2008 CAMPBELL TRACT NON-NATIVE PLANT SURVEY:

Revisiting permanent monitoring transects established in 2006

Monitoring an orange hawkweed infestation along the 8, 12, 16-Mile loop trail

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Introduction

Background

The Campbell Tract is a 730 acre site in Anchorage managed by the Anchorage Field Office of the Bureau of Land Management (BLM), Department of the Interior (DOI). With over 12 miles of trails and a uniquely located outdoor education center (Campbell Creek Science Center), the Tract provides outdoor recreation and education opportunities year-round, and receives over 80,000 visitors each year. Bureau of Land Management offices, a warehouse, communication sites, and an active airstrip and heliport are also located within the Tract.

The Tract harbors a wide variety of boreal forest plants and wildlife in relatively unaltered communities, yet, due to the surrounding urban development the Tract is highly susceptible to invasion by non-native plant propagules. Propagules are likely introduced to Tract lands in a number of ways: in contaminated materials imported for construction and maintenance projects, on the boots and bike and car tires of BLM staff and recreational trail users, and from nearby infestations that are spreading along the broader network of city trails and stream corridors. Although landscaping at the Science Center is comprised of primarily native species, roadsides and the airstrip margin appear to have been seeded (intentionally or not) with mixes of non-native clover and grasses typically used for soil stabilization.

The BLM is very interested in minimizing the establishment and spread of invasive plant species into the Tract so that the natural ecology, species diversity, and proper ecosystem functioning of the area are maintained by their good stewardship. The first step in invasive plant management is to inventory the targeted area for non-native plants so that infestations can be prioritized for control work. To meet these objectives, the Alaska Natural Heritage Program (AKNHP) entered into an agreement with the BLM in 2006 to survey the Tract for invasive plants, record their locations and recommend areas for control. The main outcomes of this initial survey are summarized in the following section; a full report is available online at http://akweeds.uaa.alaska.edu/akweeds_literature.htm#_2006.

Summary of 2006 Campbell Tract work

During the 2006 field season AKNHP conducted 'high-priority', non-native plant surveys in the Campbell Tract. For the purpose of this project, 'high-priority' plant species are those ranked at 60 points or greater by the Alaska Invasive Plant Ranking System. This system evaluates non-native species on a scale from zero to 100 points, with 100 points being the most aggressive invasiveness (Appendix I). Exceptions were made for species that are already too widespread and for which efficient eradication is no longer a realistic option (*e.g.* chickweed [*Stellaria media*], common dandelion [*Taraxacum officinale* ssp. *officinale*], and Kentucky bluegrass [*Poa pratensis* ssp. *pratensis*]), and for species whose taxonomy or whose nativity to Alaska is unresolved, such as foxtail barley (*Hordeum jubatum*). It is currently thought that there may be native and non-native genotypes of foxtail barley in Alaska, but these cannot be distinguished

phenotypically. In addition, it is possible that hybridization between the two genotypes may have taken place, further blurring the distinction between these two (potential) species.

The work was carried out in two phases:

1. Phase I: non-native plant inventories were conducted in high-use areas (major trails, roads, the material source area, and other developed sites) throughout the Tract.
2. Phase II: less human-disturbed habitats (along creeks and in forested areas) were surveyed to determine the extent of problematic infestations in the low-use areas of the Tract.

The invasive plants most commonly encountered during this initial survey effort were white clover (*Trifolium repens*, invasiveness rank 59 points), alsike clover (*Trifolium hybridum*, 57), narrowleaf hawksbeard (*Crepis tectorum*, 54), white sweetclover (*Melilotus alba*, 80), and timothy (*Phleum pratense*, 56) (Carlson *et al.* 2006). These species were present on most roadsides, the airstrip, and most trails, and in a few cases had established in woodland habitats. Most of these species manifest as large and nearly continuous populations except for white sweetclover and timothy, which are composed of numerous, yet small and therefore controllable, infestations.

A few small infestations of more problematic invasive species were also located. Orange hawkweed (*Hieracium* aurantiacum, 79), butter and eggs (*Linaria vulgaris*, 73), brittlestem hempnettle (*Galeopsis tetrahit*, 40), and oxeye daisy (*Leucanthemum vulgare*, 61) are highly invasive species that were found in largely undisturbed woodlands. Two individuals of European bird cherry (*Prunus padus*, 74) were found (and pulled) along Campbell Creek (Carlson *et al.* 2006, see Appendix II [this report] for species distribution maps). Please note; despite its low rank (40) *Galeopsis tetrahit* and its' subspecies have been observed moving off the human footprint into adjacent native vegetation in the greater Anchorage area which suggests that this species complex may currently be under-ranked.
As a result of this initial survey, Carlson *et al*. (2006) determined that the areas of greatest concern, based on the threat of invasive plants moving into natural habitats, are (1) the material source area, (2) the meadow adjacent to the airstrip parking lot, (3) a number of isolated invasive plant populations in the forests, and (4) the airstrip margins.

In addition to the 2006 surveys, AKNHP erected nine permanent transects throughout Campbell Tract, all of which originated at a known infestation of a priority weed species and extended into adjacent, less developed areas. The locations of these transects were recorded photographically and geographically by reading GPS points at the origin and end point of each transect. The goal was to establish long-term, photo-monitoring sites to track the potential establishment and spread of non-native plants in the Campbell Tract area.

Objectives

In 2008 AKNHP worked with BLM to revisit five of the nine long-term, photo-monitoring transects erected in 2006. The main objectives of this second survey were to determine if there had been any measurable changes in the composition or extent of the non-native plant populations since 2006.

Methods

In 2006 the origin of each of the nine transects was established at the location of a known infestation of a high-priority species (Appendix I) or at a high disturbance site where non-native species, hereafter also referred to as weeds, were likely to establish. All transects were set up so that they extended away from the infestation into a less-developed area or into native vegetation (Table 1). In 2008 we revisited four transects set up in 2006 (5, 8, 9, and 10), established Transect 6, which had only been proposed but not created in 2006, and set up three additional long-term photo-monitoring plots (Transects 5B, 6B, and 8B).

Table 1. List of sites at which AKNHP field crews established or planned to establish long-term photo-monitoring transects in 2006, and actions taken at those sites in 2008.

Transect No.	Location	Transect origin	Transect endpoint	Revisited in 2008?
1	Smoke Jumper Trailhead	61.15863ºN -149.8013ºW	61.15881ºN -149.80141ºW	No
2	BLM headquarters parking lot	61.1567ºN -149.79591ºW	61.15646ºN -149.79663ºW	No
3	BLM headquarters parking lot/corner between parking lot and Coyote Trail/ by sign Stop No Entry Active Runway	61.15511ºN -149.79205ºW	61.15491ºN -149.79208ºW	No
4	8-Mile Loop/ heavily wooded portion of trail	61.15781ºN -149.79099ºW	61.15787ºN -149.79094ºW	No
5	Road to Campbell Creek Science Center, material source area	61.16099ºN -149.79045ºW	61.16114ºN -149.79024ºW	Yes
6	8, 12, 16-Mile Loop trail	Proposed transect not constructed in 2006 61.16151ºN -149.78655ºW		Constructed in 2008
7	Viewpoint Trail, at the tower and large green shed	61.15377ºN -149.78072ºW	61.15374ºN -147.7803ºW	No
8	Northeast end of airstrip	61.16339ºN -149.77066ºW	61.16334ºN -149.77016ºW	Yes
9	Campbell Creek, west of sled dog trail bridge	61.1657ºN -149.76979ºW	61.16587ºN -149.76971ºW	Yes
10	Campbell Airstrip entrance to the Tract	61.16557ºN -149.76587ºW	61.16542ºN -149.76541ºW	Yes

The spatial distribution of transects established across Campbell Tract in 2006 and 2008 is shown in Fig. 1. Transects ranged from 10 meters to 30 meters in length depending on the extent of the infestation, with the transect continuing for at least four meters beyond the last invasive plant individual encountered. Within each transect established in 2006 a series of 0.1 × 1 meter temporary subplots spaced one meter apart were sampled. The origin and end points of each transect was marked with a GPS, permanent markers and flagging tape in areas not subject to extensive human use. Reference photos were taken to assist with relocation. Data collected within each 0.1 × 1 meter plot included the following: percent covers of individual non-native and native species, vegetation type (*e.g*. open white spruce forest), disturbance type (*i.e*. imported fill, brush cutting/mowing, trampling, stream erosion, or none), description of substrate (*i.e*. relative proportion of organic to mineral soil), and previous control action, if any.

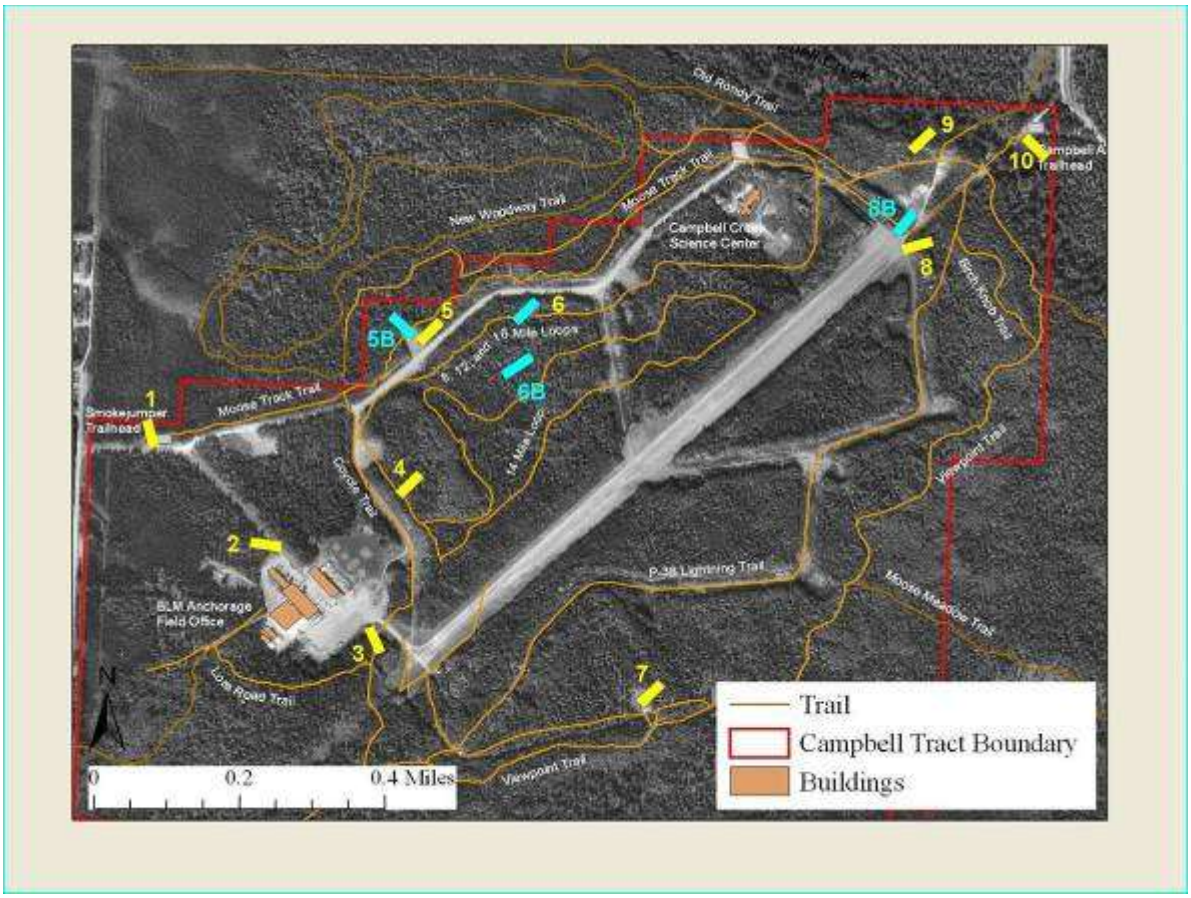

Figure 1. Locations of the nine transects established in 2006 (marked in yellow) and the four transects established in 2008 (marked in blue) in the Campbell Tract. Transects 5, 8, 9 and 10 were reread in 2008.

In 2008 this protocol was modified in the following two ways:

1. The original 0.1 × 1 meter subplots (Fig. 2A) did not seem large enough to capture potential changes in the diversity or extent of non-native species infestations at each site. We therefore read 1 × 1 meter temporary subplots at each transect, also spaced one meter apart (Fig. 2B)

2. We were unable to find any permanent markers for the transects, so we placed aluminum tags on at least one tree at each of the transects revisited, generally at or close to the endpoint of the transect (*i.e.* away from the trails and high use areas). The following information was recorded on each aluminum tag: 2008 transect site code, survey date, scientific name of the priority species being tracked, and the identification code of the 2008 waypoint taken at the origin of the transect (Fig. 3).

