# **2009 CAMPBELL TRACT NON-NATIVE PLANT SURVEY:**

Revisiting permanent monitoring transects established in 2006



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# **Table of Contents**

Abstract	iii
Acknowledgements	iv
Introduction	1
Background	1
Summary of 2006 Campbell Tract work	2
Summary of 2008 Campbell Tract work	2
2009 survey objectives	3
Project deliverables	3
Methods	4
Results	7
Transect 1	10
Transect 2	13
Transect 3	16
Transect 4	18
Transect 7	19
Summary & Recommendations	21
Literature Cited	
Appendix I: High-priority non-native plant species targeted in Campbell Tract surveys	
Appendix II: Non-native plant species occurring in Campbell Tract	
Appendix III: Non-native plant species distribution maps	
Field mustard (Brassica rapa; NR)	29
Smooth brome (Bromus inermis ssp. inermis; 62)	30
Perennial cornflower (Centaurea montana; NR)	31
Narrowleaf hawksbeard (Crepis tectorum; 54)	32
Quackgrass (Elymus repens; 59)	
Hempnettle (Galeopsis tetrahit s.l.; 40)	34
Orange hawkweed (Hieracium aurantiacum; 79)	35
Oxeye daisy (Leucanthemum vulgare; 61)	36
Butter and eggs (Linaria vulgaris; 69)	
Italian ryegrass (Lolium perenne ssp. multiflorum; 41)	38
Perennial ryegrass (Lolium perenne ssp. perenne; NR)	
White sweetclover (Melilotus alba; 81)	40
European bird cherry (Prunus padus; 74)	41
Alsike clover (Trifolium hybridum; 57)	
Red clover (Trifolium pratense; 53)	43
White clover (Trifolium repens; 59)	44
Bird vetch (Vicia cracca; 73)	45

### List of Tables

Table 1. Location and revisit log of permanent monitoring transects.	4
<b>Table 2.</b> Percent frequency of occurrence <sup>1</sup> of non-native plant species detected in the Campbell Tract by	
AKNHP staff since 2006	8
Table 3. Non-native plant species detected at Transect 1	12
Table 4. Non-native plant species detected in the vicinity of the Smokejumpers Trailhead	12
<b>Table 5.</b> Non-native plant species new to Campbell Tract in 2009, all are located at the Smokejumpers	
Trailhead	12
Table 6. Non-native plant species detected at Transect 2.	15
Table 7. Non-native plant species detected in the vicinity of Transect 2.	15
Table 8. Non-native plant species detected at Transect 3.	17
Table 9. Non-native plant species detected in the vicinity of Transect 3.	17
Table 10. Non-native plant species detected at Transect 4.	18
Table 11. Non-native plant species detected at Transect 7	20

# List of Figures

Figure 1. Locations of the nine transects established in 2006 (yellow) and the four transects established in	
2008 (blue) in the Campbell Tract, Anchorage, Alaska	5
Figure 2. Schematic representation of transect (solid line) and subplot (dotted line) organization.	5
Figure 3. Example aluminum tag placed within each transect to facilitate relocation	5
<b>Figure 4.</b> Proportion of non-native plant species cover to total vegetated cover (native and non-native plant species) compared to the percent cover of unvegetated ground surface for all subplots sampled in 2009 (Transects 1-4, 7) at the Campbell Tract, Anchorage, Alaska	9
<b>Figure 5.</b> Comparison of non-native plant species cover to distance from disturbance for Transects 1-4 and 7 at the Campbell Tract, Anchorage, Alaska.	9
Figure 6. Transect 1 showing new location and recently seeded lawn at the Smokejumpers Trailhead in 2009	1
Figure 7. Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 1 at the Campbell Tract, Anchorage, Alaska	3
Figure 8. Large populations of <i>Linaria vulgaris</i> along the BLM Road (Transect 2) in 200713	3
Figure 9. Transect 2 showing location and recently seeded lawn along the BLM Road in 200914	1
Figure 10. Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 2 at the Campbell Tract, Anchorage, Alaska	6
<b>Figure 11.</b> Transect 3 in 2009 showing location, recently bladed section and aluminum tag in foreground. <b> 10</b> <b>Figure 12.</b> Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of	5
Transect 3 at the Campbell Tract, Anchorage, Alaska	7
Figure 13. Transect 4 showing location with aluminum tag in foreground and patch of <i>Trifolium repens</i> in trail in 2009	8
<b>Figure 14.</b> Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 4 at the Campbell Tract. Anchorage. Alaska	<b>a</b>
Figure 15. Transect 7 showing location in 2009	э
Figure 16. Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 7 at the Campbell Tract, Anchorage, Alaska	D

### Abstract

In 2009, botanists from the Alaska Natural Heritage Program revisited five long-term monitoring transects (Transects 1-4, 7) located in the Campbell Tract in Anchorage and operated by the Bureau of Land Management, Anchorage Field Office. These transects were established in 2006 to document long-term change in plant community composition and extent of non-native species infestations. Non-native plant species appear to establish preferentially in human disturbed areas and naturally open habitats, specifically those with a high presence of unvegetated ground surface. In accordance with this observation, the percent of non-native species cover decreased with increasing distance from the location of primary disturbance. Forty-six non-native plant species have been documented to date within the Tract; eight of these species were new to the Tract in 2009 and were presumably introduced during construction activity completed in 2008 between Elmore Road and the BLM field offices.

In accordance with previous surveys, the airstrip, material source area, BLM field office buildings, and Smokejumpers Trailhead continue to be locations of concern. The activity at these locations makes them susceptible to weed introductions, and the connectivity of these sites to the rest of Campbell Tract makes them potential source areas for the further dispersal of non-native plant species. The control recommendations made herein are largely based on the new species occurrences and distribution data collected in 2009. Comprehensive management recommendations will be made for the Tract in the forthcoming Campbell Tract Weed Management Plan, currently in preparation by AKNHP.

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### Introduction

#### Background

The 730-acre Campbell Tract in Anchorage, Alaska is managed by the Bureau of Land Management (BLM). With over 12 miles of trails and an outdoor education center, the Campbell Creek Science Center, the Tract provides year-round outdoor recreation and education opportunities for its 120,000 annual visitors. Bureau of Land Management Anchorage Field Offices (AFO), 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 Campbell Tract 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 re-graded and reseeded with topsoil or seed mixes contaminated with non-native plant propagules.

The BLM is committed to minimizing the introduction, establishment and dispersal of invasive<sup>1</sup> plant species to the Tract to conserve the natural ecology of the area. The first step in invasive plant management is to inventory the targeted area for non-native<sup>2</sup> plants, or weeds<sup>3</sup> so that species and 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 non-native plants, record their locations and recommend areas for control (Carlson et al. 2006); long-term monitoring transects set up in conjunction with the initial survey have been revisited on a rotating, biennial basis in 2008 (Cortés-Burns 2009), and 2009 (this report). Results of the initial 2006 survey and 2008 revisit work are summarized in the following sections.

<sup>&</sup>lt;sup>1</sup> Invasive plants are non-native plants that produce viable offspring in large numbers and have the potential to establish and spread in natural areas.

