BLM-BAER Final Report
Invasive Plant Species Monitoring and Control: Areas impacted by 2004 and 2005 Fires in Interior Alaska

A survey of Alaska BLM lands along the Dalton, Steese, and Taylor Highways

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ABSTRACT

We completed invasive plants species surveys for three major Interior Alaska highways (Steese, Dalton, and Taylor) that were affected by the 2004 and 2005 fires. Particular emphasis was directed to roadsides and adjacent Bureau of Land Management lands. Non-native plant establishment was greatest and most widespread along the Dalton Highway, with aggressively invasive species occurring throughout the area surveyed. Infestations along the Steese corridor were fewer and more localized, while the Taylor Highway was the least infested. Most non-native populations were restricted to anthropogenically disturbed sites, including road construction and revegetation activities, parking lots, campgrounds, and Alaska Department of Transportation stations. While these sources of disturbance are more important in current patterns of invasive species establishment, invasive species were also spreading in recently burned (but otherwise undisturbed) areas. Two infestations were recorded spreading from the roadside into fire-disturbed areas (*Crepis tectorum* and *Hieracium umbellatum* along the Dalton). Additionally, one infestation (*Caragana arborescens*) was invading undisturbed, native plant communities along the Steese Highway. It is likely that a greater number of invasive species populations will eventually spread into native ecosystems due to the increase in propagule pressure and in the volume of traffic along these roads.

We provide specific recommendations for the removal or containment of the infestations. Overall, invasive species eradication and containment work must prioritize (1) infestations of species that have already been detected spreading into fire-disturbed sites and undisturbed, native communities, and (2) all populations of highly aggressive species. This effort must be followed up with monitoring, especially for species with seeds that can remain viable for many years and for species that can resprout from underground parts. In addition, we urge agencies involved in the maintenance and construction of Alaska's transportation networks to enforce measures when conducting roadwork that will minimize, rather than facilitate, the spread of non-native species. Finally, we suggest that activities promoting public awareness on invasive plants and the danger they pose to Alaska's native ecosystems be organized and encouraged.

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INTRODUCTION

Background

The establishment, growth, and persistence of non-native plant species pose a serious threat to native ecosystems. Even though not all non-native species cause significant economic or ecological harm, those species that are *invasive* are well known to alter community composition, successional pathways, nutrient cycling, hydrology, and fire regimes, as well as reduce or eliminate threatened and endangered native species populations (U.S. Congress 1993, Busch 1995, Myers 1997, Brooks 1999, Stein *et al.* 2000).

While invasive plants constitute a major problem in the Lower 48 states (*cf.* Randall 1996), Alaska has been considered relatively immune to their deleterious impacts. In the past five years, however, this perception has changed (Shephard 2004, Carlson and Shephard 2007). More and more non-native species and populations are being recorded and, disturbingly, a number of species have moved off of the anthropogenic footprint and have overrun natural areas, clearly damaging the area's ecology (Carlson 2006, Conn *et al*. in press). Even so, invasive plants in this state are still mainly restricted to the regions of greatest anthropogenic disturbance. Consequently, land managers in Alaska have the unique opportunity to be proactive in managing exotic and invasive plants.

Invasive plants are often opportunistic species that thrive under the types of conditions created by disturbances: increased light and nutrient availability, reduced interspecific competition, and increased bare soil (Rejmánek 1989, Harrod and Reichard 2001). Forest and grassland fires are a well known disturbance and have accelerated non-native plant establishment in the Lower 48, through both increase in availability of disturbed habitat and due to inadvertent dispersal during firefighting activities (Hobbs and Huenneke 1992, Brooks 2001, Harrod and Reichard 2001). Forest fires also create a complex matrix of disturbance and natural, undisturbed plant communities that may offer a transitional foothold habitat for non-native plants to invade more intact habitats. Thus, the 2004 and 2005 fires that burned over ten million acres in Alaska provide a dangerous opportunity for the expansion of established invasive plants and invasion of new invasive plant species into the state's wildlands.

BLM-AKNHP Assistance Agreement

Severe fires throughout Alaska's interior region in 2004 and 2005 may have facilitated the expansion of non-native plants into previously undisturbed, natural communities in Alaska. The potential for invasive plants to move into burned lands is greatest near pre-existing populations and high use areas such as roads, trails, campgrounds, cabins, landing zones, or firefighting activity sites. As part of the Burned Area Emergency Rehabilitation and Stabilization plan for Alaska's 2004 fires, the BLM received funding to investigate fire related sites that may subsequently have introduced invasive plants, and entered into an assistance agreement with the Alaska Natural Heritage Program (AKNHP), University of Alaska, to assess the (potential)

expansion of invasive plants from high use areas into adjacent BLM interior Alaska lands that were affected by the 2004 and 2005 fires.

Under this agreement, during the 2006 field season, the AKNHP was responsible for surveying BLM land along the Dalton, Steese, and Taylor Highways, with emphasis on areas affected by the following 2004 and 2005 fires:

1. Steese Highway (Fairbanks northeast to Circle):
   - 2004 fires: Bolgen Creek, Boundary
2. Dalton Highway (Fairbanks north to Wiseman):
   - 2004 fires: Fort Hamlin Hills, Dall City, Evansville
   - 2005 fires: Ray river, North Bonanza, Chapman Creek
3. Taylor Highway (Tetlin Junction northeast to Eagle):
   - 2004 fires: Porcupine, Chicken, Wall Street, King Creek, Deer Creek
   - 2005 fires: Boundary Creek

The aim of these surveys was to identify the locations, species, and extent of establishment of invasive plant populations. The information collected was then used to prioritize infestation areas for invasive plant management and eradication work. It also guided efforts to detect currently invasive plant-free areas that are at high risk of being invaded from surrounding, non-native plant sources based on parameters such as type and frequency of disturbance in the invasive plant-free site, proximity to the source location, and aggressiveness of the species. In addition, the AKNHP will enter the data collected into the Alaska Exotic Plant Clearinghouse (AKEPIC), the statewide invasive plant database, thus making it available to local, regional, state, and federal agencies and private individuals involved in invasive species issues. Lastly, the results from this work, together with those of other Alaska federal and state agencies that received BAER funds, will provide greater insight into the relationship between fires and the spread of non-native plants in interior Alaska lands.

LOGISTICS, SAMPLING PROTOCOLS, AND DATA ANALYSIS

Pre-fieldwork: logistics

The AKNHP adapted the sampling protocol developed by the Alaska Exotic Plants Mapping Program (see http://akweeds.uaa.alaska.edu/) to fit the goals of the current project. The AKNHP Program Botanist and BLM Vegetation Specialist (Matthew Carlson and Jeanne Standley, respectively) put together a list of priority invasive plants (Appendix I.a.) based on the invasiveness values given by the state's "Weed Ranking Project" (http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm), whereby non-native species ranked 50 and above were considered priority species. Exceptions were made for species that are already too widespread and for which efficient eradication is no longer a realistic option (e.g.: *Stellaria media*, *Taraxacum officinale* ssp. *officinale*, and *Poa pratensis* ssp. *pratensis*), and for species whose taxonomic or nativity status is unclear. An example of the latter would be foxtail barley (*Hordeum jubatum*), as it is currently thought that there may be native and non-native genotypes of this species 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. Finally, Trimble GPS units were programmed with data dictionaries that are compatible with BLM's data format.

Fieldwork methodology

Field work was carried out during July and August 2006 by three AKNHP crews, consisting of two surveyors each.

Two types of surveys were conducted for each highway:
1. following AKEPIC data protocols, which includes all non-native plants
2. using BLM data protocols, which collects information on potential invasive plant source areas and on high priority species infestations located in and near burned lands along the highways

For the AKEPIC-based inventories, plots were read at five mile intervals at right-of-way sites along the highways, regardless of the presence/absence of invasive species at a given site (Fig. 1). Plot data were recorded using Garmin GPS units and paper datasheets, and included information on the locality, disturbance type and age, infestation size, non-native species' names and aggressiveness, associated habitat, and control measures taken, if any (see Appendix XII for a blank copy of the datasheets used). The AKEPIC-based inventories were conducted prior to the BLM-based protocols to inform the surveyors of the scope and general patterns of non-native plants.

In the second phase, inventories were made both at sites that constituted potential sources of invasive plant dispersal into BLM burned areas, and at burned areas that were infested by one or more of the invasive plant species defined as "priority" (Appendix I.a., Fig. 2). Surveys were also carried out in roadside areas that appeared to harbor new non-native species, to have high degrees of infestation, or to be particularly sensitive locations (for example, the confluence of highways and rivers). Last, approximately one mile of the side roads or trails that originate from this road system and provide access to burned BLM managed lands were also monitored if it was considered that there was a moderate to high risk of invasion and establishment by invasive plants.

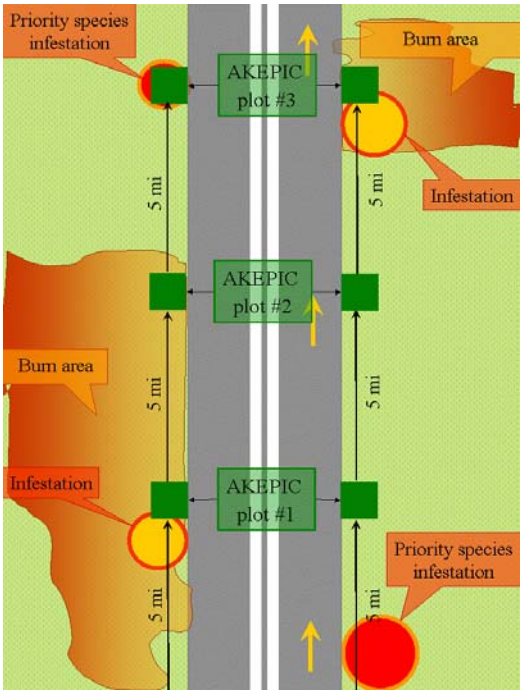

Figure 1. AKEPIC-based plots were read on the outbound trip.

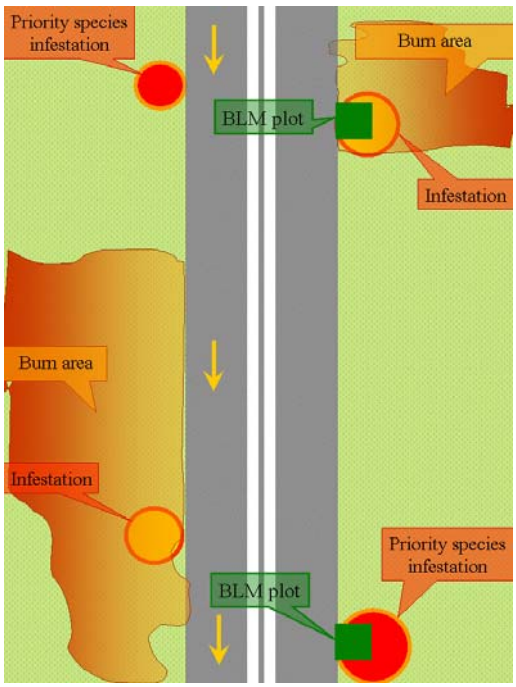

Figure 2. BLM-BAER methodology plots were erected on the way back.

Surveyors used Trimble GPS units that had been programmed and provided by BLM. At each plot the following information was recorded: vegetation type, percent canopy cover, disturbance type and age, non-native species' names and aggressiveness, stem count and acres infested, phenological stage of each species (flowering, fruiting, seed set), voucher specimen collected (yes/no), photo taken (yes/no), and, when pertinent, information on photo-monitoring points established and on control actions taken.

Photo-monitoring points were set up either in sites that seemed especially susceptible to invasion and would provide an early warning on likely infestations, or in sites that had invasive species and were in or near BLM burned land. To help assess treatment effectiveness over time, photographs of the photo-monitoring points were taken and a compass reading from the photographer to the point was taken. To facilitate relocation of each site, aluminum tags with the highway name, site number and date were nailed to the nearest hard surface (e.g. a standing or fallen tree). The GPS reading and the description of point and tag location were recorded.

Control of high priority invasive plants was carried out on some small infestations (less than 1000 plants) by hand pulling. Individuals removed were immediately bagged and taken to disposal sites to minimize the risk of dispersal following this action. At sites in which control measures were taken, additional plot information was recorded, including the number of acres treated and the number hours spent controlling the population. Photographs of the site were taken before and after invasive plant control. Both invasive plant infestations that are recommended for control and those where control work had been done were marked with flagging tape, and the

plant code, date, and surveyors' initials were written on the flagging tape with a permanent marker.

For both AKEPIC-based and BLM-BAER-based inventories, invasive plant species were identified by their scientific name or species code as recorded in USDA PLANTS database (http://plants.usda.gov).

Post-fieldwork

Upon completion of the fieldwork, all data collected on the Trimble and Garmin GPS units were transferred to a computer database. Data recorded for all plots and for the photo-monitoring sites, including photographs, were transferred into a database and can now be accessed as a GIS product. These data will also be uploaded into the BLM database and the statewide Alaska Exotic Plant Information Clearinghouse (AKEPIC) database after they have been proofread and corrected to ensure accuracy.

All plant specimens collected have been determined by AKNHP botanists. Voucher specimens were collected for the reference herbarium at BLM, and duplicates will be deposited at the UAA and UAF herbaria. These species include non-native plant species, unknown species that are possibly non-native, and species commonly used for roadside revegetation. A total of 70 specimens, with two vouchers for each priority species encountered, will be mounted, labeled, and given to the BLM. When relevant and possible, duplicates of voucher specimens will be deposited at the University of Alaska Anchorage herbarium.

RESULTS

Three AKNHP crews conducted non-native plant surveys along the Steese, Dalton, and Taylor Highways during July and August 2006. Areas that constituted major potential vectors for invasive plant dispersal into burned BLM managed lands were inventoried following BLM-BAER and AKEPIC data protocols.

Below we present a detailed account of the findings and observations. For each highway, we identify areas that constitute invasive species 'hotspots', we list all the non-native plant species found in the burned areas surveyed, and provide information on which infestations were controlled and which ones require future monitoring, management, and/or eradication work.

Steese Highway

Overview

Fieldwork was carried out along the Steese Highway right-of-ways, from its intersection with the Elliott Highway to the town of Circle, from 17 July to 2 August 2006. Exhaustive surveys were conducted along the roadside areas affected by the 2004 Boundary and Bolgen Creek fires. Secondary roads and trails branching off the highway were inventoried for up to one mile or until no more invasive species were found. Plots were generally read in herbaceous-shrub roadside vegetation, or in mixed, birch-black spruce forests.

A total of 41 AKEPIC-based plots were inventoried along the highway and the Circle Hot Springs Road, in an effort that covered over 150 miles of highway and more than 50 acres of disturbed land, including right-of-ways, trails and fire access roads. These surveys included 11 gravel pits and rock quarries, 20 parking lots and nearby trailheads, three (3) BLM managed campgrounds, and more than 50 highway-creek crossings. More than 100 additional infestations were detected and recorded within the Bolgen Creek and Boundary fire perimeters, and two photo-monitoring plots were created and read in each of these following the BLM-BAER protocol.

In all, 33 non-native plant species, representing nine (9) families, were noted (Table 1). The most frequently recorded species were *Bromus inermis* ssp. *inermis*, *Matricaria discoidea*, *Plantago major*, and *Taraxacum officinale* ssp. *officinale*. Some species, such as *Leucanthemum vulgare* (oxeye daisy) and *Trifolium repens* (white clover) were only found outside the (Bolgen and Boundary) burned areas. (Maps showing the sites at which *Bromus inermis* ssp. *inermis*, *Melilotus alba*, *Trifolium hybridum*, *T. pratense*, and *Vicia cracca* were observed are provided in Appendix II).

Table 1. List of non-native plant species encountered along the Steese Highway in 2006.

Family Name	Scientific Name	Common Name	Invasiveness Rank	Bolgen Creek Fire	Boundary Fire
Poaceae	*Bromus inermis* ssp. *inermis*	smooth brome	62	X	X
Brassicaceae	*Capsella bursa-pastoris*	shepherd's purse	40		X
Fabaceae	*Caragana arborescens*	Siberian peashrub	66		X
Chenopodiaceae	*Chenopodium album*	lambs quarters	35	X	
Polemoniaceae	*Collomia linearis*	narrowleaf mountaintrumpet	not ranked		X
Asteraceae	*Crepis tectorum*	narrowleaf hawksbeard	54		X
Poaceae	*Elymus repens*	quackgrass	59		
Poaceae	*Elymus sibiricus*	Siberian wildrye	not ranked		X
Brassicaceae	*Erysimum cheiranthoides*	wallflower mustard	not ranked		
Asteraceae	*Hieracium umbellatum*	narrowleaf hawkweed	46		X
Poaceae	*Hordeum jubatum*	foxtail barley	63	X	X
Brassicaceae	*Lepidium densiflorum*	common pepperweed	25		
Asteraceae	*Leucanthemum vulgare*	oxeye daisy	61		
Poaceae	*Lolium perenne* ssp. *perenne*	Italian ryegrass	41		
Asteraceae	*Matricaria discoidea*	pineapple weed	33	X	X
Fabaceae	*Melilotus alba*	white sweetclover	80	X	X
Fabaceae	*Melilotus officinalis*	yellow sweetclover	65		X
Poaceae	*Phleum pratense*	timothy	56		X
Plantaginaceae	*Plantago major*	common plantain	44	X	X
Poaceae	*Poa annua*	annual bluegrass	46		X
Poaceae	*Poa pratensis* ssp. *irrigata*	spreading bluegrass	52		X
Poaceae	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	52	X	X
Poaceae	*Poa trivialis*	rough bluegrass	52		
Polygonaceae	*Polygonum aviculare*	prostrate knotweed	45		X
Polygonaceae	*Polygonum convolvulus*	black bindweed	50		X
Polygonaceae	*Rumex longifolius*	dooryard dock	48	X	
Caryophyllaceae	*Stellaria media*	chickweed	42		
Asteraceae	*Taraxacum officinale* ssp. *officinale*	common dandelion	58		X
Fabaceae	*Trifolium hybridum*	alsike clover	57		X
Fabaceae	*Trifolium pratense*	red clover	53		
Fabaceae	*Trifolium repens*	white clover	59		X
Fabaceae	*Vicia cracca*	bird vetch	73		X
Violaceae	*Viola tricolor*	pansy violet	not ranked		X

Burned area survey results

Bolgen Creek Burn (04)

The following eight (8) non-native species were recorded in the section of the highway affected by the Bolgen Creek fire: *Bromus inermis* ssp. *inermis*, *Chenopodium album*, *Hordeum jubatum*, *Matricaria discoidea*, *Melilotus alba*, *Plantago major*, *Poa pratensis* ssp. *pratensis*, and *Rumex longifolius*. Of these, white sweetclover (*Melilotus alba*, with an aggressiveness value of 80 points out of 100), bird vetch (*Vicia cracca*, ranked at 73 points), and smooth brome (*Bromus inermis* ssp. *inermis*, 62 points) were the most aggressively invasive species found. None of the infestations seen were spreading into burned areas or into undisturbed sites.

