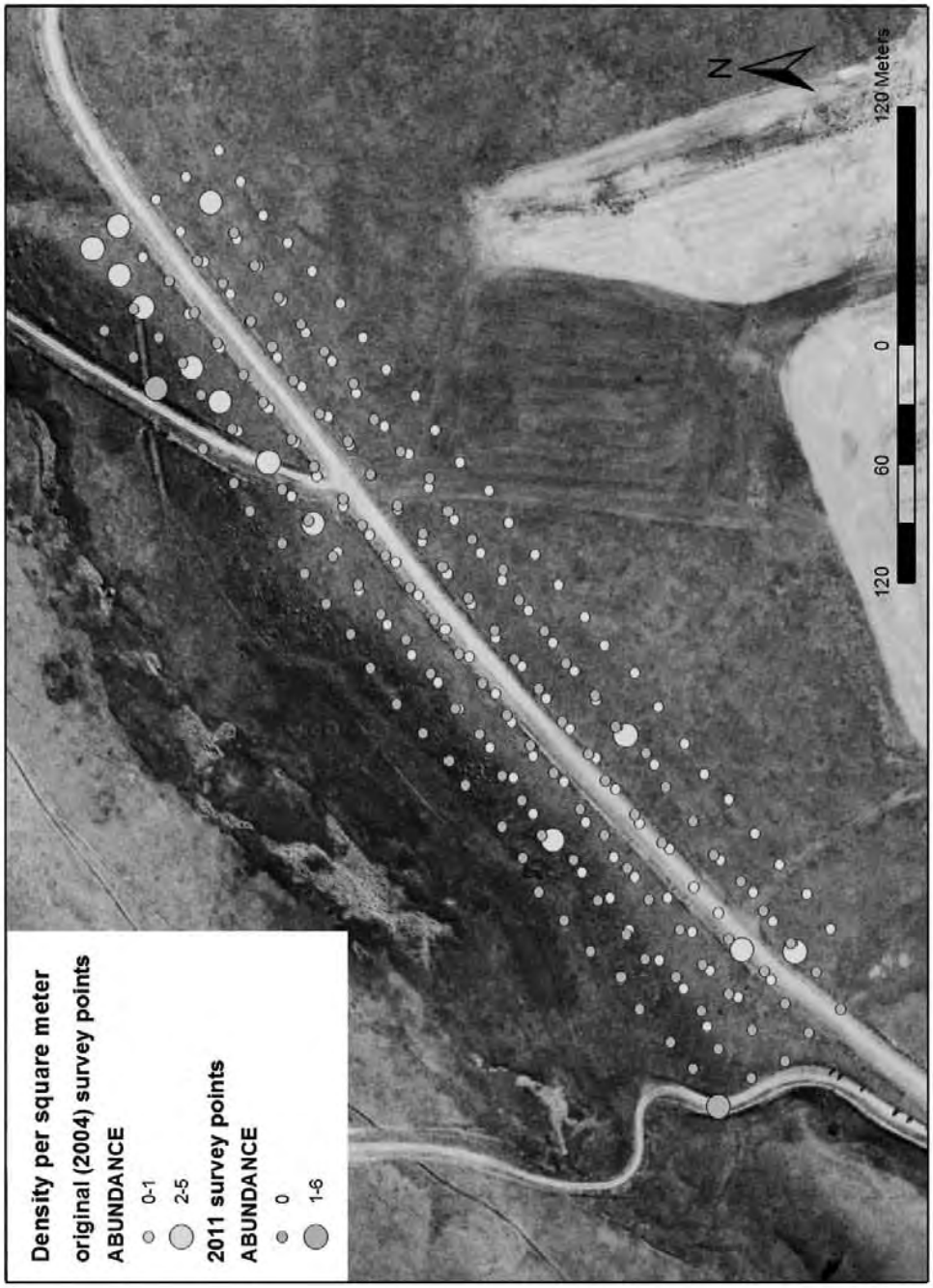
Rocky Flats National Wildlife Refuge



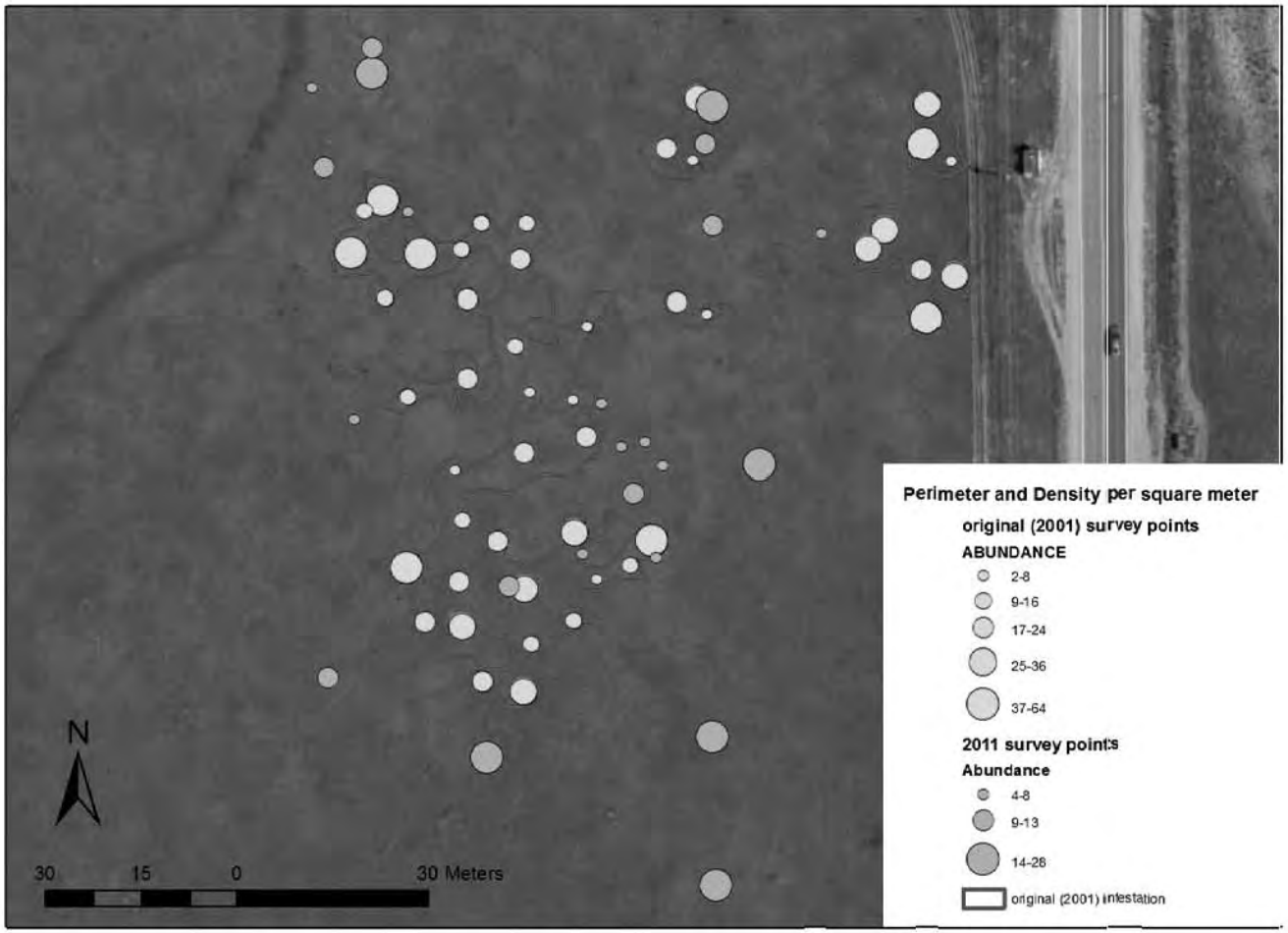
Lindsay Ranch Canada Thistle 2011



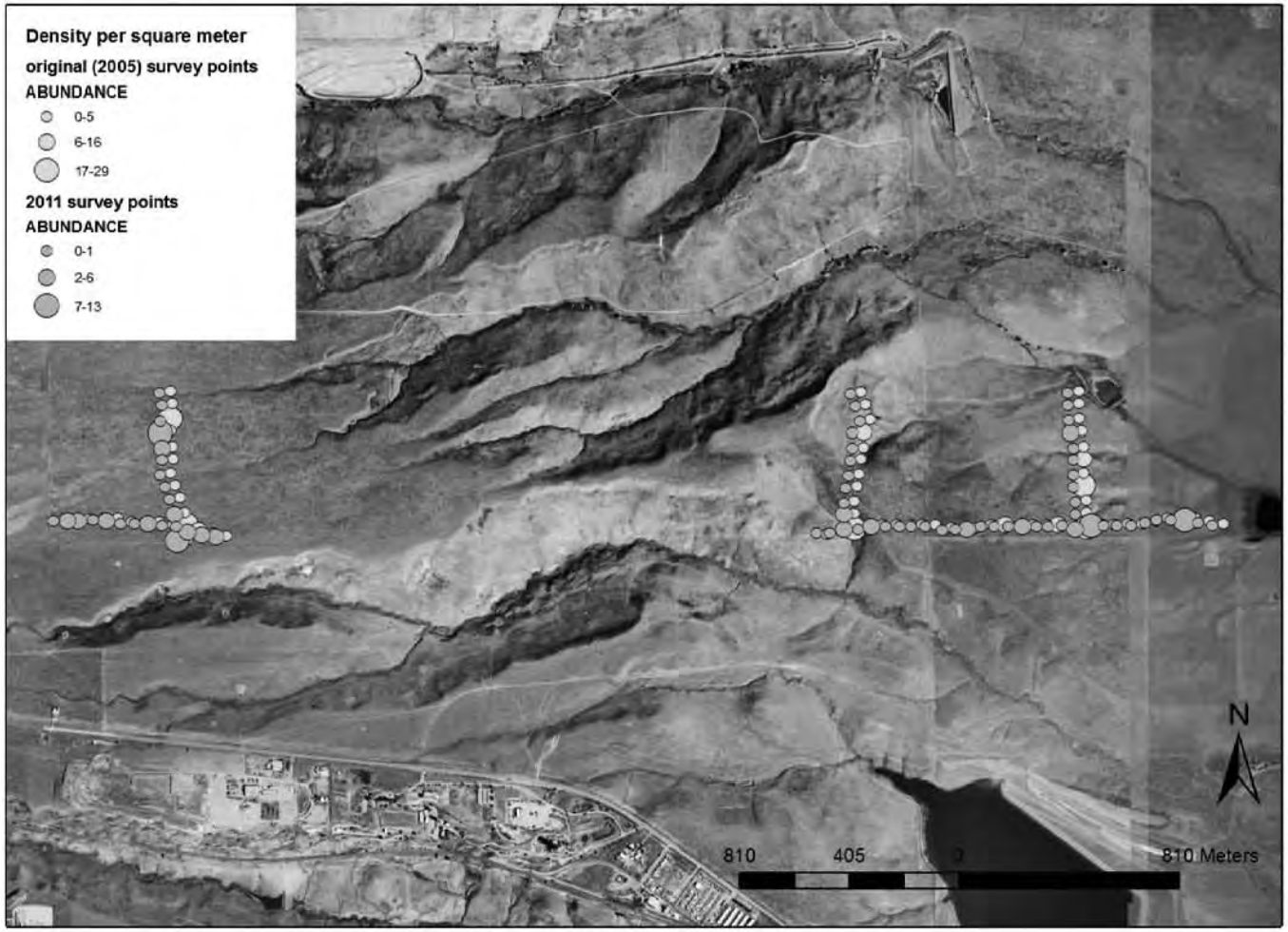
Cardinal Diffuse Knapweed 2011



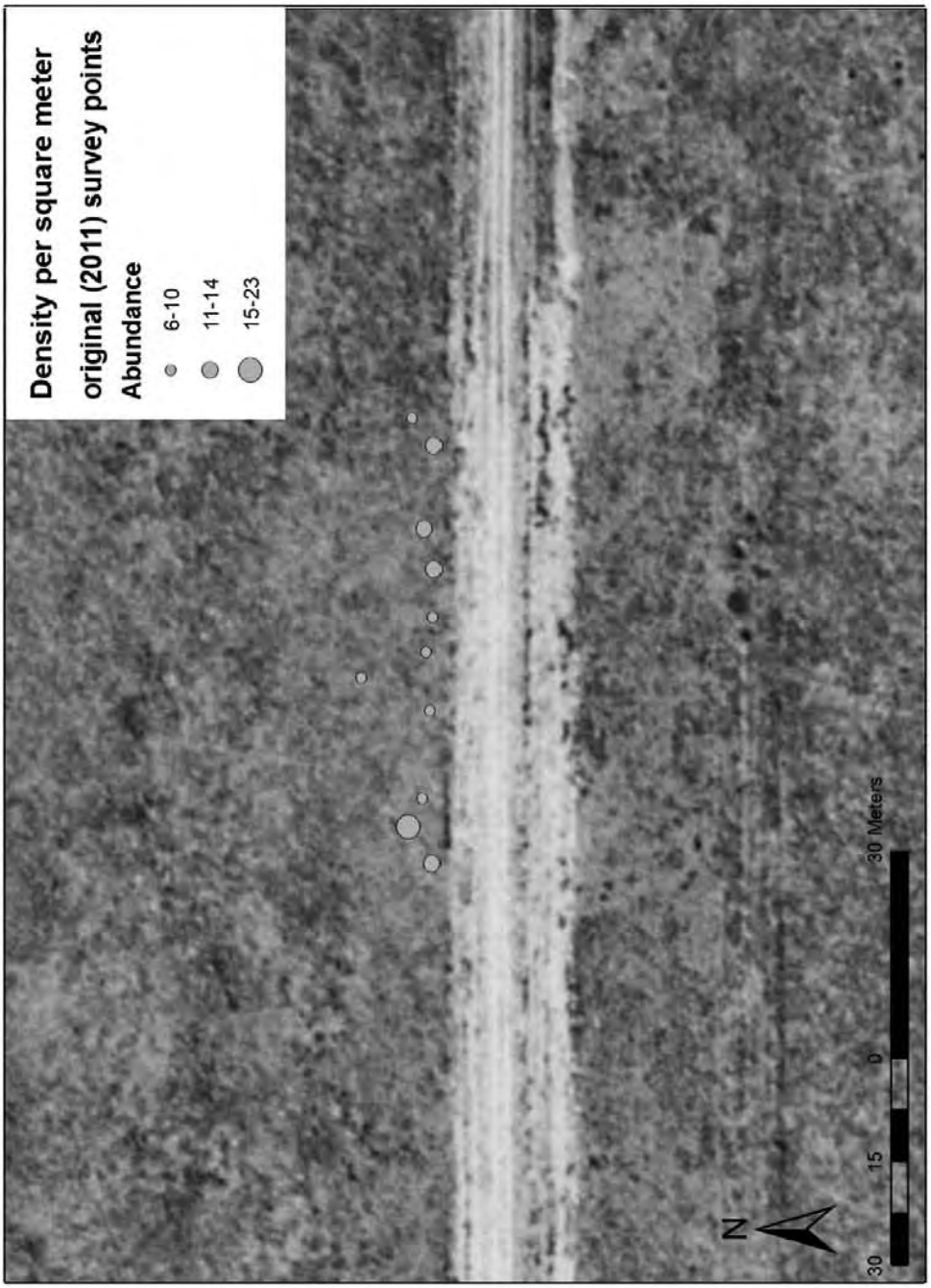
Line Diffuse Knapweed 2011



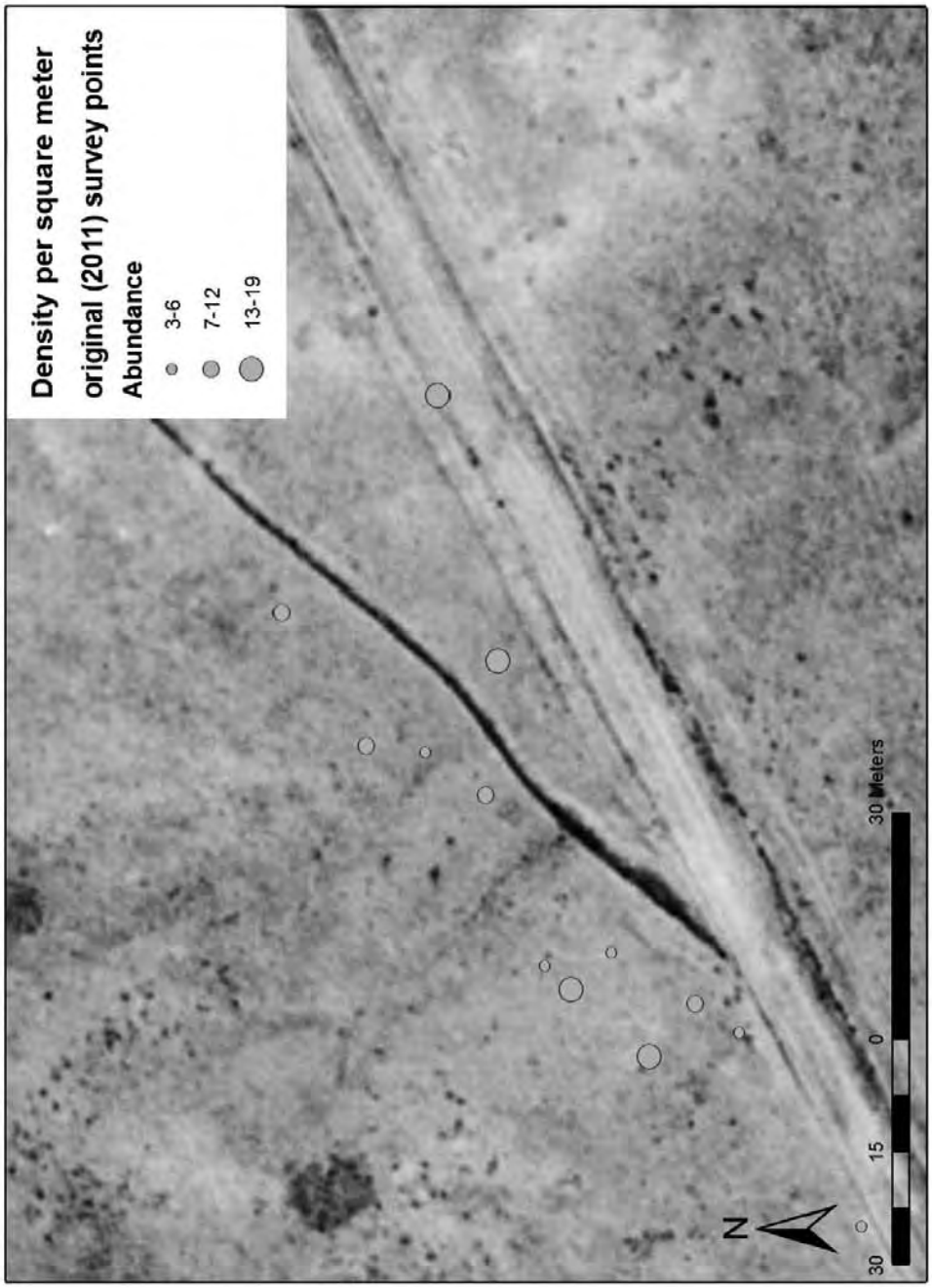
Original Dalmatian Toadflax 2011



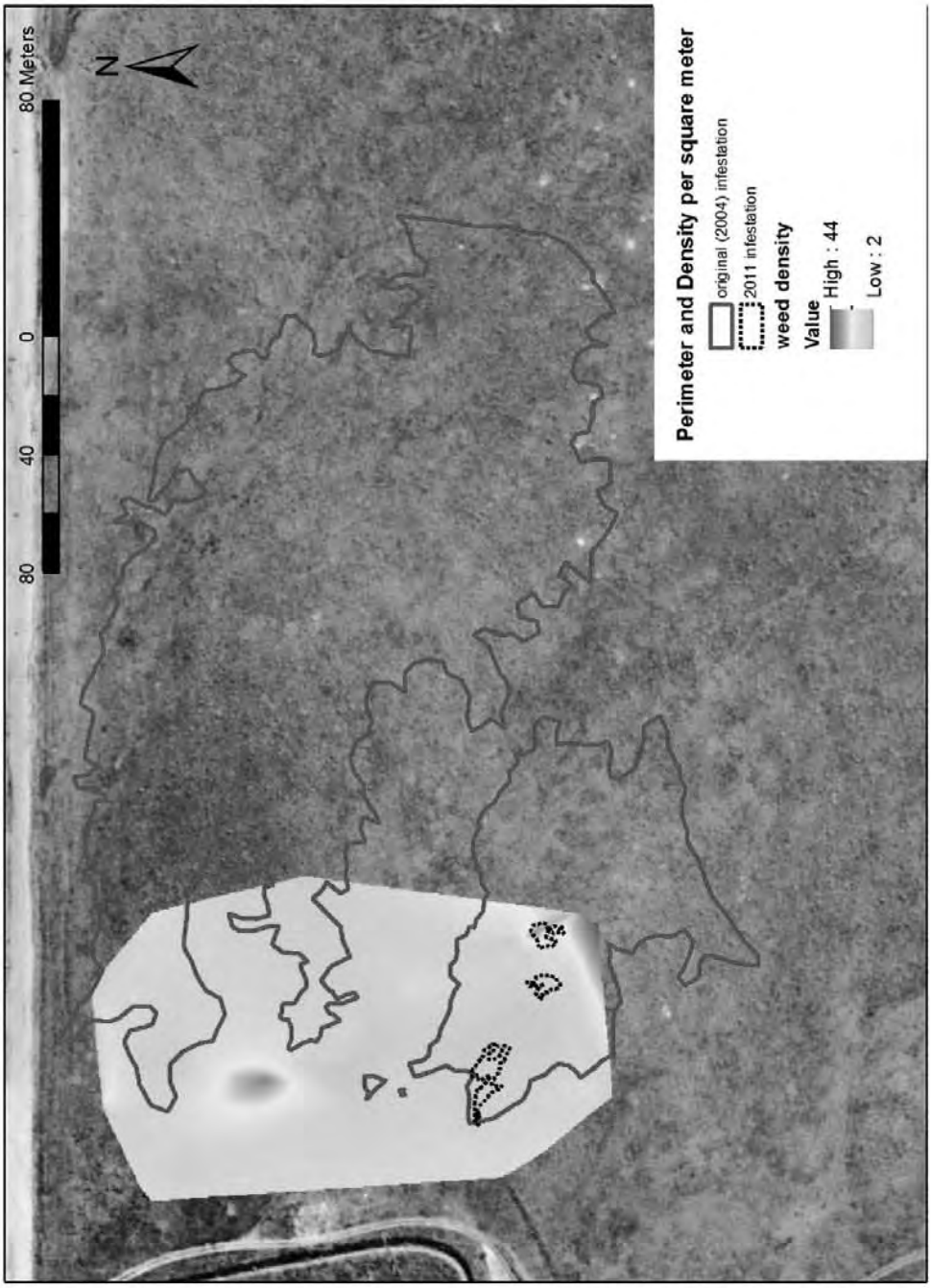
South Fence Dalmatian Toadflax 2011



Site 1 Dalmatian Toadflax 2011

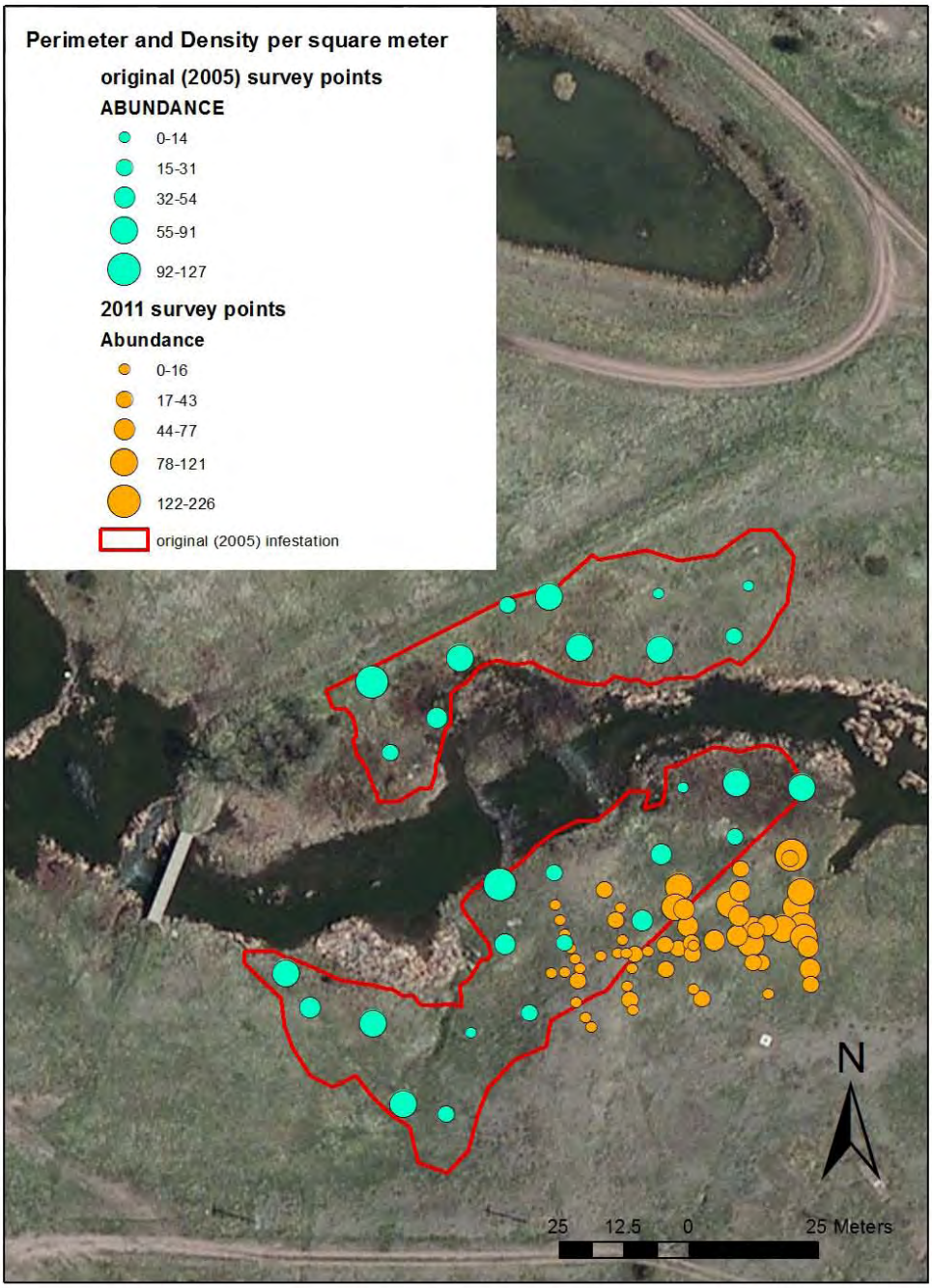


Site 2 Dalmatian Toadflax 2011

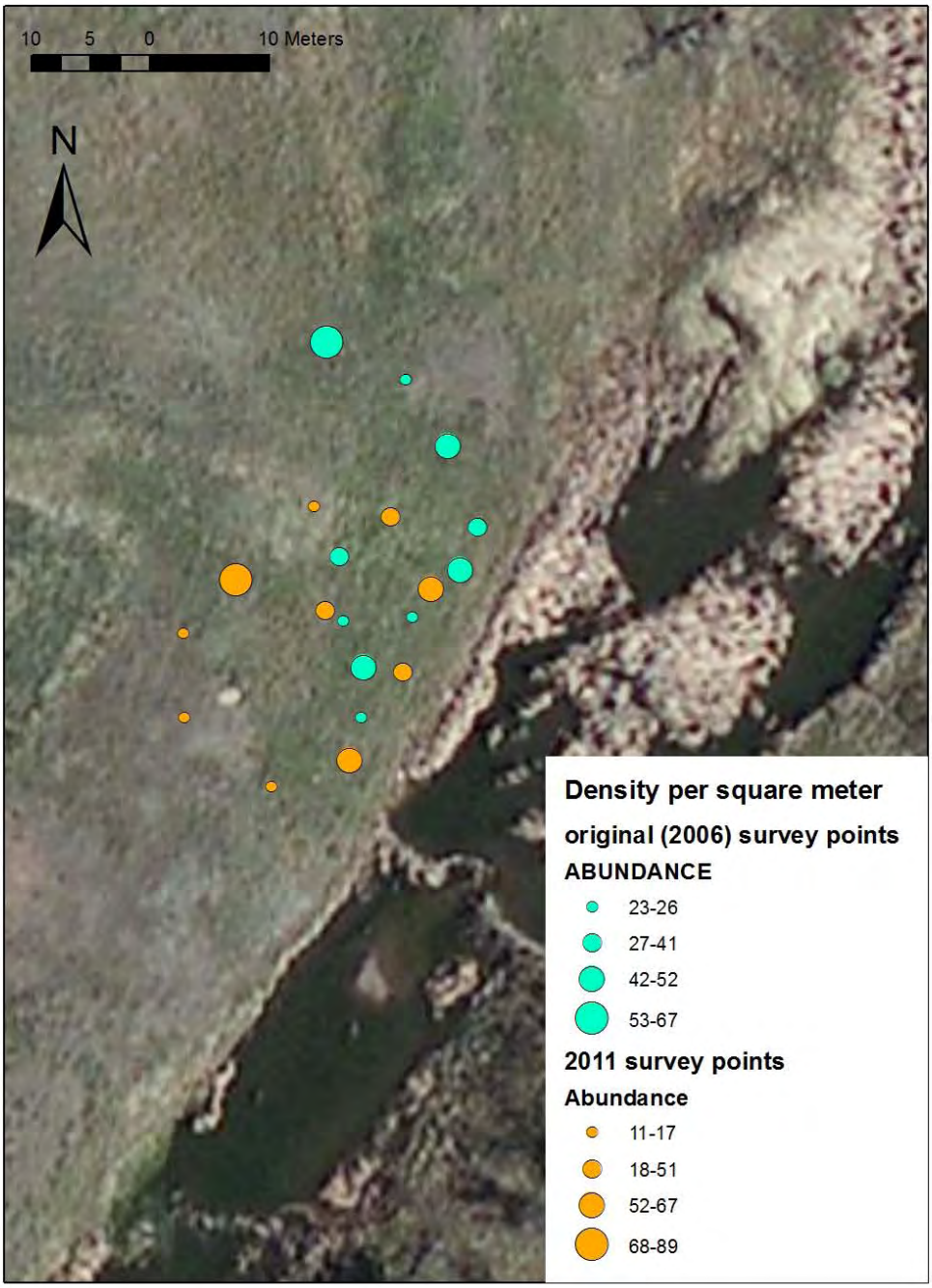


Weather Dalmatian Toadflax 2011

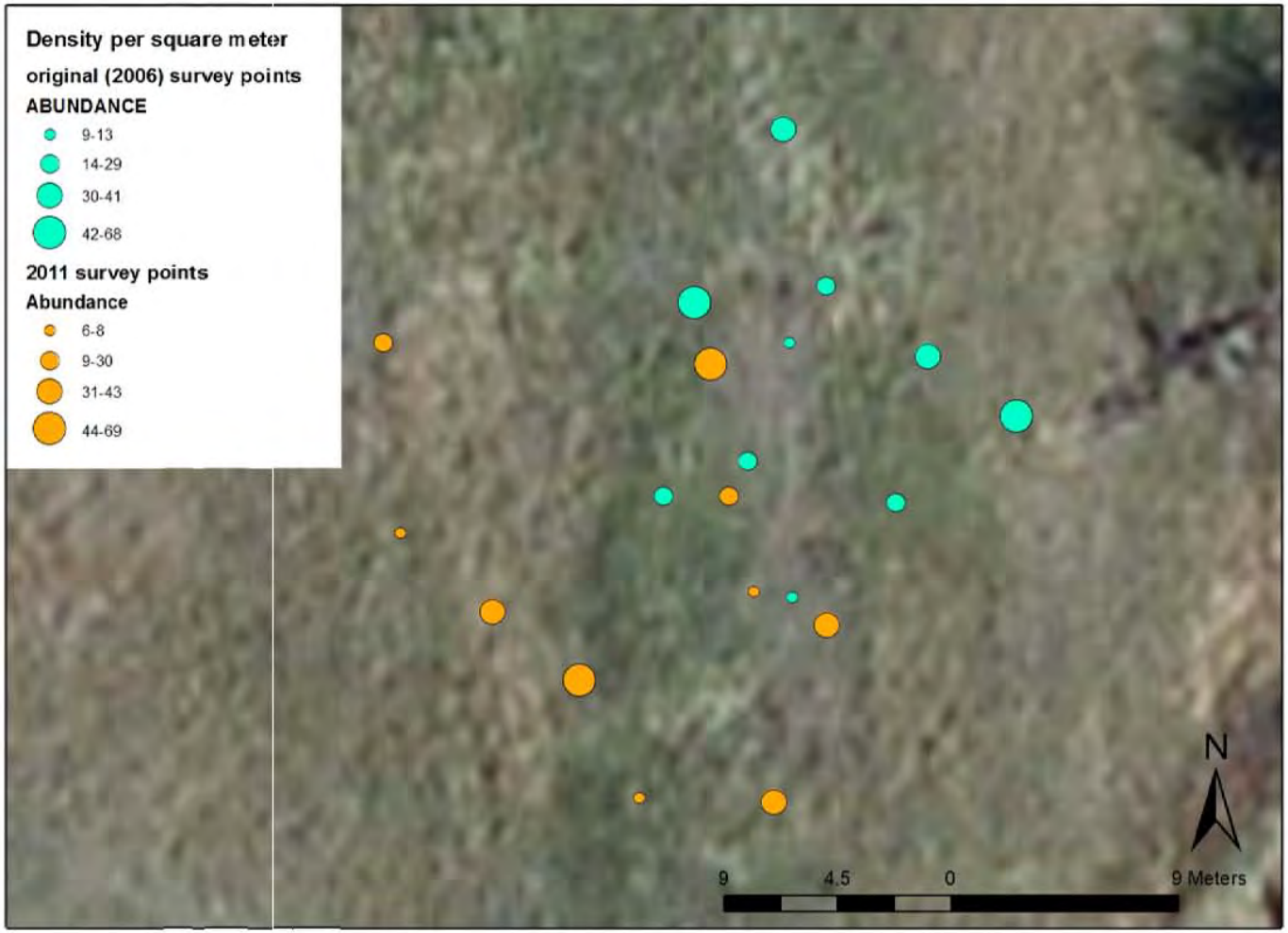
F. E. Warren Air Force Base



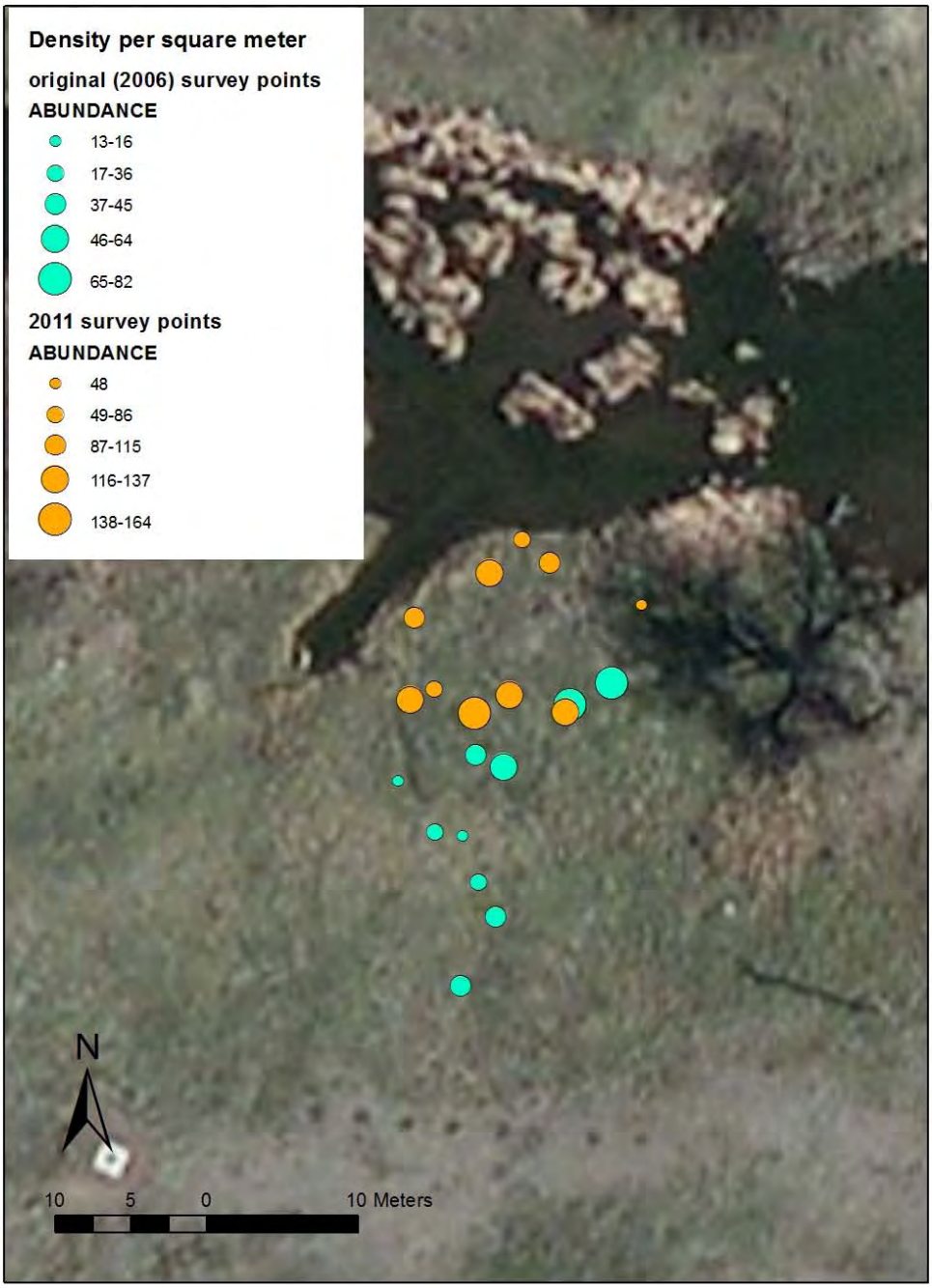
Black Powder Leafy Spurge 2011



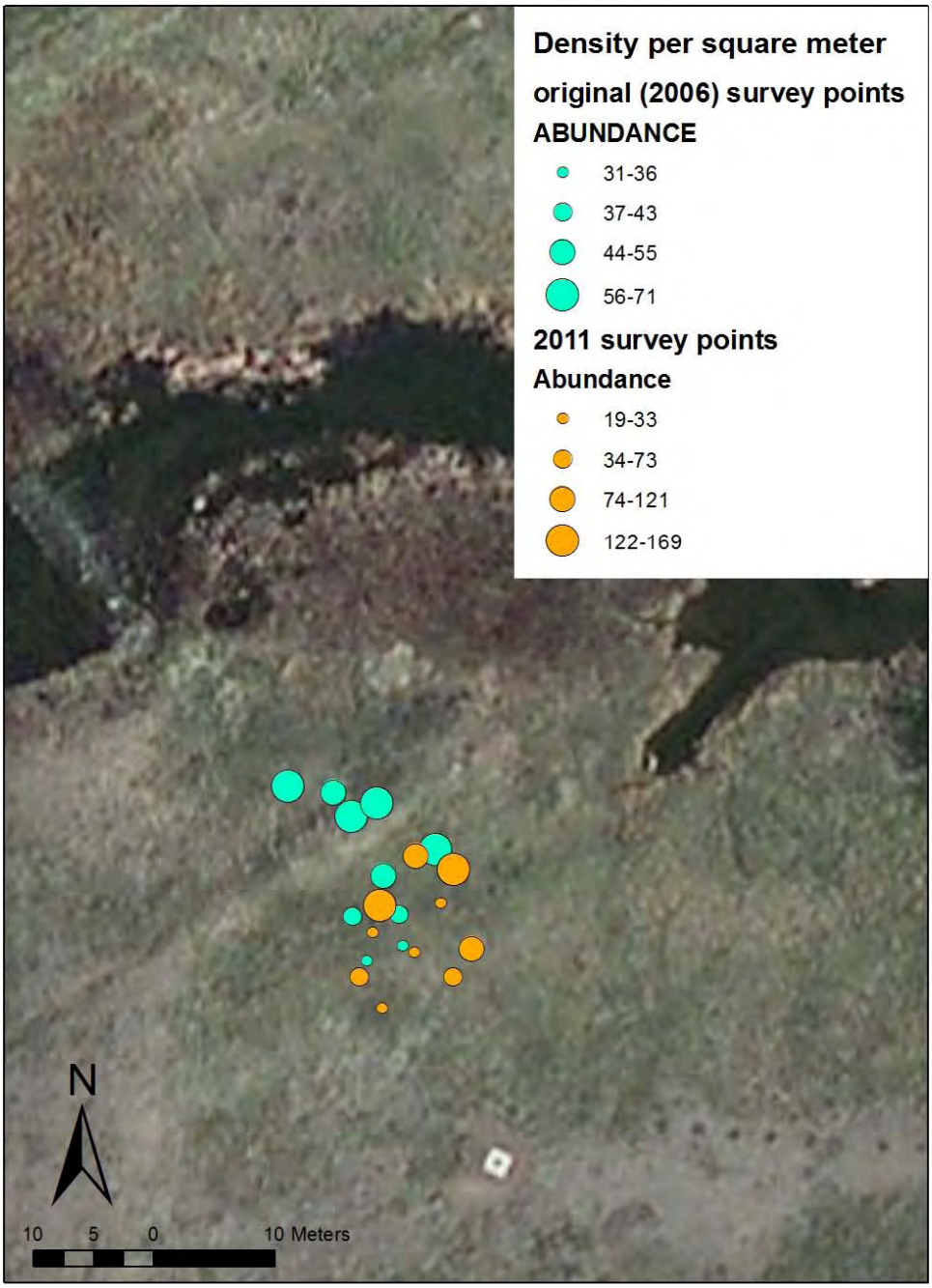
Black Powder 1 Leafy Spurge 2011



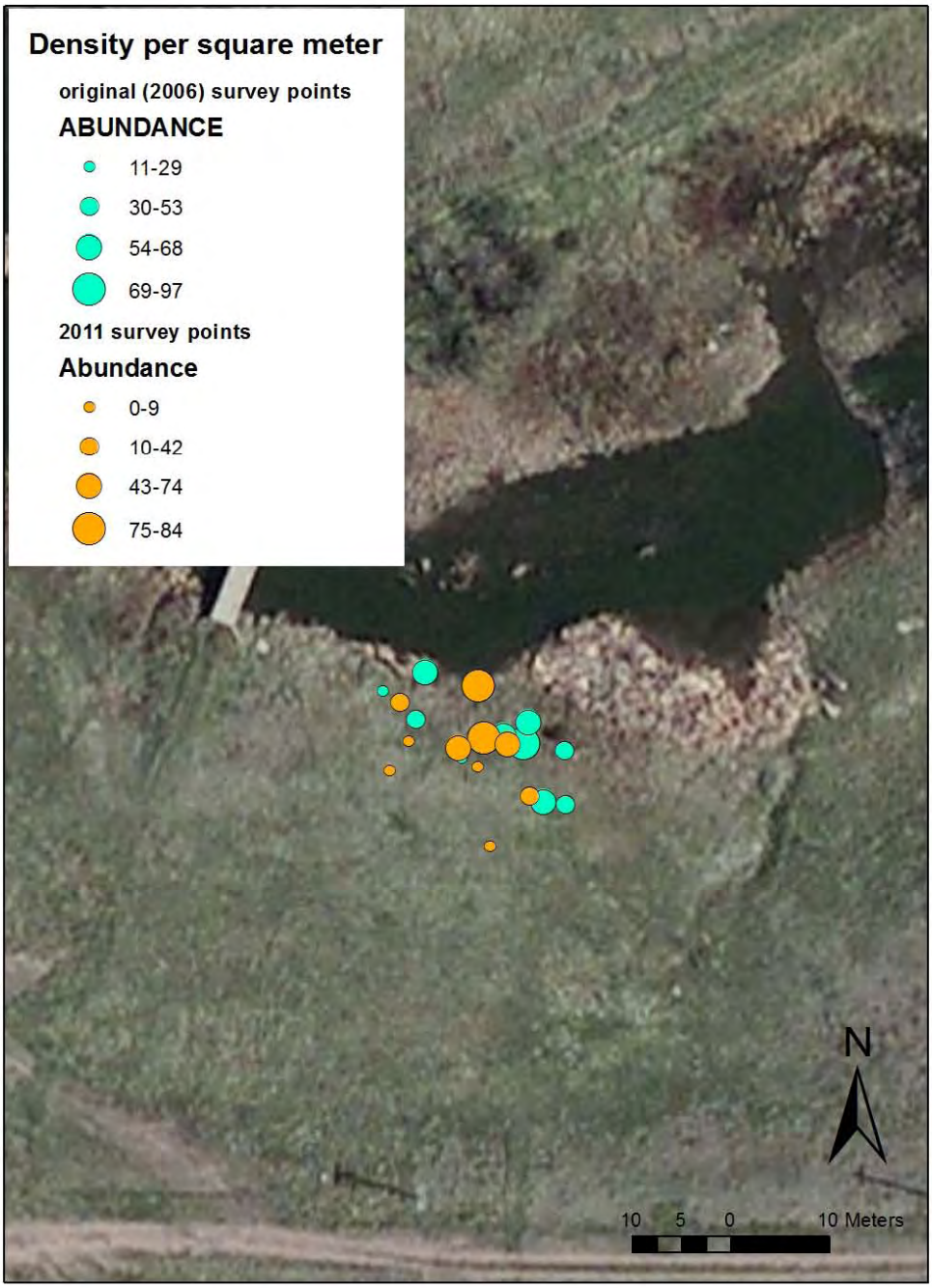
Black Powder 2 Leafy Spurge 2011



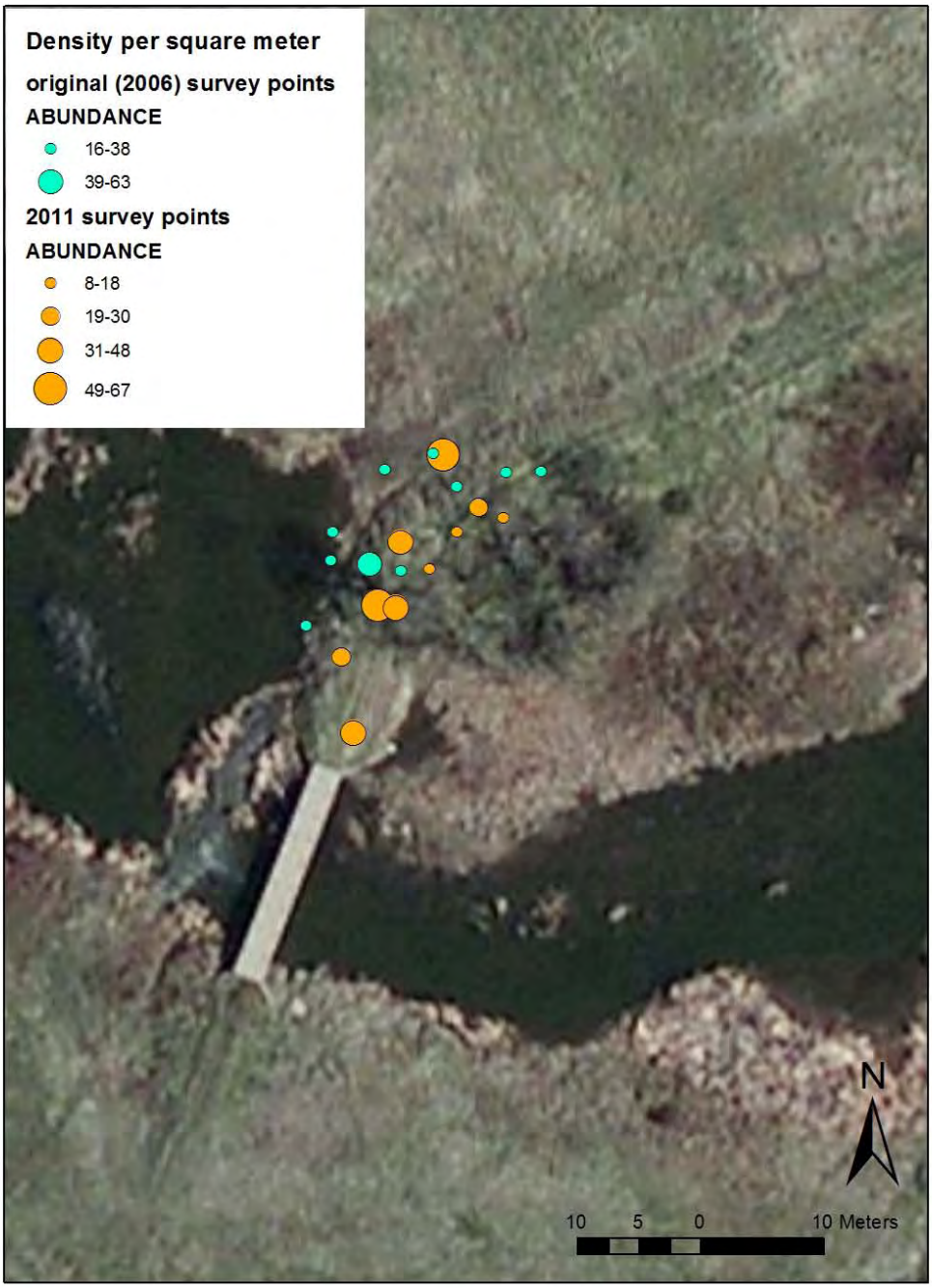
Black Powder 3 Leafy Spurge 2011



Black Powder 4 Leafy Spurge 2011

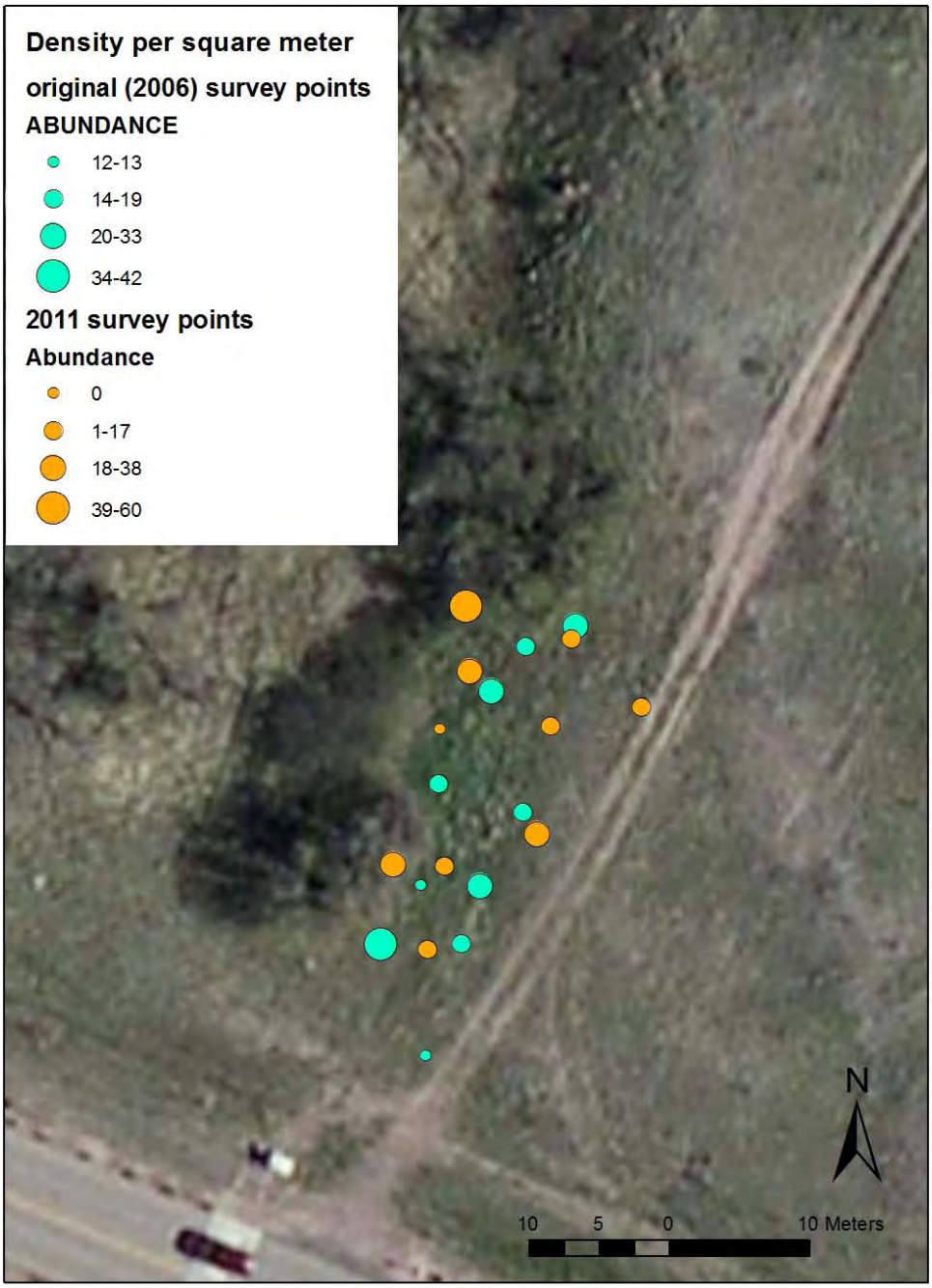


Black Powder 5 Leafy Spurge 2011

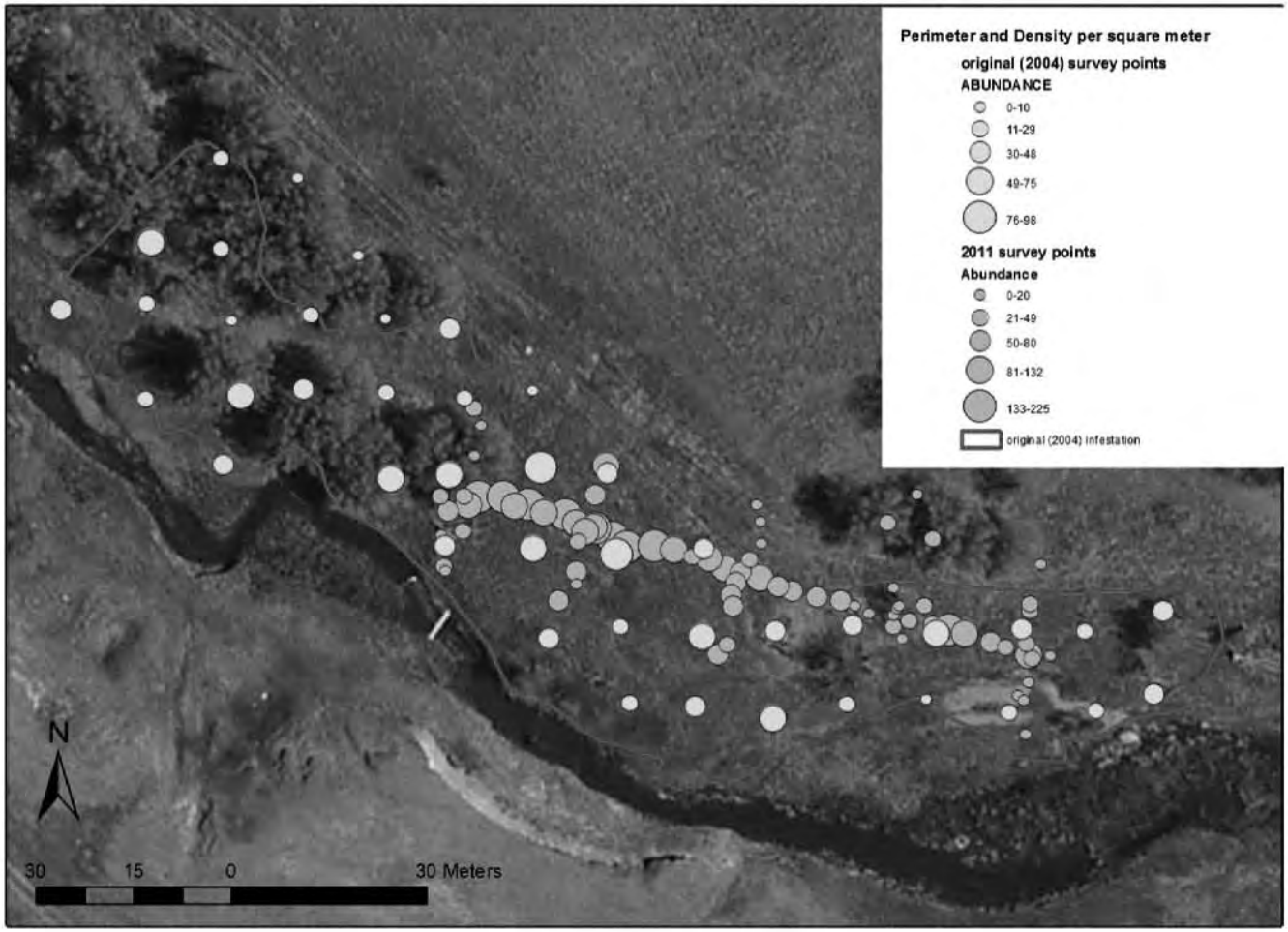


Black Powder 6 Leafy Spurge 2011

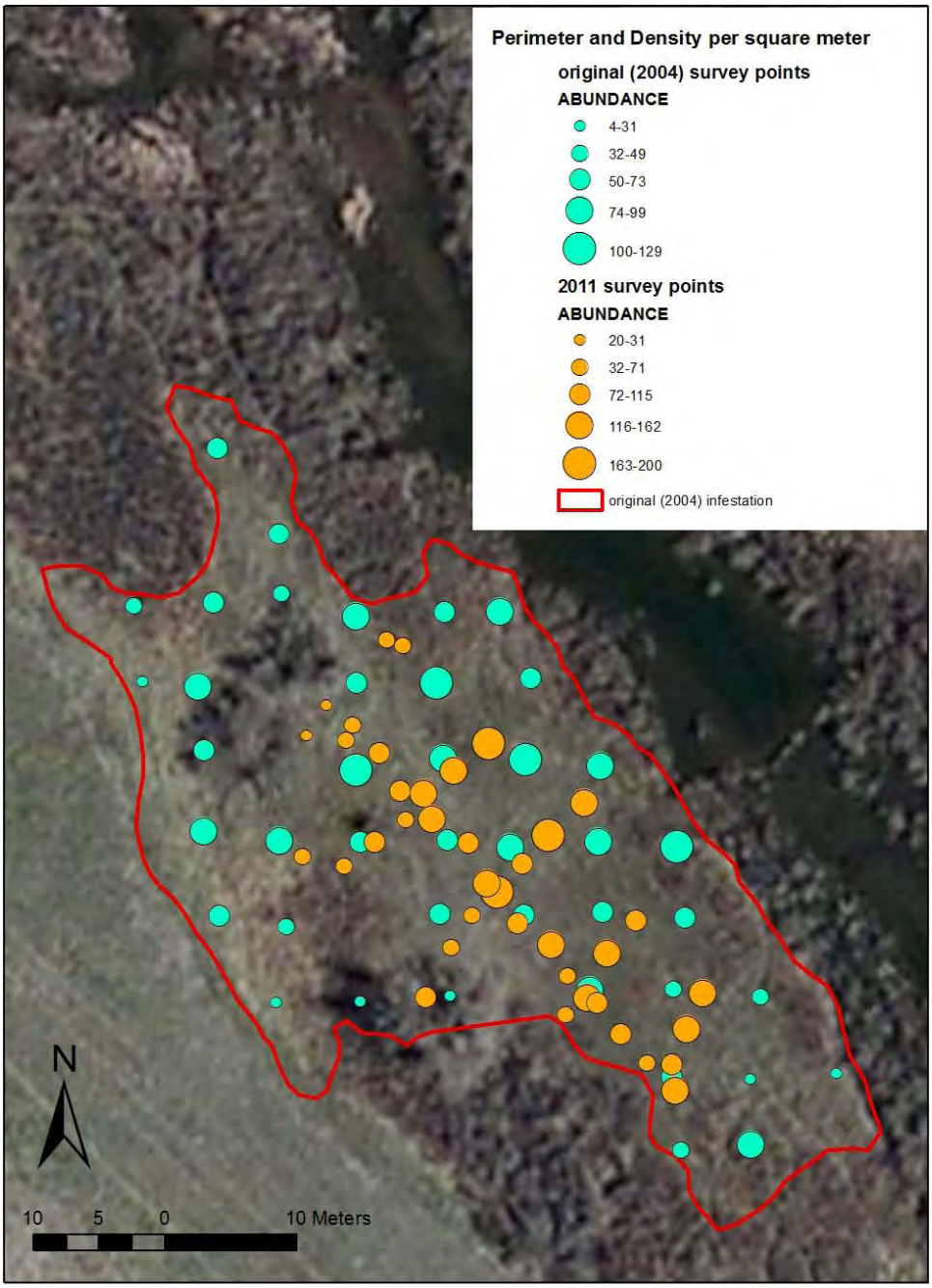
Bridge 1 Leafy Spurge 2011



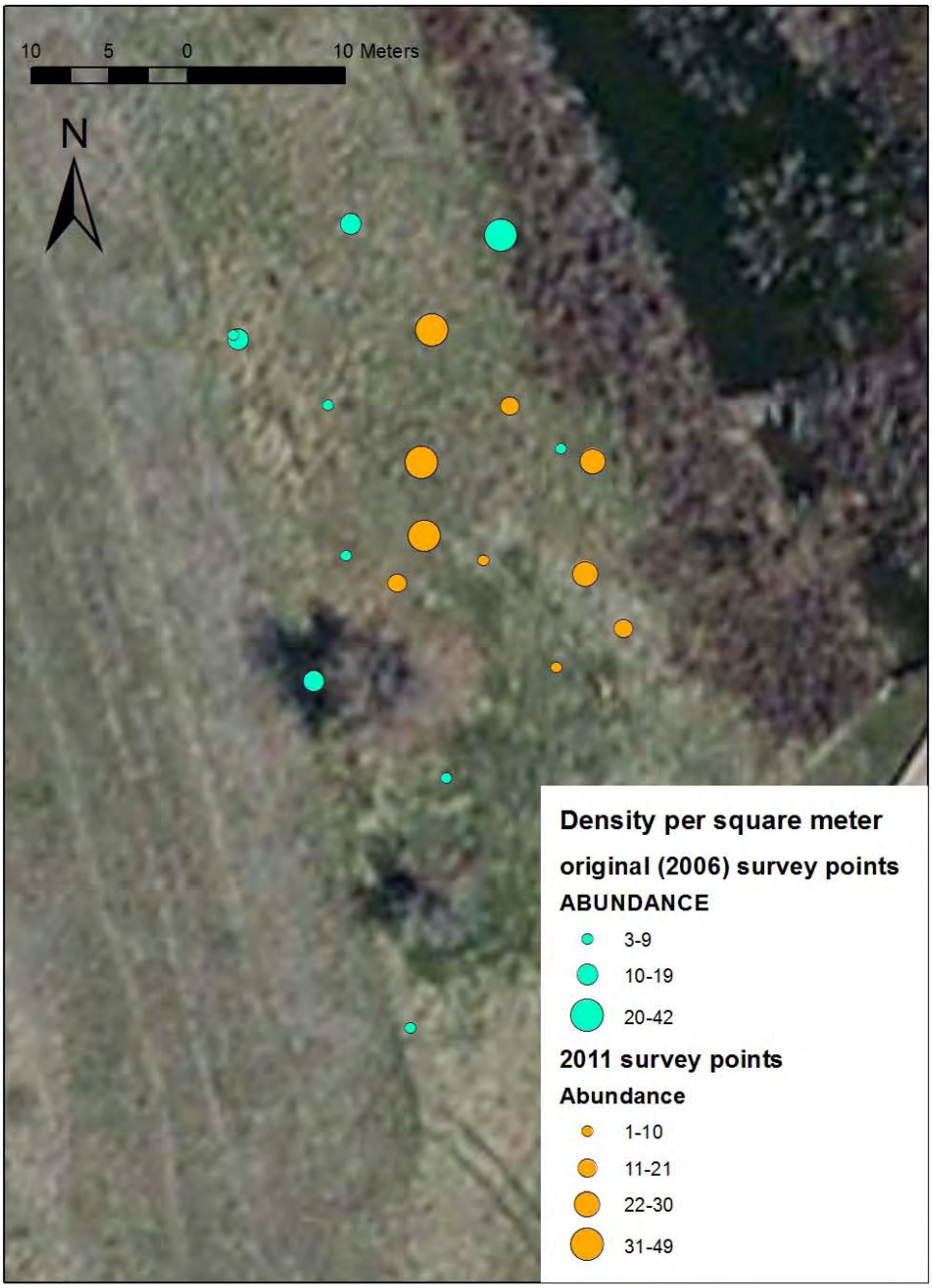
Bridge 2 Leafy Spurge 2011



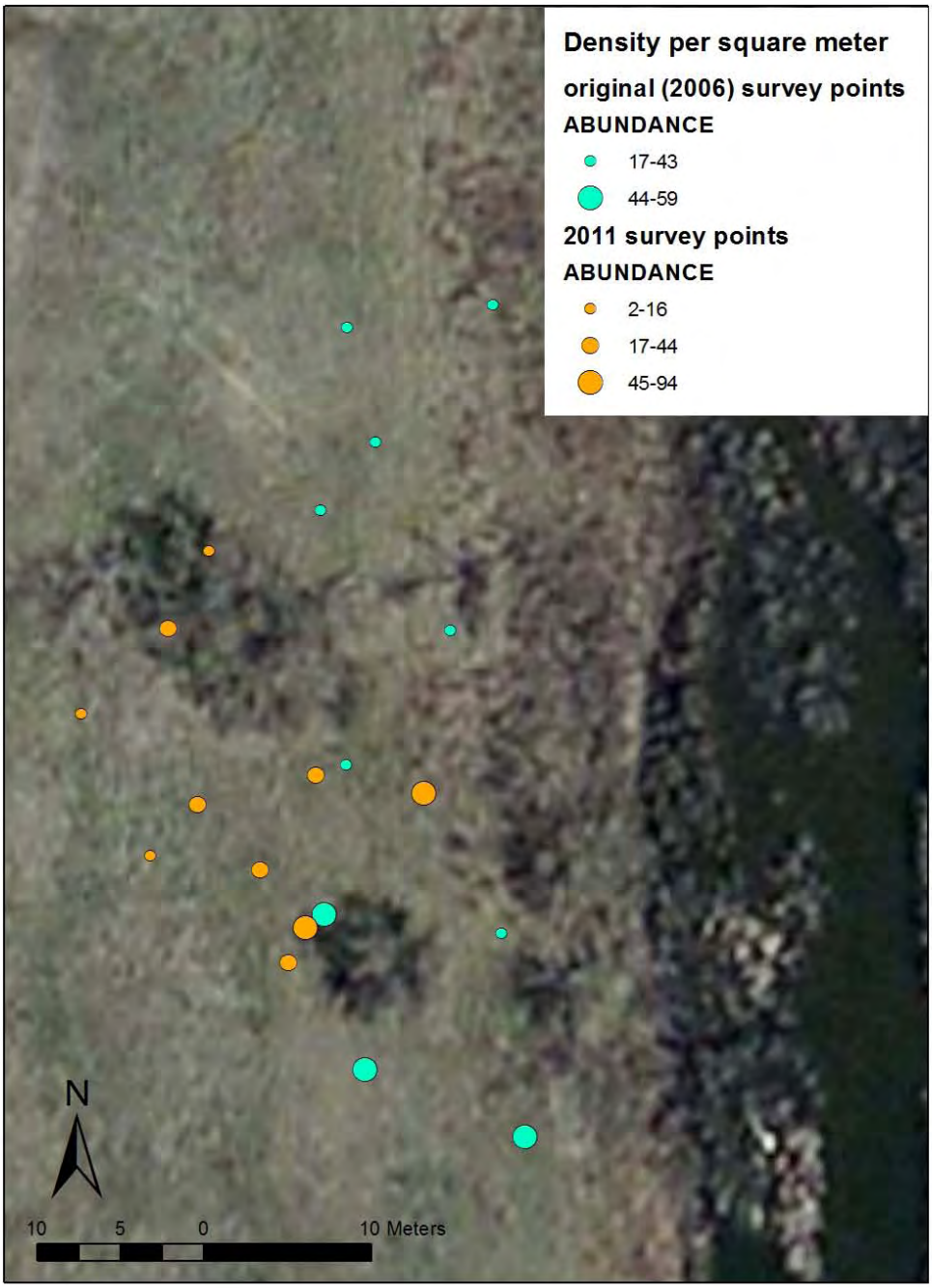
Control Leafy Spurge 2011



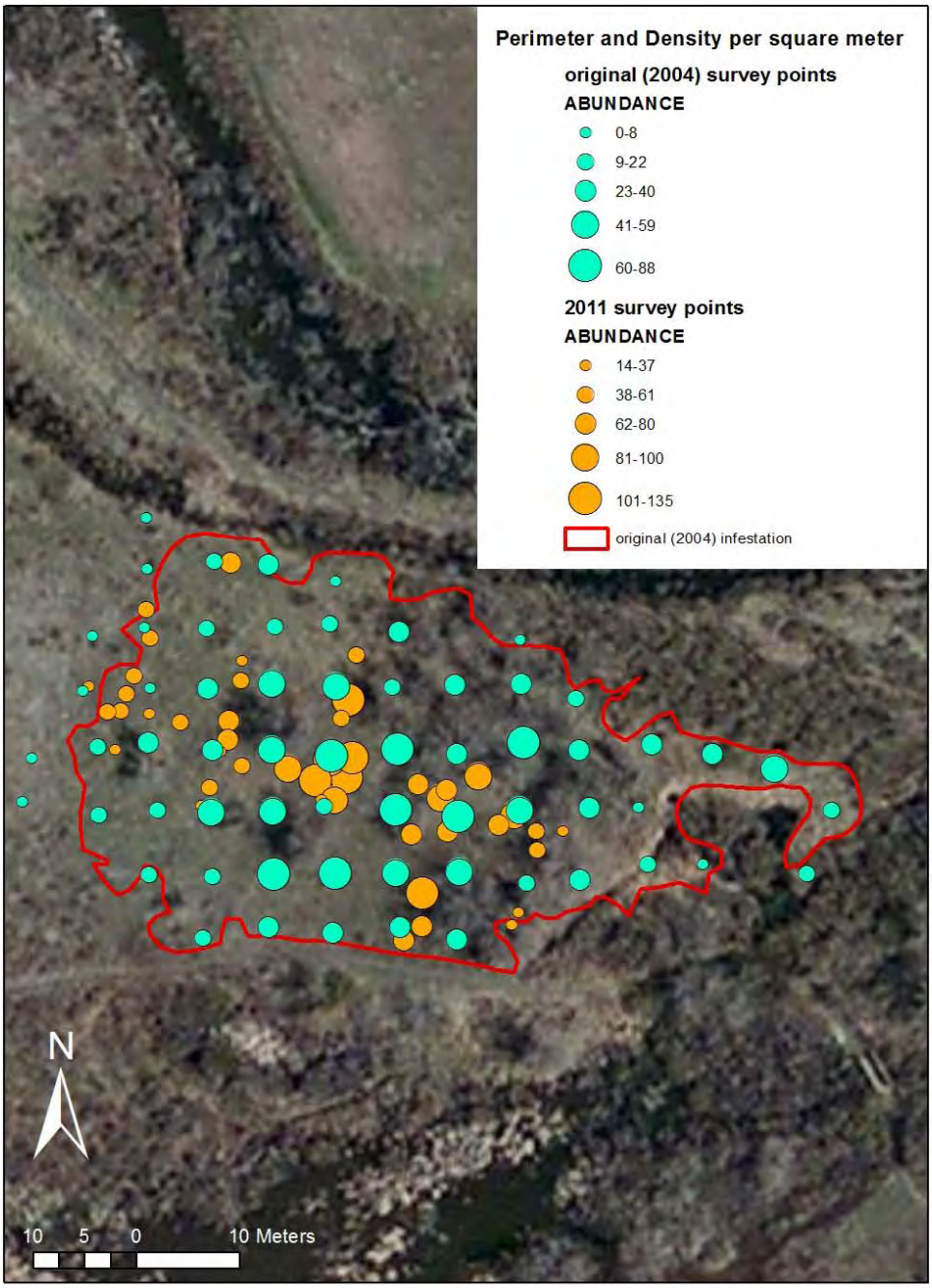
Nature 2 Leafy Spurge 2011