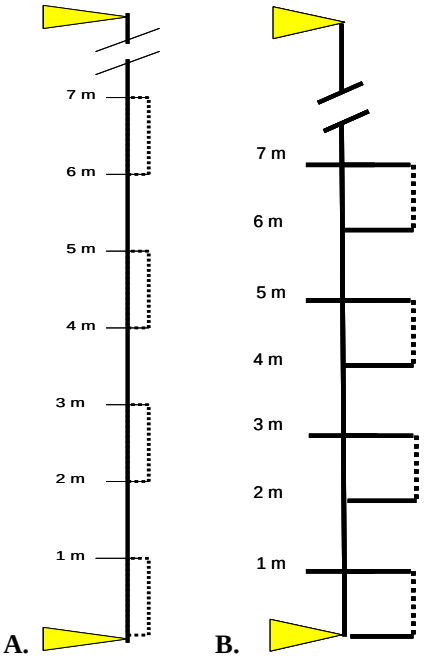

Figure 2. A) 2006 transect and subplot (dotted rectangles) representations; B) diagram reflecting the change in subplot size for transects read in 2008.

Figure 3. Aluminum tags were placed on at least one tree within each transect boundary to facilitate relocating the plots.

Results & Discussion

In 2008 AKNHP Botanist Helen Cortés-Burns and field technician Kellee Hampy revisited four of the nine transects, and established a tenth transect (Transect 6). Transect 6 had been proposed but not erected in 2006 to monitor the spread of an orange hawkweed infestation on the 8, 12, 16-Mile Loop trail (see Transect 6 section for details).

We also set up three new transects: 1) Transect 5B was established to monitor an additional section of the Campbell Tract material source area, 2) Transect 8B was established to track a bird vetch (*Vicia cracca*) infestation observed at the northern edge of the airstrip, slightly northwest of Transect 8, that had not been recorded in 2006, and 3) Transect 6B was established to capture a second orange hawkweed infestation on the 8-Mile Loop trail.

Because we were unable to find the permanent markers at any of the four existing transects, and to facilitate relocating them in the future, the following steps were taken when erecting transects in 2008:

a- The origin and endpoint of each transect was recorded using GPS
b- Once we had marked the boundaries of each subplot with flags, new photographs of the transects were taken (Fig. 4)
c- At least one tree located at or near each transect (usually away from the trail) was marked with an aluminum tag and photographed.

Figure 4. Once a monitoring site was located the transect was subdivided into 1 meter intervals to facilitate reading the vegetation in each subplot and to assist relocating the site in the future.

Transect 5

Results

Transect 5

Transect 5 is located at the material source area along the road to the Campbell Creek Science Center (Figs. 5 and 6). In 2006, a number of non-native plant species were found growing at this site (Table 2), the most aggressive of which were narrowleaf hawksbeard, with an invasiveness rank of 54 points, and white clover, with a rank of 59 points (see Appendix II for species distribution maps). In 2008, the transect was almost weed-free (Table 2), except for a few common dandelion (58) plants (1-5 stems), this species was not targeted in this study as it is already too widespread to allow for efficient eradication

Figure 5. In 2006, multiple invasive species including narrowleaf hawksbeard were recorded at Transect 5.

Figure 6. In 2008, the only non-native plant species recorded was common dandelion. BLM field crews had conducted weed pulls at the site just a few weeks before AKNHP visited the plot, and mulch had recently been deposited where the weeds were previously recorded. The arrow indicates the approximate origin of the transect.

Table 2. Non-native plant species found at Transect 5 in 2006 and 2008.

Non-native species recorded in 2006	Invasiveness Rank	Non-native species recorded in 2008	Invasiveness Rank
Trifolium repens	59		
Taraxacum officinale ssp. officinale	58		
Crepis tectorum	54	*Taraxacum officinale* ssp. *officinale*	58
Polygonum aviculare	46		
Plantago major	44		

The apparent decline in non-native plant populations recorded at Transect 5 between 2006 and 2008 is misleading: weeks before AKNHP revisited this transect BLM field crews had pulled most of the butter-and-eggs plants. In addition, the site had been recently bulldozed and mulched, removing or covering any weeds that may have been left behind by BLM crews. It was therefore impossible to gage whether this infestation had increased or decreased since 2006.

More importantly, the newly imported mulch could contain weed propagules and act as a vector for the introduction of additional non-native species into the material source area. This site should be a priority in future monitoring efforts so that any new invasive plants that may have been brought in as contaminants in the mulch can be detected and eradicated prior to significant establishment.

Figure 7. Transect 5B was a second transect established in 2008 on the road to the Campbell Creek Science Center, at the material source area (an area of high disturbance). Populations of smooth brome, yellow toadflax, and multiple other invasive species were recorded here. The arrow indicates the approximate location of the transect.

Transect 5B

We set up a new transect (Transect 5B) to monitor an additional section of the Campbell Tract material source area where a number of non-native species were observed growing on a pile of gravel (Fig. 7). The most aggressively invasive species recorded here include: smooth brome (*Bromus inermis* ssp. *inermis*,), butter-and-eggs (61) and quackgrass (*Elymus repens*, 59) (see Appendix II for distribution maps).

The rest of the material source area supports a number of invasive species, listed in Table 3. A number of native but weedy (ruderal) species such as: common yarrow (*Achillea millefolium*), American sloughgrass (*Beckmannia sizigachne*), Norwegian cinquefoil (*Potentilla norvegica*), and hoary yellowcress (*Rorippa barbareifolia*) are also growing at the site.

Table 3. All non-native species found at the material source area in 2008 (includes species found at Transect 5 and 5B).

Common name	Scientific name	Family	Invasiveness rank
smooth brome	*Bromus inermis ssp. inermis*	Poaceae	62
butter and eggs	*Linaria vulgaris*	Scrophulariaceae	61
quackgrass	*Elymus repens*	Poaceae	59
common dandelion	*Taraxacum officinale* ssp. *officinale*	Asteraceae	58
alsike clover	*Trifolium hybridum*	Fabaceae	57
common timothy	*Phleum pratense*	Poaceae	54
narrowleaf hawksbeard	*Crepis tectorum*	Asteraceae	54
curlytop knotweed	*Persicaria lapathifolia*	Polygonaceae	47
prostrate knotweed	*Polygonum aviculare*	Polygonaceae	46
common plantain	*Plantago major*	Plantaginaceae	44
common chickweed	*Stellaria media*	Caryophyllaceae	42
annual ryegrass	*Lolium perenne* ssp. *multiflorum*	Poaceae	41
perennial ryegrass	*Lolium perenne* ssp. *perenne*	Poaceae	41
hempnettle	*Galeopsis sp.*	Lamiaceae	40
pineapple weed	*Matricaria discoidea*	Asteraceae	32
common pepperweed	*Lepidium densiflorum*	Brassicaceae	25
Siberian wildrye	*Elymus sibiricus*	Poaceae	unranked

Discussion

The temporary material source area was cited by Carlson *et al.* (2006) as one of the invasive plants hotspots for Campbell Tract. Even though fewer species were recorded along Transect 5 in 2008 than in 2006, this site remains one of the most problematic areas in the Tract due to the importation of potentially contaminated fill. For this reason the material source area should be monitored yearly to allow for the early detection and eradication of any new invasive weeds to preventing their dispersal throughout Campbell Tract lands.

BLM field crews have been pulling weeds at this site which is an effective method of eliminating incipient infestations before they become too large to be eliminated manually. However, we also recommend that best management practices which require that equipment used in the material source area be cleaned prior to use in other parts of the Tract be implemented. We also recommend that the pile of mulch at the origin of Transect 5 be revisited in 2009 to control for any invasive weeds that may have established. Finally, because there is a mix of native and invasive ruderal species growing at the material source area, BLM field crews should continue to receive training by well-informed BLM/Campbell Creek Science Center personnel in non-native plant identification before conducting weed pulls anywhere along the Tract.

Transect 6

Results

Transect 6

In 2006, a small to medium sized (25-50 stems) orange hawkweed population was observed along a heavily wooded section of the 8, 12, 16-Mile Loop trail (Fig. 8, Appendix II for distribution maps). This population was subsequently controlled in late July 2006, and for this reason the BLM did not advise erecting a transect. However, control efforts in 2006 proved to be unsuccessful, and for the past two years Campbell Creek Science Center staff and BLM field crews have had to conduct repeated pulls/digs at this site in an attempt to control the infestation.

Because this infestation has grown since 2006 and is not responding well to hand pulling and digging, AKNHP in consultation with Luise Woelflein, Environmental Education Coordinator of the Campbell Creek Science Center, erected a permanent monitoring transect so that future changes in the extent and size of this population can be tracked. The transect is located by breeding bird survey post CT8, at the junction of the 8, 12, 16-Mile Loop trail with the smaller 8-Mile trail (Fig. 1).

Figure 8. Transect 6 was established in 2008 to monitor a medium sized orange hawkweed infestation growing along the trail. The circle marks the tree with the aluminum tag.

Extensive control work by BLM field crews was also conducted at this location the week before we revisited the infestation. Despite their efforts, we found, pulled, and bagged over 100 orange hawkweed rosettes and stems in the vicinity of the transect, all growing along the trail. Of these, 10-25 plants were growing in the subplot of Transect 6 that was infested in 2006 (the 2006 stem count for the transect was 25-50 individuals). Therefore, given that control work had just been carried out, we can assume the actual population size for 2008 was significantly greater than in 2006.

In addition, up to 700 stems of mouse-ear chickweed (*Cerastium fontanum* ssp. *vulgare*) were recorded in and around Transect 6, and smaller amounts of common plantain (*Plantago major*), common dandelion and white clover were also found in the area (see Appendix II for species distribution maps). White clover was the only species in this group that had already been reported in the area (although not in the transect) in 2006 (Table 4).

Table. 4. Non-native plant species found at Transect 6.

Non-native species recorded in 2006	Invasiveness Rank	Non-native species recorded in 2008	Invasiveness Rank
– *Hieracium aurantiacum*	79	– *Cerastium fontanum* ssp. *vulgare* – *Hieracium aurantiacum*	36 79

Transect 6B

A second photo-monitoring point (Transect 6B) was established on the 8-Mile trail approximately 20 meters south of its intersection with the 8-, 12-, 16-Mile Loop trail (Fig. 9). This transect marks a smaller (*c.* 25 stems, all pulled during the survey) orange hawkweed infestation (no other non-native species were recorded). This same infestation was already recorded during the 2006 surveys, and the population size does not appear to have changed significantly over time (6-25 stems counted both in 2006 and 2008). We recommend that this site also be revisited in 2009 to determine whether control efforts were effective.

Figure 9. Transect 6B is a second photo-monitoring point established 20 meters south of Transect 6. An infestation of orange hawkweed was first observed during the 2006 surveys, and the estimated stem count (*c.* 6-25) was similar in 2008. The circle marks the tree with the aluminum tag.

Discussion

Orange hawkweed is a very effective invader because it can reproduce sexually by seed and asexually by leafy runners (stolons) or by resprouting from rhizome fragments. A one meter square mat of orange hawkweed can produce up to 40,000 seeds per year, which can remain viable in the soil for up to seven years. Furthermore, each plant can produce four to eight stolons annually. Orange hawkweed may also have an allelopathic effect on surrounding vegetation by exuding toxic chemicals into the soil. Using these various strategies, this species is able to

effectively colonize an area, and can quickly form large, dense patches that exclude native vegetation (North Dakota Department of Agriculture 2003).

At least two of the three orange hawkweed infestations recorded in 2006 have been controlled by hand-pulling. However, because plants can resprout from rhizome fragments, hand-pulling is only effective if the entire root system is removed. Although digging has been shown to be effective in the control of very small infestations, it can also stimulate growth of new plants if rhizomes, stolons, and fragmented roots are left behind.

Seefeldt and Carr (2007) have conducted a series of experiments to determine the effectiveness of hand-pulling and digging over chemical control methods on a large orange hawkweed infestation located along the airstrip in Talkeetna, Alaska. Their results indicate that hand pulling was not effective (mainly because of the difficulty of correctly extirpating all the underground parts) and that chemical treatments were required to eliminate this species. Given the high aggressiveness of this species and the longevity of its seeds, Seefeldt and Carr (2007) recommended that controlled infestations be monitored for multiple years following herbicide application (preferably for a length of time similar to that of the species' seed viability). Herbicides (2, 4-D, picloram, and clopyralid are recommended) must all be applied early in the growing season when the plants are in the rosette stage to prevent flowering and seed production (North Dakota Department of Agriculture 2003).

To conclude, although hand pulling and digging will help control the extent of the existing infestations in the Campbell Tract, it is unlikely that these methods will succeed in eliminating them. It is important to note that if the plant is in flower, the flower head must be cut off, bagged, and disposed (still bagged) into the regular trash. Hawkweeds **can form viable seeds after** they are **cut or dug up** (King County Noxious Weed Control Program 2005). Ultimately, we recommend herbicide application; however, if chemical treatments are not possible, the three infestations should be manually controlled early in the growing season, when plants are still in the rosette stage, and be revisited throughout the summer to prevent re-sprouting and, especially, the production of flowering stems. Given that seeds can remain viable in the soil for multiple years, long-term goals should aim to prevent the formation of a seed bank, and to conduct enough pulling to prevent the current infestations from expanding vegetatively.

Transect 8

Results

Transect 8

Transect T8 is located at the northeast end of the Campbell Tract airstrip, and extends from the airstrip along a trail that cuts into the surrounding mixed white spruce-birch forest (Figs. 10 and 11).