Bromus inermis ssp. *inermis* was likely used in past roadside revegetation work throughout the length of the Steese Highway, which explains why it was the most frequently recorded species in this burn (see Appendix II for a map of smooth brome infestation sites). Although most infestations were small and restricted to the roadside, there was one particularly large stand of smooth brome that covered over one acre of land at the Albert Creek crossing (Site #7, N 65.591208°, W 144.703986°, mile marker 131, just north of Central,; Fig. 3). This site was probably cleared when the highway was built, and has since been colonized by a pure stand of this grass (no other non-native or native species were observed here). Mechanical or chemical control methods must be implemented to either suppress seed production, or eradicate the population.

Figure 3. Monospecific smooth brome stand at a former clear cut by the Albert Creek crossing.

Bolgen Creek Burn photo-monitoring points

Two photo-monitoring plots were established in this burn. One was set up at Site #6 (N 65.673749°, W 144.408275°, Mile 143; Fig. 4), in an area that had recently been bulldozed and used for firefighting activities. The resulting high percentage of bare, unvegetated, and disturbed soil made it a likely target for non-native plant colonization, which could then spread into the adjacent burned land. At the time of the survey, however, there were no non-natives at this location.

A second monitoring plot was established at Site #8 (N 65.590152°, W 144.724637°) at mile marker 131, just east of Central, where there was a small (approx. 0.2 acres),

isolated population of *Melilotus alba* (white sweetclover) growing on the right of way, adjacent to burned land (Figs. 5 and 9). We strongly recommend that control work be carried out here immediately, before a large seed bank forms and the infestation becomes fully established.

Figure 4. Photo-monitoring point at Site #6, in the Bolgen Creek Burn area. This site had been used to load firefighting equipment.

Figure 5. Infestation of white sweetclover at one of the photo-monitoring points within the Bolgen Creek Fire perimeter (Site #8, Mile 131).

Boundary Burn (04)

A total of 23 non-native plants were detected in the 2004 Boundary Fire section of the highway. These were: *Bromus inermis* ssp. *inermis*, *Capsella bursa-pastoris*, *Caragana arborescens*, *Collomia linearis*, *Crepis tectorum*, *Elymus sibiricus*, *Hieracium umbellatum*, *Hordeum jubatum*, *Matricaria discoidea*, *Melilotus alba*, *Melilotus officinalis*, *Phleum pratense*, *Plantago major*, *Poa annua*, *Poa pratensis* ssp. *irrigata*, *Poa pratensis* ssp. *pratensis*, *Polygonum aviculare*, *Polygonum convolvulus*, *Taraxacum officinale* ssp. *officinale*, *Trifolium hybridum*, *Trifolium repens*, *Vicia cracca*, and *Viola tricolor*. Of these, *Bromus inermis* ssp. *inermis*, *Caragana arborescens*, *Melilotus alba*, and *Vicia cracca* were the most aggressively invasive species found. The latter two, which were also the most frequently recorded, were strongly restricted to road fill importation sites and gravel pits. *Caragana arborescens*, on the other hand, was observed growing in natural, undisturbed habitats.

Several areas within the Boundary Fire perimeter were infested with *Vicia cracca* (bird vetch), *Trifolium hybridum* (alsike clover), and *T. repens* (white clover). Scattered patches of these three species were recorded along the highway between Miles 38 and 52: some near the Upper Chatanika River Recreation Site, one at the Boston Creek-highway crossing, and

multiple infestations of all three species growing around the pond at the end of a side gravel road that branches off the highway at Mile 52 (Site #131). These species were generally growing together, at the same sites, and were not encountered in any other areas of the highway, nor were they moving into undisturbed sites. Their clumped but infrequent occurrence suggests that there is a common seed source for these species, which is likely linked to the fact that road work was being carried out in this section of the highway. We recommend that control efforts be carried out soon on these incipient, disjunct infestations, as it will be harder and more expensive to eliminate them once they become entrenched and have spread. (See Appendix II for maps of the sites at which these species were observed).

In addition, *Bromus inermis* ssp. *inermis* (smooth brome) was detected at Site #146 (N 65.17831°, W 147.275504°, Mile 38), where it had most likely been seeded as a result of roadside revegetation work. Current roadside infestations should be contained, and areas in which gravel has recently been added should be monitored for new infestations, as many of the gravel pits surveyed along this highway were contaminated with *Melilotus alba* and *B. inermis* ssp. *inermis*.

Finally, an area that was particularly rich in aggressively invasive species was the intersection of the Steese Highway with Boston Creek. *Bromus inermis* ssp. *inermis*, *Caragana arborescens*, *Trifolium hybridum*, and *Vicia cracca* were all recorded on the north side of the road, close to a burned hillside.

Boundary Burn photo-monitoring points

One photo-monitoring point was set up to facilitate the management and eradication of a *Caragana arborescens* (Siberian peashrub) stand at Site #139 (N 65.225124°, W 147.127824°). This species must have been planted around the rest-area and parking lot, and has since spread beyond the roadside fill area. A large number of seedlings and young plants were growing in the adjacent, undisturbed, mixed spruce-birch forest. Furthermore, mature plants had abundant numbers of fruits, so that additional seedlings and opportunities for seed dispersal are likely. This site requires immediate control and long-term monitoring work.

A second photo-monitoring plot was erected at Site #142 (N 65.1874°, W 147.254121°, Mile 38; Fig. 6), to mark a *Melilotus alba* (white sweetclover) infestation. This site had first and second year plants growing on a pile of coarse material extracted from a mine or excavation pit on the south side of the road, and is adjacent to the burn. The population must be extirpated to prevent the formation of a seed bank in the excavated area. Furthermore, if the

Figure 6. Photo-monitoring point at Site #142, Mile 38, marking a *Melilotus alba* infestation within the Boundary Burn section.

contaminated, mined materials are transported to other construction sites, the latter will have to be tracked and monitored for incipient white sweetclover infestations.

Steese Highway problematic areas

Despite there being non-native plants throughout the length of the highway, the following two areas constitute definite invasive species 'hotspots':

1. Fox to Davidson Ditch: The section of the highway from Fox to Mile 60 had the greatest diversity of non-native species. This is likely due to the large volume of traffic in this area, and to the many road construction projects taking place here. The area comprised between Mile 52 and Mile 60, which is near Davidson Ditch and was affected by the Boundary Fire, was of particular interest (Figs. 7 and 8): a number of species found here, such as *Crepis tectorum, Elymus sibiricus, Phleum pratense, Polygonum convolvulus*, and *Viola tricolor*, were not seen anywhere else on the Steese Highway. These plants may have been introduced with top soil, seed mix or contaminated construction equipment, given that some parts of this portion of the highway were under construction and others had just recently been built and revegetated.

2. The area around the junction of the Elliot and Steese Highways (Fig. 8).

3. In and around the towns of Central and Circle.

Figure 7. Recent road construction work near Davidson Ditch.

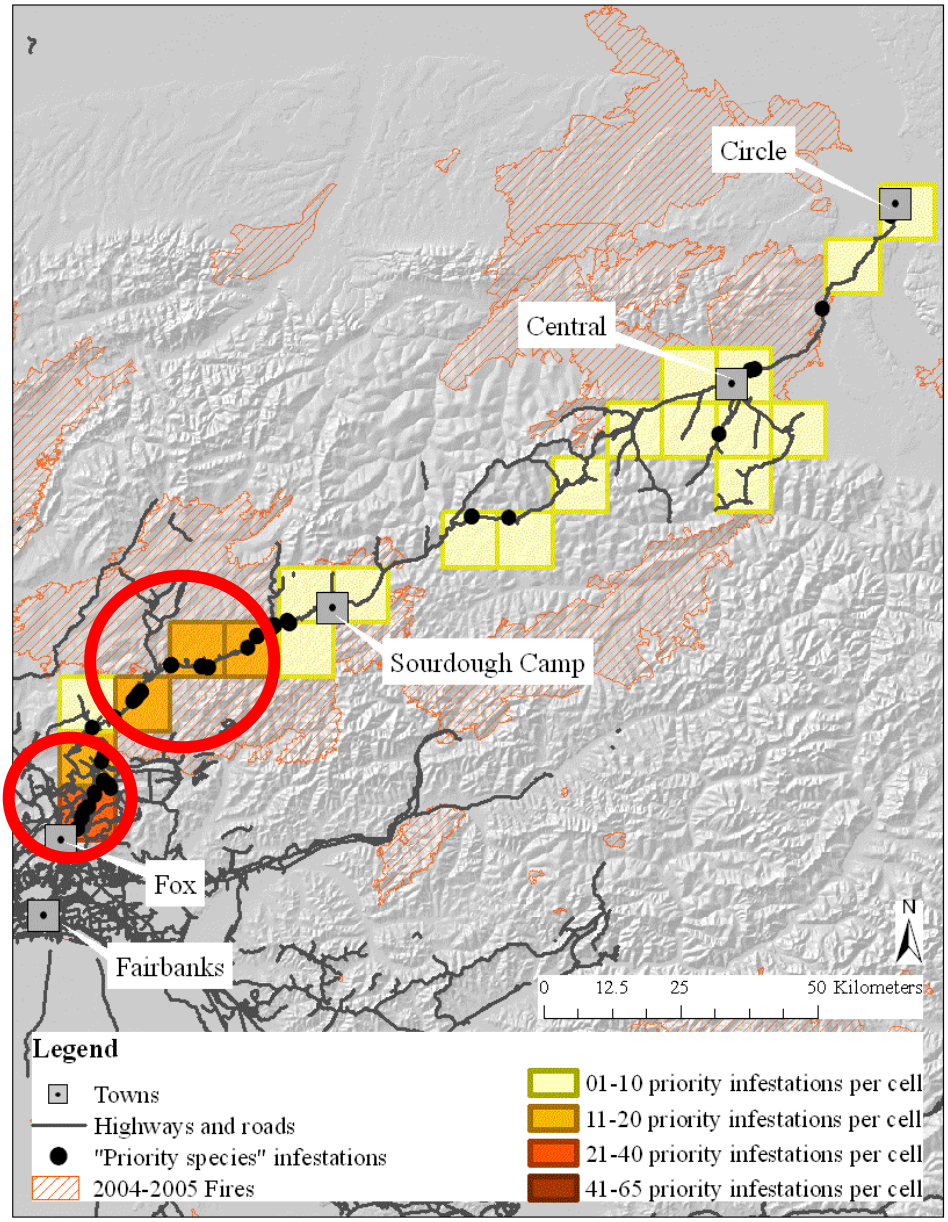

Figure 8. Infestation density along the Steese Highway. We divided the highway into 10km^2 cells, then totaled the number of priority species infestations per cell. Moderate to high infestation densities (with 10-20 priority infestations in a 10km^2 area) were found between Fox and Sourdough Camp, along Davidson Ditch. High densities, with 20-40 priority infestations per cell, were recorded at the junction of the Elliot and Steese Highways. These two hotspots are highlighted with red circles.

Additional Steese Highway infestations

Noteworthy infestations were also recorded outside the burned sections of the highway for the following invasive species:

1. *Melilotus alba* (white sweetclover): In addition to the small burned area populations (Figs. 9 and 10), *Melilotus alba* was found outside the burns, including the following sites:

1.a. Mile marker 90: this population was growing on a gravel pit on the north side of the road. Survey tape was placed around a couple of the plants. The AKNHP crew pulled many of the larger stems to reduce seed production, but still, numerous seedlings and vegetative plants remain.

Figure 9. Infestation of white sweetclover in the Bolgen Creek Burn boundary (photo-monitoring point coincides with Mile 131 of the highway).

1.b. Site #156 (N 65.13694°, W 147.455534°): another large infestation was recorded at a gravel extraction pit along the Watershed Road, on the way to the Poker Flats Watershed Research Station, near mile marker 33 (Fig. 11). It is likely that the contaminated gravel extracted here has been transported to other areas, thus promoting the spread and establishment of this highly invasive species across the region.

1.c. Sites #9 (N 65.573063°, W 144.802503°), at the BLM bunkhouse in Central, and #10 (N 65.273827°, W 146.646509°), at the BLM maintained Cripple Creek Campground: the two populations detected here were also growing on gravel material. The two gravel piles, which are most likely contaminated with white sweetclover seeds, are being used for trail and campground maintenance work. Some removal work was done at each site, but both should be revisited and new individuals must be pulled prior to seed set.

Figure 10. Discrete infestation of white sweetclover in the Boundary Burn area. This photo illustrates the very strong correlation that exists between road construction work (and the consequent use of contaminated materials) and non-native plant infestations.

Figure 11. Gravel extraction pit on Watershed Road infested with white sweetclover.

2. *Bromus inermis* ssp. *inermis* (smooth brome): Two large, monospecific stands of approximately 1,000 to 10,000 stems each were recorded outside the burns, at Site #1 (N 65.572929°N, W 144.801884°), on the formerly cleared banks of Crooked Creek, by the BLM bunkhouse. These infestations constitute two potential dispersal foci from which this species could spread into the surrounding areas, including the Bolgen Burn, which is only ¼ mile down the creek. Consequently, these two patches must be targeted for eradication. The abundance of smooth brome on this highway is probably linked with its use in roadside revegetation projects. Work should focus on containing the current roadside infestations, with emphasis on those occurring between Miles 38 and 39.

3. *Leucanthemum vulgare* (oxeye daisy): A relatively large population of approximately 1,000 to 10,000 individuals was observed on the right-of-way 5.5 mile northeast of Fox, next to a driveway and gate to private property (Fig. 12). This ornamental plant was probably first planted here by the private land owner. The majority of the population (60%) consists of seedlings and of young, first year plants. However, mature flowering individuals were also observed. This infestation should be extirpated.

Figure 12. Oxeye daisies on the right-of-way 5.5 miles northeast of Fox.

Figure 13. Roadside infestation of red clover at Mile 161.

4. *Trifolium pratense* (red clover): A small (less than 200 individuals) population of red clover was discovered just outside Circle, at Mile 161 (Fig. 13). This species is used for forage in the Matanuska-Susitna region, where it has escaped from cultivation and established along roadsides and in disturbed sites. However, it is still infrequent in Interior Alaska, and must therefore be controlled.

5. *Hieracium umbellatum* (narrowleaf hawkweed): A relatively small infestation of less than 1,000 stems, occupying under 0.1 acres, was recorded at the entrance to the Pedro Creek parking across from the Felice Pedroni Memorial (Fig. 14). Pedro Creek is a very popular recreational site for tourists and local residents, and this invasive species was likely brought here unintentionally by visitors. Prompt elimination of this infestation will prevent the species from spreading and establishing along the Pedro Creek.

Figure 14. Visitors panning for gold at Pedro Creek, where a narrowleaf hawkweed (*Hieracium umbellatum*) infestation was detected.

Finally, we note that much of the recent roadside revegetation work carried out at the junction of the Steese and Elliot Highways was done using a seed mix of native, perennial *Poa alpina* (alpine bluegrass) and non-native, annual *Lolium perenne* ssp. *multiflorum* (Italian ryegrass) (Fig. 15). Even though the non-natives found at the time of the survey were not aggressive (e.g. *Chenopodium album*, *Lolium perenne* ssp. *multiflorum*), we recommend that BLM and/or

Department of Transportation (DOT) crews monitor this area carefully for the next two to three years, to ensure that it does not get colonized by aggressively invasive species.

Figure 15. The roadsides at the junction of the Elliot and Steese Highways had recently been revegetated with native, perennial *Poa alpina* and exotic, annual *Lolium perenne* ssp. *perenne*.

Eradication work completed

Control work along the Steese Highway included hand pulling isolated individuals of *Crepis tectorum*, *Elymus sibiricus*, *Melilotus alba*, *Polygonum convolvulus*, and *Trifolium hybridum*. Several patches of *Vicia cracca* were also dug up or pulled. In all, 29 control actions were taken on more than nine (9) acres (see Appendix III.a. for a table and Appendix III.b. for a map of the sites along the Steese Highway where control work was done in 2006). Most of the plants extirpated consisted of adult individuals, in either the flowering or seed setting stage (i.e., not seedlings). Once pulled, the plants were bagged and removed from the infestation site, and then taken to the BLM field office for disposal.

Recommended control actions

Below we outline the control methods that should be used for some of the most invasive or abundant non-native species found along the Steese Highway. (More detailed locality information for the 16 infestations that need to be prioritized for control work is provided in Appendix IV).

1. *Bromus inermis* ssp. *inermis* (smooth brome): this species was broadly distributed along the highway, and was frequently observed on roadsides, at parking lots, and other sites with disturbed soil. In most of the infestations, smooth brome constituted up to 5% of the canopy, with notable exceptions such as the monospecific stand at the Albert Creek crossing, in the Bolgen Burn. Control work for this species should focus on containing the current roadside infestations, with emphasis on the ones occurring at Miles 38 and 39 (hand pulling, mowing). Other populations selected for mechanical removal (mowing) are those at the BLM Bunkhouse and the Steese Highway-Albert Creek intersection. Repeated cuttings are possibly the most effective means of control for this species. In particular, mowing an infested patch four times during the growing season over a four-year period could greatly reduce smooth brome persistence (Marten and Hovin 1980).

2. *Melilotus alba* (white sweetclover): this species generally formed small and discrete populations. Infestations were often correlated with the presence of gravel materials used in road and trail construction (Fig. 10). Therefore, Alaska Department of Transportation records of transport from and use of infested materials sources (e.g., gravel from Sites #9, #10, and #156) will facilitate early detection and eradiation prior to large populations forming. This species is notoriously difficult to eradicate because its seeds remain viable in the soil for many years and it is able to quickly spread along roadside and fire-disturbed areas. All the infestations recorded must be treated by hand-pulling individuals, roots included, and control work must always be carried out as soon as possible, to prevent the formation of a large seed bank.