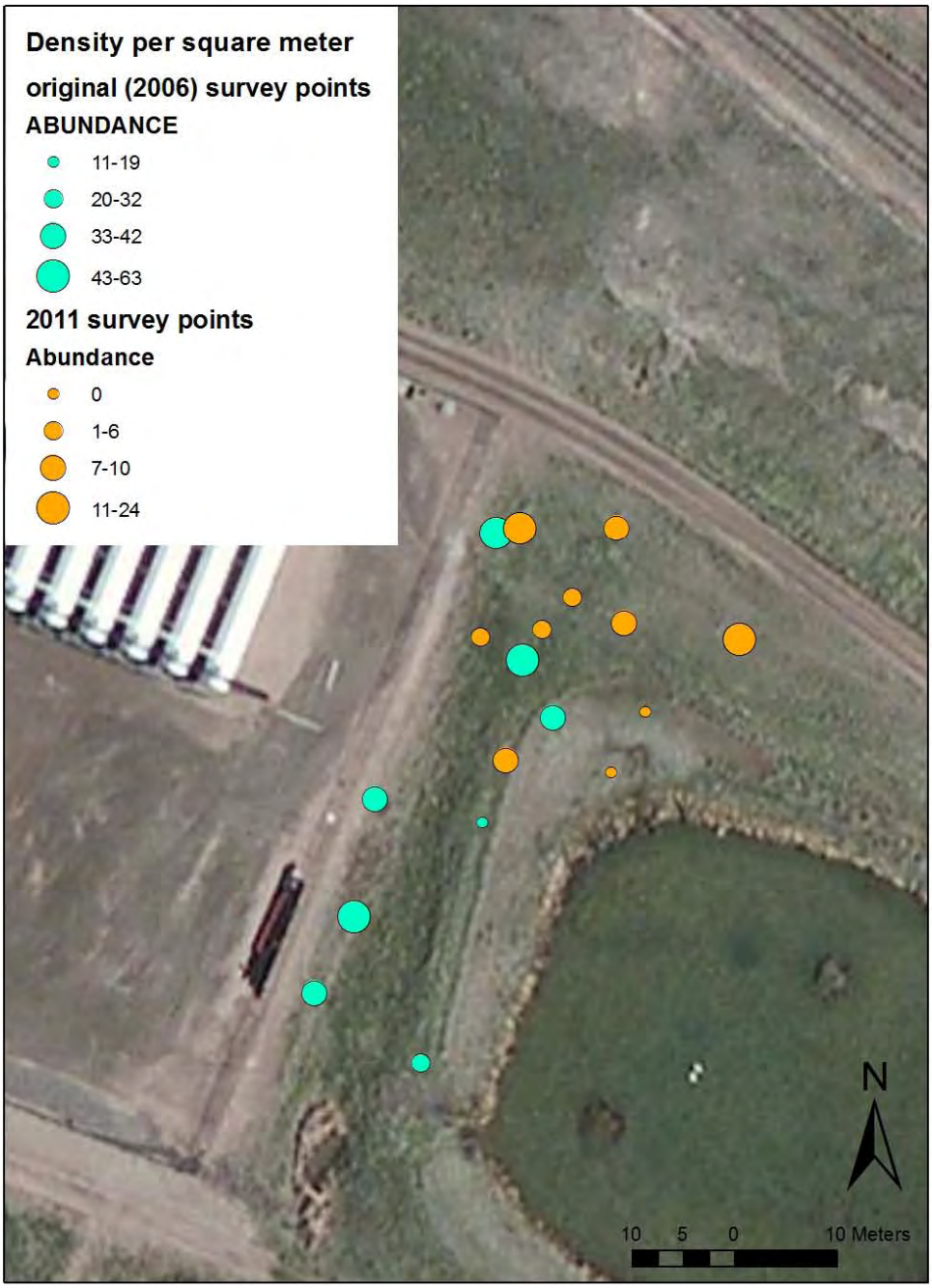
Nature 3 Leafy Spurge 2011



Nature 4 Leafy Spurge 2011



Nature Leafy Spurge 2011



Propane Leafy Spurge 2011

Appendix II: Agent Recovery for 2011

The following tables offer record of biological control agents documented at each site during the 2011 season. These tables show presence-absence data, both from data collected during surveys and from fortuitous observations. Both agents released by our program and those coming from other, unknown sources are represented in the tables.

Table A1. Noxious weed biological control sites, target weeds, species released and recoveries at Air Force Academy, Colorado, 2011.

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		
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Trichosirocalus horridus*	X		
AFA	Canada thistle & Musk thistle	Ice Lake Road I	*Cassida rubiginosa*			
AFA	Canada thistle	Ice Lake Road I	*Urophora carduii*	X		
AFA	Canada thistle	Ice Lake Road I	*Larinus planus*	X		
AFA	Canada thistle	Ice Lake Road II	*Cassida rubiginosa*			
AFA	Canada thistle	Ice Lake Road II	*Larinus planus*	X		
AFA	Canada thistle	Ice Lake Road II	*Urophora carduii*	X		
AFA	Canada thistle	Kettle Lake	*Cassida rubiginosa*	X		
AFA	Canada thistle	Kettle Lake	*Ceutorynchus litura*			
AFA	Canada thistle	Kettle Lake	*Larinus planus*			
AFA	Canada thistle	Kettle Lake	*Rhinocyllus conicus*	X		
AFA	Canada thistle	Kettle Lake	*Urophora carduii*	X[2]		
AFA	Canada thistle	Parade Loop	*Urophora carduii*	X		