In 2006, numerous but sparsely distributed populations of highly-invasive white sweetclover (80) and narrowleaf hawksbeard (54) were recorded along the airstrip and in the first subplot of the transect. Larger and denser infestations of white clover (59) were also observed, both along the

airstrip and extending into the adjacent forest. Please note; narrowleaf hawksbeard is one of two non-native species that has been observed establishing on burned lands along the Dalton Highway in interior Alaska (Cortés-Burns *et al*. 2008). The other species is white sweetclover, which is currently considered much more aggressive than narrowleaf hawksbeard. For this reason, we consider narrowleaf hawksbeard to be under-ranked.

In 2008, narrowleaf hawksbeard and white sweetclover remained the most invasive non-native weeds observed throughout the length of the airstrip (see Appendix II for distribution maps). However, within the boundaries of Transect 8 a total of eight (not including foxtail barley) non-native plant species were recorded (Table 5). Although the white sweetclover and narrowleaf hawksbeard infestations continue to be spotty and broadly dispersed along the airstrip, the extent and percent cover of narrowleaf hawksbeard within Transect 8 has increased since 2006. In 2006, this species was only recorded in the first subplot at one percent canopy cover, whereas in 2008, it was present in the first seven subplots (over 14 meters) and constituted 10-20 percent of the total canopy cover.

Figure 10. Transect 8 was established in 2006 at the northeast end of airstrip to monitor narrowleaf hawksbeard and white sweetclover. This transect was revisited in 2008. The circle marks the tree with the aluminum tag.

Figure 11. Transect 8 viewed from the tagged tree.

Table 5. Non-native species found along Transect 8.

Non-native species recorded in 2006	Invasiveness Rank	Non-native species recorded in 2008	Invasiveness Rank
		– *Crepis tectorum*	54
		– *Elymus repens*	59
– *Crepis tectorum*	54	– [*Hordeum jubatum*]	63
– *Melilotus alba*	80	– *Melilotus alba*	80
– *Plantago major*	44	– *Plantago major*	44
– *Poa pratensis*	56	– *Poa pratensis* ssp. *pratensis*	56
– *Taraxacum officinale* ssp. *officinale*	58	– *Taraxacum officinale* ssp. *officinale*	58
– *Trifolium repens*	59	– *Trifolium hybridum*	57
		– *Trifolium repens*	59

Note: *Hordeum jubatum* is rejected from further consideration due to its unresolved nativity, general abundance and broad distribution in Alaska.

There has also been a marked rise in the percent cover of white clover along the transect (and therefore the trail). Maximum percent cover values recorded in some of the subplots have increased from 30 to 70 percent (Fig.12). The spread of white clover along the trail appears to have remained the same, extending approximately 20 meters into the forest in both years, and does not appear to be spreading beyond the trampled portions of the woodland (see Appendix II for distribution map).

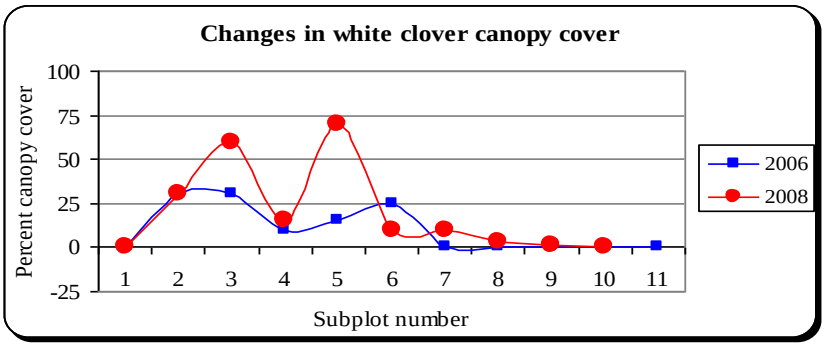

Figure 12. A marked increase in percent cover values for white clover between 2006 and 2008 was recorded along Transect 8.

Lastly, no invasive weeds were found beyond the first 20-24 meters of trail, and the percent cover of non-native species decreases rapidly as one moves from the disturbed airstrip soil into the forest.

Transect 8B

A second photo-monitoring point (Transect 8B) was established just west of Transect 8, also at the northern end of the airstrip, on the opposite side of the multi-use trail (Fig. 13), to mark a small bird vetch (73) infestation (Fig. 14, Appendix II for distribution map).

Figure 13. Transect 8B was a second transect established in 2008 at the Northeast end of airstrip to monitor a small bird vetch population.

Figure 14. Bird vetch plants (with blue inflorescences) were growing over native vegetation at Transect 8B. Bird vetch was not recorded along the airstrip during the 2006 surveys.

In 2006, bird vetch was only recorded by the BLM headquarters parking lot, close to the Coyote Trail (Transect 3) and in the vicinity of the Campbell Creek Science Center (around the buildings and also spreading north to the parking lot). The new infestation found in 2008 consisted of 10-25 stems and was growing over native vegetation just a few meters from the airstrip. No non-native species were recorded beyond the bird vetch population on Transect 8B. The rest of the non-native plants found at Transect 8B were not as highly aggressive, with quackgrass (59) and narrowleaf hawksbeard (52) the next highest ranked species after bird vetch (see Appendix II for species distribution maps).

We tried to remove as much of the bird vetch infestation by hand. However, because this species is able to resprout from rhizome fragments, control work should be repeated throughout the growing season. Furthermore, as bird vetch seeds can remain viable in the soil for up to five years (Seefeldt, pers. comm.), this population should be manually or mechanically controlled for at least that period of time or until eradicated.

Discussion

Although the percent cover for both narrowleaf hawksbeard and white clover appears to have increased along Transect 8 since 2006, neither of these infestations appear to be spreading beyond the human footprint into undisturbed, native vegetation. For this reason Transect 8 is not recommended as a high-priority site for the next monitoring effort.

However, Transect 8B, which marks a new but small and therefore controllable infestation of bird vetch, should be revisited by field crews frequently in the 2009 growing season to try to extirpate this infestation before a large seed bank is formed and the population starts to spread.

Bird vetch is an ecologically damaging species that can form dense mats covering short (less than three feet tall) native vegetation and can climb over taller shrubs such as alder and willow, thereby reducing light availability for native species in the understory. Furthermore, bird vetch is able to fix atmospheric nitrogen, which fertilizes the soil and facilitates invasion by other weedy species that often thrive in nitrogen-rich soils (USDA Forest Service 2005).

Complete eradication of all bird vetch populations recorded as well as additional monitoring work, should be a priority throughout the Campbell Tract. Initial control efforts can include manual pulls and digs, mowing, or a combination of mowing and digging. It is recommended that sites be visited before flower initiation (early to late July), and that plants be mown near the base of their stem or hand-pulled (Seefeldt, pers. comm.). When time and size permits, both aboveground and belowground parts should be removed to prevent reproduction from either seed or rhizome fragments. The infested site should be revisited every six weeks and the treatment repeated until the end of the growing season. The area within at least a 50 meter radius and any disturbed areas within a half mile should be surveyed for new plants (Seefeldt, pers. comm.). Bird vetch infestations should be treated and monitored for at least five years (period of soil seed bank viability) to guarantee the depletion of the seed bank (Seefeldt, pers. comm., Nolen 2002). If plants continue to regrow after five years of mechanical control, they can be sprayed with one pint/acre of clopyralid (Transline) with an approved adjuvant while they are actively growing but have not yet flowered (Seefeldt, pers. comm.).

Carlson *et al.* (2006) cited the margins of and the meadow adjacent to the airstrip as two of the three areas of greatest concern within Campbell Tract. The numerous infestations of highly invasive white sweetclover and narrowleaf hawksbeard, together with this single occurrence of bird vetch, suggest that this area is an invasive species' hotspot, and that monitoring and control efforts should focus on this area to a) detect the introduction and prevent the establishment of any additional high-priority weeds, and b) monitor the current infestations to limit their migration to other disturbed areas and into the surrounding native vegetation.

Transect 9

Results

This transect was established in 2006, just west of the mushing trail bridge along Campbell Creek at the intersection of Rover's Run and a side trail branching off towards the creek (Figs. 15 and 16). This site marks an infestation of common chickweed (*Stellaria media*, 42), although annual bluegrass (46), and common plantain (44) were also recorded (Table 6).

Figure 15. Transect 9 was revisited in 2008. In 2008, chickweed was still present.

Figure 16. In 2008 we extended Transect 9 to capture the entire extent of the chickweed population. Dotted arrows indicate the section of trail covered by the transect.

Table 6. Non-native species found at Transect 9 in 2006 and 2008.

Non-native species recorded in 2006	Invasiveness Rank	Non-native species recorded in 2008	Invasiveness Rank
– *Plantago major* – *Poa annua* – *Stellaria media*	44 46 42	– *Plantago major* – *Poa annua* – *Stellaria media* – *Taraxacum officinale* ssp. *officinale*	44 46 42 58

Our 2008 results show that the percent cover per subplot as well as the overall extent of both the chickweed and common plantain populations has increased relative to 2006 (Figs. 17 and 18, respectively). The chickweed and the common plantain infestations have spread at least four and six meters farther down the transect, respectively.

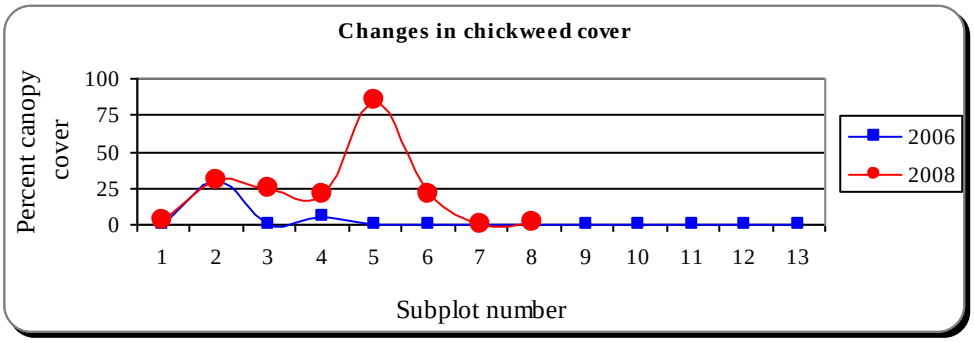

Figure 17. In 2008 higher percent canopy covers of chickweed were recorded in most subplots.

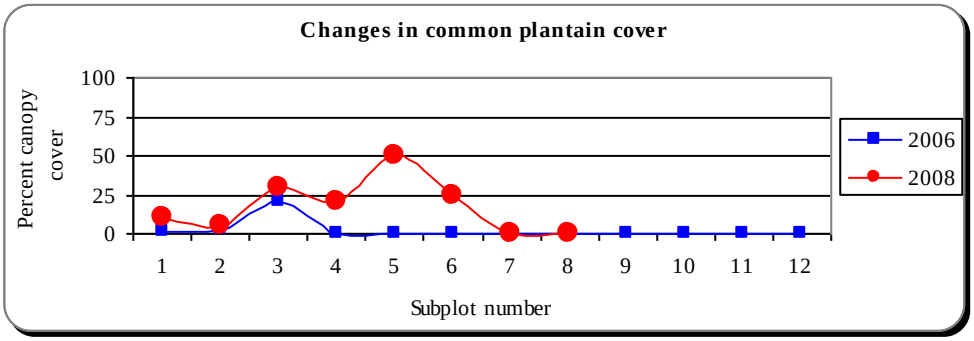

Figure 18. In 2008 higher percent covers of common plantail were recorded in most subplots.

During 2008 we surveyed an area along Campbell Creek that is close to Transect 9 for the highly invasive tree species, European bird cherry (74). Two stems of this species were found and pulled in 2006 (see Appendix II for location). No bird cherry plants were found in 2008, however, we recommend that this area be carefully monitored for potential new infestations each year, given that once this species becomes established it is highly invasive.

Discussion

The non-native species found at Transect 9 are all low-priority species; however, monitoring is important at this site as it is susceptible to invasion by way of proximity to the following weed dispersal routes or sources:

1. The Campbell Creek Science Center parking lot, where, among others, white sweetclover, narrowleaf hawksbeard, and hempnettle (*Galeopsis* spp.) have been recorded (Carlson *et al.* 2006)
2. The Campbell Creek and the Tour of Anchorage trail, both of which connect Campbell Tract to sections of the city that are highly infested by a number of high-priority, non-native plant species, most notably, European bird cherry.

3. the Campbell Tract airstrip parking lot and trailhead, where populations of high-priority species such as smooth brome and oxeye daisy have been previously recorded (Carlson *et al.* 2006)

As a result of BLM's proactive approach to invasive species management, the only two seedlings of European bird cherry recorded on Campbell Tract lands were pulled in 2006, and none were found during the 2008 revisit work. This early detection and effective control of the European bird cherry individuals is largely due to the ongoing monitoring efforts conducted by Campbell Creek Science Center personnel.

Given the proximity of Transect 9 to high-use areas and to source areas of invasive plant propagules, we recommend that the area surrounding the transect and including nearby stream banks, be monitored at frequency sufficient to detect infestations before they become too large to efficiently eradicate. Monitoring efforts should focus on highly-aggressive species such as European bird cherry, which is replacing native trees and shrubs in downstream sections of the Chester and Campbell Creeks. It is thought that the shift vegetation from mixed deciduous shrub to a monospecific stand of bird cherry in these lower stream sections will have direct effects on the quality of browse for moose and leaf litter for aquatic invertebrates. Such a change in the quality of organic matter input and subsequent nutrient cycling will likely affect higher trophic levels (*e.g.* salmon) and general ecosystem function. Specific effects are being studied by University of Alaska Fairbanks student Dave Roon (Cortés-Burns, pers. comms.).