3. *Vicia cracca* (bird vetch), *Trifolium hybridum* (alsike clover), and *T. repens* (white clover): scattered patches of these three species were recorded in the Boundary Burn section of the highway, between Miles 38 and 52. Removal work must include above and below ground parts, since *V. cracca* and *T. repens* are able to resprout from rhizome fragments, and *T. hybridum* is able to develop new shoots from adventitious buds on the stem. There were several additional, large infestations (ranging from 500 to over 1000 individuals) of *V. cracca* just east of the Steese and Elliott Highway junction, for which we would recommend the use of herbicides were it not that this section of the Steese runs through a residential subdivision, and we consequently expect that such measures would be met with strong opposition. All infestations that are controlled must subsequently be monitored for 4-5 years, as new plants may come up from the seedbank.

4. *Caragana arborescens* (Siberian peashrub): a single infestation was located at Site #139 in the Boundary Burn. It must be removed immediately, using a combination of mechanical (hand pulling, cutting, digging) and chemical (stamp injection) methods. Post-control

monitoring work should also be enforced, in case new individuals come up from the seedbank.

5. *Elymus sibiricus* (Siberian wildrye) and *Polygonum convolvulus* (black bindweed): these two species were also observed in the Boundary Fire section of the highway, at Mile 44 and adjacent to the burn at Mile 58, respectively. Both can be effectively eliminated by hand pulling.

6. *Leucanthemum vulgare* (oxeye daisy): a large infestation of this ornamental plant was observed 5.5 miles northeast of Fox. A first step towards controlling this population would be to reduce seed production by cutting and bagging the flowering heads (one could also dig out the rosettes, but this would be very labor intensive). In addition to this, the combined application of selective herbicides and fertilizers would also help eradicate this stand. Collaborative work between the Department of Transportation and the property owner will be indispensable.

7. *Trifolium pratense* (red clover): recorded at Mile 161, this infestation can be eliminated by pulling the entire plant, which must include underground parts to avoid resprouting. Post-control monitoring work will be necessary to extirpate any new individuals arising from the seedbank.

8. *Hieracium umbellatum* (narrowleaf hawkweed): this species was growing at the entrance to the Pedro Creek parking across from the Felice Pedroni Memorial. Given the small size of the infestation, it can be extirpated through a combination of mechanical (digging), chemical (spot treatment), and fertilizing-revegetation methods.

Steese Highway summary of findings

All priority invasive species detected along the Steese Highway in the 2006 surveys must be targeted for eradication (see Appendix IV for a list of infestations recommended for control). Invasive species generally formed small, scattered infestations, and can therefore be successfully extirpated. For more widespread invasives, such as smooth brome, efforts should focus on containing the existing infestations and preventing new ones.

Most non-native species observed were restricted to anthropogenically disturbed sites. However, the highly invasive *Caragana arborescens* (Siberian peashrub) was found spreading into undisturbed, native communities in the Boundary Burn region. This infestation requires immediate eradication work. Unlike the Dalton Highway, no non-natives were observed growing on fire-disturbed sites at the time of this survey. Nonetheless, these surveys were conducted very recently after the fires and burned areas remain highly vulnerable to invasion and should be monitored accordingly.

Two invasive species 'hotspots' were identified: the towns of Circle and Central, and the section of highway extending from Fox to Davidson Ditch. The presence of infestations along the highway was strongly correlated with road building and roadside revegetation activities, with the

importation of contaminated gravel and other construction materials, and with parking lots, trailheads, campgrounds, and boat launch sites. Consequently, all these sites must be inventoried and monitored for early detection of new non-native plant establishment. Furthermore, sites at which control work was conducted in 2006 must be revisited in 2007 to remove all new individuals that will have emerged from the seed bank in the ground (see Appendix III for a list of populations controlled in 2006).

Finally, plant collections were made for the reference herbarium at BLM. All non-native species encountered were collected, together with unknown species that could potentially be non-native, and with species commonly used in roadside revegetation work. The list of voucher specimens collected along the Steese Highway includes: *Crepis tectorum*, *Caragana arborescens*, *Elymus sibiricus*, *Hieracium umbellatum*, *Leucanthemum vulgare*, *Polygonum convolvulus*, *Phleum pratense*, and *Vicia cracca*.

Dalton Highway

Overview

Fieldwork along the Dalton Highway was conducted from 22 July through 27 July 2006. The dominant vegetation type in this area was open, black spruce forest.

Monitoring efforts extended from one mile south of the Yukon River-Dalton Highway crossing to the town of Coldfoot, and covered a total of five fires: Fort Hamlin Hills (2004), Ray River (2005), Dall City (2004), North Bonanza (2005), and Chapman Creek (2005). The 2004 Evansville Burn was excluded from the surveys because there was no road access to it. Secondary roads and trails were also surveyed for up to one mile or until no more invasive species were found. Additional sites included trailheads, fire access roads, and pipeline access roads.

A total of 24 non-native species belonging to seven (7) families were recorded in the approximately 120 miles of highway and roughly 214 acres of roadside and adjacent lands inventoried (Table 2). Surveyors read 20 AKEPIC-based plots, which included nine (9) plots on pipeline maintenance access pullouts and three (3) at rest stops and picnic areas, and 451 BLM-BAER plots, which were erected whenever priority invasive species were found on or near BLM land, including right-of-ways, trailheads, fire access roads, and pipeline access roads. Nine (9) permanent photo-monitoring plots were established, two in each of the Fort Hamlin Hills, Dall City, 2005 North Bonanza, and Chapman Creek burned areas, and one along the Ray River Burn because the portion of the highway affected by this fire is very short (see Appendix VII for a map of sites at which photo-monitoring points were established).

Table 2. List of non-native plant species encountered along the Dalton Highway in 2006.

Family Name	Scientific Name	Common Name	Invasiveness Rank
Poaceae	*Alopecurus pratensis*	meadow-foxtail	not ranked
Poaceae	*Bromus inermis* ssp. *inermis*	smooth brome	62
Brassicaceae	*Capsella bursa-pastoris*	shepherd's purse	40
Chenopodiaceae	*Chenopodium album*	lambs quarters	35
Asteraceae	*Crepis tectorum*	narrowleaf hawksbeard	54
Brassicaceae	*Descurainia sophia*	flaxweed tansymustard	41
Asteraceae	*Hieracium umbellatum*	narrowleaf hawkweed	46
Poaceae	*Hordeum jubatum*	foxtail barley	63
Brassicaceae	*Lepidium densiflorum*	common pepperweed	25
Asteraceae	*Leucanthemum vulgare*	oxeye daisy	61
Fabaceae	*Lotus corniculatus*	birdsfoot trefoil	not ranked
Asteraceae	*Matricaria discoidea*	pineapple weed	33
Fabaceae	*Medicago sativa* ssp. *sativa*	alfalfa	59
Fabaceae	*Melilotus alba*	white sweetclover	80
Fabaceae	*Melilotus officinalis*	yellow sweetclover	65
Plantaginaceae	*Plantago major*	common plantain	44
Poaceae	*Poa pratensis* ssp. *irrigata*	spreading bluegrass	52
Poaceae	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	52
Polygonaceae	*Polygonum aviculare*	prostrate knotweed	45
Asteraceae	*Taraxacum officinale* ssp. *officinale*	common dandelion	58
Fabaceae	*Trifolium hybridum*	alsike clover	57
Fabaceae	*Trifolium pratense*	red clover	53
Fabaceae	*Trifolium repens*	white clover	59
Fabaceae	*Vicia cracca*	bird vetch	73

Burned area survey results

Fort Hamlin Hills Burn (04)

The Fort Hamlin Hills Burn is the most southerly burn along the Dalton Highway. The following five (5) non-native species were found in this section: *Crepis tectorum*, *Bromus inermis* ssp. *inermis*, *Melilotus alba*, *Trifolium hybridum*, and *Vicia cracca*. Of these, the most invasive species were *Melilotus alba* (ranked at 80 points out of 100) and *Vicia cracca* (73 points). The latter was also the most frequently recorded together with *Crepis tectorum* (54 points).

Trifolium hybridum (invasiveness rank of 57 points) was widespread locally and was recorded at Sites #447 (N 65.912291°, W 149.794946°) and 448 (N 65.911066°, W 149.790749°). These sites must be prioritized for eradication. (Appendix V shows all *T. hybridum* infestations observed on the Dalton Highway)..

No invasive species were expanding from anthropogenically disturbed sites into burned areas.

Fort Hamlin Hills Burn photo-monitoring points

One photo-monitoring point was established at Site #144 (N 65.933015°, W 149.852656°), marking a population of *Vicia cracca* on the right-of-way (Fig. 16). The second one was set up at Site #150 (N 65.906983°, W 149.779104°), which was infested with *Melilotus alba* (Fig. 17).

Figure 16. Photo-monitoring point marking a Vicia cracca infestation on a right-of-way (Site #144, Fort Hamlin Hills Burn, Dalton Highway).

Figure 17. This *Melilotus alba* infestation covers approximately one acre of roadside and is adjacent to the Fort Hamlin Hills Burn. A photo-monitoring point was established here (Site #150).

Ray River Burn (05)

Seven (7) non-native species were recorded in the Ray River Burn section: *Crepis tectorum, Bromus inermis* ssp. *inermis*, *Melilotus alba, Trifolium hybridum*, *T. pratense, Hieracium umbellatum,* and *Vicia cracca*. The most aggressively invasive species were *Melilotus alba* (80 points, Fig. 18) and *Vicia cracca* (73 points), while *Bromus inermis* ssp. *inermis* (62 points) and *Trifolium hybridum* (57 points) were the most frequently recorded.

Figure 18. Photo-monitoring point marking a *Melilotus alba* infestation on a gravel pullout adjacent to the Ray River Burn (Site #129).

A population of *T. pratense* (53 points) was recorded at Site #136 (N 65.937828°, W 149.867187°), on a side road leading to a BLM

camp and DOT station, approx. 0.25 m east of the highway, less than one (1) mile away from the Fort Hamlin Fire boundary, and a quarter mile from the Ray Fire perimeter. We recommend that control actions are carried out before it disperses and establishes in the neighboring burned areas (Fig. 19).

No invasive species were recorded extending into the burned areas.

Ray River Burns photo-monitoring points

A single photo-monitoring point was set up at Site #129 (N 65.97571°, W -149.99953°), approx. 10.5 miles north of the Yukon River, at a gravel pullout adjacent to the burned spruce forest, where there was a *Melilotus alba* infestation.

Figure 19. *Trifolium pratense* (red clover) at Site #136 along the Dalton Highway.

Dall City Burn (04)

Fifteen (15) non-native species were observed in this portion of the Dalton Highway: *Alopecurus pratensis, Crepis tectorum, Bromus inermis* ssp. *inermis, Melilotus alba, M. officinalis, Trifolium hybridum, T. pratense, Hieracium umbellatum, Lepidium densiflorum, Lotus corniculatus, Medicago sativa* ssp. *sativa, Plantago major, Polygonum aviculare, Taraxacum officinale* ssp. *officinale,* and *Vicia cracca*. As in the preceding two fires, the most invasive species were *M. alba* and *V. cracca,* and the most common ones were *B. inermis* ssp. *inermis,* and *T. hybridum,* together with *M. alba*. These last three species were broadly distributed, and control efforts should therefore focus on containing the existing populations and preventing their further expansion.

Three notable findings were made in the Dall City Burn:

1. Individual plants of *Lotus corniculatus* (birdsfoot trefoil) were recorded at two locations: Site #94 (N 66.267175°, W 150.345131°), and Site #89 (N 66.279834°, W 150.360537°; Fig. 20). (See Appendix V for a distribution map).

   In the Lower 48 and Canada this plant develops thick mats on disturbed ground and prevents colonization of native species (Cal-IPC 2003, Czarapata 2005). It has been widely planted for erosion control along roadsides and as livestock forage, which is problematic because birdsfoot trefoil easily escapes cultivation, colonizing roadsides, fields, pastures and forests (Turkington and Franko 1980). Fires have been found to increase seed germination and promote seedling establishment (Czarapata 2005), which makes the 2004 and 2005 burn areas particularly susceptible to invasion by this species.

Figure 20. Flowering *Lotus corniculatus* plant along the roadside, within the Dall City Fire perimeter (Site #94).

   All plants found during this survey were dug out. However, we strongly recommend that these two sites be revisited and monitored for early detection and elimination of any new plants.

2. A single population of *Medicago sativa* ssp. *sativa* was found at Site #90 (N 66.273931°, W 150.35138°) and must be pulled. This species is known from the agricultural regions of South-central Alaska, where it has escaped from cultivation. However, it is extremely infrequent in Interior Alaska, with only two other known records, both from the Fairbanks Experimental Station (see Appendix V for a map showing the distribution of alfalfa and bird vetch along the Dalton Highway).

3. An isolated occurrence of *Vicia cracca* was observed at Site #101 (N 66.215723°, W 150.25254°), and must be extirpated before it disperses and establishes in other areas (see Appendix V for a map showing the distribution of *Medicago sativa* ssp. *sativa* and *Vicia cracca* along the Dalton Highway).

Dall City Burn photo-monitoring points

The following two photo-monitoring points were established in this burn:

1. Site #95 (N 66.260409°, W 50.331254°), where approximately five acres of roadside land are infested with *Trifolium hybridum* and *Melilotus alba* (Fig. 21). The *Trifolium*

hybridum population was dense and very well established along the right-of-way, but was not extending into the forest. This species, however, delays the establishment of native species on the roadside, making it susceptible to invasion by other non-natives. The infestation is so dense that it would be virtually impossible to eradicate it completely from the site. Control work must be done here to prevent it from expanding any further.

Figure 21. Dall City Fire photo-monitoring plot with *Trifolium hybridum* and *Melilotus alba*.

2. Site #86 (N 66.305984°, W 150.400036°) marks a *Melilotus alba* infestation (Fig. 22). The population is restricted to the right-of-way and next to a black spruce forest that burned in the 2004 Dall City Fire. Up to 50 stems of *Melilotus alba* were counted, some setting seed while others were still in flower at the time of this survey (22-27 July 2006).

Figure 22. Photo-monitoring point marking a *Melilotus alba* (white sweetclover) infestation next to a black spruce forest burned in the Dall City Fire (Site #86).

North Bonanza Burn (05)

Nine (9) non-native species were observed in the 2005 North Bonanza Burn area: *Bromus inermis* ssp. *inermis, Crepis tectorum, Hieracium umbellatum, Melilotus alba, M. officinalis, Trifolium hybridum, T. pratense, Trifolium repens,* and *Vicia cracca*. The most invasive species were *Melilotus alba* (white sweetclover) and *Vicia cracca* (bird vetch). White sweetclover was also one of the most frequently recorded species, with *Crepis tectorum* and *Trifolium hybridum*.

A total of 17 *Trifolium hybridum* infestations were observed, scattered throughout the northern two thirds of this burned section of the highway. These populations must be contained, and control work should be conducted from the periphery of the infestation inwards.

Other invasive species recorded in this burn section include:

1. *Trifolium repens*: this highly aggressive species was locally very abundant at Sites #222 (N 66.75052°, W 150.677°) and #229 (N 66.729236°, W 150.667°).

2. *Vicia cracca*, forming a single, isolated, and small population at Site #69 (N 66.706811°, W 150.67568°; Fig. 23). This infestation must be controlled and monitored.

Figure 23. *Vicia cracca* patch adjacent to black spruce forest burned by the 2005 Bonanza Creek Fire (Site #69, photo-monitoring point).

3. *Hieracium umbellatum*, with large numbers of individuals extending into the burned areas (Fig. 24). This species was recorded at the following sites:
   - Site #63 (N 66.731326°, W 150.667192°)
   - Site #67 (N 66.718057°, W 150.670958°)
   - Site #230 (N 66.727754°, W 150.667311°)
   - Site #231 (N 66.718288°, W 150.666955°)

4. *Crepis tectorum*, observed at Site #54 (N 66.822731°, W 150.662952°), on the Jim River D.O.T Station Road. The plants were expanding into the adjacent fire-disturbed, black spruce forest (Fig. 25). This population consists of up to 500 stems, and is likely to have arrived here as a contaminant in fill importation that was also present at the site. The *Crepis tectorum* plants now cover the fill material. Several individuals at different phenological stages (some flowering, some setting seed) were observed growing into the burned forest of the right-of-way. Control and monitoring work are also recommended for this infestation.

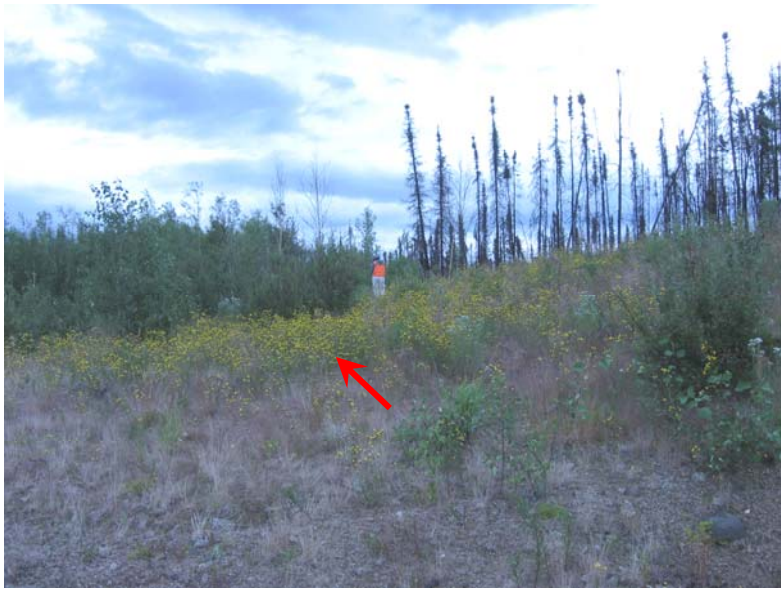

Figure 24. *Hieracium umbellatum* (narrowleaf hawkweed) extending into burned black spruce forest. North Bonanza Creek Burn.

It is important to highlight that *Crepis tectorum* (Site #54) and *Hieracium umbellatum* (Sites #63, 67, 230, and 231) were the only species in this section of the highway that had moved off the human footprint and expanded into the fire-disturbed forest. Their aggressively invasive behavior merits that they be prioritized for eradication work (See Appendix V for maps of the sites at which these two species were recorded on the Dalton Highway).

Figure 25. Flowering and seed-setting individuals of *Crepis tectorum* are invading the fire-disturbed black spruce forest by the Jim River DOT station road (Site #54, photo-monitoring point, North Bonanza Burn).

Lastly, we note the presence of an additional population of *Hieracium umbellatum* approximately two miles south of the North Bonanza Fire perimeter, which should be monitored and controlled to prevent its expansion along the right-of-way (see Appendix VIII for a list of infestations on the Dalton Highway requiring future control work).