AFA	Field bindweed	FERL	*Aceria malherbae*	X		
AFA	Field bindweed	Stadium	*Aceria malherbae*			
AFA	Field bindweed	MTR1	*Aceria malherbae*	X		
AFA	Field bindweed	MTR2	*Aceria malherbae*	X	X	
AFA	Leafy spurge	Deadman's Trail	*Aphthona cyparissiae*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona czwalinae*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona lacertosa*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona flava*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona nigriscutis*			
AFA	Leafy spurge	Deadman's Trail	*Aphthona spp*	X		

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	Leafy spurge	Deadman's Trail	*Oberea erythrocephala*		X	
AFA	Leafy spurge	Deadman's Trail	*Spurgia esula*		X	
AFA	Leafy spurge	Douglas School	*Aphthona czwalinae*	X		
AFA	Leafy spurge	Douglas School	*Aphthona lacertosa*			
AFA	Leafy spurge	Douglas School	*Aphthona nigriscutis*			
AFA	Leafy spurge	Douglas School	*Aphthona spp*	X		
AFA	Leafy spurge	FERL	*Aphthona cyparissiae*			
AFA	Leafy spurge	FERL	*Aphthona czwalinae*			
AFA	Leafy spurge	FERL	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL	*Aphthona spp*	X		
AFA	Leafy spurge	FERL	*Oberea erythrocephala*		X	X
AFA	Leafy spurge	FERL	*Spurgia esula*		X	X
AFA	Leafy spurge	FERL North	*Aphthona cyparissiae*			
AFA	Leafy spurge	FERL North	*Aphthona czwalinae*	X		
AFA	Leafy spurge	FERL North	*Aphthona lacertosa*			
AFA	Leafy spurge	FERL North	*Aphthona nigriscutis*			
AFA	Leafy spurge	FERL North	*Aphthona spp.*	X		