Transect 10

Results

The Campbell Airstrip entrance to the Tract hosts an abundance of non-native invasive plants including oxeye daisy, common timothy grass, white clover, common plantain, common dandelion, and Kentucky bluegrass (*Poa pratensis* ssp. *irrigata*) (Carlson *et al*. 2006). A permanent monitoring transect was established at this location in 2006 to determine if these species are moving into less disturbed portions of the Tract. In 2008 we relocated the transect, which runs from the disturbed, trampled grassy lawn by the parking lot (mesic graminoid meadow) into the adjacent mixed white spruce-birch forest. Non-native species recorded during the most recent monitoring effort include oxeye daisy (61), common plantain (44), common dandelion (58), Kentucky bluegrass (52), annual bluegrass (*Poa annua*, 46), alsike clover (57) and pineapple weed (*Matricaria discoidea*, 32) (Table 7, Appendix II for select species' distribution maps).

Table 7. Non-native species recorded at Transect 10 in 2006 and 2008.

Non-native species recorded in 2006	Invasiveness Rank	Non-native species recorded in 2008	Invasiveness Rank
– *Leucanthemum vulgare*	61	– *Leucanthemum vulgare*	61
– *Phleum pratense*	56	– *Matricaria discoidea*	32
– *Plantago major*	44	– *Plantago major*	44
– *Poa pratensis*	52	– *Poa annua*	46
– *Taraxacum officinale* ssp. *officinale*	58	– *Poa pratensis*	52
– *Trifolium repens*	59	– *Taraxacum officinale* ssp. *officinale*	58
		– *Trifolium hybridum*	57

The percent cover of oxeye daisies at each subplot appear to have increased sharply from 2006 to 2008, especially in the first 14 meters of the transect (Figs. 19 and 20). This is the section of the transect that coincides with the meadow/lawn in front of the Campbell Airstrip parking lot. In comparing 2006 and 2008 percent cover values for (1) grasses, (2) forbs, and (3) bare soil, we found that the increases in the density of oxeye daisy in each subplot often coincided with a decrease in the amount of soil that is unvegetated or covered with non-vascular species (lichens, mosses) (Figs. 21 and 22).

Figure 19. Oxeye daisy rosettes comprised up to 90 percent cover in some subplots in 2008, whereas in 2006 percent cover did not exceed 25 percent in any subplot.

Figure 20. Transect 10 was revisited in 2008, when a notable increase in the density and size of the oxeye daisy infestation was observed.

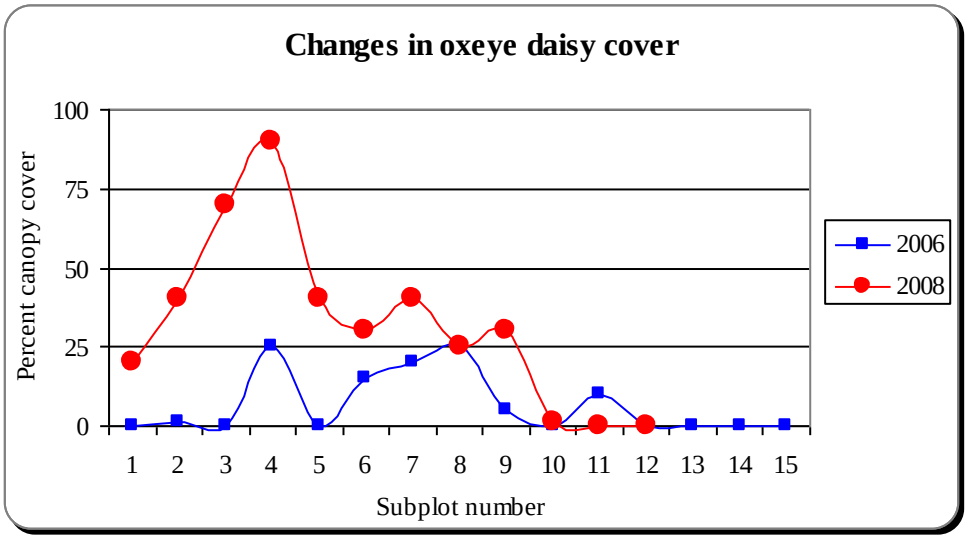

Figure 21. There is a distinct increase in the percent cover of oxeye daisy in the first subplots along Transect 10 between 2006 and 2008.

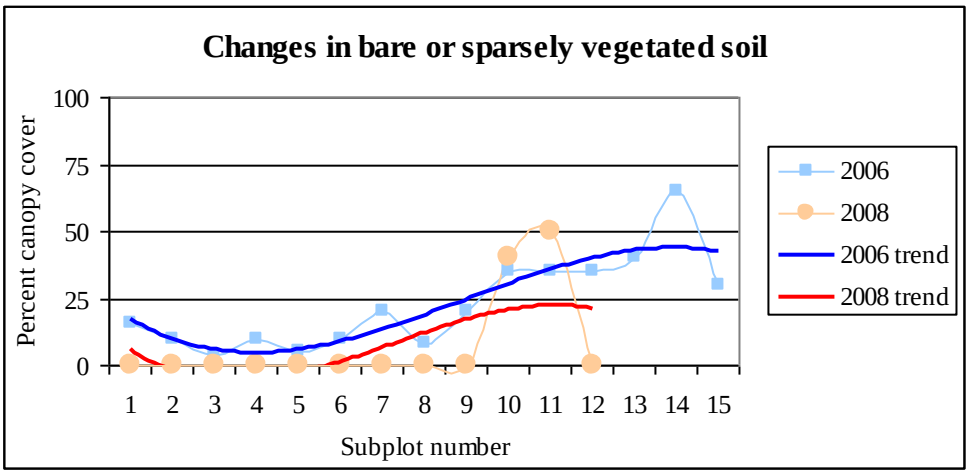

Figure 22. In 2006, up to 20 percent cover of the first subplots in Transect 10 were unvegetated, or occupied by non-vascular plants. In 2008 no bare soil patches were recorded in those sections; the percent cover values of oxeye daisy had greatly increased in these same sections.

Discussion

Although the decrease in bare soil per subplot from 2006 to 2008 is less marked than the increase in oxeye daisy cover, it seems plausible that oxeye daisy may have colonized the unvegetated ground over the past two growing seasons, as no significant changes were detected in the percent cover values for grasses or for other forbs between the first and the second reading.

The nearby Campbell Airstrip parking lot constitutes a likely point of entry for new invasive weeds into the Campbell Tract. However, the only highly aggressive species recorded there to date is oxeye daisy. Given that this species appears to have become much more established in the past two growing seasons, we recommend that control and monitoring efforts focus on limiting this infestation to its current size, and to detecting any new invasive species that may be brought in on cars or by trail users, so that they can be eradicated before they become problematic.

Project deliverables

The results presented herein have been extracted from a database and GIS shapefiles compiled by AKNHP that include information on the location, vegetation class, and percent covers of individual native and non-native species for each subplot in each transect surveyed in 2008. In addition, AKNHP has submitted the non-native plant data collected to the Alaska Exotic Plant Clearinghouse (AKEPIC), our statewide invasive plant database. Once uploaded, this data will become available to local, regional, state, and federal agencies and private individuals involved in invasive species issues.

The species identities of all plant specimens collected have been determined by AKNHP botanists. We have also mounted a total of 15 specimens (representing ten species plus duplicates) so they can be used by as a reference for non-native plant identification. Duplicates of voucher specimens will be deposited at the University of Alaska Anchorage herbarium.

Summary & Recommendations

As previously noted by Carlson *et al.* (2006), the material source area and the airstrip continue to be major sources of weed propagules. For this reason, we strongly recommend that monitoring efforts be maintained not just at Transects 5 and 8 that fall in these areas, but both areas in general.

In particular, we suggest that future control and monitoring efforts focus on the following:

1. Airstrip infestations:
   - controlling the spread of **narrowleaf hawksbeard** and **white sweetclover** beyond the contaminated gravel of the airstrip into adjacent trails and woodlands
   - extirpating the new, small patch of **bird vetch** recorded at Transect 8B, west of Transect 8 in the northeast corner of the airstrip
2. Material source area:
   - Eradicating highly aggressive plants from the material source area such as **butter-and-eggs**, which in other parts of the Tract have migrated from the human footprint (roadsides, parking lots) into the adjacent native vegetation. For instance, extensive infestations of butter-and-eggs and white sweetclover were noted growing among native dwarf shrub vegetation near the Anchorage Field Office headquarters in 2007 (Helen Cortés-Burns, pers. obs., Fig. 23)

- monitoring the expansion of other species such as **hempnettle**, which are starting to form dense populations and are moving into native vegetation along other Anchorage trails [*e.g.* in Kincaid Park and along Chester Creek trail (Cortés-Burns, pers. obs.)]

3. Campbell Creek area:
   - monitoring the trails and banks along Campbell Creek to allow for the early detection and eradication of **European bird cherry** tree seedlings, as it is very likely there will be future introductions of this aggressively invasive species' propagules over the coming years (by humans, birds, or by the gradual expansion of this species upstream from lower infestations)

Figure 23. Large populations of butter-and-eggs were found lining the perimeter of the Anchorage Field Office parking lot and buildings. Some plants were observed spreading from the imported gravel into natural clearings in the adjacent native vegetation.

4. 8-Mile and 8-, 12-, 16-Mile Loop trails:
   - Two of the three orange hawkweed infestations recorded in 2006 were revisited in 2008. Despite repeated manual control efforts, both populations continue to be well established along what would otherwise appear to be relatively undisturbed trails surrounded by muskeg and spruce forests. As suggested in the discussion section for Transect 6, we strongly recommend that the application of herbicides be considered for at least these two infestations

Our 2008 findings corroborate many of the conclusions drawn by Carlson *et al*. (2006), among others, that: (a) the cover of non-native plants declines from the center of the infestation towards undisturbed habitats, and (b) overall infestations are still largely confined to areas of high anthropogenic disturbance. Carlson *et al*.'s (2006) also concluded that the associated vegetation type is strongly related to non-native cover, with non-native plant percent canopy cover values decreasing from open herbaceous vegetation to mixed shrub-herbaceous vegetation to forest classifications. Our field observations from 2008 surveys support this statement.

Finally, we encourage that best management practices for activities with the potential to introduce and disperse weeds be developed. Such management practices could provide, for example, guidelines on how to clean equipment that has been used in areas supporting invasive species populations, information on how to avoid using potentially invasive plants in landscaping projects, weed awareness notices or programs for recreational trail users, and suggestions to dog mushers on why and where to purchase certified weed-free straw.

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Appendix I

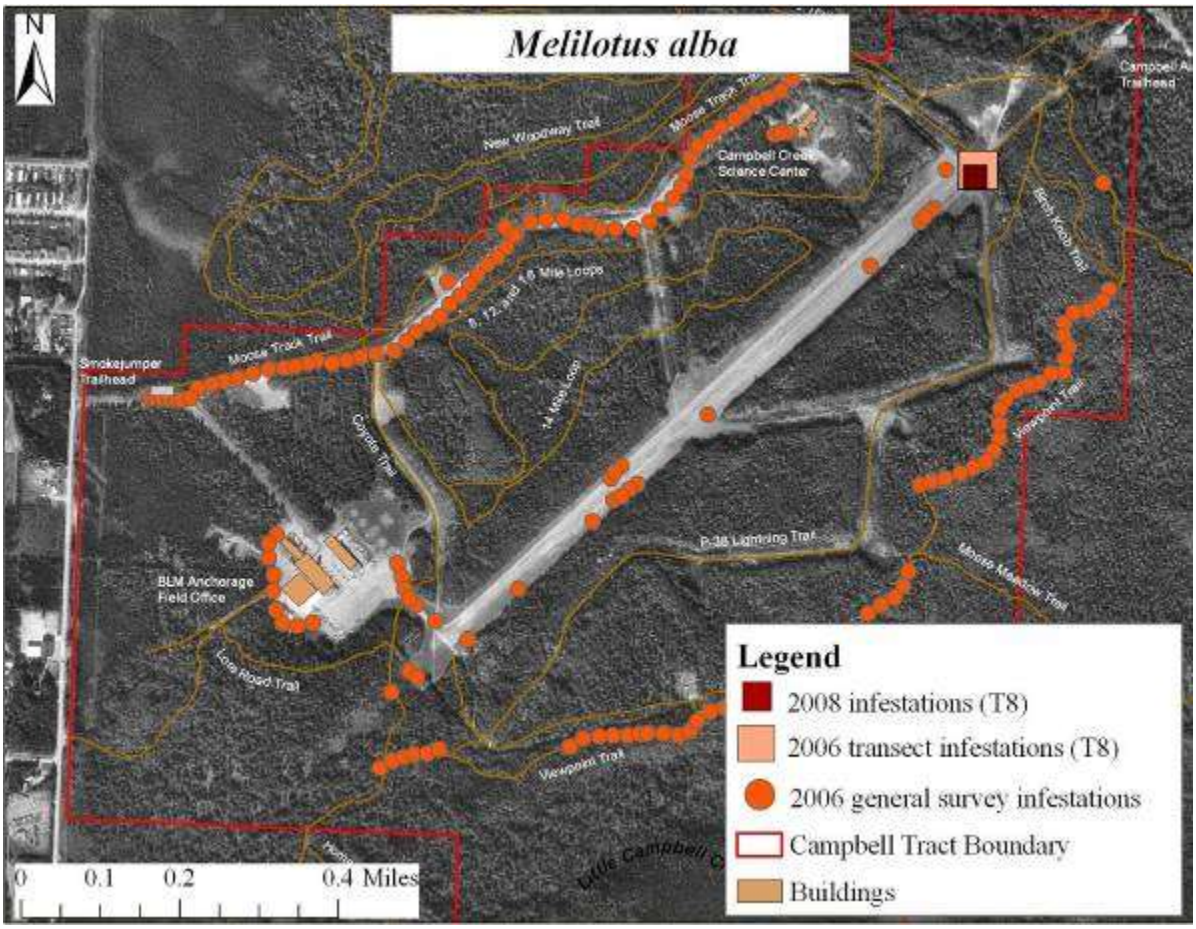
Table 1. List of priority non-native plants targeted during the 2006 Campbell Tract surveys (*i.e.* all species with an invasiveness score greater than 60 points).