<sup>&</sup>lt;sup>2</sup> Non-native plants are plants whose presence in a given area is due to accidental or intentional introduction by humans.

<sup>&</sup>lt;sup>3</sup> A weed is a plant, native or not, whose presence is undesirable to people in a particular time or place. In this work, given the potential negative impacts of non-native plants on ecosystem integrity and function, we also refer to non-native plants as weeds.

#### Summary of 2006 Campbell Tract work

The Alaska Natural Heritage Program surveyed the Campbell Tract for high-priority<sup>4</sup>, nonnative plant species (Appendix I) during the 2006 field season. The non-native species most commonly encountered during this initial survey were: white clover (*Trifolium repens*; 59<sup>5</sup>), alsike clover (*Trifolium hybridum*; 57), narrowleaf hawksbeard (*Crepis tectorum*; 54), white sweetclover (*Melilotus alba*; 81), and timothy (*Phleum pratense*; 56). These species were commonly found on roadsides, the gravel airstrip and some trails. Most species occurred as large, semi-continuous infestations except for *Melilotus alba* and *Phleum pratense*, which occur as numerous, 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), hempnettle (*Galeopsis tetrahit* s.l.; 40), and oxeye daisy (*Leucanthemum vulgare*; 61) are highly invasive species that were found in largely undisturbed woodlands. Two European bird cherry (*Prunus padus*; 74) individuals were found (and pulled) along Campbell Creek.

Based on this initial survey, the areas of greatest concern, as determined by the threat of invasive plants moving into natural habitats, are: 1) the material source area (Transects 5 and 5B; Figure 1), 2) the meadow adjacent to the airstrip parking lot (vicinity of Transect 3), 3) a number of isolated invasive plant populations in the forests (*e.g. Hieracium aurantiacum*, Transects 6 and 6B), and 4) the airstrip margins (area between Transects 3 and 8).

In addition to the 2006 surveys, AKNHP erected nine (Transects 1-5, 7-10) permanent transects to track the potential establishment and spread of non-native plants in the Campbell Tract. Each transect originated at an infestation of a priority weed species and extended away from the area of greatest disturbance into native vegetation.

#### Summary of 2008 Campbell Tract work

In 2008, AKNHP revisited permanent transects to determine if there had been any measurable changes in plant community composition and established new transects to capture additional infestations of high-priority species. Specifically, 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 permanent transects (Transects 5B, 6B, and 8B).

Our 2008 revisit work confirmed that the material source area (Transects 5 and 5B) and the airstrip (area between Transects 3 and 8) continue to be major sources of weed

<sup>&</sup>lt;sup>4</sup> High-priority plant species are those ranked at 60 points or greater by the Alaska Invasive Plant Ranking System (Carlson et al. 2008). This system ranks plant species on a scale of 0 to 100 with 100 being an extremely invasive species.

<sup>&</sup>lt;sup>5</sup> Species are listed by common name, with scientific name and invasiveness provided parenthetically at the first mention within each section, after which they are referred to by scientific name only. Invasiveness rank is scaled from zero (very weakly invasive) to 100 (extremely invasive); taken from Carlson et al. 2008.

propagules. Infestations of particular concern at these source locations were: 1) the *Linaria vulgaris* and *Galeopsis tetrahit* s.l. populations at the material source area, which have the potential to invade native vegetation, 2) the *Crepis tectorum* and *Melilotus alba* infestations that are invading native vegetation along the airstrip, and 3) a new infestation of bird vetch (*Vicia cracca;* 73) at the NE end of the airstrip (Transect 8B was set up to monitor this infestation). Treatment and monitoring was recommended for all these locations. Continued monitoring of the Campbell Creek corridor for establishment of the riparian-specialist and highly invasive tree, *Prunus padus*, as well as herbicide treatment for *Hieracium aurantiacum* infestations at Transects 6 and 6B that had not been reduced by hand-pulling were also recommended.

#### 2009 survey objectives

In 2009 AKNHP worked with BLM to revisit five of the long-term, permanent 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 at these sites since 2006.

#### **Project deliverables**

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

# Methods

AKNHP botanists Lindsey Flagstad and Helen Cortés Burns revisited five (Transects 1-4, 7) of the 13 transects on August 2 and 4, 2009. Transects were revisited over the course of two years (four in 2008 and five in 2009) due to funding limitations (see Table 1 for transect locations and revisit log). Transect 1, located at the Smokejumpers Trailhead, was relocated approximately 25 meters (m) west of its original position to accommodate for the expansion of the parking lot it is adjacent to and which was completed in 2008. Campbell Tract transect locations are shown in Figure 1.

Transect	Location	Transect	Transect	Revisited	Revisited
No.	Location	origin	terminus	in 2008?	in 2009?
1	Smolyojumpor Trailhoad	61.15873ºN	61.15877⁰N	No	Relocated
1	Sinokejumper Hanneau	-149.8019ºW	-149.80206ºW	NO	in 2009
2	NW corner of BLM AFO	61.15670ºN	61.15646⁰N	No	Voc
2	parking lot	-149.79591ºW	-149.79663⁰W	NO	Tes
2	SE corner of BLM AFO parking	61.15511⁰N	61.15491⁰N	No	Voc
5	lot	-149.79205ºW	-149.79208ºW	NO	165
4	9 Mile Loop	61.15781ºN	61.15787⁰N	No	Voc
4	о-мпе соор	-149.79099⁰W	-149.79094ºW	NO	Tes
E	Matorial course area	61.16099⁰N	61.16114ºN	Voc	No
5	Matel lai source area	-149.79045ºW	-149.79024ºW	Tes	NO
ED	Matorial course area	61.161020ºN	not recorded	Established	No
30	Material source area	-149.79047ºW	not recorded	in 2008	INO
6	9 12 16 Mile Loop	61.16151⁰N	not recorded	Established	No
6	8, 12, 10-Mile Loop	-149.78655⁰W	not recorded	in 2008	INO
6 P	9 12 16 Mile Loop	61.160829 ⁰N	not recorded	Established	No
OD	o, 12, 10-Mile Loop	-149.78619ºW	not recorded	in 2008	NO
7	Viewpoint Trail	61.15377⁰N	61.15374⁰N	No	Voc
/		-149.78072ºW	-147.7803ºW	NO	Tes
0	NE and of airstrin	61.16339⁰N	61.16334⁰N	Voc	No
0	NE end of an surp	-149.77066⁰W	-149.77016ºW	Tes	NO
OD	NE and of airstrin	61.163280ºN	not recorded	Established	No
88	NE end of an surp	-149.77075ºW	not recorded	in 2008	INO
0	Campbell Creek, west of sled	61.16570ºN	61.16587⁰N	Voc	No
9	dog bridge	-149.76979ºW	-149.76971ºW	res	NO
10	Campbell Airstrip Trailbard	61.16557⁰N	61.16542ºN	Voc	No
10	Campbell All surprisaineau	-149.76587ºW	-149.76541ºW	ies	INO

**Table 1.** Location and revisit log of permanent monitoring transects.



**Figure 1.** Locations of the nine transects established in 2006 (yellow) and the four transects established in 2008 (blue) in the Campbell Tract, Anchorage, Alaska.