AFA	Diffuse knapweed	Bike Trail	*Agapeta zoegana*			
AFA	Diffuse knapweed	Bike Trail	*Cyphocleonus achates*			
AFA	Diffuse knapweed	Bike Trail	*Larinus minutus*			
AFA	Diffuse knapweed	Bike Trail	*Metzneria paucipunctella*			
AFA	Diffuse knapweed	Bike Trail	*Sphenoptera jugoslavica*			
AFA	Diffuse knapweed	Bike Trail	*Urophora affinis*	X[2]		
AFA	Diffuse knapweed	Bike Trail	*Urophora quadrifasciata*			
AFA	Diffuse knapweed	Highway 83	*Agapeta zoegana*			
AFA	Diffuse knapweed	Highway 83	*Cyphocleonus achates*	X		
AFA	Diffuse knapweed	Highway 83	*Larinus minutus*	X		
AFA	Diffuse knapweed	Highway 83	*Larinus obtusus*			
AFA	Diffuse knapweed	Highway 83	*Metzneria paucipunctella*			

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	Diffuse knapweed	Highway 83	*Urophora affinis*	X		
AFA	Diffuse knapweed	Highway 83	*Urophora quadrifasciata*			
AFA	Diffuse knapweed	Railroad	*Larinus minutus*	X		
AFA	Diffuse knapweed	Railroad	*Metzneria paucipunctella*			
AFA	Diffuse knapweed	Railroad	*Urophora affinis*			
AFA	Diffuse knapweed	Railroad	*Urophora quadrifasciata*			
AFA	Spotted knapweed	Deadman's Creek	*Agapeta zoegana*			
AFA	Spotted knapweed	Deadman's Creek	*Cyphocleonus achates*			
AFA	Spotted knapweed	Deadman's Creek	*Larinus minutus*			
AFA	Spotted knapweed	Deadman's Creek	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Deadman's Creek	*Urophora affinis*			
AFA	Spotted knapweed	Deadman's Creek	*Urophora quadrifasciata*	X		
AFA	Spotted knapweed	Monument Trail Road	*Agapeta zoegana*			