North Bonanza Burn photo-monitoring points

Two photo-monitoring points were set up: one at Site #69 (N 66.706811°, W 150.67568°), to mark the above described single, isolated, and small population of *Vicia cracca* (see above, Fig. 23); the other at Site #54 (N 66.822731°, W 150.662952°), to monitor a *Crepis tectorum* roadside infestation (see above, Fig. 25).

Chapman Creek Burn (05)

A total of nine (9) non-native species were found along the intersection of the 2005 Chapman Creek Burn with the Dalton Highway: *Alopecurus pratensis, Crepis tectorum, Bromus inermis* ssp. *inermis, Lepidium densiflorum, Matricaria discoidea, Melilotus alba, Plantago major, Taraxacum officinale* ssp. *officinale*, and *Vicia cracca* (Figs. 26 and 27). As is the case for all the other burned areas along this highway, *Melilotus alba* and *Vicia cracca* were the most aggressively invasive species recorded. *Melilotus alba* was also the most frequently recorded species. Control work is needed at Site #18 (N 67.055936°, W 150.350407°), which was infested with *Vicia cracca*, and at Site #37 (N 66.97558°, W 150.338362°), ca. 2.5 miles south of this fire's boundary, where *Trifolium hybridum* was observed.

Chapman Creek Burn photo-monitoring points

One point was established at Site #13 (N 67.157043°, W -150.357703°), where there was a *Bromus inermis* ssp. *inermis* infestation adjacent to the burn (Fig. 26). The second point is at Site #23 (N 67.042832°, W -150.313559°), and marks a *Melilotus alba* infestation (Fig. 27). The behavior of both populations must be monitored.

Figure 26. Chapman Creek Burn photo-monitoring point marking a *Bromus inermis* ssp. *inermis* infestation (Site #13).

Figure 27. *Melilotus alba* infestation at the second photo-monitoring point in the Chapman Creek Burn (Site #23).

Dalton Highway problematic areas

Even though aggressively invasive *Melilotus alba* and *Vicia cracca* were recorded throughout the Dalton Highway, they were especially abundant within the Fort Hamlin Hills, Ray River, and Dall City Fire perimeters (Fig. 28; see Appendix V for maps of the sites at which these two species were recorded).

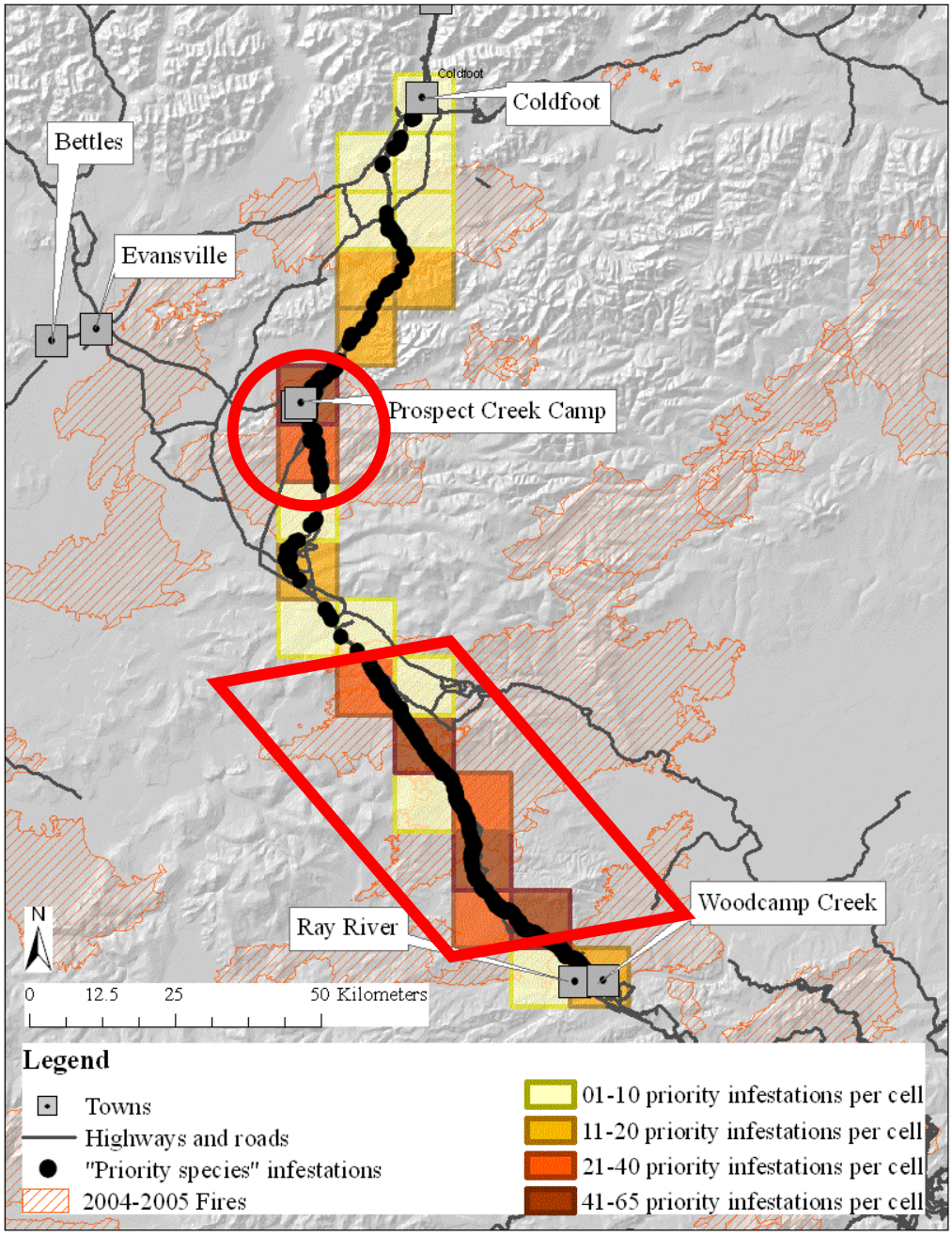

Figure 28. Infestation density along the Dalton Highway. We divided the highway into 10km^2 cells, then totaled the number of priority species infestations per cell. This is the only highway of the three surveyed with sections that hade over 50 priority infestations in a 10km^2 area. Very high densities (with over 40 infestations per 10km^2 cell) of priority infestations were recorded in and north of the Ray River-Fort Hamlin Hills Burns, extending into the Dall City Fire section. The area around Prospect Creek Camp, in the North Bonanza Burn, constituted a second hotspot. These two areas are highlighted in red.

Eradication work completed

Manual pulls were carried out at a total of 21 locations, 14 of which were done to control *Melilotus alba* populations. Three non-native species populations were extirpated in the Dall City Burn, two of *Lotus corniculatus* (Sites #89 and 94) and one of *Medicago sativa* ssp. *sativa* (Site #90). Additional control work was conducted in the Chapman Creek Burn, on a *Crepis tectorum* infestation (Site #26, N 67.034665°, W -150.3044492°, 1.7 miles north of the South Fork of the Koyukuk River), and on a *Bromus inermis* ssp. inermis infestation (Site #14, N 67.082281°, W -150.352538°, 5 miles north of the South Fork of the Koyukuk, at a Winter Trail trailhead). Finally, two small *Leucanthemum vulgare* infestations (Sites #1 and 2, approximately two to three miles southwest of the town of Coldfoot) were pulled. (See Appendix VI for more details on all the infestations that were controlled).

Recommended control actions

Here we outline the control and eradication methods recommended for the most common and aggressively invasive species found along the Dalton Highway (see Appendix VIII for a list of problematic infestations requiring future control and monitoring work):

1. *Bromus inermis* ssp. *inermis* (smooth brome): this is one of the more problematic and widespread invasive species in Alaska. It has been widely used for roadside revegetation projects, and now persists in Interior Alaska. (See Appendix V for a map of sites infested with smooth brome along the Dalton Highway). In the Dalton Highway surveys this grass was observed along roadsides, on parking lot edges, abandoned areas, and clearings. Control work should focus on containing the current roadside infestations. Smooth brome often forms pure stands, which facilitates control and eradication work, and repeated cuttings are possibly the most effective means of control. In particular, mowing an infested patch four times during the growing season over a four-year period could greatly reduce smooth brome persistence (Marten and Hovin 1980).

2. *Trifolium hybridum* (alsike clover): *Trifolium hybridum* was widespread along the Dalton Highway right-of-ways, and a total of 21 infestations were recorded. Two are located within the Fort Hamlin Hills Burn (Sites # 447 and 448), and can be extirpated by digging the individuals out. A large infestation was recorded at Site #95 in the Dall City Fire, and must be controlled to prevent it from expanding any further. Similarly, the 17 populations that were observed throughout the northern two thirds of the North Bonanza Creek Burn must be contained, and control work should be conducted from the periphery of infestation inwards. Finally, there is a discrete population at Site #37, ca. 2.5 miles south of the Chapman Creek Burn boundary, which must be dug out. Alsike cover can reproduce vegetatively from adventitious buds left on the stem. Therefore, it can only be eliminated if it is dug out in its entirety, or cut at ground level, without leaving a stump. Control work must be carried out at the beginning of the flowering period, to prevent seed set, and is recommended for all the infestations observed. Additionally, four to five years of post-control monitoring work will be necessary to extirpate any new individuals arising from the seedbank. (See Appendix V for a map of sites along the Dalton Highway at which alsike clover was recorded).

3. *Trifolium pratense* (red clover): a single population was recorded at Site #136, on a side road leading to a BLM camp and DOT station, between the Fort Hamlin Hills and Ray River Burns. This infestation can be extirpated by hand-pulling each plant, which must include underground parts to avoid resprouting. Given the longevity of this species' seeds, any infestations that are pulled will also require subsequent long-term monitoring work, so that any new individuals arising from the seedbank can be detected and extirpated in time.

4. *Trifolium repens* (white clover): infestations were locally very abundant at Site #222, just north of Gobblers Knob pullout and picnic area, and Site #229, between Prospect Creek and the North Fork of Bonanza Creek, both within the North Bonanza Creek Burn boundary. Once white clover becomes established on bare ground, it can expand into naturally disturbed areas. It is known to invade canopy gaps in native vegetation, as well as to colonize river gravel bars (Coladonato 1993). To prevent it from spreading into native vegetation, the isolated infestations detected in the North Bonanza Burn section must be controlled by digging all individuals out, and subsequently monitored for new individuals coming up from the seedbank. The extirpated plant fragments must be bagged and removed from the site, as stem fragments can produce new, viable individuals. (See Appendix V for a map of sites infested with white clover along the Dalton Highway).

5. *Lotus corniculatus* (birdsfoot trefoil): two small, localized, and disjunct infestations were recorded at Sites #89 and 94, in the Dall City Burn. Although all individuals found in 2006 were dug out, this site should be revisited and monitored for new plants in the coming (2007) growing season. To effectively eliminate this species, both above and below ground parts must be removed through hand pulling or digging, as it has the ability to resprout from root fragments. The treated populations must be monitored for a period of four to five years for new seedlings that may emerge from the seedbank.

6. *Medicago sativa* ssp. *sativa* (alfalfa): two populations were observed, both in the Dall City Fire area. One was at Site #90, between the two forks of West Fork Dall River, and the second between mile markers 91 and 93, in an area that had been recently seeded with grasses. Suggested control actions for this species include mowing and hand pulling, followed by four to five years of monitoring for new seedlings coming up from the seedbank.

7. *Melilotus alba* (white sweetclover): Two infestations are recommended for control work: one in the Fort Hamlin Hills Burn area, at Site #150, at the intersection of the highway with the Fort Hamlin Hills creek, and one in the Dall City Burn, at Site #86, Mile 93. First year plants can be controlled by hand-pulling. Second-year plants, on the other hand, should be cut at the ground level before flowering, to prevent seed set. Sweetclover seeds are extremely long lived. Consequently, long-term control programs will be needed until the seedbank is depleted (Cole 1991, Densmore *et al*. 2001).

8. *Vicia cracca* (bird vetch): A total of four bird vetch populations need to be extirpated. One at Site #144, in the Fort Hamlin Hills Burn section, a second one at Site #101, across from pipeline pullout, in the Dall City Fire area (this isolated occurrence of *Vicia cracca* must be eradicated before it disperses and establishes in other areas), a third one at Site #69, in the

North Bonanza Burn area (this small infestation must be controlled and monitored), and finally one at Site #18, in Chapman Creek Burn.

Bird vetch is an ecologically damaging species which was locally abundant in the area inventoried. It can overgrow herbaceous vegetation and climb over shrubs, such as alder and willow, altering native ecosystem function. Complete eradication of the recorded populations, as well as additional monitoring work, must be prioritized.

Mechanical control methods are best suited for management of bird vetch on right-of-ways. Plants must be cut near the base of their stem before the end of the flowering period (end of June to mid July), and repeating this process for a number of years should eliminate most infestations, including new seedlings that may arise from the seedbank. Individuals that cannot be mowed (because they are on trees or fences) must be hand-pulled (Nolen 2002). (See Appendix V for a map of sites infested with bird vetch along the Dalton Highway). Chemical control may not be necessary this stage, as the majority of infestations recorded along the Dalton Highway were small enough that the mechanical treatment specified above should be effective (one exception to this would be the Fort Hamlin Hills Fire population at Site #144, which is very large, with 1,000-10,000 individuals). It is important that this species not be confused with native *Hedysarum alpinum* and *Lathyrus palustris*, which are also frequent colonizers of roadside areas in interior Alaska.

9. *Crepis tectorum* (narrowleaf hawksbeard): this species can be controlled both through mechanical and chemical methods. Plants can be mowed early in season to prevent seed production. However, plants resprout easily from the stump, producing new, reproductive individuals. Hand pulling the entire plant is therefore more effective, so long as the plants are bagged and removed from the site. *Crepis tectorum* was widespread along the Dalton Highway right-of-ways, and populations of this species were found in every burn surveyed. Control work is especially recommended for the population recorded at Site #54 (Fig. 25), on the Jim River DOT Station Road, which covers fill material and was expanding into the adjacent burned forest. Plants here must be hand-pulled and bagged. (Appendix V marks the sites along the Dalton at which narrowleaf hawksbeard was observed).

10. *Hieracium umbellatum* (narrowleaf hawkweed): This species was relatively recently introduced in Alaska (the first collection made here is recorded in the University of Alaska Museum of the North database, ARCTOS, and dates back to 1986). So far, no records of establishment in undisturbed, native communities have been made.

    Small populations of *H. umbellatum* were found in the Dall City, North Bonanza, and Ray River Burn sections. Individuals were also noted between these burned areas (Appendix V marks the sites along the Dalton Highway at which narrowleaf hawkweed was recorded). They must all be extirpated. Infestations with very few individuals can be extirpated by digging, including roots and rhizomes. Special attention should be given to minimize soil disturbance when pulling these plants. Hawkweed seedlings from the existing seed bank will quickly re-colonize area. Re-seeding with native grass is highly recommended to suppress hawkweed reestablishment. Monitoring should be done at least once in the spring and once in the fall, for several years.

If the populations persist, herbicide application will be necessary. There are various reasons why the use of chemical treatments on well established populations is warranted. First, herbicides can successfully extirpate these infestations without disturbing the soil in which they grow, thus minimizing the chances of post-disturbance, vigorous plant reestablishment. Also, because the current populations are small and restricted to human-disturbed areas, they can be eliminated with equally small amounts of chemicals, thus minimizing the negative side-effects of the chemicals on the surrounding, native communities. Previous work shows that using selective herbicides, followed by re-seeding with perennial grass and nitrogen fertilizer application, will hamper hawkweed reestablishment for three years (Prather and Robins 2005). Additionally, spot treatment is recommended to minimize effect of the chemicals used on the surrounding native plants and wildlife.

11. *Leucanthemum vulgare* (oxeye daisy): Oxeye daisy is a highly invasive species (61 points). Infestations were recorded at Sites #1 and 2, two to three (2-3) miles southwest of Coldfoot. Its presence in this area is likely associated with its proximity to urban areas and gardens. Both populations were very small, with no more than five flowering individuals each, and consequently the possibility of successfully eradicating them is high. As this species' seeds remain viable for as long as 60 years (Chippindale and Milton 1934), both infestations must be extirpated before a seed bank is formed. The first step that should be taken to control this infestation is to reduce seed production by cutting and bagging the flowering heads. Given the small size of the infestations, we also suggest digging up the rosettes formed by each individual.

Dalton Highway summary of findings

The most aggressively invasive species recorded in the Dalton Highway surveys were *Melilotus alba* (80 points), *Vicia cracca* (73 points), *Melilotus officinalis* (65 points), *Bromus inermis* ssp. *inermis* (62 points), and *Leucanthemum vulgare* (61 points). (See Appendix V for Dalton Highway distribution maps for some of these species).

Melilotus alba and *Bromus inermis* ssp. *inermis*, which were observed throughout the length of the highway, were particularly abundant within the Fort Hamlin Hills, Ray River, and Dall City Fire perimeters. *Crepis tectorum* and *Trifolium hybridum* were also widespread along the Dalton Highway right-of-ways. Given the broad distribution of these four species, efforts should focus on containing the current infestations by (a) extirpating any small patches or isolated occurrences of these plants, and (b) controlling and reducing larger populations.

Quite critically, individuals of *Crepis tectorum* and *Hieracium umbellatum* were detected spreading into the North Bonanza Creek Burn. Given the aggressive behavior of these species, it is crucial that these populations be targeted for eradication.

Finally, plant collections of all the non-native species that were encountered were made for the reference herbarium at BLM. We also collected unknown species that could potentially be non-native, as well as species commonly used for roadside revegetation. The list of voucher

specimens collected along the Dalton Highway includes: *Crepis tectorum*, *Hieracium umbellatum*, *Leucanthemum vulgare*, *Lotus corniculatus*, *Medicago sativa* ssp. *sativa*, *Melilotus alba*, *M. officinalis*, *Trifolium repens*, and *Vicia cracca*.

Taylor Highway

Overview

Fieldwork along the Taylor Highway, from Tetlin Junction to Eagle, was conducted from 11 July through 16 July 2006. Roadside vegetation consisted mainly of tall scrub (alder-willow), early seral-herbaceous communities, and mixed, open spruce forests.

Six burned areas were monitored along the way, corresponding to the intersection of the highway with the 2004 Porcupine, Chicken, Wall Street, King Creek, and Deer Creek Fires, as well as the 2005 Boundary Creek Fire. Plots were read on right-of-ways, and secondary roads, winter trails, and ATV trails were inventoried for up to one mile or until no invasive species were present. Potential invasive plant dispersal foci, such as the DOT maintenance station and the junction of the Taylor and the Alaska Highways, were also targeted.