Transects originate at a high-priority weed infestation and are orientated away from the area of greatest disturbance into native vegetation. Transects extend for at least 1 m beyond the last invasive plant encountered; accordingly, overall transect lengths range from 10 to 30 m. In 2006, a series of  $0.1 \times 1$  m temporary subplots spaced 1 m apart were sampled within Transects 1-5 and 7-10. Subplot dimensions were increased to  $1 \times 1$  m in 2008 to better capture potential changes in the diversity or extent of non-native species infestations (Figure 2). Data collected within each subplot 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), description of substrate (*i.e.* percent unvegetated ground cover), and previous control action, if any. The species identities of all plants have been determined by AKNHP botanists.

To aid in relocation, the origin and terminus of each transect was marked with a GPS, permanent markers (aluminum tags) and flagging tape in areas not subject to extensive human use; reference photos were also taken. Aluminum tags were placed on at least one tree at each of the transects revisited, generally at or close to the terminus of the transect

(*i.e.* away from the trails and high use areas). The following information was recorded on each aluminum tag: site code, survey date, scientific name of the priority species being tracked, and the identification code of the waypoint taken at the origin of the transect (Figure 3).



**Figure 2.** Schematic representation of transect (solid line) and subplot (dotted line) organization.



**Figure 3.** Example aluminum tag placed within each transect to facilitate relocation

This report focuses on high-priority (invasiveness rank greater than or equal to 60 points; Appendix I) non-native plant species. Unranked species that display moderately invasive behavior such as; field mustard (*Brassica rapa*) and perennial cornflower (*Centaurea montana*), as well as potentially under-ranked species such as narrowleaf hawksbeard (*Crepis tectorum*; 54) and hempnettle (*Galeopsis tetrahit* s.l.; 40) are also treated as priority species herein. Plant species that are already too widespread and for which efficient eradication is no longer a realistic option (*e.g.* common dandelion [*Taraxacum officinale* ssp. *officinale*; 58], Kentucky and spreading bluegrass [*Poa pratensis* ssp. *irrigata* and *P. pratensis* ssp. *pratensis*; 52]), and chickweed [*Stellaria media*; 42], and for species whose nativity to Alaska is unresolved, such as foxtail barley (*Hordeum jubatum*; 63) were not prioritized for treatment despite their relatively high invasiveness ranks.

### Results

Non-native species records collected by AKNHP since 2006 show a total of 43 non-native species occurring within the Campbell Tract (Table 2 and listed alphabetically in <u>Appendix</u> <u>II</u>). Species not captured in this total include tumble mustard (*Sisymbrium altissimum*; NR) collected by BLM staff outside the Campbell Creek Science Center in 2006, Canada thistle (*Cirsium arvense*; 76) found in the open area surrounding the RAWS weather station in 2008 and 2009, and reed canarygrass (*Phalaris arundinacea*; 83) observed at the Smokejumpers Trailhead by Municipality of Anchorage Invasive Weeds Program Coordinator, Gretchen Gary, in 2010.

Percent frequency of occurrence (Table 2) indicates that the most common species are weakly to modestly invasive; this includes species such as white clover (*Trifolium repens*; 59), alsike clover (*Trifolium hybridum*; 57), common dandelion (*Taraxacum officinale* ssp. *officinale*; 58), timothy (*Phleum pretense*; 54) and common plantain (*Plantago major*; 44). Due to their wide distribution in Alaska and abundance within the Tract, management and control is a low priority for these commonly occurring species. Of greater concern are the also abundant and extremely to moderately invasive species such as narrowleaf hawksbeard (*Crepis tectorum*; 54), white sweetclover (*Melilotus alba*; 81), oxeye daisy (*Leucanthemum vulgare*; 61), butter and eggs (*Linaria vulgaris*; 69) and quackgrass (*Elymus repens*, 59), as well as the smaller or more discrete infestations of bird vetch (*Vicia cracca*; 73), orange hawkweed (*Hieracium aurantiacum*; 79), smooth brome (*Bromus inermis* ssp. *inermis*; 62), hempnettle (*Galeopsis tetrahit* s.l.; 40), and European bird cherry (*Prunus padus*; 74). Percent frequency was calculated by dividing the number of times a given nonnative plant species occurred by the total number of non-native plant species occurrences within the Tract; these calculations include all data collected in 2006, 2008 and 2009.

The occurrence of several unranked species in the Tract also bears mention. Siberian wildrye (*Elymus sibiricus*; NR), hairy cat's ear (*Hypochaeris radicata*; NR), woodland ragwort (*Senecio sylvaticus*; NR), field mustard (*Brassica rapa*; NR) and perennial cornflower (*Centaurea montana*; NR) have not been ranked with respect to their invasiveness, however the biological character and distribution of these species within the southcentral region indicate their potential to cause ecosystem harm.

Table 2. Percent frequency of occurrence<sup>1</sup> of non-native plant species detected in the Campbell Tract by AKNHP staff since 2006. .

		Percent	Invasiveness
Scientific Name	Common Name	<b>Frequency</b> <sup>1</sup>	Rank <sup>2</sup>
Trifolium repens	white clover	24.65	59
Crepis tectorum	narrowleaf hawksbeard	12.61	54
Melilotus alba	white sweetclover	12.61	81
Trifolium hybridum	alsike clover	10.06	57
Taraxacum officinale ssp. officinale	common dandelion	9.92	58
Phleum pratense	timothy	4.25	54
Plantago major	common plantain	4.11	44
Leucanthemum vulgare	oxeye daisy	2.97	61
Poa pratensis (ssp. irrigata and ssp. pratensis)	Kentucky bluegrass	2.97	52
Stellaria media	common chickweed	2.55	42
Linaria vulgaris	butter and eggs	2.41	69
Elymus repens	quackgrass	1.27	59
Poa annua	annual bluegrass	0.99	46
Cerastium fontanum ssp. vulgare	common mouse-ear chickweed	0.85	36
Polygonum aviculare	prostrate knotweed	0.85	45
Vicia cracca	bird vetch	0.85	73
Hieracium aurantiacum	orange hawkweed	0.71	79
Chenopodium album	lambsquarters	0.57	37
Bromus inermis ssp. inermis	smooth brome	0.42	62
Erucastrum gallicum	common dogmustard	0.42	NR
Galeopsis tetrahit s.l.	hempnettle	0.42	40
Lolium perenne ssp. perenne	perennial ryegrass	0.42	NR
<i>Elymus sibiricus</i>	Siberian wildrye	0.28	NR
Hordeum jubatum	foxtail barley	0.28	63
Matricaria discoidea	pineappleweed	0.28	32
Trifolium pratense	red clover	0.28	53
Tripleurospermum inodorum	scentless false mayweed	0.28	48
Alopecurus pratensis	meadow foxtail	0.14	NR
Hypochaeris radicata	hairy cat's ear	0.14	NR
Lepidium densiflorum	common pepperweed	0.14	25
Lolium perenne ssp. multiflorum	annual ryegrass	0.14	41
Lupinus polyphyllus	bigleaf lupine	0.14	55
Persicaria lapathifolia	curlytop knotweed	0.14	47
Prunus padus	European bird cherry	0.14	74
Rumex acetosella	common sheep sorrel	0.14	51
Rumex longifolius	dooryard dock	0.14	48
Senecio sylvaticus	woodland ragwort	0.14	NR
Silene armeria	sweet William	0.14	NR
Silene dioica	Clairville red catchfly	0.14	42
Brassica rapa	field mustard	0.00	NR
Capsella bursa-pastoris	shepherd's purse	0.00	40
Centaurea montana	perennial cornflower	0.00	NR
Spergula arvensis	corn spurry	0.00	32