Plant species	**Invasiveness Score (2008)**	Family	Common name
Polygonum cuspidatum Sieb. & Zucc., Polygonym sachalinense F. Schmidt ex Maxim.) R. Decr.	**87**	Polygonaceae	Giant knotweed, Bohemian knotweed, Japanese knotweed
Centaurea biebersteinii DC	**86**	Asteraceae	spotted knapweed
Euphorbia esula L.	**84**	Euphorbiaceae	leafy spurge
Lythrum salicaria L. & *L. virgatum* L.	**84**	Lythraceae	purple loosestrife, spike loostrife
Phalaris arundinacea L.	**83**	Poaceae	reed canarygrass, canarygrass
Impatiens glandulifera Royle	**82**	Balsaminaceae	ornamental jewelweed
Melilotus alba Medikus	**80**	Fabaceae	white sweetclover
**Nymphaea odorata* ssp. *odorata Ait.*	**80**	Nymphaceae	white waterlilly
Hieracium aurantiacum L. and *H. caespitosum* Dumort.	**79**	Asteraceae	orange hawkweed
Bromus tectorum L.	**78**	Poaceae	cheatgrass
**Rubus discolor* Weihe & Nees	**77**	Rosaceae	Himalyan blackberry
Cirsium arvense (L.) Scop.	**76**	Asteraceae	Canada thistle
Prunus padus L.	**74**	Rosaceae	European bird cherry
Vicia cracca L.	**73**	Fabaceae	bird vetch, cow vetch, tufted vetch
Lepidium latifolium L.	**72**	Brassicaceae	common pepperweed
**Alliaria petiolata* (Bieb.) Cavara & Grande	**70**	Brassicaceae	garlic mustard
**Cytisus scoparius* (L.) Link	**69**	Fabaceae	English broom, Scotch broom
Linaria vulgaris Miller	**69**	Scrophulariaceae	yellow toadflax, butter and eggs
Caragana arborescens Lam.	**66**	Fabaceae	Siberian pea shrub
Lonicera tatarica L.	**66**	Caprifoliaceae	bush honeysuckle
Melilotus officinalis (L.) Lam	**65**	Fabaceae	yellow sweetclover, king's crown
Campanula rapunculoides L.	**64**	Campanulaceae	Creeping bellflower
Medicago sativa ssp. falcata (L.) Arcang.	**64**	Fabaceae	Yellow alfalfa
**Senecio jacobaea* L.	**63**	Asteraceae	ragwort, stinking willie
Bromus inermis ssp. *inermis* Leyss.	**62**	Poaceae	smooth brome
Carduus nutans L., *C. acanthoides* L., *C. pycnocephalus* L. , *C. tenuiflorus* W. Curtis	**61**	Asteraceae	musk thistle, plumeless thistle, Italian thistle, slender-flowered thistle
Cirsium vulgare (Savi) Ten.	**61**	Asteraceae	bull thistle, common thistle
Leucanthemum vulgare Lam.	**61**	Asteraceae	oxeye daisy, white daisy
Sonchus arvensis ssp. *uliginosus* (Bieb.) Nyman	**61**	Asteraceae	perennial sowthistle, moist sowthistle
Hordeum murinum ssp. leporinum	**60**	Poaceae	leporinum barley, lepor barley

Plant species	Invasiveness Score (2008)	Family	Common name
Elymus repens (L.) Gould	**59**	Poaceae	quackgrass, couchgrass,
Medicago sativa ssp. *sativa* L.	**59**	Fabaceae	Alfalfa
Sorbus aucuparia L.	**59**	Rosaceae	European mountain ash, rowan
Trifolium repens L.	**59**	Fabaceae	white clover, ladino clover
Convolvulus arvensis L.	**58**	Convolvulaceae	field bindweed, morning glory
Linaria dalmatica L.	**58**	Scrophulariaceae	Dalmatian toadflax
Gypsophila paniculata L.	**57**	Caryophyllaceae	baby's breath
Tanacetum vulgare L.	**57**	Asteraceae	common tansy, garden tansy
Trifolium hybridum L.	**57**	Fabaceae	alsike clover
Phleum pratense L.	**56**	Poaceae	common timothy
Crepis tectorum L.	**54**	Asteraceae	narrow-leaf hawk's beard
**Ranunculus repens L. and R. acris L.*	**54**	Ranunculaceae	creeping buttercup and tall buttercup
Dactylis glomerata L.	**53**	Poaceae	orchardgrass
Trifolium pratense L.	**53**	Fabaceae	red clover
Vicia villosa Roth	**53**	Fabaceae	winter vetch
**Zostera japonica* Aschers. & Graebn.	**53**	Zosteraceae	dwarf eelgrass
**Hypericum perforatum* L.	**52**	Clusiaceae	St. Johnswort
Verbascum thapsus L.	**52**	Scrophulariaceae	common mullein
Digitalis purpurea L.	**51**	Scrophulariaceae	purple foxglove
Rumex acetosella L.	**51**	Polygonaceae	sheep sorrel
Fallopia convolvulus (L.) Löve	**50**	Polygonaceae	black bindweed
Tragopogon dubius L.	**50**	Asteraceae	yellow salsify, goat's bear
Hieracium umbellatum L.	**46**	Asteraceae	narrow-leaved hawkweed
Plant species rejected from consideration due to abundance and broad distribution			
Hordeum jubatum L.	**63**	Poaceae	foxtail barley
Stellaria media (L.) Vill.	**42/54**	Caryophyllaceae	common chickweed
Taraxacum officinale G.H. Weber ex Wiggers	**58**	Asteraceae	common dandelion
Poa pratensis ssp. *pratensis* L., *P. pratensis* ssp. *irrigata* (Lindm.) Lindb. f. & *P. trivialis* L.	**52**	Asteraceae	Kentucky bluegrass, spreading bluegrass and rough bluegrass

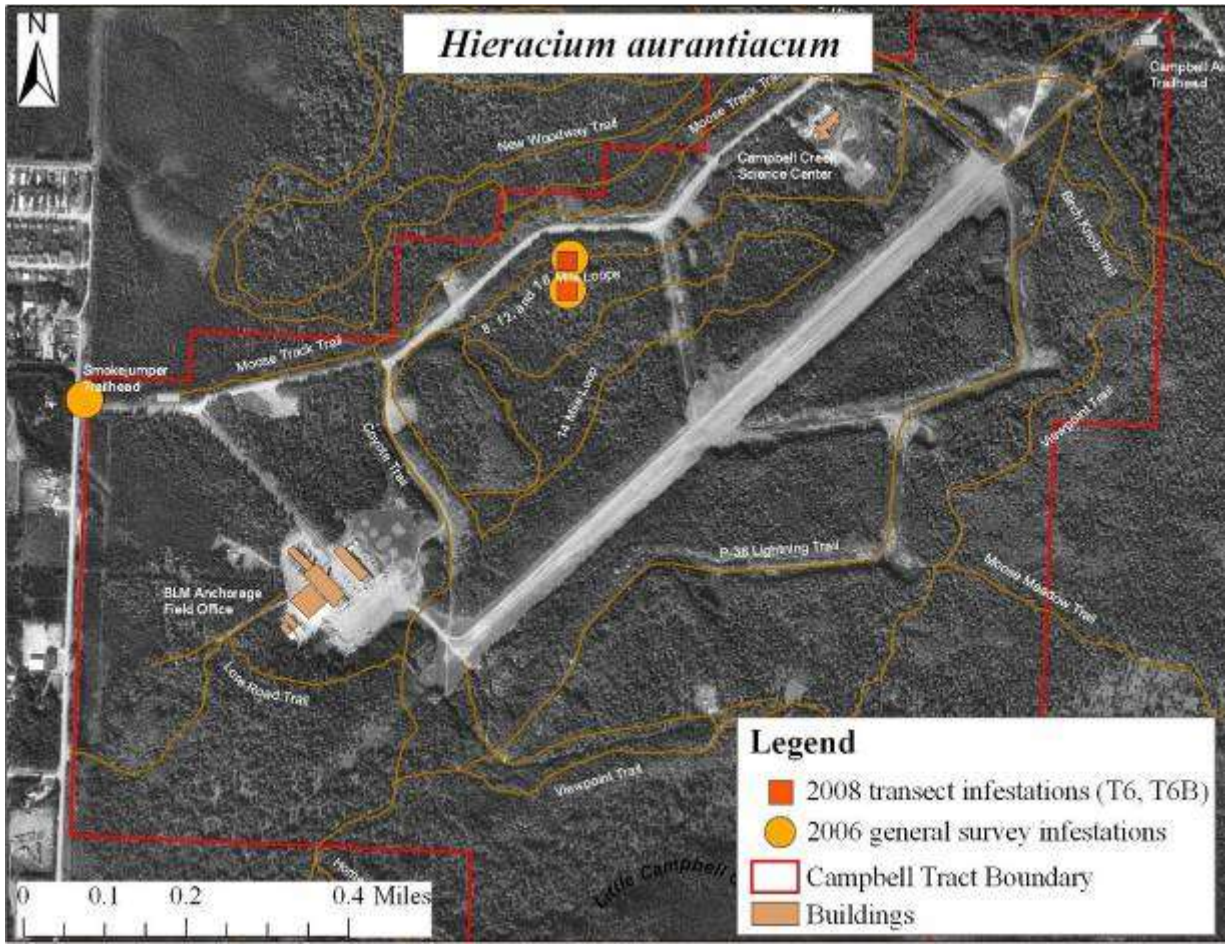
Appendix II

Melilotus alba distributions



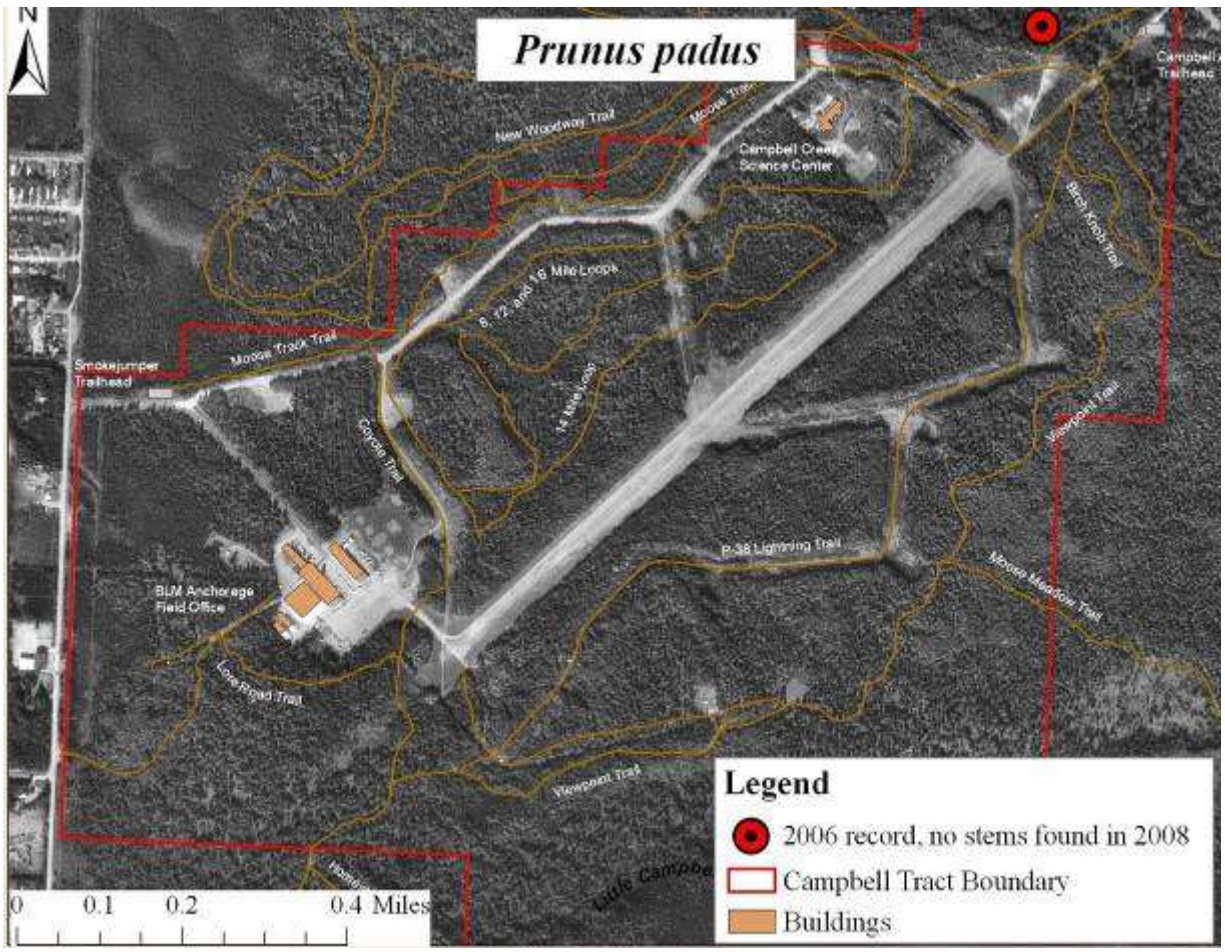
Comparative distribution of white sweetclover (*Melilotus alba*, 80) in the Campbell Tract.