In all, 160 miles of highway were covered, and 102 plots were read. Of these, 33 used the AKEPIC protocol, while the rest (69) followed BLM-BAER methodology, and were established only when priority invasive plant infestations were detected. Six (6) of these plots were set up as photo-monitoring points.

Excluding species whose nativity status remains questionable (*Erysimum cheiranthoides*, *Hordeum jubatum*, and *Potentilla norvegica*,), a total of 25 non-native species were recorded (Table 3). The most common ones were: *Bromus inermis* ssp. *inermis, Plantago major, Taraxacum officinale* ssp. *officinale*, and *Trifolium hybridum.*

Most of the invasives documented near the burns rank low to very low in terms of their invasiveness, with the exception of *Vicia cracca* (bird vetch), which was seen (slightly) invading the undisturbed shrub understory adjacent to the highway's right-of-way (see Appendix IX for a map of the sites at which bird vetch populations were observed).

Non-native plants found outside of the fire perimeters include: *Collomia linearis, Descurainia sophia, Lappula squarrosa, Linum perenne, Medicago sativa* ssp. *falcata, Melilotus alba, Melilotus officinalis, Poa pratensis* ssp. *pratensis, Rumex acetosella, Rumex crispus,* and *Stellaria media.* No non-natives were found on the winter trails. Invasive plants were more common and appeared to extend farther along upland ATV trails.

Table 3. List of non-native plant species encountered along the Taylor Highway in 2006.

Family Name	Scientific Name	Common Name	Invasiveness Rank	Porcupine	Chicken	Wall Street	King Cr	Boundary Cr
Caryophyllaceae	*Agrostemma githago*	corncockle	not ranked		X			
Poaceae	*Bromus inermis* ssp. *inermis*	smooth brome	62	X	X			
Chenopodiaceae	*Chenopodium album*	lambs quarters	35		X			
Polemoniaceae	*Collomia linearis*	narrowleaf mountaintrumpet	not ranked					
Asteraceae	*Crepis tectorum*	narrowleaf hawksbeard	54	X			X	
Brassicaceae	*Descurainia sophia*	flaxweed tansymustard	41					
Poaceae	*Hordeum jubatum*	foxtail barley	63	X	X	X	X	X
Boraginaceae	*Lappula squarrosa*	bristly sheepburr	44					
Brassicaceae	*Lepidium densiflorum*	common pepperweed	25				X	
Linaceae	*Linum perenne*	blue flax	not ranked					
Asteraceae	*Matricaria discoidea*	pineapple weed	32	X	X		X	X
Fabaceae	*Medicago sativa* ssp. *falcata*	yellow alfalfa	64					
Fabaceae	*Melilotus alba*	white sweetclover	80					
Fabaceae	*Melilotus officinalis*	yellow sweetclover	65					
Papaveraceae	*Papaver nudicaule*	Icelandic poppy	not ranked			X		
Plantaginaceae	*Plantago major*	common plantain	44	X	X		X	X
Poaceae	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	52					
Polygonaceae	*Polygonum aviculare*	prostrate knotweed	45	X	X			X
Rosaceae	*Potentilla norvegica*	Norwegian cinquefoil	not ranked				X	
Polygonaceae	*Rumex acetosella*	sheep sorrel	51					
Polygonaceae	*Rumex crispus*	curly dock	48					
Caryophyllaceae	*Stellaria media*	chickweed	42					
Asteraceae	*Taraxacum officinale* ssp. *officinale*	common dandelion	58	X		X	X	
Fabaceae	*Trifolium hybridum*	alsike clover	57		X		X	
Fabaceae	*Vicia cracca*	bird vetch	73			X		

Burned area survey results

Porcupine Burn (04)

Seven (7) non-native species were found inside the boundaries of the Porcupine Burn. These were *Bromus inermis* ssp. *inermis*, *Crepis tectorum*, *Hordeum jubatum*, *Matricaria discoidea*, *Polygonum aviculare*, *Plantago major,* and *Taraxacum officinale* ssp. *officinale*. The first two, which rank at 62 and 54 points of invasiveness respectively, were the most problematic species in this area.

Bromus inermis ssp. *inermis* was found at three locations in the northern portion of the burn: Site TAY06-0006 (N 63.59794°, W 142.34946°), Site TAY06-0007 (N 63.64768°, W 142.2888°), and Site #13 (N 63.631731°, W 142.313992°). A population of *Crepis tectorum* infestation was also located in this area, at Site #12 (N 63.631412°, W 142.314083°) (see Appendix IX for maps of the sites at which *Bromus inermis* ssp. *inermis* and *Crepis tectorum* were recorded).

Porcupine Burn photo-monitoring points

No photo-monitoring plots were established in this area.

Chicken Burn (04)

Agrostemma githago, *Bromus inermis* ssp. *inermis*, *Chenopodium album*, *Hordeum jubatum*, *Matricaria discoidea*, *Plantago major*, *Polygonum aviculare*, and *Trifolium hybridum* were recorded in this burn, with *Bromus inermis* ssp. *inermis* (62 points out of 100) and *Trifolium hybridum* (57 points) being the most aggressively invasive, as well as the most frequently observed.

Chicken Burn photo-monitoring points

Two photo-monitoring points were erected in the Chicken Fire perimeter.
1. Site #23 (N 64.04641°, W 142.054339°) marks a smooth brome (*Bromus inermis* ssp. *inermis*) and alsike clover (*Trifolium hybridum*) infestation (Fig. 29).

2. Site #6 (N 63.865919°, W 142.228878°), was set up to monitor an alsike clover (*Trifolium hybridum*) population that was invading native grass adjacent to a burned, black spruce bog (Fig. 30).

Figure 29. This Chicken Burn photo-monitoring point was established at a site infested by *Bromus inermis* ssp. *inermis* and *Trifolium hybridum* (Site #23).

Figure 30. *Trifolium hybridum* is invading native vegetation adjacent to a burned, black spruce bog at this photo-monitoring point (Site #6, Chicken Burn).

Wall Street Burn (04)

Two populations of *Vicia cracca* and one of *Papaver nudicaule* were identified in the Wall Street Burn. The larger of the two *V. cracca* infestations (up to 5,000 stems) was located at Site #3 (N 64.0503°, W 141.785981°), growing behind the fence of the South Fork DOT Station (Fig. 31). The other infestation was one (1) mile west of this point, at Site #1 (N 64.056813°, W 141.809232°). Because bird vetch was only found at these two locations and nowhere else along the highway (see Appendix IX for a map of the two sites where *V. cracca* was recorded), control efforts should aim to completely eliminate both populations. Furthermore, the stations and the equipment stored in it must be periodically monitored and controlled for invasive species.

Figure 31. These two photos were taken at the DOT South Fork Station, which has a large infestation of bird vetch (*Vicia cracca*) (Site #3, Wall Street Burn). Both the DOT population and the one located less than a mile west from here should be targeted for eradication.

Wall Street Burn photo-monitoring points

Both photo-monitoring points established in the Wall Street Burn are free of invasive plants. One is located on the west side of the highway at Site #8 (N 64.086225°, W 141.665243°), in a native forb-graminoid roadside community (Fig. 32). The second one is at Site #6 (N 64.08569°, W 141.648632°), and is dominated by native willows, alder, and grasses. (Fig. 33).

Figure 32. Native forb-graminoid roadside vegetation (Site #8, Wall Street Burn).

Figure 33. Weed-free photo-monitoring plot at Site #6, Wall Street Burn.

King Creek Burn (04)

One population of each of the following species were observed along the King Creek Burn area: *Crepis tectorum, Matricaria discoidea, Plantago major*, and *Trifolium hybridum* (see Appendix IX for a map of the sites where alsike clover was recorded).

King Creek Burn photo-monitoring points

A single photo-monitoring point was set up at Site #12 (N 64.370089°, W 141.413751°), in an early seral herbaceous roadside vegetative community. Species recorded here include *Potentilla norvegica* (no longer being tracked as a non-native in AKEPIC), *Hordeum jubatum* (whose non-nativity is questionable), and *Taraxacum officinale* ssp. *officinale* (extremely widespread in Alaska, and thus not worth prioritizing for control anymore) (Fig. 34).

Figure 34. King Creek photo-monitoring point. Roadside vegetation here included *Potentilla norvegica*, *Hordeum jubatum*, and *Taraxacum officinale* ssp. *officinale.* These species should not be prioritized for control.

Boundary Creek Burn (05)

A single population of *Matricaria discoidea* was all that was recorded from this burn.

Boundary Creek Burn photo-monitoring points

A photo-monitoring point was established at Site #8 (N 64.58596°, W 141.27352°), marking a native, early seal herbaceous roadside community (Fig. 35).

Figure 35. Weed-free Boundary Creek Fire photo-monitoring point.

Deer Creek Burn (04)

The Deer Creek Burn was not surveyed because it was off the road network. However, the AKNHP crew did inventory the very beginning of the 70-Mile Trail leading to this burn until no invasives species were found (less than one mile, Fig. 36). Very few non-natives were recorded here, and most of these (e.g. *Erysimum cheiranthoides*, *Hordeum jubatum*, and *Plantago major*) were not aggressive, with the exception of a small (ca. 100 stems) population of smooth brome (*Bromus inermis* ssp. *inermis*) at the beginning of the trail (Site #1, N 64.792036°, W 141.236519°).

Figure 36. Wetland on the 70-Mile Trail leading to the Deer Creek Burn, west of Eagle.

Deer Creek Burn photo-monitoring points

Because the area was not surveyed, no photo-monitoring points were set up.

Taylor Highway problematic areas

The largest numbers of non-native species were concentrated in the first three miles from the Alaska-Taylor Highway junction (Fig. 37). Other invasive species 'hotspots' were at the intersection of the 2004 Chicken Burn with the road, at the town of Eagle, and at the 70-Mile trailhead leading to the Deer Creek Burn.

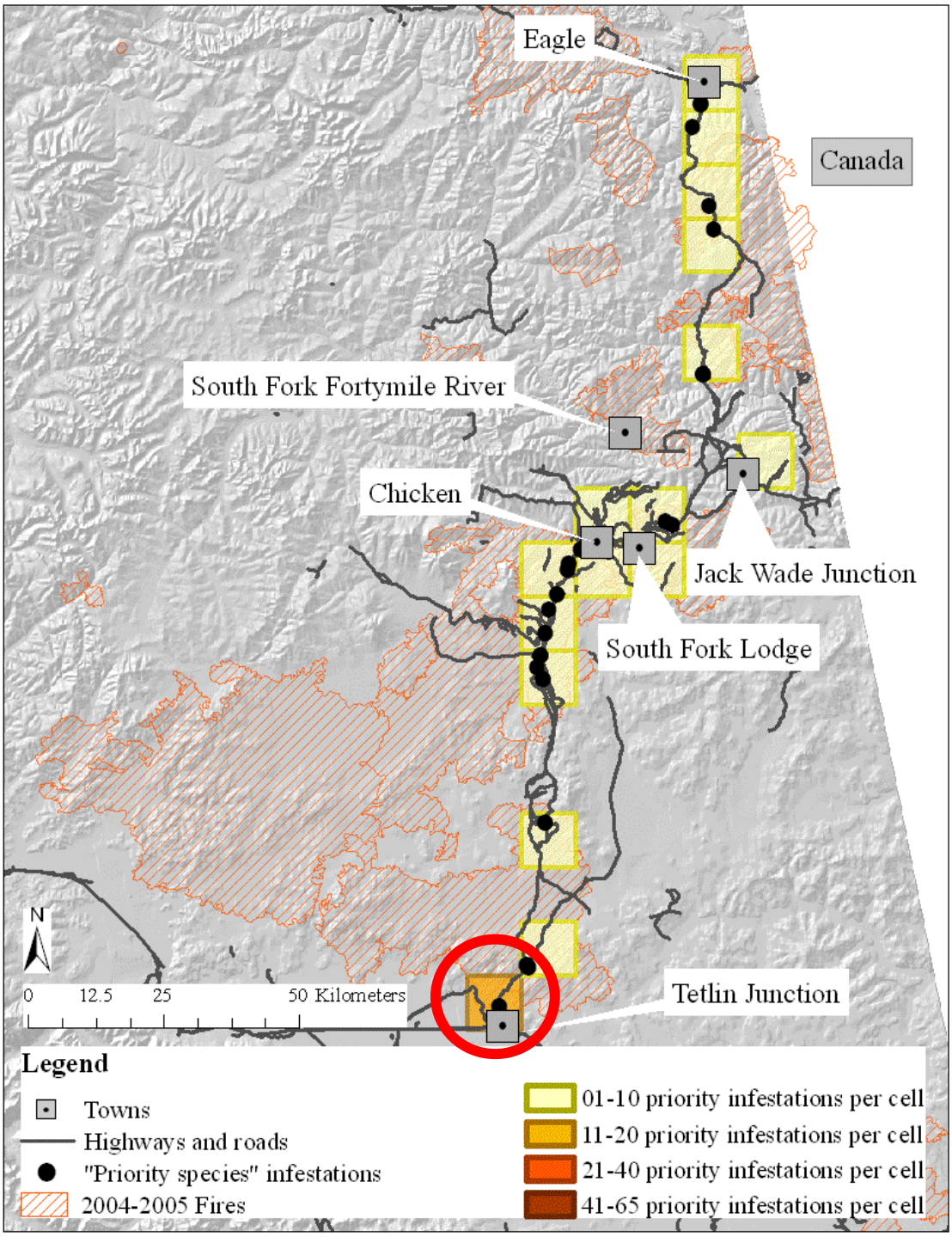

Figure 37. Infestation density along the Taylor Highway. We divided the highway into 10km^2 cells, then totaled the number of priority species infestations per cell. Overall, the density of infestations was lowest for this highway. Moderate levels were recorded for the first section of the Highway, at and near the junction of the Alaska and Taylor Highways. This area is highlighted in red.

Non-native species recorded in the three mile section north of the junction included: *Bromus inermis* ssp. *inermis*, *Chenopodium album*, *Crepis tectorum*, *Lappula squarrosa*, *Lepidium densiflorum*, *Medicago sativa* ssp. *falcata*, *Melilotus alba*, *Melilotus officinalis*, *Polygonum aviculare*, and *Trifolium hybridum*.

Populations of *Melilotus alba*, both the most frequently and most invasive species recorded in this three mile long section of the highway, were observed in the following areas:

1. Site #26 (N 63.344889°, W 142.601039°): this infestation of up to 700 individuals, all in the seedling stage, and located at Mile 2.5 of the highway, was marked with yellow flagging tied to a willow tree (Fig. 38).

Figure 38. *Melilotus alba* infestation at Site #26 (left). The willow tree that was next to the infestation was tagged with yellow flagging tape (right).

2. Site #27 (N 63.328065°, W 142.59663°): a mixed population of flowering individuals and first year seedlings, totaling some 700 individuals, was observed at Mile 1.1 of the highway, and hand pulled. We recommend that this site be revisited to check for new seedlings that may emerge from the seedbank (Fig. 39).

3. Site #28 (N 63.328467°, W 142.596738°): a second population, consisting mainly of seedlings, was also observed at Mile 1.1, near a parking sign. Although the bigger plants were hand pulled, smaller seedlings remain.

4. Site #29 (N 63.311692°, W 142.602427°): The infestations recorded here, at the junction of the Alaska and Taylor Highways, were dispersing northwards into the Taylor.

Bromus inermis ssp. *inermis*, *Crepis tectorum*, *Medicago sativa* ssp. *falcata*, *Melilotus officinalis*, and *Trifolium hybridum* were also documented at the junction of the Taylor and Alaska Highways (i.e. Site #29), but unlike *Melilotus alba*, they had not yet expanded northwards. Annual monitoring and pulling efforts are recommended for all the above mentioned sites.

Figure 39. This *Melilotus alba* infestation was hand-pulled (Site #27).

Eradication work completed

During the 2006 survey, a total of four infestations were controlled (see Appendix X for a list of the sites where control work was conducted). *Melilotus alba* populations were extirpated by hand-pulling at Sites #25 (N 63.344946°, W 142.601168°) and #27. In addition, about 0.1 acres of *Polygonum aviculare* were pulled from Site #24 (N 63.403103°, W 142.470529°), in the Porcupine Burn section. Finally, roughly 1,000 flowering stems of *Vicia cracca* were pulled at Site #1, about 6.5 miles north of Chicken. (Even though all adult *V. cracca* individuals were removed, there were still some seedlings left that must be pulled next season together with new plants recruited from the seed bank).

Recommended control actions

Here we outline the control and eradication methods recommended for the most common and aggressively invasive species found along the Taylor Highway (see Appendix XI for a list of problematic infestations requiring future control and monitoring work):

1. *Bromus inermis* ssp. *inermis* (smooth brome): Smooth brome was especially abundant in the Chicken and Porcupine Burns, but was also recorded in Eagle and at the junction of the

Taylor and Alaska Highways (see Appendix IX for a map of sites where smooth brome was observed). Priority must be given to the following four populations: three in the northern portion of the Porcupine Burn (TAY06-0006, TAYO6-0007, and Site #13), and one at the beginning of the 70-Mile Trail (Site #1). Repeated cuttings are possibly the most effective means of control for this species (see *Recommended control actions* for the Steese and Dalton Highways).

2. *Trifolium hybridum* (alsike clover): *Trifolium hybridum* was most frequently observed in the Chicken Burn, even though there are additional record from near Tetlin Junction, King Creek Burn, and Eagle. Populations at Sites #6 and 23, which fall in/near the Chicken Fire section, must be controlled (see Appendix IX for a map of sites where alsike clover was recorded). *Trifolium hybridum* can reproduce vegetatively from adventitious buds left on the stem. Therefore, it can only be eliminated if it is dug out in its entirety, or cut at ground level, without leaving a stump. Control work must be carried out at the beginning of the flowering period, to prevent seed set, and is recommended for all the infestations observed (see *Recommended control actions* for the Steese and Dalton Highways).

3. *Melilotus alba* (white sweetclover): White sweetclover was only found at the beginning of the Taylor Highway, at its junction with the Alaska Highway. (see Appendix IX for a map showing the distribution of the *M. alba* and *Vicia cracca* populations recorded). Inventory Sites #25-29 have infestations that must be extirpated, to prevent this species from expanding further north along the Taylor. First year plants can be controlled by hand-pulling. Second-year plants, on the other hand, should be cut at the ground level before flowering, to prevent seed set. Because sweetclover seeds are extremely long lived, long-term control programs will be needed to monitor and guarantee the success of all control work done (Cole 1991, Densmore *et al*. 2001).