1: Percent frequency of occurrence is calculated as (100 \* number of records for species A / total number of records for non-native

species) 2: Invasiveness ranks are taken from Carlson et al. 2008; 'NR' indicates that the species has not yet been ranked and does not imply low invasiveness

Similar to the trends established by Carlson et al. (2006) and Cortés-Burns (2009), we observed non-native plant species establishing preferentially in human disturbed areas and naturally open habitats across the Tract. These observations are supported by a general increase in the proportion of non-native plant species cover with unvegetated (and presumably disturbed) ground surface for the 43 subplots sampled in 2009 (Figure 4).



**Figure 4.** Proportion of non-native plant species cover to total vegetated cover (native and non-native plant species) compared to the percent cover of unvegetated ground surface for all subplots sampled in 2009 (Transects 1-4, 7) at the Campbell Tract, Anchorage, Alaska.

The percent of non-native species cover decreased with increasing distance from the location of primary disturbance, typically a trail or road corridor (Figure 5). Large scale construction activity such as the expansion of the Smokejumpers Trailhead and water line replacement along BLM Road completed in 2008 appears to be the greatest factor in the introduction and spread of non-native plant species in the Tract.



**Figure 5.** Comparison of non-native plant species cover to distance from disturbance for Transects 1-4 and 7 at the Campbell Tract, Anchorage, Alaska.

Transects were revisited to document long-term change in plant community composition and extent of non-native species infestations. Detailed descriptions of non-native species biology, ecology and control mechanisms can be found in the Invasive Plants of Alaska field guide book (AKEPIC 2005) and on-line at the AKEPIC (Alaska Exotic Plants Inventory and Clearinghouse) invasiveness raking page (http://akweeds.uaa.alaska.edu/akweeds ranking page.htm).

#### Transect 1

Transect 1 is located at the Smokejumpers Trailhead immediately beyond the Elmore Road entrance to the Tract (Figure 6). The location of Transect 1 was originally proposed to capture a population of *Galeopsis tetrahit* s.l. that was observed in the forest adjacent to the Trailhead, however when the transect was erected in 2006, this infestation could not be relocated. It is thought that the plants may have been pulled in the time between when they were originally observed and placement of the transect. Interestingly, *Galeopsis tetrahit* s.l. plants were recorded at this location in 2009.

In 2009, this transect was relocated approximately 25 m to the west of its original position to accommodate parking lot expansion completed in 2008. The topsoil and/or seed mix that were used to re-grade and revegetate this site were apparently contaminated with a variety of non-native plant propagules. The non-native species assemblage and cover at this site changed considerably since the initial survey. Since the transect position was altered at this site, we cannot be confident of trends through time, however the percent cover along the transect in 2006 and 2009 shows very high cover of non-native plants at the transect origin in 2009 (Figure 7). This increased cover of non-natives is primarily the expected consequence of reseeding the disturbed area at the beginning of the transect with *Lolium perenne* ssp. *perenne*. In both years, the occurrence of non-native plants declined dramatically at the forest edge.

In 2006, *Tripleurospermum inodorum* (scentless false mayweed, 48), *Cerastium fontanum* (common mouse-ear chickweed, 36), *Taraxacum officinale* ssp. *officinale* (common dandelion, 58) and *Trifolium hybridum* (alsike clover, 57) were the only non-native species detected in this area. In 2009, 21 non-native species were found within the transect (Table 3) and in the surrounding newly reseeded area (Table 4). With the exception of *Tripleurospermum inodorum* and *Trifolium hybridum*, which were also found in 2006, all species are new to this location. In addition, all eight of the species not previously recorded anywhere in the Campbell Tract but present in 2009 are found at this location (Table 5). The presence of reed canarygrass (*Phalaris arundinacea*, 83) at the Smokejumpers Trailhead has been anecdotally reported by Municipality of Anchorage Invasive Weeds Program Coordinator, Gretchen Gary, in 2010.



**Figure 6.** Transect 1 showing new location and recently seeded lawn at the Smokejumpers Trailhead in 2009

The majority of non-native plants found at this location are either not high-priority species (invasiveness rank less than 60) or they represent unranked species that are not expected to persist under competitive pressure from native species (e.g. common dog mustard [*Erucastrum gallicum*, NR], sweet William silene [*Silene armeria*, NR], perennial ryegrass (*Lolium perenne* ssp. *perenne*, NR]).

We are, however concerned about the occurrence of *Melilotus alba, Vicia cracca* and *Phalaris arundinacea* (if confirmed) at this site due to their well-documented invasiveness in Alaska. It appears that *Vicia cracca* has either spread or been introduced to this location since 2008 when its distribution was restricted to the Campbell Creek Science Center, the northeast end of the airstrip (Transect 8B) and AFO (Transect 3, Appendix II). Despite its low rank (40), the presence of *Galeopsis tetrahit* s.l. at this location is also concerning as it is increasingly observed invading native vegetation in the Anchorage area and was documented at this location in 2006 (prior to erection of the monitoring transect) suggesting that the population is persistent at this location.

We are moderately concerned about the small populations of field mustard (*Brassica rapa*, NR) and perennial cornflower (*Centaurea montana*, NR) due to their recent rate of dispersal and apparent invasiveness in the Anchorage area. Perennial ryegrass (*Lolium perenne* spp. *perenne*, NR) is considered a species of concern at this site due to its shear abundance rather than its potential invasiveness. Similar to the related subspecies, annual ryegrass (*Lolium perenne* spp. *multiflorum*, 41), *Lolium perenne* ssp. *perenne* reproduces exclusively by seed and does not form a persistent seed bank (Thompson and Grime 1979) and is quickly replaced by tall herbaceous and woody species (Densmore et al. 2001).

**Table 3.** Non-native plant species detected at Transect 1.

Scientific name	Common name	Invasivness rank	Percent cover
Chenopodium album	lambsquarters	37	0.6
Erucastrum gallicum	common dogmustard	NR	1.4
Lolium perenne ssp. multiflorum	annual ryegrass	41	0.2
Lolium perenne ssp. perenne	perennial ryegrass	NR	29.6
Melilotus alba	white sweetclover	81	0.8
Persicaria lapathifolia	curlytop knotweed	47	0.2
Plantago major	common plantain	44	0.2
Polygonum aviculare	prostrate knotweed	45	0.2
Silene armeria	sweet William silene	NR	0.2
Silene dioica	Clairville red catchfly	42	0.2
Trifolium hybridum	alsike clover	57	0.4
Tripleurospermum inodorum	scentless false mayweed	48	0.2
Viccia cracca	bird vetch	73	0.2

Table	<ol> <li>Non-native</li> </ol>	plant species	detected in	n the vicinity	of the Sm	okejumpers	Trailhead

Scientific name	Common name	Invasivness rank
Brassica rapa	field mustard	NR
Capsella bursa-pastoris	shepherd's purse	40
Centaurea montana	perennial cornflower	NR
Galeopsis tetrahit s.l.	hempnettle	40
Matricaria discoidea	pineappleweed	32
Rumex sp.	dock	NA
Spergula arvensis	corn spurry	32
Trifolium repens	white clover	59

NR – not ranked

NA – not applicable

Table 5. Non-native plant species new to Campbell Tract in 2009,	all are located at the Smokejumpers
Trailhead.	