Hieracium aurantiacum distributions



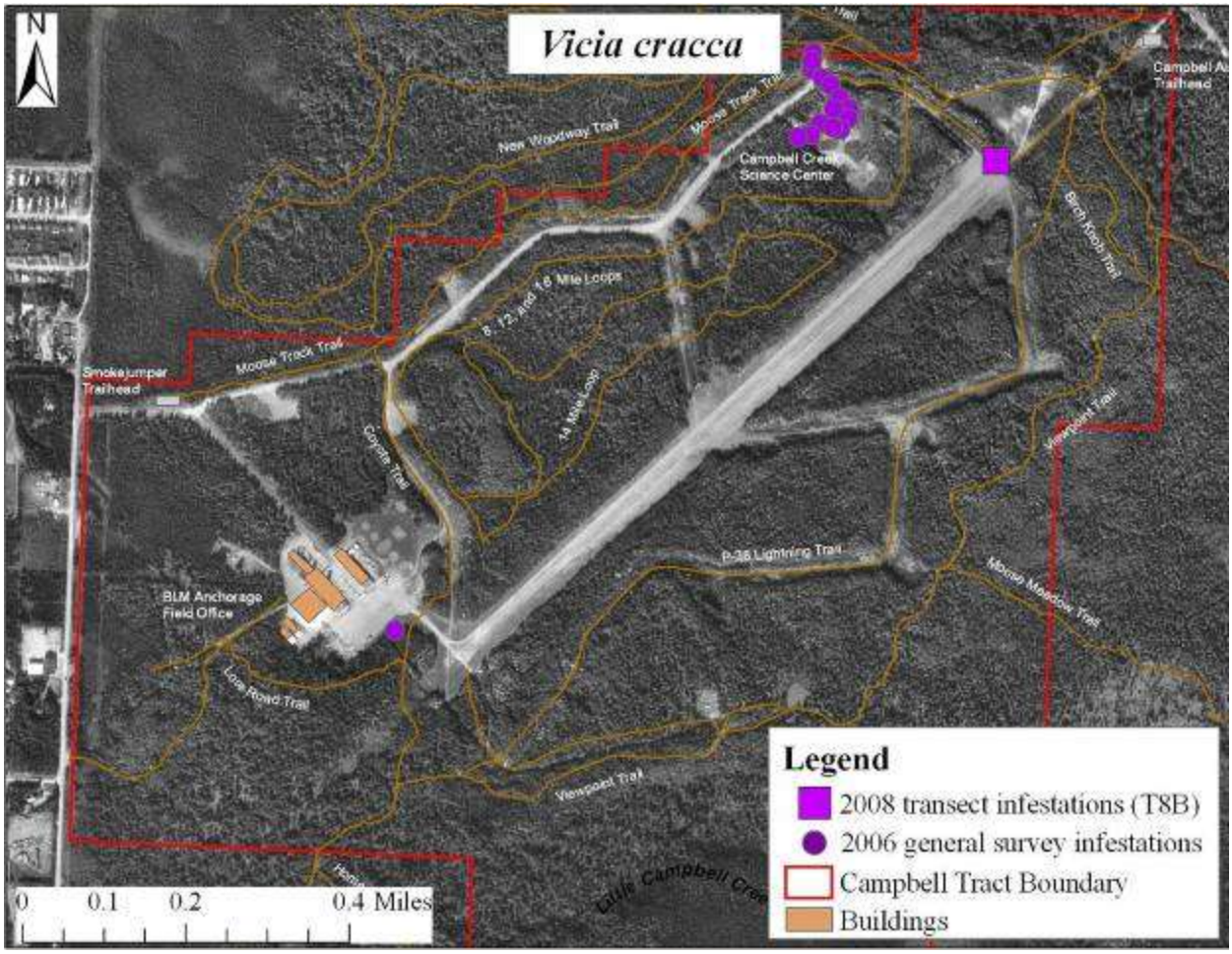
Comparative distribution of orange hawkweed (*Hieracium aurantiacum, 79*) in the Campbell Tract.

Prunus padus distributions



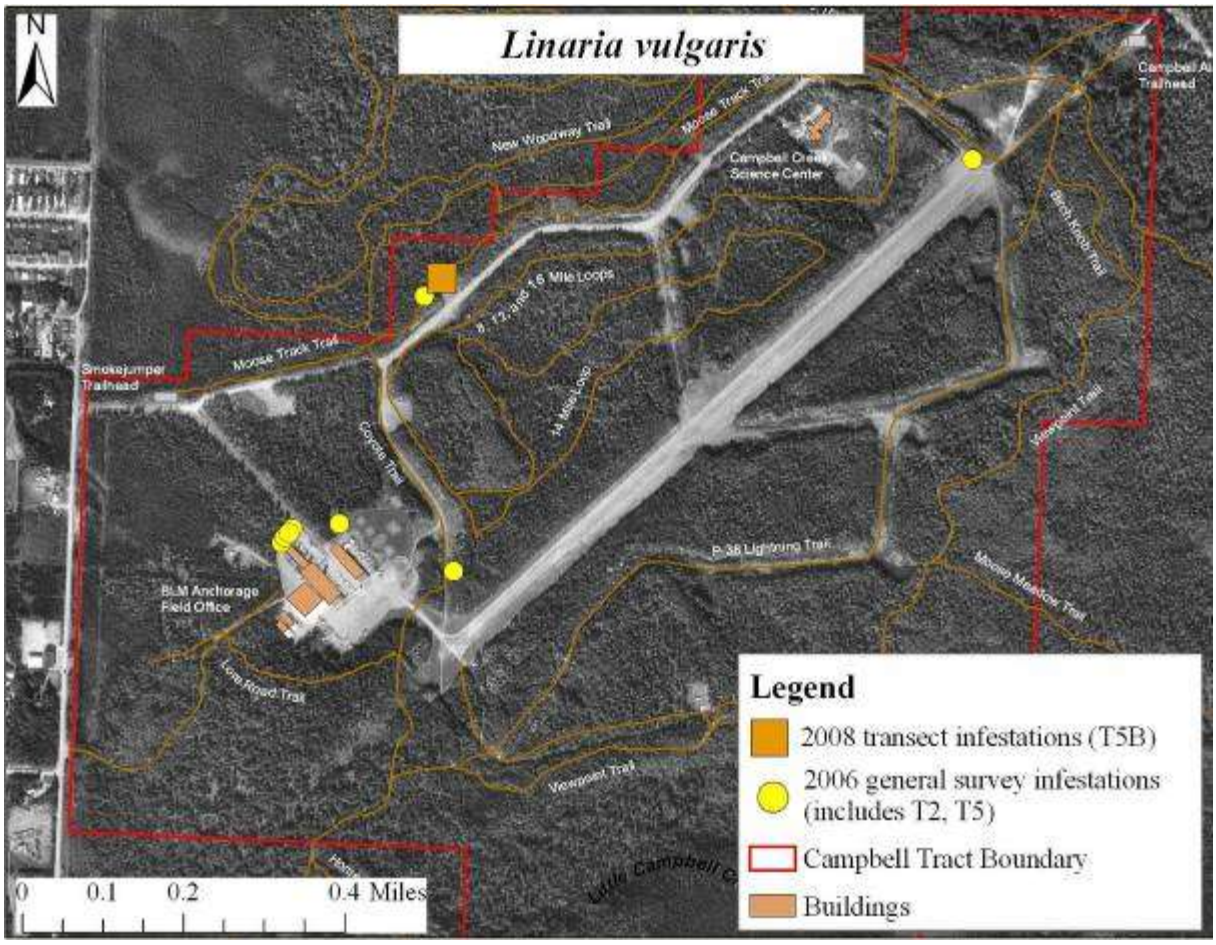
Comparative distribution of European bird cherry (*Prunus padus*, 74) in the Campbell Tract.

Vicia cracca distributions



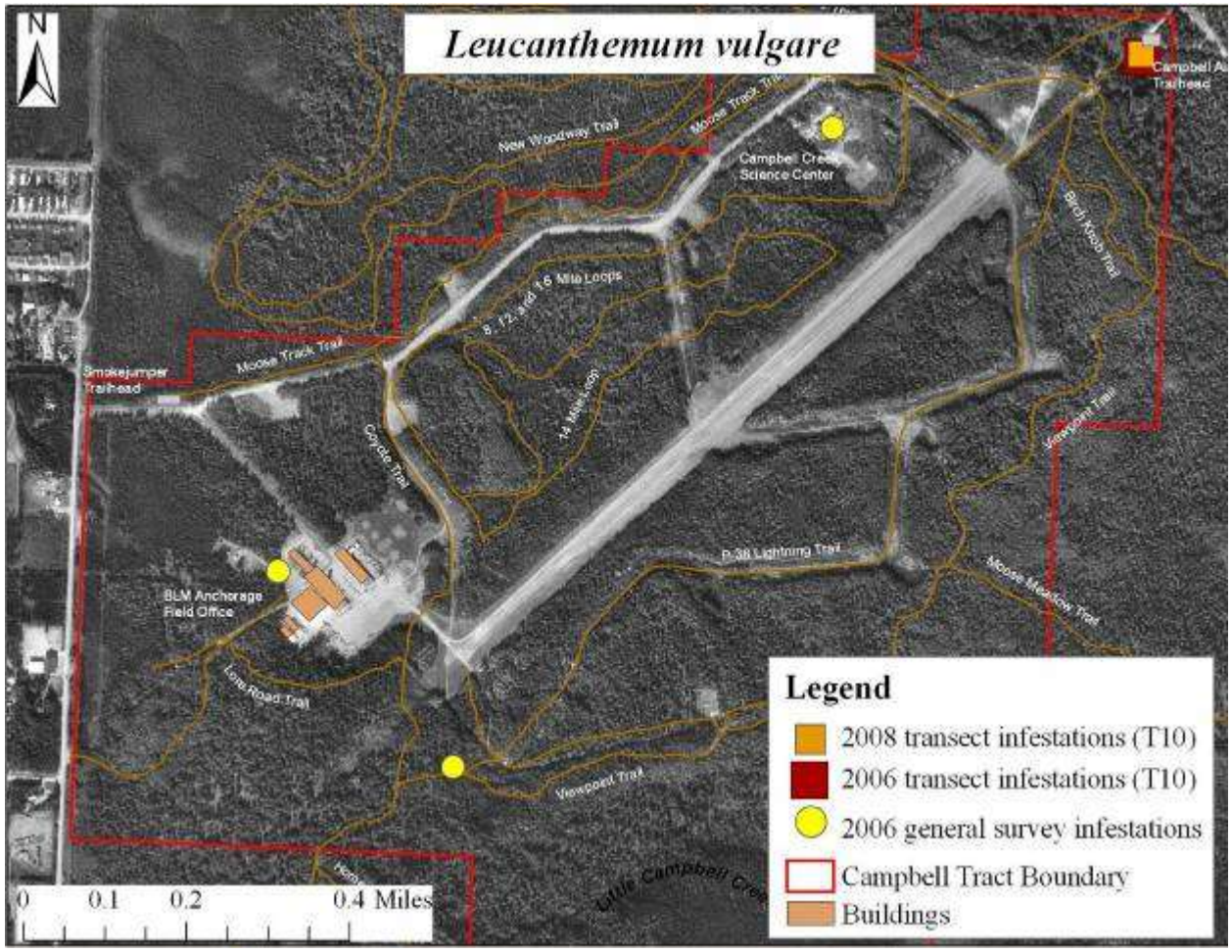
Comparative distribution of bird vetch (*Vicia cracca*, 73) in the Campbell Tract.