4. *Medicago sativa* ssp. *falcata* (yellow alfalfa): An infestation of yellow alfalfa was recorded at the intersection of the Taylor and Alaska Highways Site #29) and must be removed. Suggested control actions for this species include mowing and hand pulling. Pulling the entire plant, including underground parts to avoid resprouting) should be enough to get rid of the infestation. Underground parts should be digged out, as alfalfa can reestablish from lateral shoots sprouting (Rosenstock and Stevens 1989).

5. *Vicia cracca* (bird vetch): Two large infestations of bird vetch were observed at Sites #1 and 3 in the Wall Street Burn section of the highway (see Appendix IX for a map showing the distribution of *Vicia cracca* infestations). Chemical treatments are highly recommended for these two infestations. Alternatively, at the very least, they must be suppressed either by cutting the plants at ground level (it is critical to note that this should only to be done before they set seed) or, for individuals climbing trees and walls, by hand-pulling them off. This process will have to be repeated consecutively over a number of years (Nolen 2002) (see *Recommended control actions* for the Steese and Dalton Highways).

6. *Crepis tectorum* (narrowleaf hawksbeard): *Crepis tectorum* was recorded in the King Creek (Site #14, N 64.314382°, W -141.419353°) and Porcupine (Site #12, N 63.631412°, W -142.314083°) Burns, as well as in the first three miles of highway from the Tetlin-Alaska

Highways junction (Site #34, N 63.311697°, W -142.602288°), and near the town of Eagle. Because plants resprout easily from the stump, hand pulling the entire plant is the most effective control action, so long as the plants are bagged and removed from the site. (see Appendix IX for maps of the sites at which *Crepis tectorum* was recorded).

Taylor Highway summary of findings

The Taylor Highway is not yet as affected by invasive plant species as the Steese and Dalton corridors are. There were fewer instances of aggressively invasive species, and none were observed off of high-use areas into undisturbed native or burned habitats. Furthermore, most of the priority species were concentrated in a small area along the first three miles of the highway, close to the junction of the Taylor and Alaska Highways. This area of dense infestations constitutes a serious gateway for future non-native plant invasion and expansion.

Given that the majority of priority species found along the Taylor Highway form small and isolated infestations, they can be targeted for eradication (see Appendix X for a list of infestations that were controlled in 2006, and Appendix XI for a list of infestations requiring future control and monitoring work). The two exceptions to this are the widespread *Bromus inermis* ssp. *inermis* and *Vicia cracca*, for which containment and suppression of expansion are more realistic short-term goals.

SUMMARY OF FINDINGS AND CONCLUSIONS FOR THE 2006 SURVEYS

Native communities are susceptible to invasion by non-native plants that grow along roadsides and right-of-ways. This susceptibility is ostensibly greater in areas where the soil and vegetation have been disturbed. In 2006, three AKNHP crews carried out non-native plant surveys along the Steese, Dalton, and Taylor Highways, using AKEPIC and BLM-BAER based sampling methodologies, and paying special attention to roadside BLM lands that were affected by the 2004 and 2005 fires.

In all, over 500 acres of Interior Alaska roadside areas were surveyed, and more than 800 infestations were recorded, most of which (75 percent) were captured with the BLM-BAER plots.

An analysis of the total number of priority, non-native species infestations recorded shows that the number of infestations observed in the Dalton Highway was more than four times that of the Steese Highway, and more than seven times that of the Taylor Highway (Fig. 40). In contrast, both the diversity (which we define here as the total number of priority, non-native species per highway) and the average size of infestation remained comparable from one highway to the next (Fig. 41, Table 4).

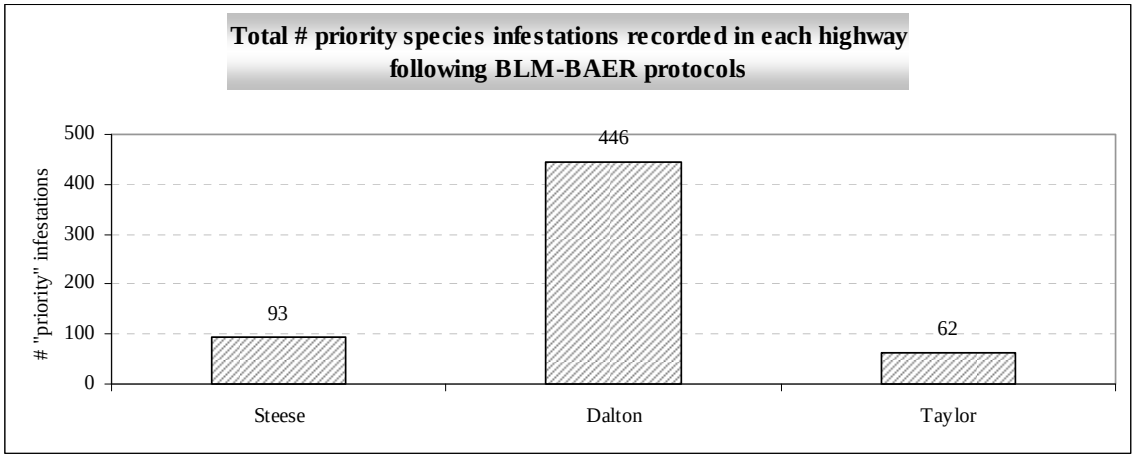

Figure 40. Total number of priority non-native species populations recorded for the Steese, Dalton, and Taylor Highways (i.e. priority species "richness").

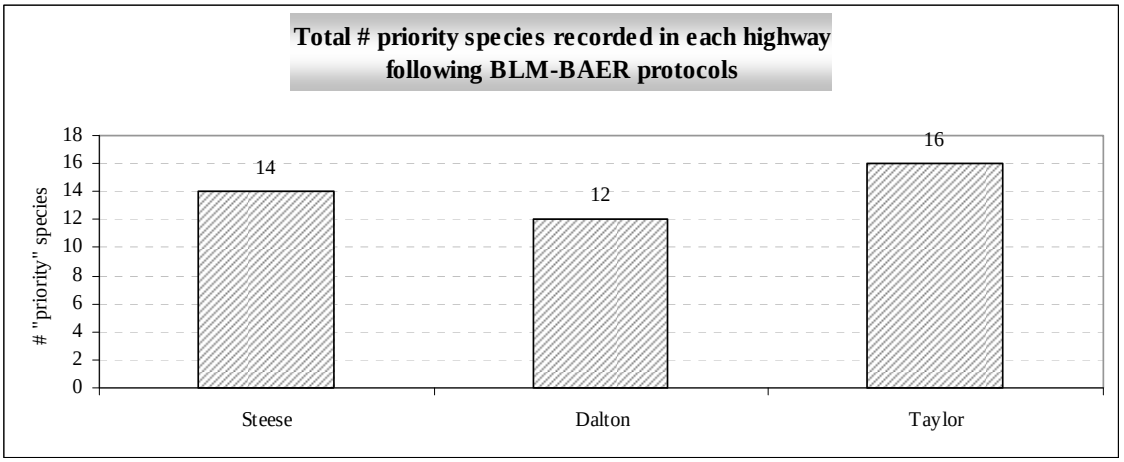

Figure 41. Total number of priority non-native species recorded for the Steese, Dalton, and Taylor Highways (i.e. priority species "diversity").

Table 4. Total number of acres infested with priority non-native species, and average size of a priority species infestation for the Steese, Dalton, and Taylor Highways.

Highway name	Total acreage infested	Average size of infestation
Steese	66	0.5
Dalton	166	0.4
Taylor	21	0.4

Thus, of the three highways surveyed, the Dalton was the most heavily infested, with populations of the highly aggressive *Melilotus alba*, *Bromus inermis* ssp. *inermis*, *Crepis tectorum*, and *Trifolium hybridum* occurring throughout the highway. Given the widespread distribution of these four species, complete eradication will be very resource-demanding and will require an integrated pest-management strategy. Initial efforts should focus on containing the current infestations by (a) extirpating any small patches or isolated occurrences of these plants, and (b) controlling and/or reducing larger populations, and should be implemented immediately.

In contrast, most of the infestations recorded along the Steese Highway were smaller and more localized, and can therefore still be targeted for extirpation (work on the few, broadly distributed species, such as *Bromus inermis* ssp. *inermis*, must aim to contain the current populations, to prevent their further expansion).

There were even fewer instances of aggressively invasive species along the Taylor Highway, and none had yet dispersed from high-use areas into native or burned vegetation.

All three road systems are located in Interior Alaska, and share the same types of soil and vegetation, as well as similar levels of natural disturbance. Therefore, the most likely explanation

for the higher levels of infestation in the Dalton corridor is that it has a greater volume of traffic, both from tourism and commercial vehicles.

In addition, the findings from the 2006 surveys allow us to identify the following invasive species 'hotspots' for each road system:

1. Dalton Highway: the area in and north of the Ray River-Fort Hamlin Hills Burns, extending into the Dall City Fire section, had very high densities of priority species, with over 40 populations per 10km^2 cell. The section of the highway around Prospect Creek Camp, in the North Bonanza Burn, constituted a second hotspot.
2. Steese Highway: The stretch of highway between Fox and Sourdough Camp, along Davidson Ditch, had moderate to high priority species densities, with 10-20 populations per 10km^2 cell. High densities, with 20-40 priority infestations per 10km^2 cell, were recorded at the junction of the Elliot and Steese Highways.
3. Taylor Highway: The majority of priority species infestations are concentrated in the first three miles of the highway from Tetlin Junction.

We also propose that there is a strong correlation between infestations and the following activities and places: (1) road building and roadside revegetation activities, especially with the importation of contaminated gravel and other construction materials (for instance, in the Steese Highway the presence of *Melilotus alba* tended to coincide with areas where new gravel had been laid); (2) parking lots, campgrounds, and other anthropogenically disturbed sites (these sites were often infested by *Bromus inermis* ssp. *inermis*); (3) DOT stations (e.g. the DOT station in the Taylor Highway is a major source of *Vicia cracca* propagules). Similar patterns of *Melilotus alba* invasions radiating from contaminated gravel fill were observed on other BLM-managed lands in Alaska (Carlson *et al.* 2006). Consequently, these activities and sites must be inventoried and monitored to guarantee the early detection and extirpation of new non-native establishment.

In all three surveys, most non-native populations were restricted to anthropogenically-disturbed, high-use areas. The one instance of a non-native species extending into completely undisturbed, native vegetation was that of *Caragana arborescens* (Siberian peashrub), in the Steese Highway. Originally planted in interior Alaska because it is winter hardy, this species is now one of the most aggressive invaders of mixed forests in the Matanuska-Susitna area (Lapina and Carlson 2005), and is known to invade and modify the structure and community composition of European boreal forests. It is therefore crucial that the Siberian peashrub infestation be prioritized for control and eradication work. Equally critical was the detection of two populations, one of *Crepis tectorum* and one of *Hieracium umbellatum*, spreading from the roadside into a fire-disturbed site in the North Bonanza Burn section of the Dalton Highway. Similar studies have documented the spread of aggressively invasive *Vicia cracca* (Steve Seefeldt, pers. comms.) and *Melilotus alba* (Katie Villano, pers. comms.) into burned areas off the Dalton Highway, which suggests that our findings are not isolated events. (No non-natives were found invading undisturbed native or fire-disturbed sites along the Taylor Highway).

Nonetheless, this overall trend whereby non-native plants are restricted to high human-use areas, must be interpreted with caution. With time, it is likely that we will see a greater number of invasive species populations spreading into native ecosystems due to the sheer increase in

propagule pressure and in the volume of traffic along these roads. Global climate changes are also expected to favor the advance and establishment of non-native species, to the detriment of native plant communities. In order to curb this trend, we not only recommend that control and management actions be taken on the current infestations, but strongly urge that the agencies involved in the maintenance of these road systems (primarily DOT) enforce measures to guarantee that the road construction and revegetation work they carry out minimizes, rather than facilitates, the spread of non-natives around the state. These actions could mimic those taken by BLM firefighting crews, and could involve using uncontaminated gravel, cleaning machinery before transporting it to a new place, and most important of all, trying to keep their stations as invasive plant-free as possible.

The specific control and management actions recommended for each species and infestation are detailed in the previous sections of this report. However, we reiterate here that eradication and/or containment work must prioritize (1) any infestations of species that have already been detected spreading into native communities (*Caragana arborescens*, *Crepis tectorum*, and *Hieracium umbellatum*), and (2) all populations of highly aggressive species (*Bromus inermis* ssp. *inermis*, *Bromus tectorum*, *Caragana arborescens*, *Crepis tectorum*, *Hieracium umbellatum*, *Leucanthemum vulgare*, *Medicago sativa* ssp. *falcata*, *Medicago sativa* ssp. *sativa*, *Melilotus alba*, *Melilotus officinalis*, *Phleum pratense*, *Polygonum convolvulus*, *Rumex acetosella*, *Trifolium hybridum*, *Trifolium pratense*, *Trifolium repens*, and *Vicia cracca*).

It is crucial that the removal or containment of infestations also be accompanied by adaptive monitoring work, especially for those species with seeds that can remain viable for many years (e.g., *Melilotus alba* and *Medicago sativa*) and for species that can resprout from underground parts (e.g., *Vicia cracca*, *Trifolium repens*). Similarly, sites at which control work was conducted in 2006 must be revisited in 2007 to remove any new individuals that may emerge from the seed bank.

Furthermore, the 2005 burned sections were surveyed when they were only in their first growing season, and it is likely that a number of non-native species will only become established during the second growing season. We therefore strongly recommend that these areas be inventoried again, in their entirety, during the 2007 field season.

Finally, in addition to the future monitoring and control work recommended here, we suggest that activities promoting public awareness on invasive plants and the danger they pose to Alaska's native ecosystems be organized and encouraged. These could include, for instance, public presentations on weeds, the distribution of invasive plant field identification guides, and invasive plant-pulling events.

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APPENDICES

Appendix I.a. BLM-AKNHP list of priority invasive species.

Scientific name	Common Name	Invasiveness Score (22 May 2006)
Polygonum cuspidatum Sieb. & Zucc.	Japanese knotweed	87
Centaurea biebersteinii DC	Spotted knapweed	86
Euphorbia esula L.	Leafy spurge	84
Lythrum salicaria L. & *L. virgatum* L.	Purple loosestrife, European wand loosestrife	84
Phalaris arundinacea L.	Reed canary grass	83
Impatiens glandulifera Royle	Ornamental jewelweed	82
† *Heracleum mantegazzianum* Sommier & Levier	Giant hogweed	81
Melilotus alba Medikus	White sweetclover	80
* *Nymphaea odorata* ssp. *odorata* Ait.	American white waterlily	80
Hieracium aurantiacum L. & *H. caespitosum* Dumort.	Orange hawkweed, meadow hawkweed	79
Bromus tectorum L.	Cheatgrass	78
* *Rubus discolor* Weihe & Nees	Himalayan blackberry	77
Cirsium arvense (L.) Scop.	Canada thistle	76
Prunus padus L.	European bird cherry	74
Vicia cracca L.	Bird vetch	73
Lepidium latifolium	Broad-leaved pepperweed	72
* *Alliaria petiolata* (Bieb.) Cavara & Grande	Garlic mustard	70
* *Cytisus scoparius* (L.) Link	Scotchbroom	69
Linaria vulgaris Miller	Butter and eggs	69
Caragana arborescens Lam.	Siberian peashrub	66
Lonicera tatarica L.	Bush honeysuckle	66
Melilotus officinalis (L.) Lam	Yellow sweetclover	65
Campanula rapunculoides L.	Creeping bellflower	64
Medicago sativa ssp. falcata (L.) Arcang.	Yellow alfalfa	64
Senecio jacobaea L.	Ragwort	63
Bromus inermis ssp. *inermis* Leyss.	Smooth brome	62
Carduus nutans, C. acanthoides, C. pycnocephalus, C. tenuiflorus	Nodding/spiny/Italian/winged plumeless thistle	61
Cirsium vulgare (Savi) Ten.	Bull thistle	61
Leucanthemum vulgare Lam.	Oxeye daisy	61
Sonchus arvensis ssp. *uliginosus* (Bieb.) Nyman	Field sowthistle	61
Hordeum murinum ssp. leporinum	Lepor barley	60

Appendix I.a. (contd'.). BLM-AKNHP list of priority invasive species.