Scientific name	Common name	Invasivness rank
Brassica rapa	field mustard	NR
Capsella bursa-pastoris	shepherd's purse	40
Centaurea montana	perennial cornflower	NR
Erucastrum gallicum	common dogmustard	NR
Lolium perenne ssp. multiflorum	annual ryegrass	41
Silene armeria	sweet William silene	NR
Silene dioica	Clairville red catchfly	42
Spergula arvensis	corn spurry	32

NR – not ranked

NA – not applicable

Please note that only one *Rumex* individual occurred in this area, and had not flowered at the time of the survey. Due to a lack of flowers and seeds we were unable to determine the identity of this plant. If this *Rumex* does represent a non-native species it is likely to be one of the larger dock species, either curly dock (*Rumex crispus*, 48), or dooryard dock (*Rumex longifolius*, NR). *Rumex longifolius* was observed on the Tract in 2006 and is expected to have an invasiveness rank similar to that of *R. crispus*, which is not a high-priority species.

However, we encourage BLM staff to collect any flowering individuals of this genus encountered at the Smokejumpers Trailhead so that its taxonomic identity can be determined.

Considering the increases in diversity and abundance (Figure 7) of non-native species in conjunction with the vehicle and foot traffic at this site, the Smokejumpers Trailhead should be considered a source and dispersal location for non-native species throughout the Tract. As such, this site is now one of the higher priorities for control work. Please note that due to relocation of Transect 1 in 2009, the comparison between percent cover of non-native vegetation in 2006 and 2009 should be used to show a general increase in percent cover at the site rather than change in percent cover specific to subplots.



**Figure 7.** Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 1 at the Campbell Tract, Anchorage, Alaska.

#### Transect 2

Transect 2 is located along the northwest boundary of the BLM AFO parking lot where the access road loops south behind the office building (Figures 8 and 9). A new waterline was installed from Elmore Road, along the south side of BLM Road to the field offices in 2008. Similar to Transect 1, the topsoil and/or seed mix that were used to re-grade and revegetate this site were apparently contaminated with a variety of nonnative plant propagules and as a result a greater diversity and abundance of nonnative species is now present at this site.



**Figure 8.** Large populations of *Linaria vulgaris* along the BLM Road (Transect 2) in 2007.

In 2006, six non-native species were recorded at this transect: smooth brome (Bromus inermis ssp. inermis; 62), narrowleaf hawksbeard (Crepis tectorum; 54), yellow toadflax (Linaria vulgaris; 61), common dandelion (Taraxacum officinale ssp. officinale; 58), alsike clover (Trifolium hybridum; 57) and red clover (Trifolium pratense; 53). Melilotus alba and Linaria vulgaris were noted growing in native dwarf shrubs near the AFO in 2007 (Helen Cortés-Burns, pers. obs., Figure 8). In 2009, 18 non-native species were recorded here. Five of these 18 species: Crepis tectorum, Linaria vulgaris, Melilotus alba, Taraxacum officinale ssp. officinale and Trifolium hybridum; were previously recorded at this location, however the remaining 14 species detected within the transect (Table 6) or in the surrounding recently seeded areas (Table 7) are new to the site and two of these species, common dog mustard (Erucastrum gallicum, NR) and shepherd's purse (Capsella bursa-pastoris, 40), are new to the Tract. It is noteworthy that both Erucastrum gallicum and Capsella bursapastoris were also present at Transect 1 (Smokejumpers Trailhead). These plants may have dispersed from the Smokejumpers Trailhead or more likely, germinated from a batch of contaminated topsoil used for both the Trailhead reconstruction and waterline burial. Based on the relative dominances of Lolium (high at Transect 1) and Poa (high at Transect 2) grass species at Transect 1 and Transect 2, respectively, it appears that different mixes may have been used for reseeding these areas.



Figure 9. Transect 2 showing location and recently seeded lawn along the BLM Road in 2009

Scientific name	Common name	Invasivness rank	Percent cover
Cerastium fontanum	common mouse-ear chickweed	36	0.1
Chenopodium album	lambsquarters	37	0.4
Crepis tectorum	narrowleaf hawksbeard	54	0.3
Linaria vulgaris	yellow toadflax	61	0.3
Poa pratensis	Kentucky bluegrass	52	3.3
Polygonum aviculare	prostrate knotweed	45	0.3
Taraxacum officinale ssp. officinale	common dandelion	58	0.7
Trifolium hybridum	alsike clover	57	3.0

**Table 6**. Non-native plant species detected at Transect 2.

**Table 7**. Non-native plant species detected in the vicinity of Transect 2.

Scientific name	Common name	Invasivness rank
Capsella bursa-pastoris	shepherd's purse	40
Erucastrum gallicum	common dogmustard	NR
Hordeum jubatum	foxtail barley	63
Lolium perenne ssp. multiflorum	annual ryegrass	41
Matricaria discoidea	pineappleweed	32
Melilotus alba	white sweetclover	81
Phleum pratense	common timothy	54
Plantago major	common plantain	44
Stellaria media	common chickweed	42
Tripleurospermum perforata	scentless false mayweed	48

NR – not ranked

Species of concern at this site are *Melilotus alba* and *Linaria vulgaris*. Despite its comparatively low rank (54), *Crepis tectorum* is also a priority for control as this species is able to invade native plant communities and is a widespread and problematic species within the Tract. The remainder of non-native plants found at this location are either not high-priority species (invasiveness rank less than 60), are unranked species that are not expected to persist under competitive pressure from native species (e.g. *Erucastrum gallicum*), or are rejected from consideration due to taxonomic uncertainly (e.g. *Hordeum jubatum*).

A comparison of non-native plant cover along the transect between the 2006 and 2009 sampling events shows a similar abundance of non-natives, however percent cover at the beginning of the transect is much lower in 2009 than it was in 2006 (Figure 10). This reduction in cover is likely due to the waterline installation and reseeding with largely native grasses within this section of the transect.



**Figure 10.** Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 2 at the Campbell Tract, Anchorage, Alaska.

#### **Transect 3**

Transect 3 crosses an open area at the northeast margin of the BLM AFO parking lot where a gravel access road leaves the parking lot to meet the southwest end of the airstrip (Figure 11). In 2006, it was noted that this open area had been seeded with Trifolium hybridum sometime in the past. Since 2006, portions of the meadow had been bladed and as a probable result several of the original infestations identified in this general area (e.g. Melilotus alba, Vicia cracca, and Phleum pratense) are no longer present. Crepis tectorum, Taraxacum officinale ssp. officinale and Trifolium *hybridum* occurred within the transect



**Figure 11.** Transect 3 in 2009 showing location, recently bladed section and aluminum tag in foreground.

in 2006; *Crepis tectorum* was not present in 2009, however *Taraxacum officinale* ssp. *officinale* and *Trifolium hybridum* infestations have persisted since 2006.