Linaria vulgaris distributions



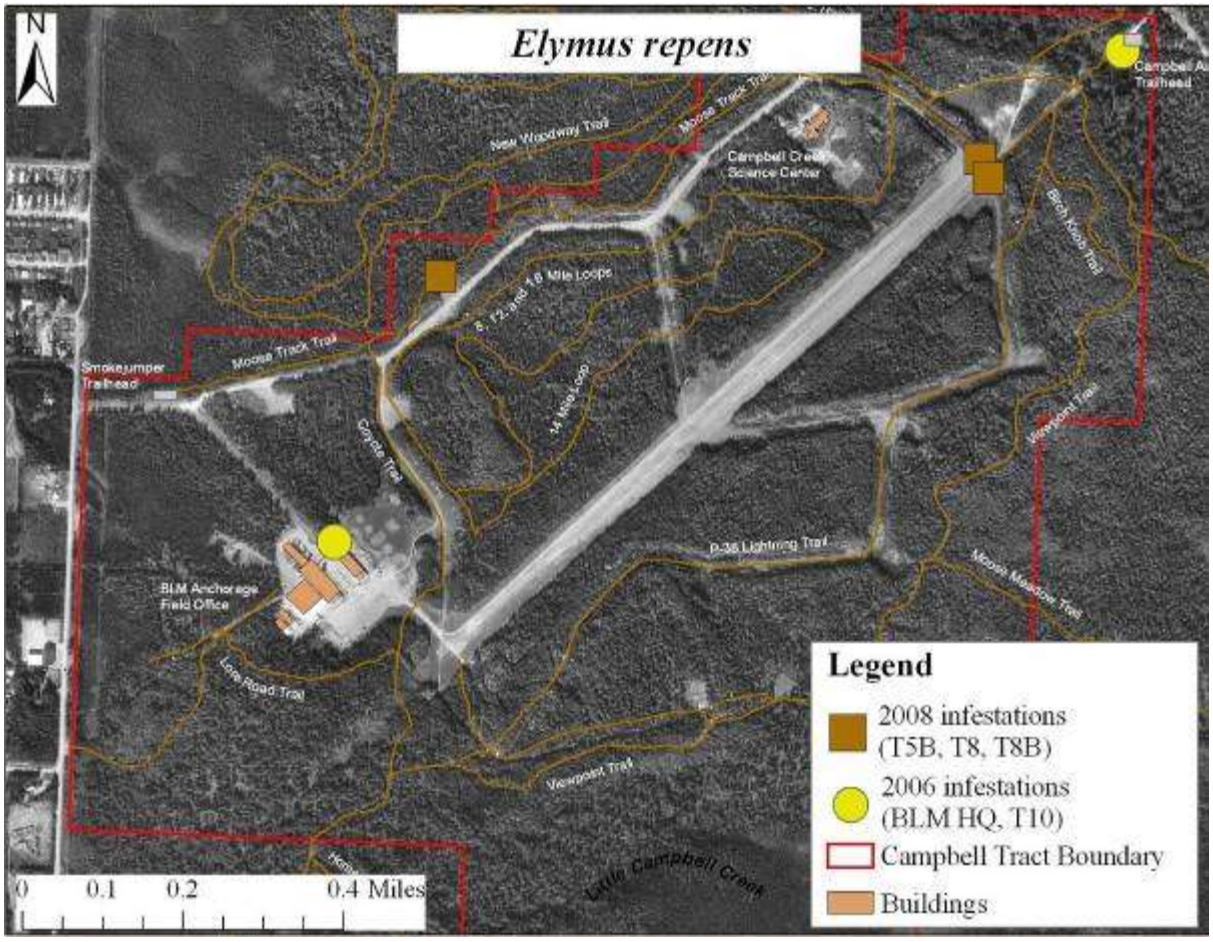
Comparative distribution of butter-and-eggs (*Linaria vulgaris*, 69) in the Campbell Tract.

Leucanthemum vulgare distributions



Comparative distribution of oxeye daisy (*Leucanthemum vulgare*, 61) in the Campbell Tract.

Elymus repens distributions



Comparative distribution of quackgrass (*Elymus repens*, 59) in the Campbell Tract.

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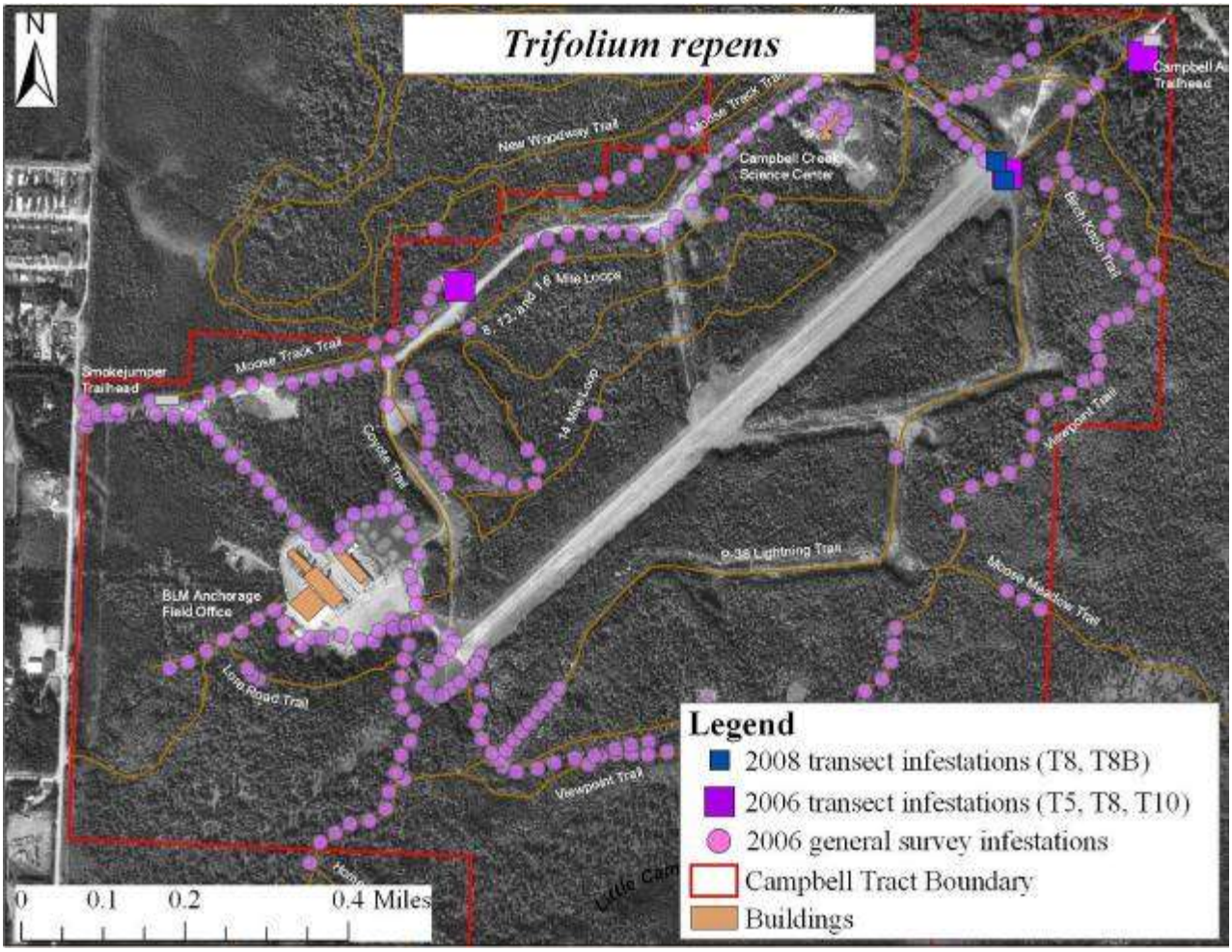
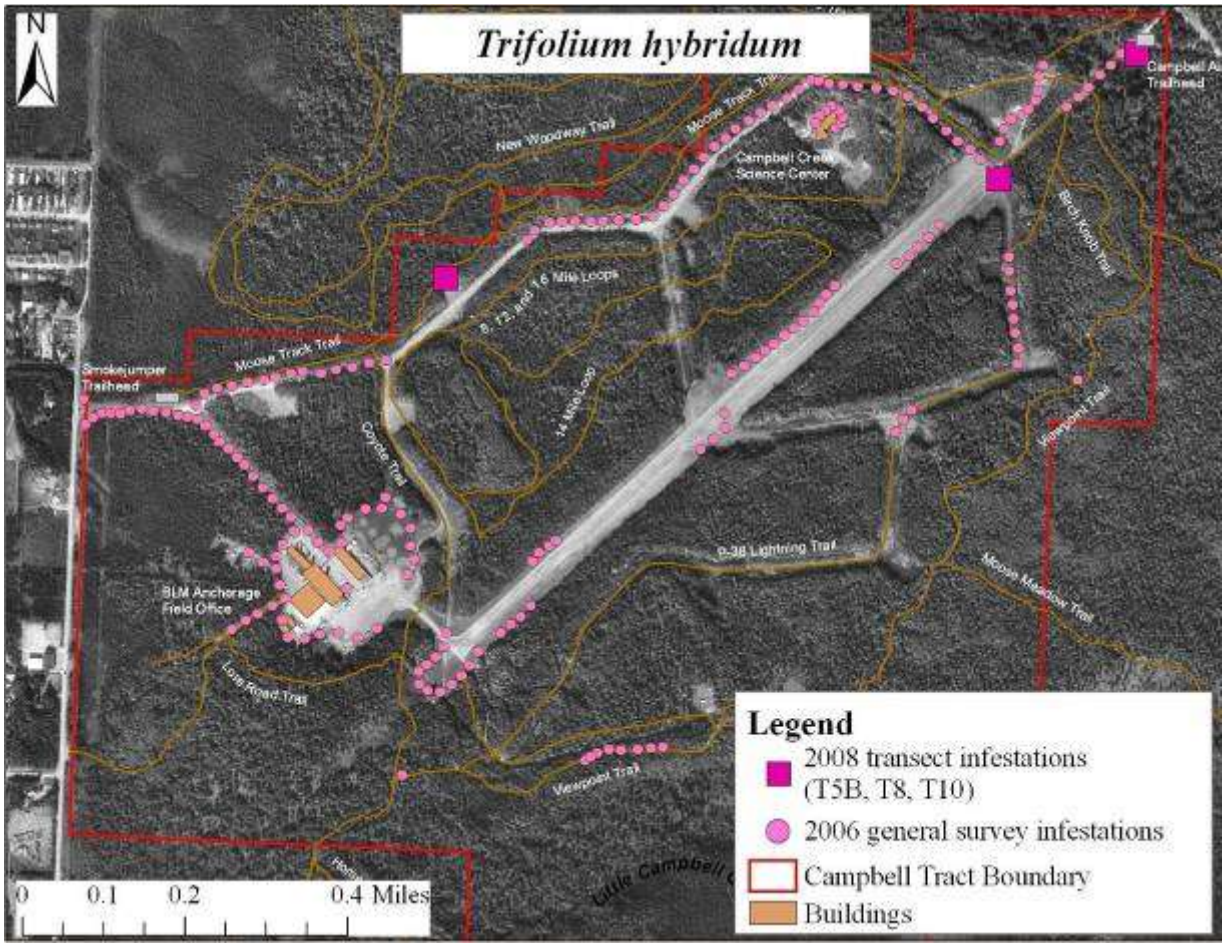
Trifolium repens distributions



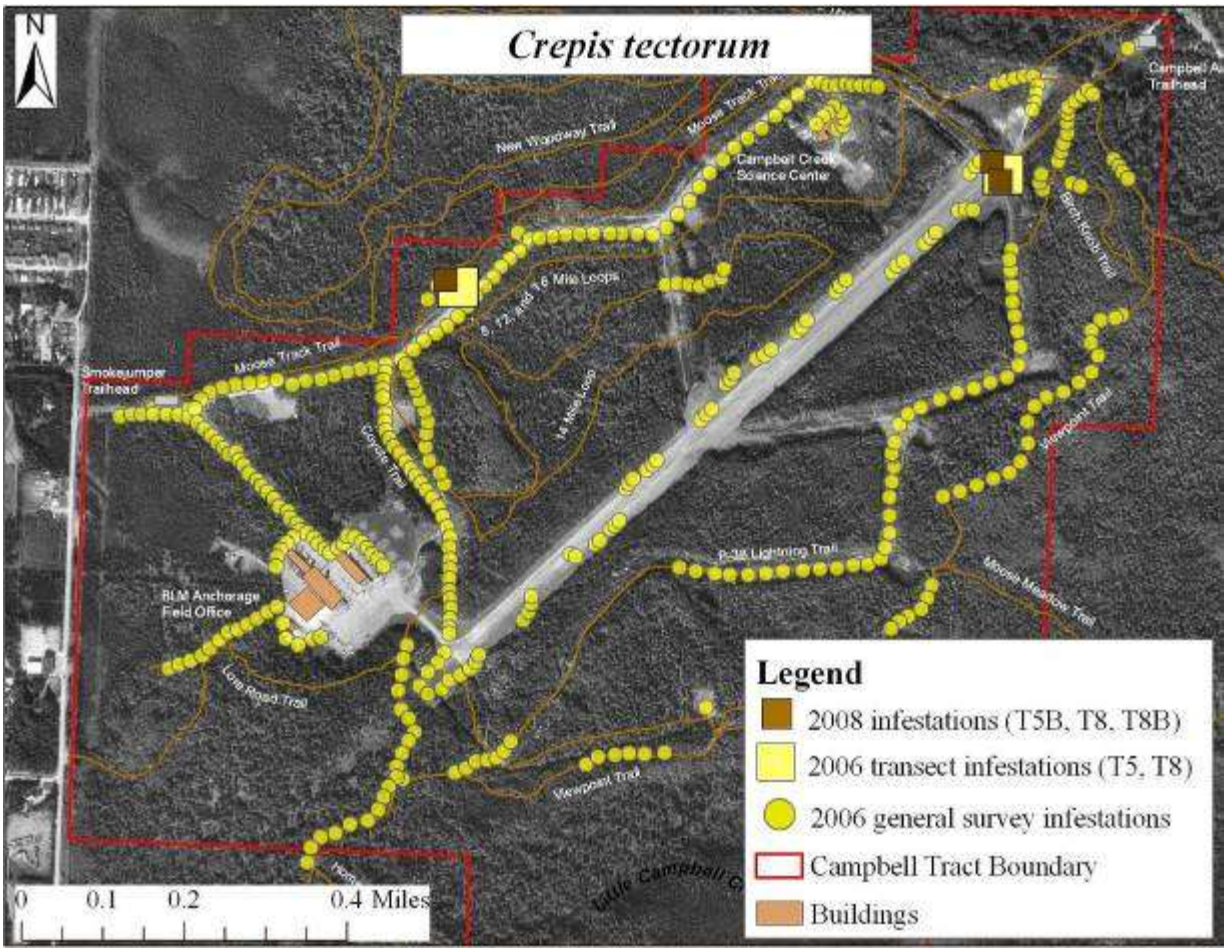
Comparative distribution of white clover (*Trifolium repens*, 59) in the Campbell Tract