Scientific name	Common Name	Invasiveness Score (22 May 2006)
Elymus repens (L.) Gould	Quackgrass	59
Medicago sativa ssp. *sativa* L.	Alfalfa	59
Sorbus aucuparia L.	European mountain ash	59
Trifolium repens L.	White clover	59
Convolvulus arvensis L.	Creeping jenny or morning glory	58
Gypsophila paniculata L.	Baby's breath	57
Tanacetum vulgare L.	Common tansy	57
Trifolium hybridum L.	Alsike clover	57
Phleum pratense L.	Timothy grass	56
Linaria dalmatica L.	Dalmatian toadlfax	55
Crepis tectorum L.	Narrowleaf hawksbeard	54
* *Ranunculus repens* L. & R. acris L.	Creeping buttercup, meadow buttercup	54
Dactylis glomerata L.	Orchard grass	53
Trifolium pratense L.	Red clover	53
Vicia villosa Roth	Hairy vetch	53
*† *Zostera japonica* Aschers. & Graebn.	Dwarf eelgrass	53
* *Hypericum perforatum* L.	St John's wort	52
Verbascum thapsus L.	Big taper	52
Digitalis purpurea L.	Purple foxglove	51
Polygonum convolvulus L.	Black bindweed	51
Rumex acetosella L.	Common sheep sorrel	51
Tragopogon dubius L.	Common salsify	50
Hieracium umbellatum L.	Narrowleaf hawkweed	46

Plant species rejected from consideration due to abundance and broad distribution	Common Name	Invasiveness Score (22 May 2006)
Hordeum jubatum L.	Foxtail barley	63
† *Stellaria media* (L.) Vill.	Chickweed	57
Taraxacum officinale ssp. *officinale* G.H. Weber ex Wiggers	Common dandelion	58
Poa pratensis ssp. *pratensis* L., *P. pratensis* ssp. *irrigata* (Lindm.) Lindb. F.	Kentucky and spreading bluegrass	52

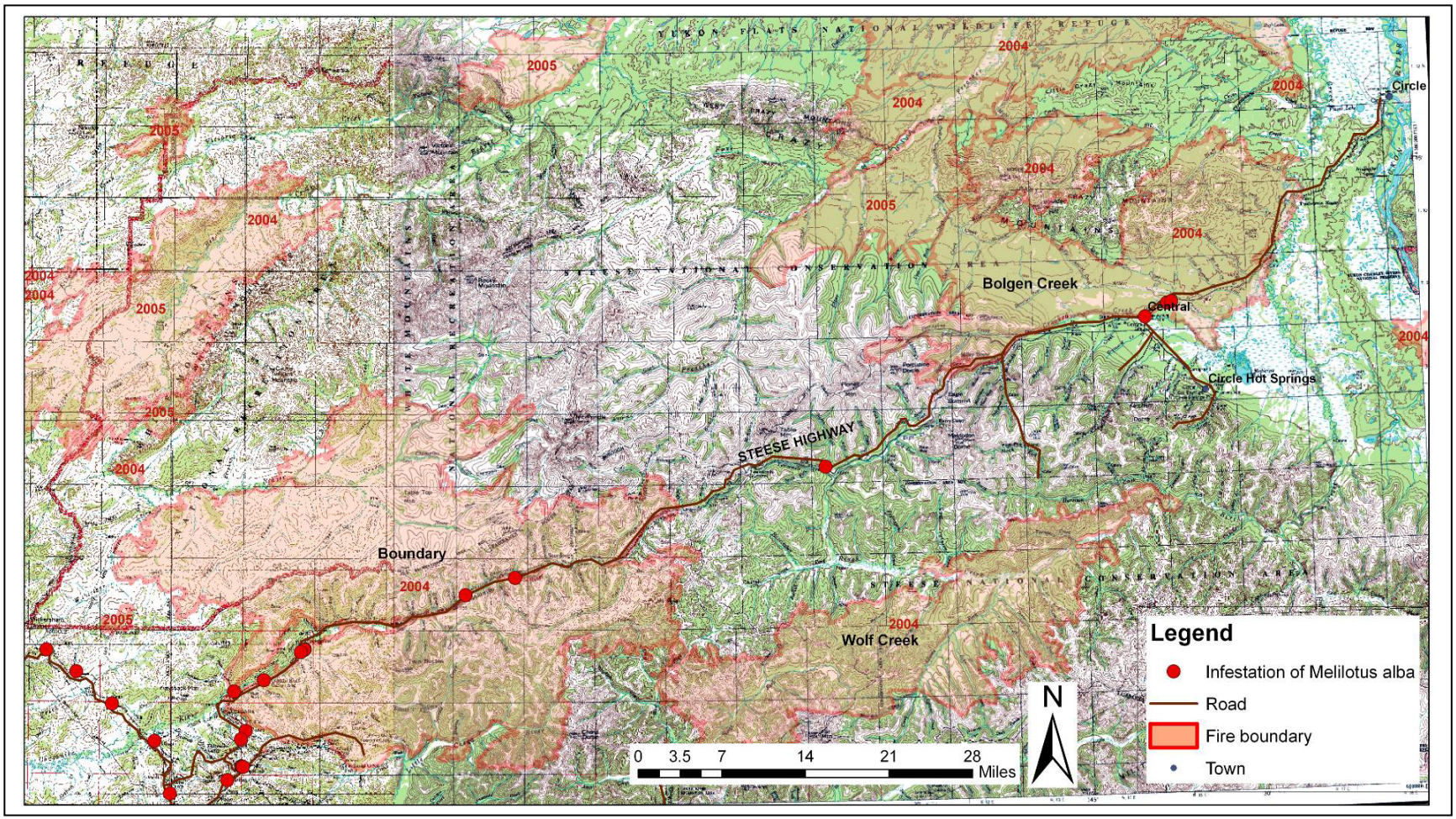
* Species unlikely to be encountered in Interior Alaska
† Invasiveness rank largely based on potential impacts to maritime breeding bird colonies

Appendix I.b. List of priority invasive species recorded.

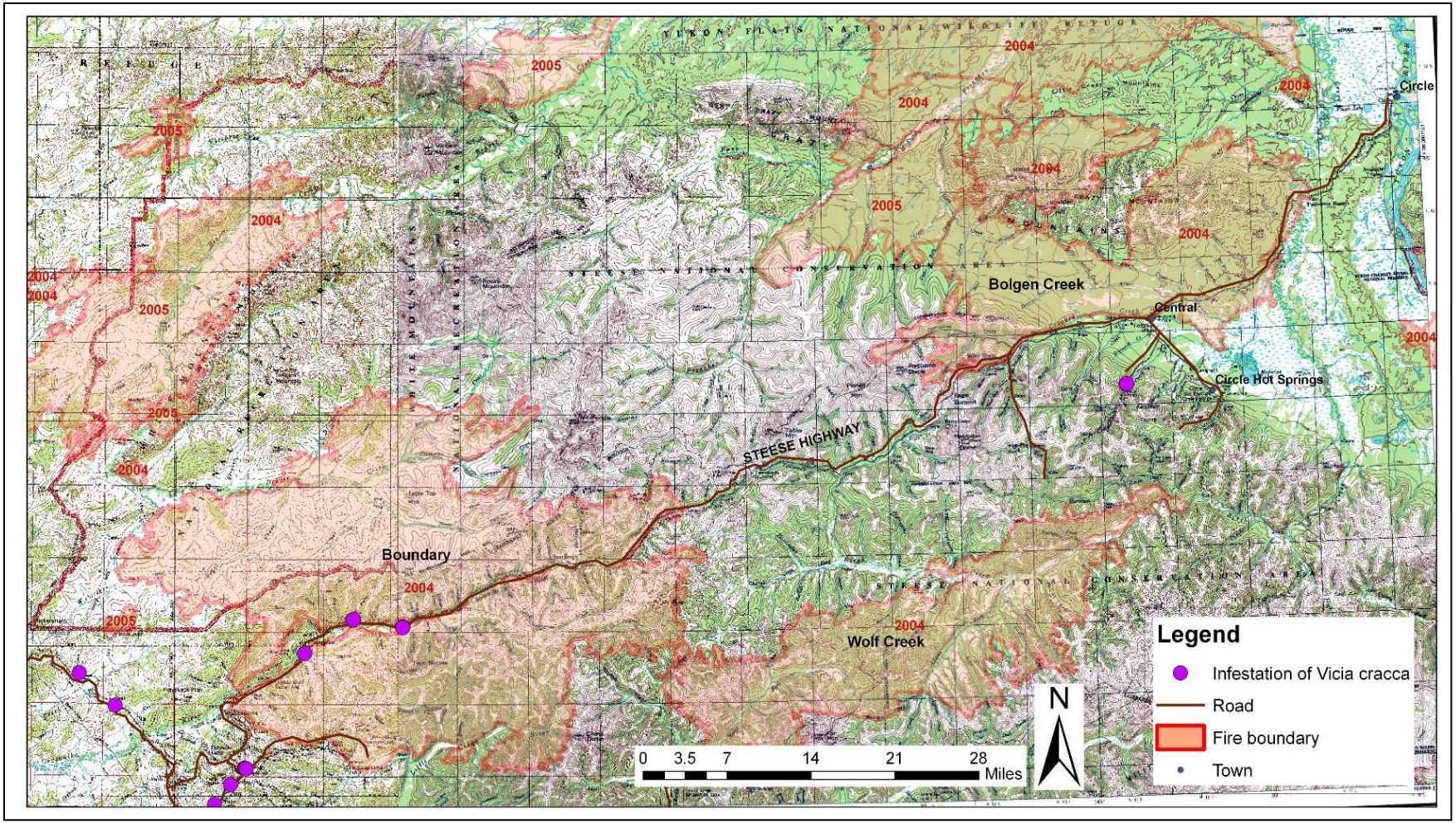
Family	Scientific Name	Common Name	Invasiveness Rank	Highway
Fabaceae	*Melilotus alba*	white sweetclover	80	Dalton, Steese, Taylor
Fabaceae	*Vicia cracca*	bird vetch	73	Dalton, Steese, Taylor
Fabaceae	*Caragana arborescens*	Siberian peashrub	66	Steese
Fabaceae	*Melilotus officinalis*	yellow sweetclover	65	Dalton, Steese, Taylor
Fabaceae	*Medicago sativa* ssp. *falcata*	yellow alfalfa	64	Taylor
Poaceae	*Hordeum jubatum*	foxtail barley	63	Dalton, Steese, Taylor
Poaceae	*Bromus inermis* ssp. *inermis*	smooth brome	62	Dalton, Steese, Taylor
Asteraceae	*Leucanthemum vulgare*	oxeye daisy	61	Dalton, Steese
Fabaceae	*Medicago sativa* ssp. *sativa*	alfalfa	59	Dalton
Fabaceae	*Trifolium repens*	white clover	59	Dalton, Steese
Poaceae	*Elymus repens*	quackgrass	59	Steese
Asteraceae	*Taraxacum officinale* ssp. *officinale*	common dandelion	58	Dalton, Steese, Taylor
Fabaceae	*Trifolium hybridum*	alsike clover	57	Dalton, Steese, Taylor
Poaceae	*Phleum pratense*	timothy	56	Steese
Asteraceae	*Crepis tectorum*	narrowleaf hawksbeard	54	Dalton, Steese, Taylor
Fabaceae	*Trifolium pratense*	red clover	53	Dalton, Steese
Poaceae	*Poa pratensis* ssp. *irrigata*	spreading bluegrass	52	Dalton, Steese
Poaceae	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	52	Dalton, Steese, Taylor
Poaceae	*Poa trivialis*	rough bluegrass	52	Steese
Polygonaceae	*Rumex acetosella*	sheep sorrel	51	Taylor
Polygonaceae	*Polygonum convolvulus*	black bindweed	50	Steese
Polygonaceae	*Rumex longifolius*	dooryard dock	48	Steese
Polygonaceae	*Rumex crispus*	curly dock	48	Taylor
Asteraceae	*Hieracium umbellatum*	narrowleaf hawkweed	46	Dalton, Steese
Poaceae	*Poa annua*	annual bluegrass	46	Steese
Poaceae	*Alopecurus pratensis*	meadow-foxtail	not ranked	Dalton
Fabaceae	*Lotus corniculatus*	birdsfoot trefoil	not ranked	Dalton
Caryophyllaceae	*Agrostemma githago*	corncockle	not ranked	Taylor
Polemoniaceae	*Collomia linearis*	narrowleaf mountaintrumpet	not ranked	Taylor
Linaceae	*Linum perenne*	blue flax	not ranked	Taylor
Papaveraceae	*Papaver nudicaule*	Icelandic poppy	not ranked	Taylor
Rosaceae	*Potentilla norvegica*	Norwegian cinquefoil	not ranked	Taylor

Appendix II. Infestation maps for key species recorded along the Steese Highway.

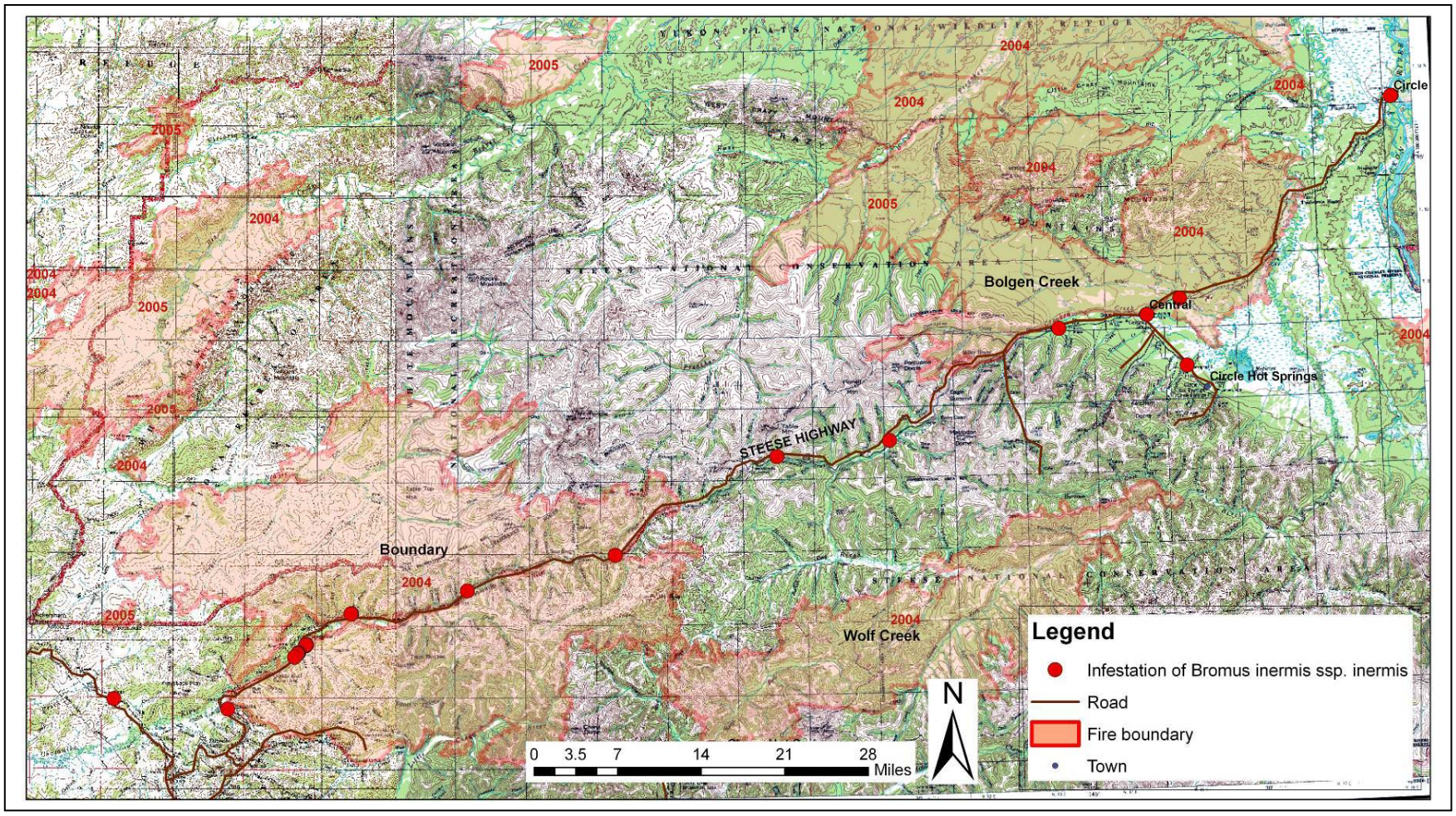
Infestations of white sweetclover (Melilotus alba) *along the Steese Highway.*



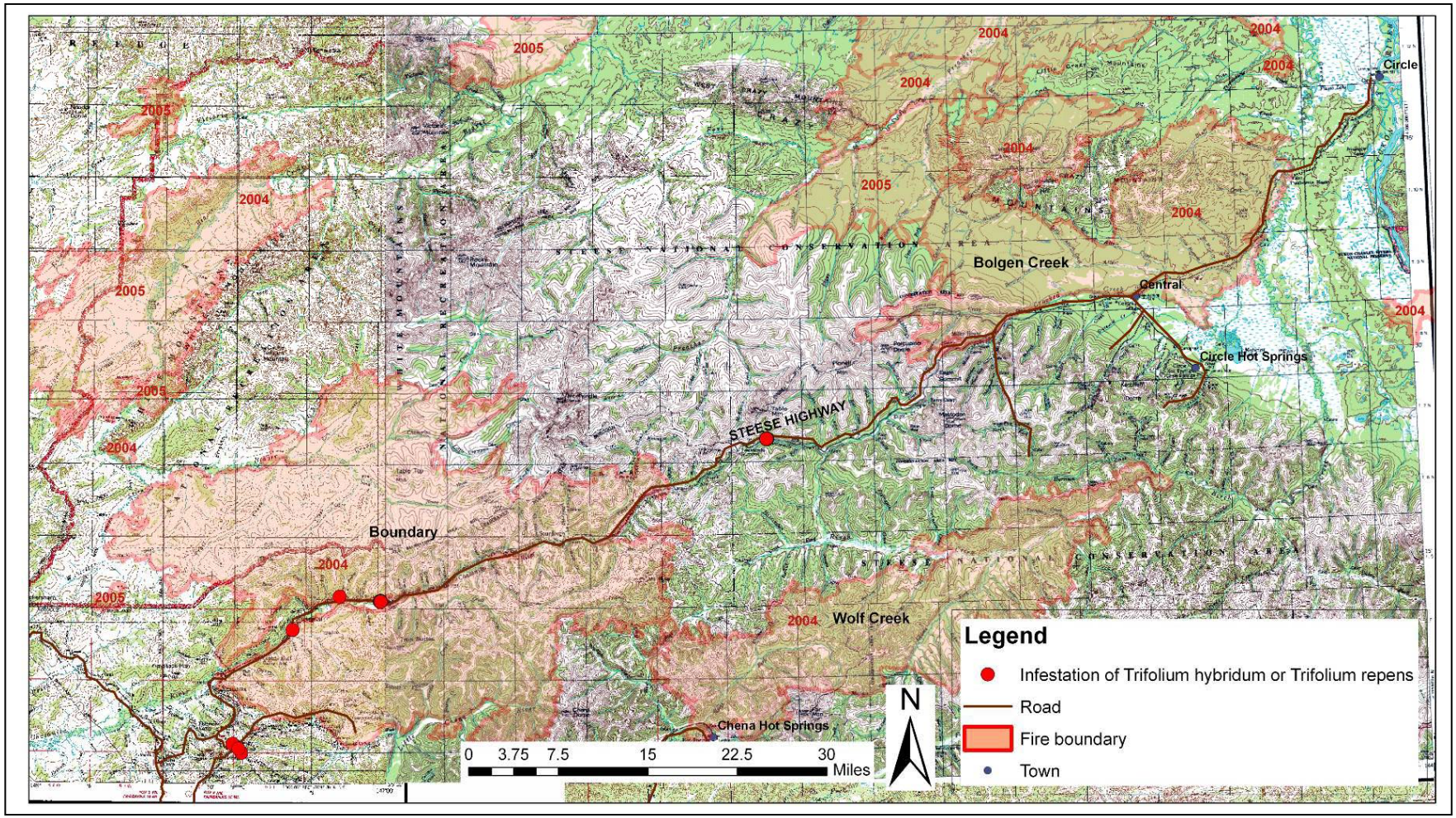
Infestations of bird vetch (Vicia cracca) *along the Steese Highway*



Infestations of smooth brome (Bromus inermis ssp. inermis) *along the Steese Highway.*



Infestations of white (Trifolium repens) *and alsike clover* (T. hybridum) *along the Steese Highway.*



Appendix III.a. Records of control work on small infestations along the Steese Highway corridor.