Of the seven non-native species documented within this transect (Table 8) and in the vicinity (Table 9) in 2009, we are most concerned with *Linaria vulgaris* and *Elymus repens*, both of which occur outside of the transect boundaries. Although *Elymus repens* is ranked below 60 points, this strongly rhizomatous grass is able to form a dense mat that excludes native species in areas of soil disturbance (Carlson et al. 2008).

**Table 8.** Non-native plant species detected at Transect 3.

Scientific name	Common name	Invasivness rank	Percent cover
Stellaria media	common chickweed	42	0.5
Taraxacum officinale ssp. officinale	common dandelion	58	32.5
Trifolium hybridum	alsike clover	57	5.5
Trifolium repens	white clover	59	5

**Table 9.** Non-native plant species detected in the vicinity of Transect 3.

Scientific name	Common name	Invasivness rank
Cerastium fontanum	common mouse-ear chickweed	36
Elymus repens	quackgrass	59
Linaria vulgaris	yellow toadflax	61

Although two of the subplots show high non-native cover (due to the presence of *Taraxacum officinale* ssp. *officinale* infestations) in 2009, the reduction in non-native plant cover towards the terminus of the transect relative to 2006 is encouraging (Figure 12). This reduction may result from the removal of infestations at the origin of the transect that may have served as a seed source for infestations farther along the transect or from heightened competition from native species at the forest edge due to natural successional processes.



**Figure 12.** Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 3 at the Campbell Tract, Anchorage, Alaska.

#### Transect 4

Transect 4 is located in a wooded section of the 8-mile dog-mushing trail that parallels the Coyote Trail (Figure 13). This transect was erected to monitor an infestation of *Trifolium repens* that appeared to be moving off the trail into the native plant community. *Trifolium repens* was the only non-native species detected at this location in 2006.



**Figure 13.** Transect 4 showing location with aluminum tag in foreground and patch of *Trifolium repens* in trail in 2009.

Four non-native species, including *Trifolium repens*, were detected at Transect 4 in 2009 (Table 10). All species are located within the trampled section of the trail. The *Trifolium repens* infestation is much smaller than it was in 2006 (Figure 14) and despite minimal intergrading with native species at the forest edge, it remains largely restricted to the trail proper. The increase in species number at this site is slightly concerning, however the new species are either weakly or very weakly invasive. There is potential for these species to be spread farther along the trail but impacts to the surrounding native plant community are expected to be negligible.

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Scientific name	Common name	Invasivness rank	Percent cover	
Matricaria discoidea	pineappleweed	32	0.1	
Plantago major	common plantain	44	0.7	
Poa annua	annual bluegrass	46	0.7	
Trifolium repens	white clover	59	1.7	

Table 10. Non-native plant species detected at Transect 4.



**Figure 14.** Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 4 at the Campbell Tract, Anchorage, Alaska.

#### **Transect 7**

Transect 7 is located at the radio tower site along the Veiwpoint Trail (Figure 15). The transect extends from the gravel pad surrounding the green shed to the tower and into the forest beyond. This transect was placed to monitor the multiple non-native species occurring at this site in 2006, specifically; *Plantago major, Poa pratensis* ssp. *irrigata, Taraxacum officinale* ssp. *officinale* and *Trifolium repens. Crepis tectorum* was also found outside of the transect boundaries but in the general area in 2006. All of these non-native plant species were redetected in the 2009 survey (Table 11).



Figure 15. Transect 7 showing location in 2009

Scientific name	Common name	Invasivness rank	Percent cover
Crepis tectorum	narrowleaf hawksbeard	54	1
Plantago major	common plantain	44	1.5
Poa pratensis ssp. irrigata	spreading bluegrass	52	5.2
Taraxacum officinale ssp. officinale	common dandelion	58	9.8
Trifolium repens	white clover	59	8.6

**Table 11.** Non-native plant species detected at Transect 7

Based on a comparison of non-native plant cover along this transect in 2006 and 2009, it appears that non-native species are establishing closer to the forest edge (Figure 16). This slight encroachment into native, undisturbed communities is somewhat concerning and should be monitored.



**Figure 16.** Comparison of non-native plant species cover in 2006 and 2009 to distance from the origin of Transect 7 at the Campbell Tract, Anchorage, Alaska.

### **Summary & Recommendations**

Long-term change in plant community composition and extent of non-native species infestations for the transects resurveyed in 2009 at the Campbell Tract appears to be largely effected by disturbance regime. In recently disturbed areas, (Transects 1-3) the non-native plant species assemblage is notably altered, non-native species diversity is increased and total non-native cover is higher. Conversely, areas that have not been disturbed since the initial 2006 survey either show a reduction in extent of infestations (Transect 4) or only slight increase in encroachment into native communities (Transect 7). In general, non-native plant populations continue to establish preferentially in human-disturbed areas and naturally-open habitats. Specifically, large-scale construction activity, especially that involving soil disturbance and revegetation appears to be the greatest contributor to the introduction and establishment of non-native plant species within the Campbell Tract.

Based on the body of work completed at the Campbell Tract since 2006 the species of greatest concern are, listed in decreasing order of occurrence, the broadly distributed infestations of: **narrowleaf hawksbeard** (*Crepis tectorum*), **white sweetclover** (*Melilotus alba*), **oxeye daisy** (*Leucanthemum vulgare*), **butter and eggs** (*Linaria vulgaris*) and **quackgrass** (*Elymus repens*), as well as the smaller or more discrete infestations of **bird vetch** (*Vicia cracca*), **orange hawkweed** (*Hieracium aurantiacum*), **smooth brome** (*Bromus inermis* ssp. *inermis*), **hempnettle** (*Galeopsis tetrahit* s.l.), and **European bird cherry** (*Prunus padus*). Control is recommended for infestations of these high-priority species.

We recommend hand-pulling for small (less than 50 stems [Seefeldt 2007]) and outlying populations (separated by 400 m for non-wind dispersed species or 800 m for winddispersed species [Prather 2006]) of high-priority species that are not able to reproduce vegetatively, such as *Crepis tectorum, Melilotus alba, Leucanthemum vulgare* and *Galeopsis tetrahit* s.l. Hand-pulling should be repeated throughout the growing season and sites should be monitored annually to evaluate the effectiveness of the control.

However, for small, outlying populations of high-priority species that are able to reproduce or spread vegetatively from the root system such as *Linaria vulgaris, Elymus repens, Vicia cracca, Hieracium aurantiacum, Bromus inermis* ssp. *inermis* and *Phalaris arundinacea* we recommend that all above- and below-ground parts be removed by hand-digging. For larger (more than 50 stems) or persistent (no reduction in population size after one year of hand-digging [Seefeldt 2007]) populations, mechanical digging or application of herbicides may be necessary for eradication (Rutledge and McLendon 1996, Batcher 2002, Nolen 2002, Seefeldt 2010, Apfelbaum and Sams 1987).