AFA	Spotted knapweed	Monument Trail Road	*Cyphocleonus achates*			
AFA	Spotted knapweed	Monument Trail Road	*Larinus minutus*	X		
AFA	Spotted knapweed	Monument Trail Road	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Monument Trail Road	*Sphenoptera jugoslavica*			
AFA	Spotted knapweed	Monument Trail Road	*Urophora affinis*			
AFA	Spotted knapweed	Monument Trail Road	*Urophora cardui*			
AFA	Spotted knapweed	Monument Trail Road	*Urophora quadrifasciata*	X		
AFA	Spotted knapweed	New Monument Creek	*Agapeta zoegana*			
AFA	Spotted knapweed	New Monument Creek	*Cyphocleonus achates*			
AFA	Spotted knapweed	New Monument Creek	*Larinus minutus*	X		
AFA	Spotted knapweed	New Monument Creek	*Metzneria paucipunctella*			
AFA	Spotted knapweed	New Monument Creek	*Sphenoptera jugoslavica*			
AFA	Spotted knapweed	New Monument Creek	*Urophora affinis*			
AFA	Spotted knapweed	New Monument Creek	*Urophora quadrifasciata*			
AFA	Spotted knapweed	New Monument Creek	*Urophora spp*	X		
AFA	Spotted knapweed	NPWR	*Larinus minutus*			
AFA	Spotted knapweed	NPWR	*Metzneria paucipunctella*			

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	Spotted knapweed	NPWR	*Sphenoptera jugoslavica*			
AFA	Spotted knapweed	NPWR	*Urophora affinis*			
AFA	Spotted knapweed	Old Monument Creek	*Agapeta zoegana*			
AFA	Spotted knapweed	Old Monument Creek	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	Old Monument Creek	*Larinus minutus*	X		
AFA	Spotted knapweed	Old Monument Creek	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Old Monument Creek	*Urophora affinis*			