Trifolium hybridum distributions



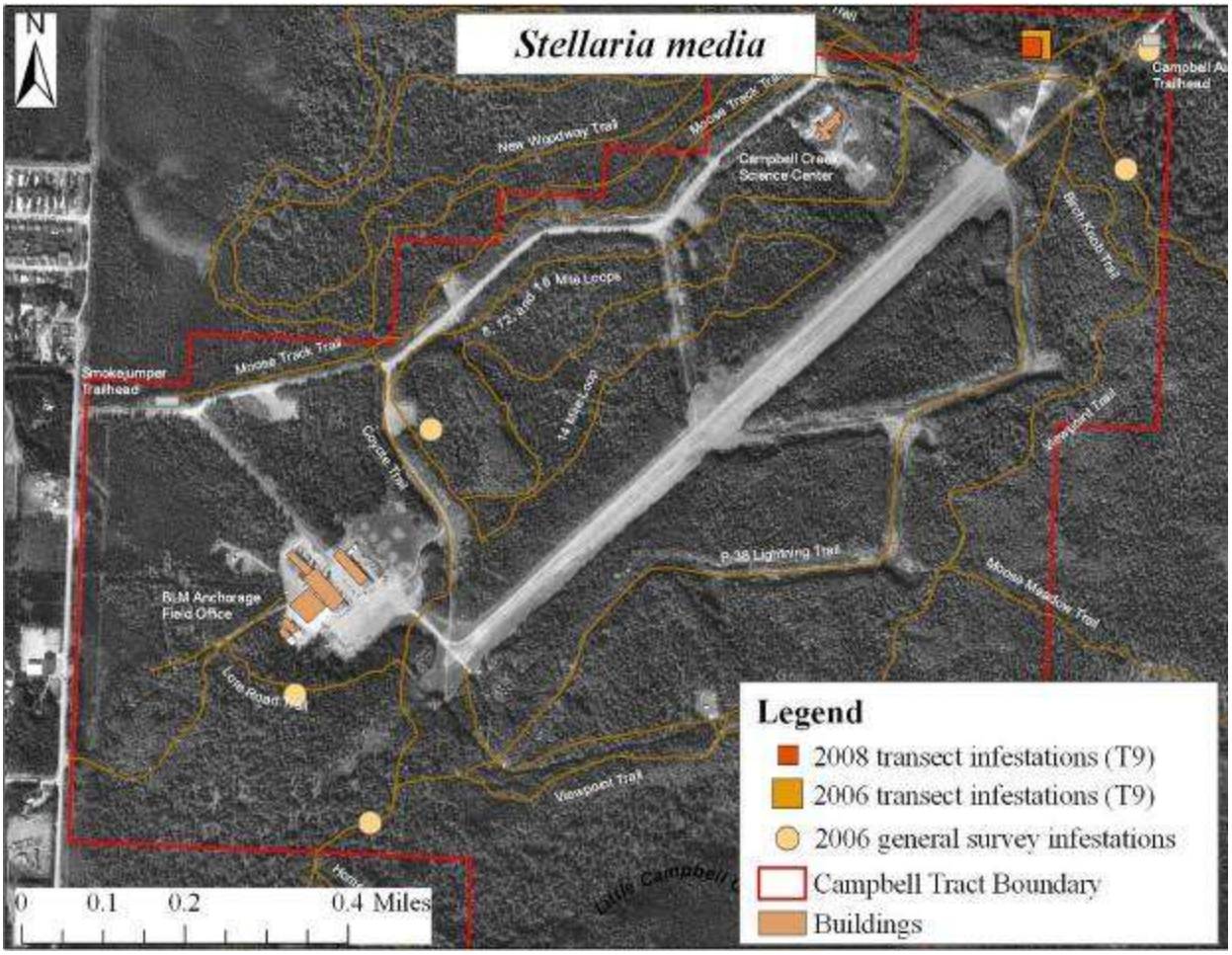
Comparative distribution of alsike clover (*Trifolium hybridum*, 57) in the Campbell Tract.

Crepis tectorum distributions



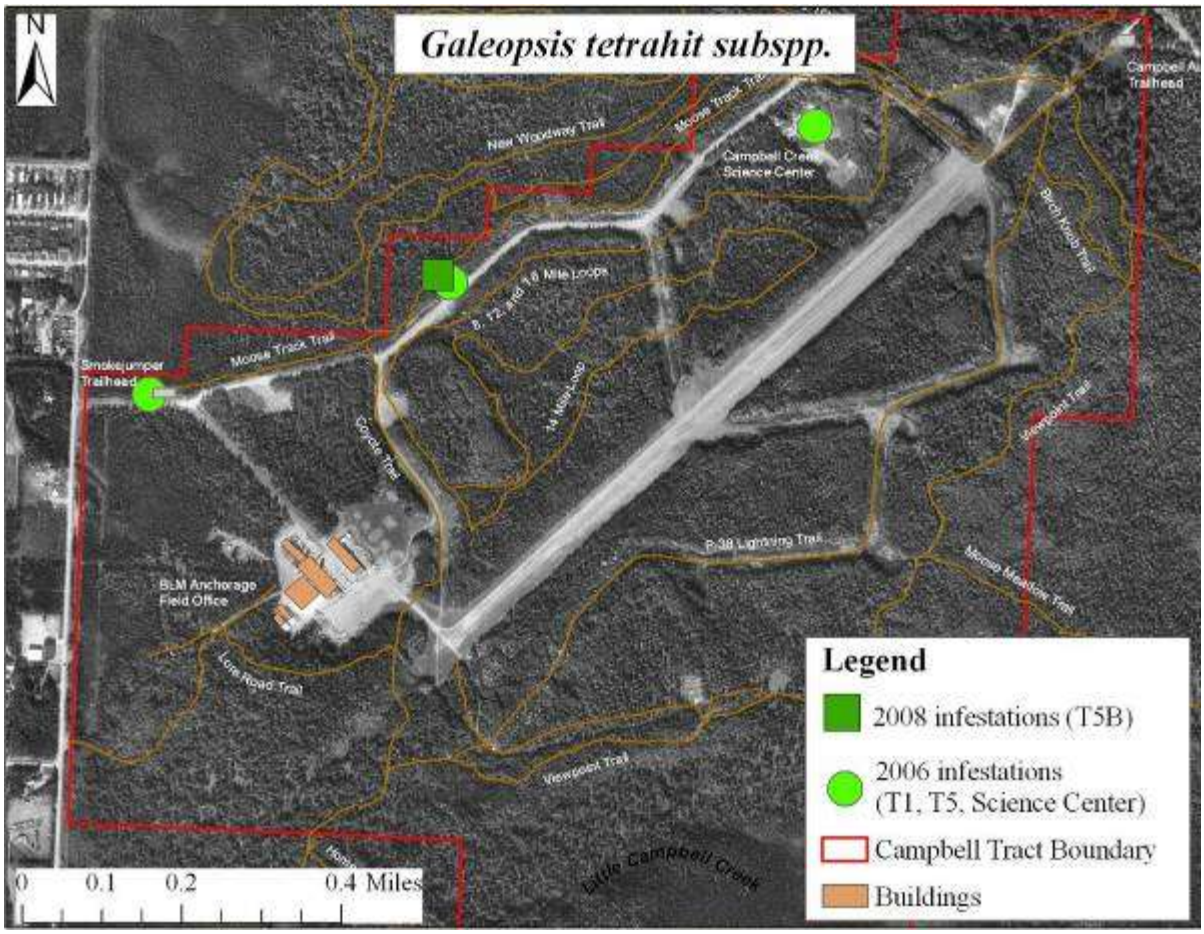
Comparative distribution of narrowleaf hawksbeard (*Crepis tectorum*, 54) in the Campbell Tract

Stellaria media distributions



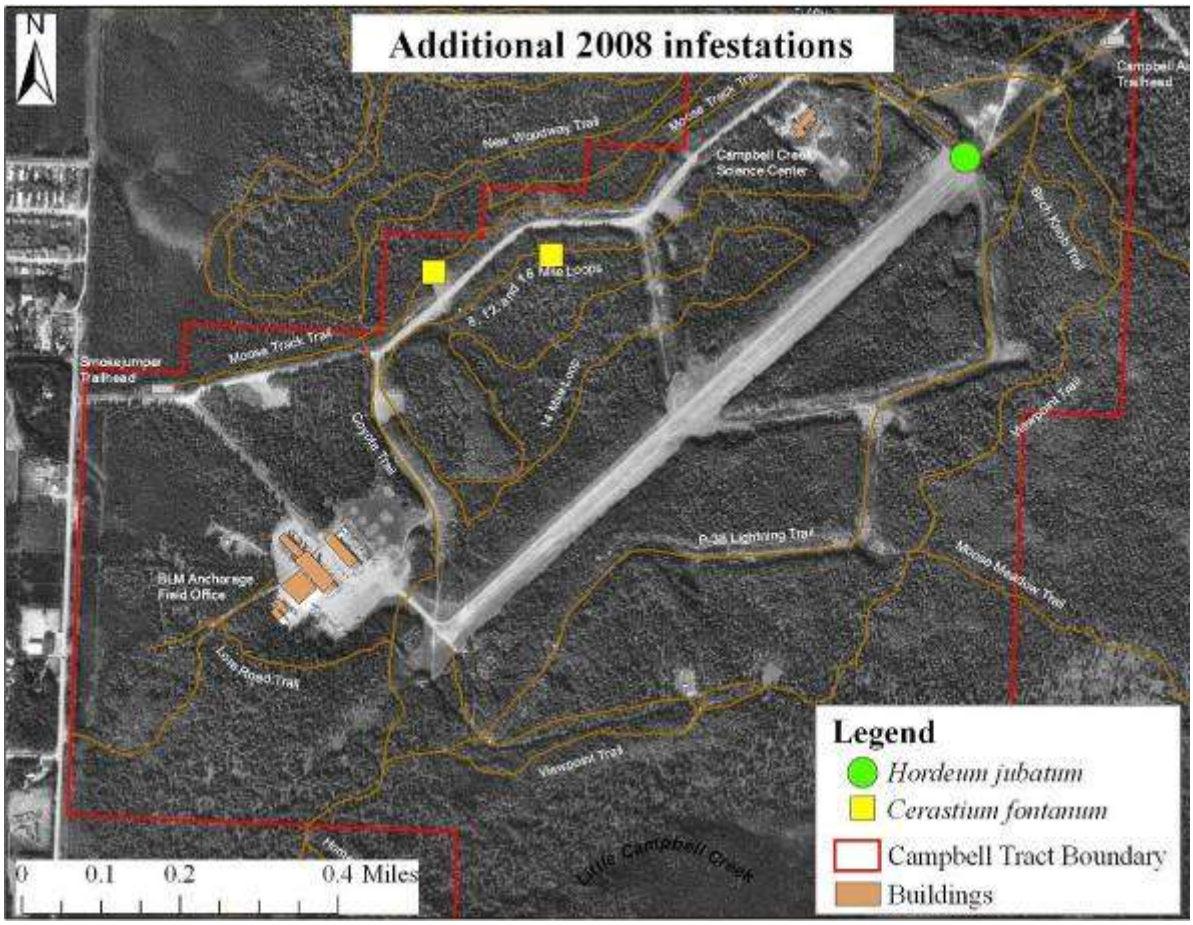
Comparative distribution of chickweed (*Stellaria media*, 42) in the Campbell Tract.

Galeopsis tetrahit subspp. distributions



Comparative distribution of hempnettle (*Galeopsis tetrahit subspp.*, 40) in the Campbell Tract.

Additional 2008 infestations distributions



Distributions of foxtail barley (Hordeum jubatum, 63) and mouse-ear chickweed (*Cerastium fontanum*, 39) in the Campbell Tract.