Mature (fruit-producing) woody invasive species such as *Prunus padus* should be cut at the ground surface and treated with herbicide. Painting or injecting stumps is generally a very effective way of delivering very small, yet localized doses of herbicides and in *Prunus padus*, is necessary to prevent basal and root sprouting. Herbicide should be applied to fresh-cut

stumps late in the growing season so that the chemical is co-transported with other phloem-born resources to the roots for storage (Cortés-Burns and Flagstad 2010).

The specific survey, monitoring, control and management priorities presented below are largely based on the new species occurrence and distribution data collected in 2009. Comprehensive management recommendations will be made for the Campbell Tract in the forthcoming Weed Monitoring and Management Plans, currently in preparation by AKNHP.

#### Survey and Monitoring priorities:

- Increase monitoring with respect to survey area and frequency at the material source area, the airstrip, and the area surrounding the BLM AFO. Because these areas are known sources for non-native plant propagules within the tract, survey should include all disturbed land (i.e. not restricted to Transects 5, 5B, 8 and 8B) and the frequency of survey should be increased to an annual basis. A diversity of problem species including *Linaria vulgaris* are established at the material source area, *Melilotus alba, Linaria vulgaris, Crepis tectorum* and *Elymus repens* are known to occur on land surrounding the field offices and problem species established along the airstrip include *Crepis tectorum*, *Melilotus alba* and *Vicia cracca*.
- Survey the open area surrounding the RAWS weather station for Canada thistle (*Cirsium arvense*). Note: approximately 50 stems were pulled from this area following a weed awareness talk given as part of the Midsummer Night Science Series at the Campbell Creek Science Center on June 30, 2010.
- Survey the road corridor between the Smokejumpers Trailhead and the BLM AFO for additional populations of reed canarygrass (*Phalaris arundinacea*), if this species is in fact present at the Smokejumpers Trailhead.
- Expand annual surveying to include all trailheads. Trailheads often serve as source locations for non-native plant species and the trails leaving these locations can act as corridors through which new non-native plant species may disperse into the Tract. Annual survey of these areas will allow early detection and rapid response to new weed species and/or populations.
- Survey areas following trail construction proposed for the 2010 field season. Specifically:
  - The small bridge downstream of the pedestrian bridge over the South Fork of Campbell Creek. Replacement of this bridge is scheduled for May, 2010.
  - Campbell Airstrip Trailhead parking area. Surface and drainage improvements are scheduled for May, 2010.
  - Old Rondy Trail. Culvert removal and bridge construction is scheduled for mid-May 2010.
  - Viewpoint Trail. Construction to enhance drainage and trail tread surface is scheduled for May-June, 2010.
- Continue to monitor the long-term permanent transects set up in conjunction with this project. At a minimum, transects 5, 5B, 6, 6B, 8, 8B, 9 and 10 (those not visited in 2009) should be revisited during the 2010 field season.
- Continue monitoring of the South Fork Campbell Creek riparian corridor for reestablishment or upstream dispersal of European bird cherry (*Prunus padus*, 74) first documented and pulled here in 2006. Note: plants were not relocated in 2008.

We also recommend that the North Fork of the Little Campbell Creek be surveyed for *Prunus padus* individuals.

#### **Control priorities:**

- Control the growth of high-priority non-native species in all recently reseeded areas between the Elmore Road entrance and the BLM AFO.
- Control the near monocultures of *Lolium perenne* ssp. *perenne* surrounding the Smokejumpers Trailhead by either regular mowing to prevent the production of seed or by reseeding with fast-growing native species such as Canada bluejoint (*Calamagrostis canadensis*) or fireweed (*Chamerion angustifolium*) to accelerate natural successional processes.
- Confirm the presence of *Phalaris arundinacea* at the Smokejumpers Trailhead. If present, the infestation of *Phalaris arundinacea* at the Smokejumpers Trailhead should be an extremely high priority for control.
- Continue monitoring and control the orange hawkweed (*Hieracium aurantiacum*) infestations at Transects 6 and 6B Although this site was not revisited in 2009, it is our understanding that the infestations at Transects 6 and 6B have been controlled by digging on a yearly basis since 2006 without reduction in population size. Infestations such as these that are not responsive to mechanical control are good candidates for herbicide treatment (Seefeldt 2010). Confirm the presence of the *Hieracium aurantiacum* population at the Elmore Road entrance to the Tract that was recorded in 2006 and control as necessary.

#### Management priorities:

- Continue to provide annual training for BLM field crews and associated personnel in weed identification and appropriate best management practices.
- Ensure the use of weed-free topsoil and seed mix in all construction projects that require soil disturbance and/or revegetation. Sources for weed free landscaping materials can be sourced through the Department of Natural Resources Plant Materials Center (http://dnr.alaska.gov/ag/ag\_pmc.htm).
- Revegetate with the original organic layer when possible or with native species from local sources. Plant shrub and tree species with bare roots to avoid importing non-native species that may be present in the soil surrounding the root ball. Additional Revegetation Guidance can be found at: http://dnr.alaska.gov/ag/ag\_pmc.htm

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# Appendix I: High-priority non-native plant species targeted in Campbell Tract surveys

High-priority species are those known to occur in Alaska with an invasiveness score greater than 60 points as ranked by Carlson et al. 2008).