AFA	Spotted knapweed	Old Monument Creek	*Urophora quadrifasciata*	X		
AFA	Spotted knapweed	Parade Loop 1	*Cyphocleonus achates*			
AFA	Spotted knapweed	Parade Loop 1	*Larinus minutus*			
AFA	Spotted knapweed	Parade Loop 1	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Parade Loop 1	*Urophora carduii*			
AFA	Spotted knapweed	Parade Loop 1	*Urophora affinis*			
AFA	Spotted knapweed	Parade Loop 2[3]	*Cyphocleonus achates*			
AFA	Spotted knapweed	Parade Loop 2[3]	*Larinus minutus*			
AFA	Spotted knapweed	Parade Loop 2[3]	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Parade Loop 2[3]	*Urophora carduii*			
AFA	Spotted knapweed	Parade Loop 2[3]	*Urophora affinis*			
AFA	Spotted knapweed	Parade Loop 3	*Cyphocleonus achates*	X		
AFA	Spotted knapweed	Parade Loop 3	*Larinus minutus*			
AFA	Spotted knapweed	Parade Loop 3	*Metzneria paucipunctella*			
AFA	Spotted knapweed	Parade Loop 3	*Urophora carduii*			
AFA	Spotted knapweed	Parade Loop 3	*Urophora affinis*			
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Agapeta zoegana*			
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Cyphocleonus achates*			
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Larinus minutus*	X		
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Metzneria paucipunctella*			
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Urophora affinis*			
AFA	Diffuse & Spotted knapweed	Water Treatment Plant	*Urophora quadrifasciata*			
AFA	St. Johnswort	Kettle Creek	*Chrysolina* sp.	X		

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
AFA	St. Johnswort	Midway Kettle Creek	*Chrysolina* sp.	X		
AFA	St. Johnswort	Santa Fe[3]	*Chrysolina* sp.			
AFA	Yellow toadflax	Comm Center Drive I	*Brachypterolus pulicarius*			
AFA	Yellow toadflax	Comm Center Drive I	*Calophasia lunula*		X	
AFA	Yellow toadflax	Comm Center Drive I	*Gymnetron antirrhini*			
AFA	Yellow toadflax	Comm Center Drive I	*Mecinus janthinus*		X	
AFA	Yellow toadflax	Comm Center Drive II	*Brachypterolus pulicarius*			
AFA	Yellow toadflax	Comm Center Drive II	*Gymnetron antirrhini*	X		
AFA	Yellow toadflax	Comm Center Drive II	*Mecinus janthinus*			
AFA	Yellow toadflax	Comm Center Drive III	*Brachypterolus pulicarius*			
AFA	Yellow toadflax	Comm Center Drive III	*Gymnetron antirrhini*			
AFA	Yellow toadflax	Ice Lake Road 2	*Brachypterolus pulicarius*			
AFA	Yellow toadflax	Ice Lake Road 2	*Gymnetron antirrhini*			
AFA	Yellow toadflax	Ice Lake Road 2	*Meciinus janthinus*		X	
AFA	Common mullein	Dead	*Gymnetron tetrum*		X	X
AFA	Common mullein	Track	*Gymnetron tetrum*		X	X

[1] New insect recovered in 2011
[2] Adventitious recoveries, no release made at this site
[3] Site not monitored for insects this year
[4] No insect releases were made at this site, however, some or all of 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*

Table A2. Noxious weed biological control sites, target weeds, species released and recoveries at Buckley Air Force Base, Colorado, 2011.