		Invasiveness	
Scientific name	Common name	rank <sup>1</sup>	Family
Polygonum cuspidatum	Japanese knotweed	87	Polygonaceae
Polygonum sachalinense	giant knotweed	87	Polygonaceae
Polygonum x bohemicum	Bohemian knotweed	87	Polygonaceae
Centaurea stoebe	spotted knapweed	86	Asteraceae
Euphorbia esula	leafy spurge	84	Euphorbiaceae
Lythrum salicaria	purple loosestrife	84	Lythraceae
Lythrum virgatum	spike loostrife	84	Lythraceae
Impatiens glandulifera	ornamental jewelweed	82	Balsaminaceae
Melilotus alba	white sweetclover	80	Fabaceae
Hieracium aurantiacum	orange hawkweed	79	Asteraceae
Hieracium caespitosum	meadow hawkweed	79	Asteraceae
Bromus tectorum	cheatgrass	78	Poaceae
Rubus discolor	Himalyan blackberry	77	Rosaceae
Cirsium arvense	Canada thistle	76	Asteraceae
Prunus padus	European bird cherry	74	Rosaceae
Sonchus arvensis ssp. uliginosus	perennial sowthistle	73	Asteraceae
Vicia cracca	bird vetch	73	Fabaceae
Lepidium latifolium	common pepperweed	71	Brassicaceae
Alliaria petiolata	garlic mustard	70	Brassicaceae
Cytisus scoparius	Scotch broom	69	Fabaceae
Linaria vulgaris	butter and eggs	69	Scrophulariaceae
Melilotus officinalis	vellow sweetclover	69	Fabaceae
Caragana arborescens	Siberian pea shrub	66	Fabaceae
Lonicera tatarica	bush honevsuckle	66	Caprifoliaceae
Campanula ranunculoides	creeping bellflower	64	Campanulaceae
Medicaao sativa ssp. falcata	vellow alfalfa	64	Fahaceae
Senecio iacobaea	stinking willie	63	Asteraceae
Bromus inermis ssp. inermis	smooth brome	62	Poaceae
Cirsium vulgare	bull thistle	61	Asteraceae
Leucanthemum vulaare	oxeve daisy	61	Asteraceae
Hordeum murinum ssp. leporinum	leporinum barley	60	Poaceae
Elvmus repens	quackgrass	59	Poaceae
Medicago sativa ssp. sativa	alfalfa	59	Fabaceae
Sorbus aucuparia	European mountain ash	59	Rosaceae
Trifolium repens	white clover	59	Fabaceae
Gypsophila paniculata	baby's breath	57	Carvophyllaceae
Tanacetum vulgare	common tansy	57	Asteraceae
Trifolium hvhridum	alsike clover	57	Fabaceae
Convolvulus arvensis	field bindweed	56	Convolvulaceae
Crepis tectorum	narrowleaf hawksbeard	54	Asteraceae
Phleum pratense	Timothy	54	Poaceae
Ranunculus acris	tall buttercup	54	Ranunculaceae
Ranunculus repens	creeping buttercup	54	Ranunculaceae
Dactylis glomerata	orchardgrass	53	Poaceae
Trifolium pratense	red clover	53	Fabaceae
Vicia villosa	winter vetch	53	Fabaceae
Hypericum perforatum	St. Johnswort	52	Clusiaceae
Verbascum thapsus	common mullein	52	Scrophulariaceae
Digitalis purpurea	purple foxglove	51	Scrophulariaceae
Hieracium umbellatum	narrowleaf hawkweed	51	Asteraceae
Rumex acetosella	sheep sorrel	51	Polygonaceae
Fallopia convolvulus	black bindweed	50	Polygonaceae
Tragopogon dubius	vellow salsify	50	Asteraceae
	,,		

# Appendix I (continued): Non-native plant species rejected from consideration in Campbell Tract surveys

Non-native plant species for which efficient eradication is no longer a realistic option due to their widespread distribution or for species whose nativity to Alaska is unresolved were not prioritized for treatment despite their relatively high invasiveness ranks.

	Invasiveness		
Scientific name	Common name	rank <sup>1</sup>	Family
Hordeum jubatum	foxtail barley	63	Poaceae
Taraxacum officinale ssp. officinale	common dandelion	58	Asteraceae
Poa pratensis (ssp. pratensis and ssp. irrigata)	Kentucky and spreading bluegrass	52	Asteraceae
Stellaria media	common chickweed	42	Caryophyllaceae

1: Invasiveness ranks are taken from Carlson et al. 2008; 'NR' indicates that the species has not yet been ranked and does not imply low invasiveness

### Appendix II: Non-native plant species occurring in Campbell Tract Includes all non-native plant species detected by AKNHP staff during surveys from 2006-

Includes all non-native plant species detected by AKNHP staff during surveys from 2006-2009.

		Percent	Invasiveness
Scientific Name	Common Name	<b>Frequency</b> <sup>1</sup>	Rank <sup>2</sup>
Alopecurus pratensis	meadow foxtail	0.14	NR
Brassica rapa	field mustard	0.00	NR
Bromus inermis ssp. inermis	smooth brome	0.42	62
Capsella bursa-pastoris	shepherd's purse	0.00	40
Centaurea montana	perennial cornflower	0.00	NR
Cerastium fontanum ssp. vulgare	common mouse-ear chickweed	0.85	36
Chenopodium album	lambsquarters	0.57	37
Crepis tectorum	narrowleaf hawksbeard	12.61	54
Elymus repens	quackgrass	1.27	59
Elymus sibiricus	Siberian wildrye	0.28	NR
Erucastrum gallicum	common dogmustard	0.42	NR
Galeopsis tetrahit s.l.	hempnettle	0.42	40
Hieracium aurantiacum	orange hawkweed	0.71	79
Hordeum jubatum	foxtail barley	0.28	63
Hypochaeris radicata	hairy cat's ear	0.14	NR
Lepidium densiflorum	common pepperweed	0.14	25
Leucanthemum vulgare	oxeye daisy	2.97	61
Linaria vulgaris	butter and eggs	2.41	69
Lolium perenne ssp. multiflorum	annual ryegrass	0.14	41
Lolium perenne ssp. perenne	perennial ryegrass	0.42	NR
Lupinus polyphyllus	bigleaf lupine	0.14	55
Matricaria discoidea	pineappleweed	0.28	32
Melilotus alba	white sweetclover	12.61	81
Persicaria lapathifolia	curlytop knotweed	0.14	47
Phleum pratense	timothy	4.25	54
Plantago major	common plantain	4.11	44
Poa annua	annual bluegrass	0.99	46
Poa pratensis (ssp. irrigata and ssp. pratensis)	Kentucky bluegrass	2.97	52
Polygonum aviculare	prostrate knotweed	0.85	45
Prunus padus	European bird cherry	0.14	74
Rumex acetosella	common sheep sorrel	0.14	51
Rumex longifolius	dooryard dock	0.14	48
Senecio sylvaticus	woodland ragwort	0.14	NR
Silene armeria	sweet William	0.14	NR
Silene dioica	Clairville red catchfly	0.14	42
Spergula arvensis	corn spurry	0.00	32
Stellaria media	common chickweed	2.55	42
Taraxacum officinale ssp. officinale	common dandelion	9.92	58
Trifolium hybridum	alsike clover	10.06	57
Trifolium pratense	red clover	0.28	53
Trifolium repens	white clover	24.65	59
Tripleurospermum inodorum	scentless false mayweed	0.28	48
Vicia cracca	bird vetch	0.85	73

1: Percent frequency is calculated as (100\*number of records for species A/total number of records for non-native species) 2: Invasiveness ranks are taken from Carlson et al. 2008; 'NR' indicates that the species has not yet been ranked and does not

2: Invasiveness ranks are taken from Carlson et al. 2008; 'NR' indicates that the species has not yet been ranked and does not imply low invasiveness

# Appendix III: Non-native plant species distribution maps

Species are listed alphabetically by scientific name. **Field mustard (***Brassica rapa***; NR)** 





# Smooth brome (Bromus inermis ssp. inermis; 62)



# Perennial cornflower (*Centaurea montana*; NR)



# Narrowleaf hawksbeard (*Crepis tectorum*; 54)

# Quackgrass (Elymus repens; 59)



# Hempnettle (Galeopsis tetrahit s.l.; 40)





# Orange hawkweed (*Hieracium aurantiacum*; 79)

# Oxeye daisy (Leucanthemum vulgare; 61)



# Butter and eggs (Linaria vulgaris; 69)





Italian ryegrass (Lolium perenne ssp. multiflorum; 41)



Perennial ryegrass (Lolium perenne ssp. perenne; NR)

# White sweetclover (Melilotus alba; 81)



### European bird cherry (Prunus padus; 74)



# Alsike clover (Trifolium hybridum; 57)



# Red clover (Trifolium pratense; 53)



# White clover (Trifolium repens; 59)



# Bird vetch (Vicia cracca; 73)