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

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New Site
BAF	Leafy spurge	North Fence	*Aphthona sp.*	X		
BAF	Leafy spurge	North Fence	*Oberea erythrocephala*	X		
BAF	Leafy spurge	South Fence	*Aphthona cyparissiae*			
BAF	Leafy spurge	South Fence	*Aphthona czwalinae*	X		
BAF	Leafy spurge	South Fence	*Aphthona flava*			
BAF	Leafy spurge	South Fence	*Aphthona lacertosa*			
BAF	Leafy spurge	South Fence	*Aphthona nigriscutis*			
BAF	Leafy spurge	South Fence	*Oberea erythrocephala*	X[2]		
BAF	Leafy spurge	Southwest Williams Lake[3]	*Aphthona czwalinae*			
BAF	Leafy spurge	SouthwestWilliams Lake[3]	*Aphthona flava*			
BAF	Leafy spurge	Southwest Williams Lake[3]	*Aphthona lacertosa*			
BAF	Leafy spurge	SouthwestWilliams Lake[3]	*Aphthona nigriscutis*			
BAF	Leafy spurge	Williams Lake	*Aphthona cyparissiae*			
BAF	Leafy spurge	Williams Lake	*Aphthona czwalinae*	X		
BAF	Leafy spurge	Williams Lake	*Aphthona cyparissiae*			
BAF	Leafy spurge	Williams Lake	*Aphthona czwalinae*			
BAF	Leafy spurge	Williams Lake	*Aphthona cyparissiae*			
BAF	Leafy spurge	Williams Lake	*Aphthona spp*	X		
BAF	Leafy spurge	Williams Lake	*Oberea erythrocephala*			
BAF	Dalmatian toadflax	South Fence[3]	*Mecinus janthinus*			
BAF	Dalmatian toadflax	South Aspen Way	*Mecinus janthinus*			

[1] New insect recovered in 2011
[2] Adventitious recovery, none released at this site
[3]Site not mapped this year

Table A3. Noxious weed biological control sites, target weeds, species released and recoveries at Fort Carson Military Post, 2011.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New Site
FTC	Canada thistle	ARA I	*Cassida rubiginosa*			
FTC	Canada thistle	ARA I	*Ceutorynchus litura*			
FTC	Canada thistle	ARA I	*Larinus planus*			
FTC	Canada thistle	ARA I	*Rhinocyllus conicus*			
FTC	Canada thistle	ARA I	*Trichosirocalus horridus*			
FTC	Canada thistle	ARA I	*Urophora carduii*			
FTC	Canada thistle	ARA II[3]	*Cassida rubiginosa*			
FTC	Canada thistle	ARA II[3]	*Ceutorynchus litura*			
FTC	Canada thistle	ARA II[3]	*Rhinocyllus conicus*			
FTC	Canada thistle	Duckpond	*Cassida rubiginosa*			
FTC	Canada thistle	Duckpond	*Ceutorynchus litura*			
FTC	Canada thistle	Duckpond	*Larinus planus*			
FTC	Canada thistle	Duckpond	*Rhinocyllus conicus*			
FTC	Canada thistle	Duckpond	*Trichosirocalus horridus*			
FTC	Canada thistle	Duckpond	*Urophora carduii*			
FTC	Canada thistle & Musk thistle	Highway 115	*Rhinocyllus conicus*			
FTC	Canada thistle & Musk thistle	Highway 115	*Trichosirocalus horridus*			
FTC	Canada thistle & Musk thistle	Highway 115	*Urophora carduii*			
FTC	Canada thistle & Musk thistle	Reservoir	*Cassida rubiginosa*			
FTC	Canada thistle & Musk thistle	Reservoir	*Ceutorynchus litura*			
FTC	Canada thistle & Musk thistle	Reservoir	*Larinus planus*			
FTC	Canada thistle & Musk thistle	Reservoir	*Rhinocyllus conicus*	X[2]		
FTC	Canada thistle & Musk thistle	Reservoir	*Urophora carduii*			
FTC	Musk thistle	Wildlife Refuge	*Rhinocyllus conicus*	X[2]		
FTC	Musk thistle	Wildlife Refuge	*Trichosirocalus horridus*			
FTC	Diffuse knapweed	Gun Club[3]	*Agapeta zoegana*			
FTC	Diffuse knapweed	Gun Club[3]	*Cyphocleonus achates*			
FTC	Diffuse knapweed	Gun Club[3]	*Larinus minutus*			

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New Site
FTC	Diffuse knapweed	Gun Club[3]	*Metzneria paucipunctella*			
FTC	Diffuse knapweed	Gun Club[3]	*Sphenoptera jugoslavica*			
FTC	Diffuse knapweed	Gun Club[3]	*Urophora affinis*			
FTC	Diffuse knapweed	Gun Club[3]	*Urophora quadrifasciata*			
FTC	Diffuse knapweed	Route 1	*Cyphocleonus achates*	X		
FTC	Diffuse knapweed	Route 1	*Larinus minutus*	X		
FTC	Diffuse knapweed	Route 1	*Larinus obtusus*			
FTC	Field bindweed	Multiple sites	*Aceria malherbae*	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	*Metzneria paucipunctella*			
FTC	Spotted knapweed	Fuel Site	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	Fuel Site	*Urophora affinis*	X		
FTC	Spotted knapweed	Fuel Site	*Urophora quadrifasciata*			
FTC	Spotted knapweed	HazMat	*Agapeta zoegana*			
FTC	Spotted knapweed	HazMat	*Bangasternus fausti*			
FTC	Spotted knapweed	HazMat	*Cyphocleonus achates*			
FTC	Spotted knapweed	HazMat	*Larinus minutus*	X		
FTC	Spotted knapweed	HazMat	*Larinus obtusus*			
FTC	Spotted knapweed	HazMat	*Metzneria paucipunctella*			
FTC	Spotted knapweed	HazMat	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	HazMat	*Urophora affinis*	X		
FTC	Spotted knapweed	HazMat	*Urophora quadrifasciata*	X		
FTC	Spotted knapweed	South Turkey Creek	*Cyphocleonus achates*			
FTC	Spotted knapweed	South Turkey Creek	*Larinus minutus*			
FTC	Spotted knapweed	South Turkey Creek	*Metzneria paucipunctella*			
FTC	Spotted knapweed	Turkey Creek	*Agapeta zoegana*			

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New Site
FTC	Spotted knapweed	Turkey Creek	*Cyphocleonus achates*			
FTC	Spotted knapweed	Turkey Creek	*Larinus minutus*	X		
FTC	Spotted knapweed	Turkey Creek	*Metzneria paucipunctella*			
FTC	Spotted knapweed	Turkey Creek	*Sphenoptera jugoslavica*			
FTC	Spotted knapweed	Turkey Creek	*Urophora affinis*			
FTC	Saltcedar	Section 36	*Diorhabda elongata*	X		

[1] New insect recovered in 2011
[2] Adventitious recoveries, no release made at this site
[3] Site not monitored for insects this year

Table A4. Noxious weed biological control sites, target weeds, species released and recoveries at Rocky Flats National Wildlife Refuge, Golden, Colorado, 2011.

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*			
RF	Canada thistle	Lindsay Ranch	*Rhinocyllus conicus*	X		
RF	Canada thistle	Lindsay Ranch	*Urophora carduii*	X		
RF	Musk thistle	North Buffer	*Rhinocyllus conicus*	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*			
RF	Diffuse knapweed	Northwest Buffer Zone	*Sphenoptera jugoslavica*			
RF	Diffuse knapweed	Northwest Buffer Zone	*Urophora affinis*			
RF	Diffuse knapweed	Northwest Buffer Zone	*Urophora quadrifasciata*			
RF	Diffuse knapweed	Sites I & II	*Larinus minutus*	X		
RF	Dalmatian toadflax	Original Site	*Brachypterolus pulicarius*	X		
RF	Dalmatian toadflax	Original Site	*Mecinus janthinus*	X		
RF	Dalmatian toadflax	Sites I & II	*Mecinus janthinus*	X		
RF	Dalmatian toadflax	South Fence	*Mecinus janthinus*	X		
RF	Dalmatian toadflax	Weather	*Mecinus janthinus*	X		
RF	Field bindweed	Multiple sites	*Aceria malherbae*	X		
RF	St. Johnswort	Lindsay[3]	*Chrysolina* sp.			

[1] New insect recovered in 2011
[2] Adventitious recoveries, no release made at this site
[3] Site not monitored for insects this year

Table A5. Noxious weed biological control sites, target weeds, species released and recoveries at, F. E. Warren Air Force Base, Cheyenne, Wyoming, 2011.

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
WAB	Leafy spurge	Black Powder	*Aphthona spp.*	X		
WAB	Leafy spurge	Black Powder	*Oberea erythrocephala*			
WAB	Leafy spurge	Black Powder I	*Aphthona spp.*	X	X	
WAB	Leafy spurge	Black Powder I	*Oberea erythrocephala*	X[2]	X	
WAB	Leafy spurge	Black Powder II	*Aphthona spp.*	X		
WAB	Leafy spurge	Black Powder II	*Oberea erythrocephala*			
WAB	Leafy spurge	Black Powder III	*Aphthona spp.*	X		
WAB	Leafy spurge	Black Powder III	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Black Powder IV	*Aphthona spp.*	X		
WAB	Leafy spurge	Black Powder IV	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Black Powder V	*Aphthona spp.*	X	X	
WAB	Leafy spurge	Black Powder V	*Oberea erythrocephala*	X[2]	X	
WAB	Leafy spurge	Black Powder VI	*Aphthona spp.*	X		
WAB	Leafy spurge	Black Powder VI	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Bridge I	*Aphthona spp.*	X		
WAB	Leafy spurge	Bridge I	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Bridge II	*Aphthona spp.*	X		
WAB	Leafy spurge	Bridge II	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Control	*Aphthona spp.*	X	X	
WAB	Leafy spurge	Control	*Oberea erythrocephala*	X		
WAB	Leafy spurge	Control II	*Aphthona spp.*	X	X	X
WAB	Leafy spurge	Control II	*Oberea erythrocephala*	X		X
WAB	Leafy spurge	Control II	*Spurgia esulae*		X	X
WAB	Leafy spurge	Nature I	*Aphthona spp.*	X	X	
WAB	Leafy spurge	Nature I	*Hyles euphorbiae*	X[2]		

Release Location	Target Weed	Release Site	Species	Species recovered	New releases	New site
WAB	Leafy spurge	Nature I	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Nature I	*Spurgia esulae*		X	
WAB	Leafy spurge	Nature II	*Aphthona spp.*	X		
WAB	Leafy spurge	Nature II	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Nature III	*Oberea erythrocephala*			
WAB	Leafy spurge	Nature IV	*Oberea erythrocephala*	X[2]		
WAB	Leafy spurge	Propane	*Aphthona spp.*	X		
WAB	Leafy spurge	Propane	*Oberea erythrocephala*			
WAB	Dalmatian toadflax	Control	*Mecinus janthinus*			
WAB	Dalmatian toadflax	Nature	*Mecinus janthinus*			
WAB	Dalmatian toadflax	Missile	*Mecinus janthinus*			
WAB	Dalmatian toadflax	Missile	*Brachypterolus pulicarius*	X		
WAB	Dalmatian toadflax	PKRR	*Mecinus janthinus*	X	X	X
WAB	Dalmatian toadflax	Central	*Mecinus janthinus*	X	X	X

Appendix III: Notes on Student Participation

Beginning in 2001, when the project expanded to include locations other than Fort Carson, it became evident that managing the project with staff located at the Texas AgriLife Research and Extension Center in Amarillo, TX, would be untenable. Therefore, that year we began hiring student workers. These students have been recruited from various institutions in Colorado, including Colorado College, Colorado State University, Pikes Peak Community College, University of Colorado in Boulder, and University of Colorado in Colorado Springs. Through the years, we have hired a total of 31 individuals, 37 total workers when those working more than one year are considered. Five students have worked more than 1 year (4 for 2 years and 1 for 3 years). Most of our student workers have been juniors or seniors, and expressed an interest in our program as a way to gain experience in environmental and ecological field work. The large majority of students were majoring in environmental studies or biology. The table below summarizes our student workers from 2001 to 2011.

Students employed in the noxious weed biological control program, 2001-11.							Total	Recurring
2001	Appleton	Zimmerman					2	
2002	Danforth	Jenkins, C.	Jenkins, K.				3	
2003	Bouton	Bruno					2	
2004	Bruno	Evers	Vick				3	1
2005	Best	Bustos	Jurovich	Mabry	Meissner	Raetz	6	2
2006	Best	Bustos	Jurovich	Karl	Taylor		5	3
2007	Baker	Blakeless	Harrington				3	
2008	Engel	Mulhern	Solanki				3	
2009	Perfors	Chen					2	
2010	Baker, K.	Fall	Jurovich	Rosing-Miller	Shickman		5	1
2011	Fall	Godshall	Madsen				3	1
Total							37	8