Species name	Site code	Mile marker	Latitude	Longitude	Location notes	Stem count	Aggressiveness	Phenology	Control action
Crepis tectorum	1	162	65.825430	-144.060886	Circle, Yukon river, boat ramp	1-5	Very Low	Flowering	Manual pull
Crepis tectorum	12	60	65.277200	-146.656447	west of mm 60	1-5	Very Low	Seed Set	Manual pull
Crepis tectorum	19	58	65.268956	-146.720079		1-5		Flowering	Manual pull
Crepis tectorum	20	57	65.257662	-146.780524	west of creek and gravel pit	1-5	Very Low	Flowering	Manual pull
Crepis tectorum	21	55	65.257593	-146.780878	west of creek and gravel pit	1-5	Very Low	Flowering	Manual pull
Crepis tectorum	22	55	65.257593	-146.780878	west of creek and gravel pit - across hwy from 21 closer to bridge	1-5	Very Low	Flowering	Manual pull
Crepis tectorum	26	56	65.240404	-146.822833	corner of side road, north of highway	1-5	Very Low	Seed Set	Manual pull
Crepis tectorum	170		65.041150	-147.416899	Fish Creek, road pull-out, across from Fairbanks Creek Road	1-5	Very Low	Flowering	Manual pull
Elymus sibiricus	14	58	65.272447	-146.706801	across from road pullout	1-5	Very Low	Flowering	Manual pull
Elymus sibiricus	23	55	65.257593	-146.780878	west of creek and gravel pit	51-150	Very Low	Seed Set	Manual pull

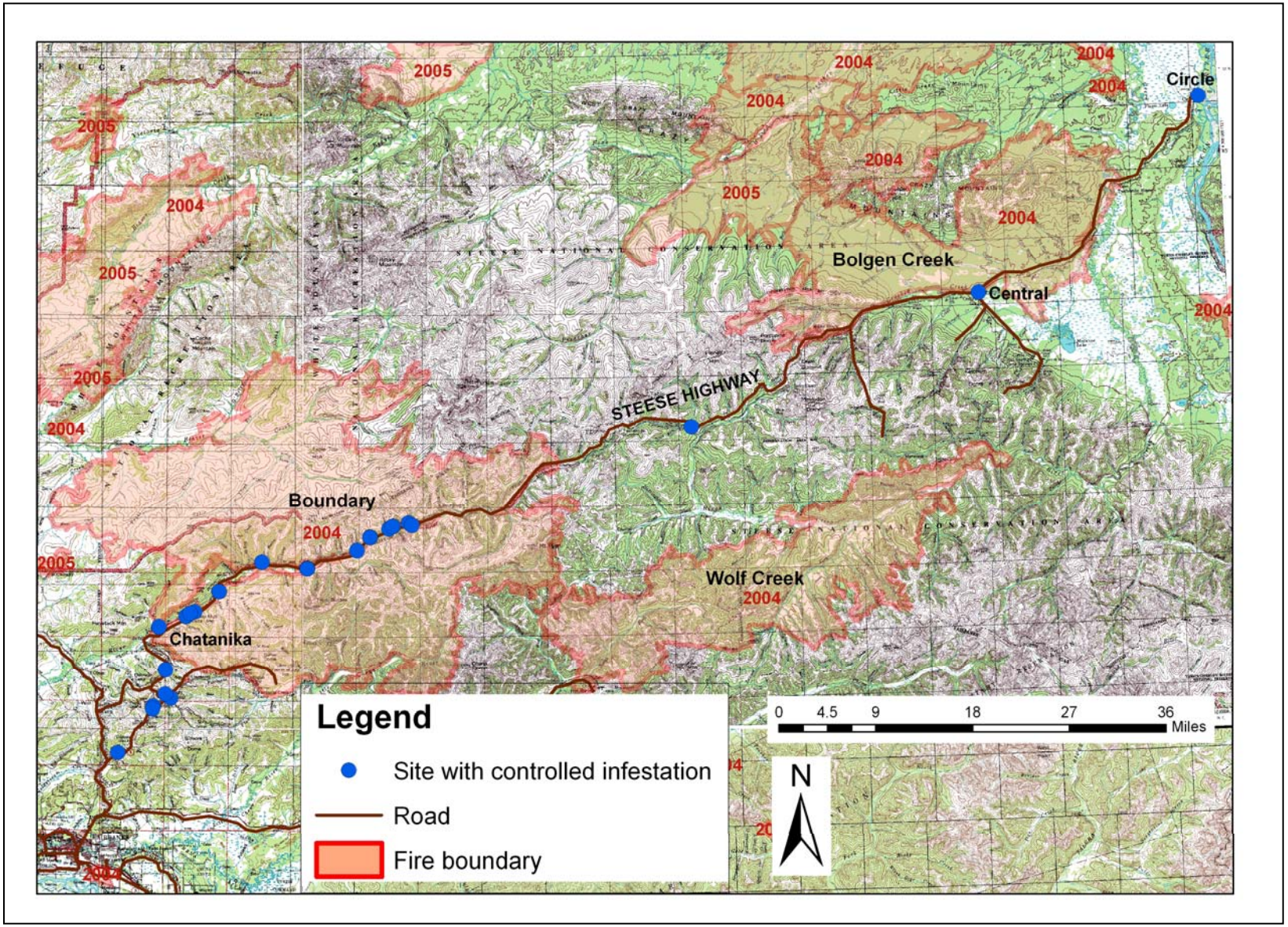
Appendix III (contd'.). Records of control work on small infestations along the Steese Highway corridor.

Species name	Site code	Mile marker	Latitude	Longitude	Location notes	Stem count	Aggressiveness	Phenology	Control action
Melilotus alba	9	130	65.573063	-144.802502	BLM Bunkhouse property	6-25		Flowering	Manual pull
Melilotus alba	4	83	65.402585	-145.743364	west side of North Fork -- gravel pit	6-25	Medium	Bud	Manual pull
Melilotus alba	11	60	65.273748	-146.646490	Cripple Creek campground river access/fill pile	1-5	Very Low	Seedling	Manual pull
Melilotus alba	145	38	65.184639	-147.264004	lake parking	26-50		Flowering	Manual pull
Melilotus alba	155	33	65.150870	-147.369514	roadside	1-5	Very Low	Flowering	Manual pull
Melilotus alba	156	33	65.136940	-147.455534	gravel pit	1000-10000		Seed Set	Manual pull
Melilotus alba	158	25	65.079497	-147.434055		1-5		Flowering	Manual dig
Melilotus alba	171	10	65.030317	-147.472619		1-5		Flowering	Manual pull
Melilotus alba	172		65.003504	-147.518344	3200 Steese	1-5		Flowering	Manual pull
Melilotus alba	181		64.967756	-147.583962		6-25		Flowering	Manual pull

Appendix III (contd'.). Records of control work on small infestations along the Steese Highway corridor.

Species name	Site code	Mile marker	Latitude	Longitude	Location notes	Stem count	Aggressiveness	Phenology	Control action
Polygonum convolvulus	16	58	65.271916	-146.710207	Burnt. road pullout on south side of road. Adjacent to burn.	1-5	Very Low	Seed Set	Manual pull
Trifolium hybridum	162		65.046888	-147.433828	Cleary Summit Road, near intersection	1-5	Very Low	Flowering	Manual pull
Vicia cracca	31	38	65.184639	-147.263995	gravel pit, parking	51-150	Medium	Flowering	Manual pull
Vicia cracca	130	52	65.216567	-146.983380	little pond at end of side road	6-25	Very Low	Flowering	Manual pull
Vicia cracca	131	52	65.216537	-146.982205	far side of pond next to 132	1-5	Very Low	Flowering	Manual dig
Vicia cracca	132	52	65.215967	-146.982689	far side of pond next to 132	6-25	Very Low	Flowering	Manual dig
Vicia cracca	141	44	65.225078	-147.127225	north side of road. Between pullout and stream. Burn on hillside behind sampling site	6-25	Low	Flowering	Manual dig
Vicia cracca	153		65.157263	-147.341628		6-25	Low	Flowering	Manual pull
Vicia cracca	154	34	65.155383	-147.356988	gravel pit, south side of road	6-25	Low	Flowering	Manual dig

Appendix III.b. Map of sites along the Steese Highway where control work was done in 2006.

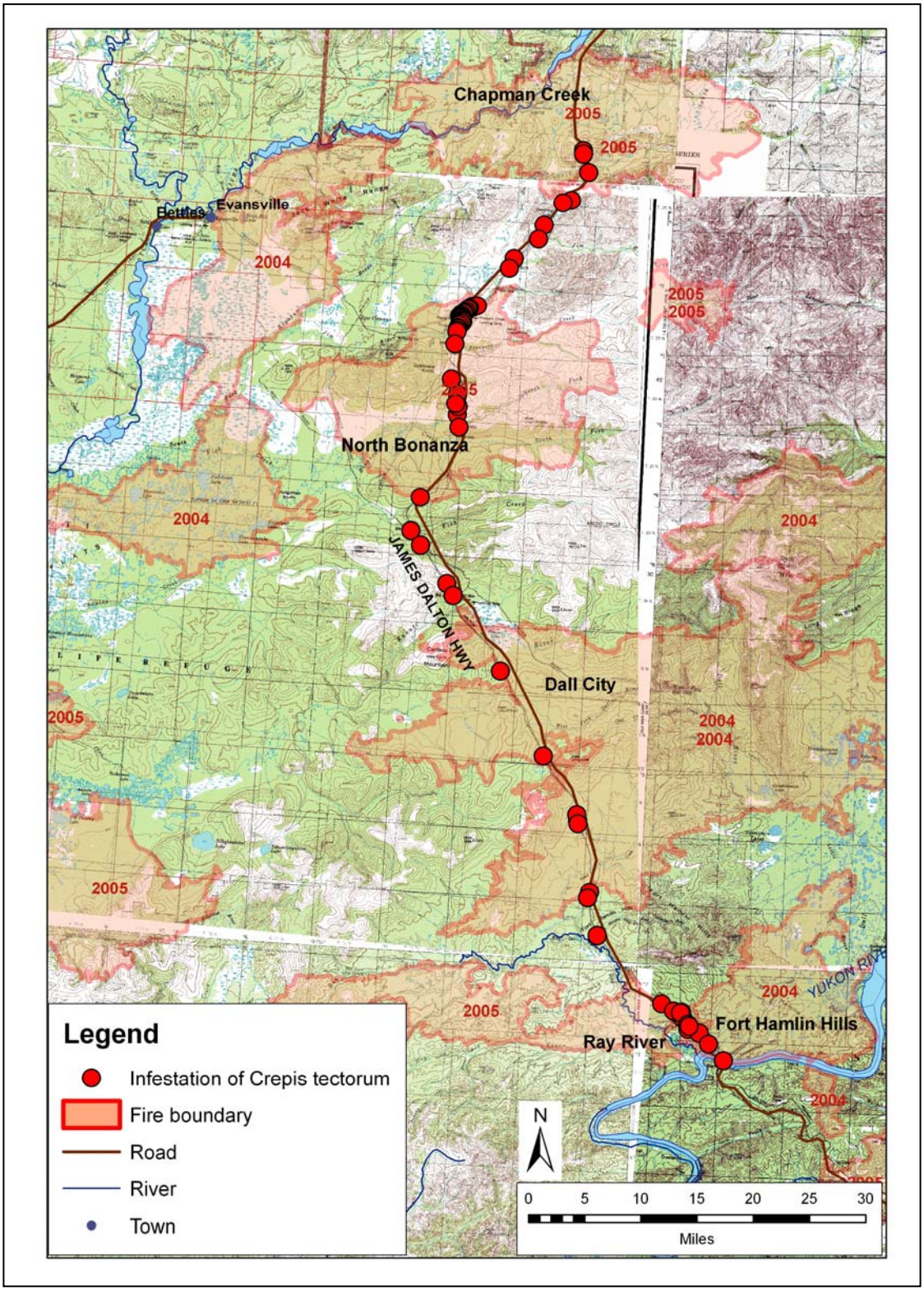


Appendix IV. Location of problematic infestations along the Steese Highway recommended for control and monitoring.

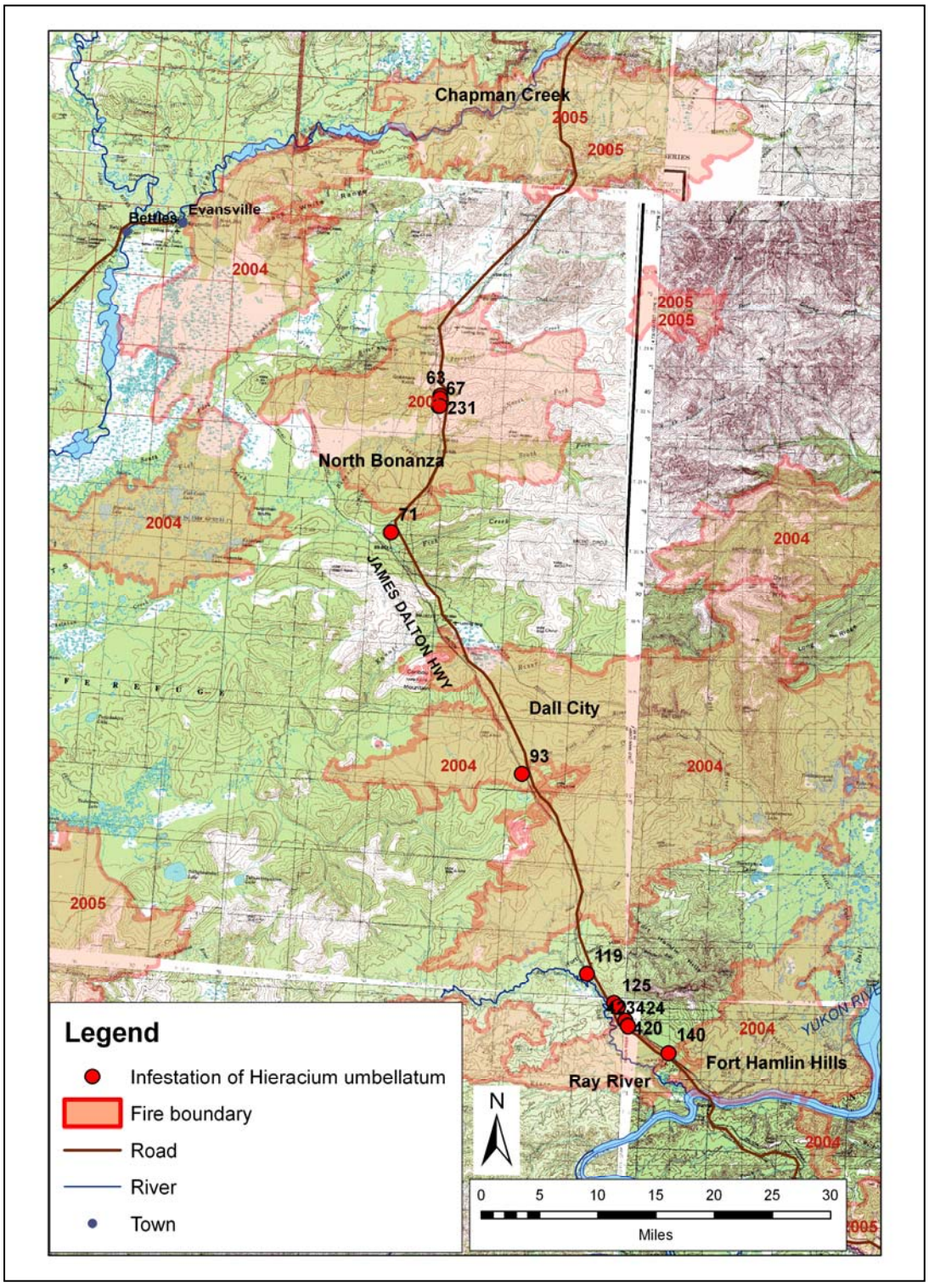
Fire	Site code	Location notes	Latitude	Longitude	Species name	Recommended methods of control
Bolgen Creek	1	BLM Bunkhouse, near river, Mile 130	65.572928	-144.801883	*Bromus inermis* ssp. *inermis*	
Bolgen Creek	7	Albert Creek crossing/former parking lot, Mile 131	65.591207	-144.703986	*Bromus inermis* ssp. *inermis*	Mechanical: mowing
Bolgen Creek	8	0.7 miles E of Central, Mile 131	65.590152	-144.724637	*Melilotus alba*	Mechanical: hand pulling, cutting
Bolgen Creek	9	BLM Bunkhouse, Mile 130	65.573063	-144.802502	*Melilotus alba*	Mechanical: hand pulling, cutting
Boundary	10	Cripple creek campground - day use area	65.273827	-146.646509	*Melilotus alba*	Mechanical: hand pulling, cutting
Boundary	14	across from road pullout, Mile 58	65.272447	-146.706801	*Elymus sibiricus*	Mechanical: hand pulling
Boundary	16	road pullout, on S side of road, adjacent to the burn, Mile 58	65.271916	-146.710207	*Polygonum convolvulus*	Mechanical: hand pulling
Boundary	17	Mile 58	65.268961	-146.720290	*Elymus sibiricus*	Mechanical: hand pulling
Boundary	139	N side of road, from the pullout to the stream, Mile 44	65.225123	-147.127824	*Caragana arborescens*	Mechanical: hand pulling, cutting, digging. Chemical: stamp injection
Boundary	142	S side of the road, on a pile of coarse material extracted from the mine, Mile 38	65.187399	-147.254120	*Melilotus alba*	Mechanical: hand pulling, cutting
Boundary	146	Mile 38	65.178310	-147.275503	*Bromus inermis* ssp. *inermis*	Mechanical: hand pulling, mowing
Boundary	156	gravel pit, Mile 33	65.136940	-147.455534	*Melilotus alba*	Mechanical: hand pulling, cutting
Outside of fire	4	west side of the North Fork, on the north side of the road, Mile 83	65.402585	-145.743365	*Melilotus alba*	Mechanical: hand pulling, cutting
Outside of fire	174		64.991544	-147.533088	*Leucanthemum vulgare*	Mechanical: cutting, gigging
Outside of fire	5	Just south of Circle, on north side of road, in a woodland clearing, , Mile 161	65.807752	-144.083652	*Trifolium pratense*	Mechanical: hand pulling, cutting
Outside of fire	173	Opposite the Felice Pedroni Memorial; at the parking lot on the east side of the road	65.008214	-147.501301	*Hieracium umbellatum*	Integrated Pest Management: mechanical (digging), chemical (spot treatment), and fertilizing-revegetation.

Appendix V. Infestation maps for key species recorded along the Dalton Highway.

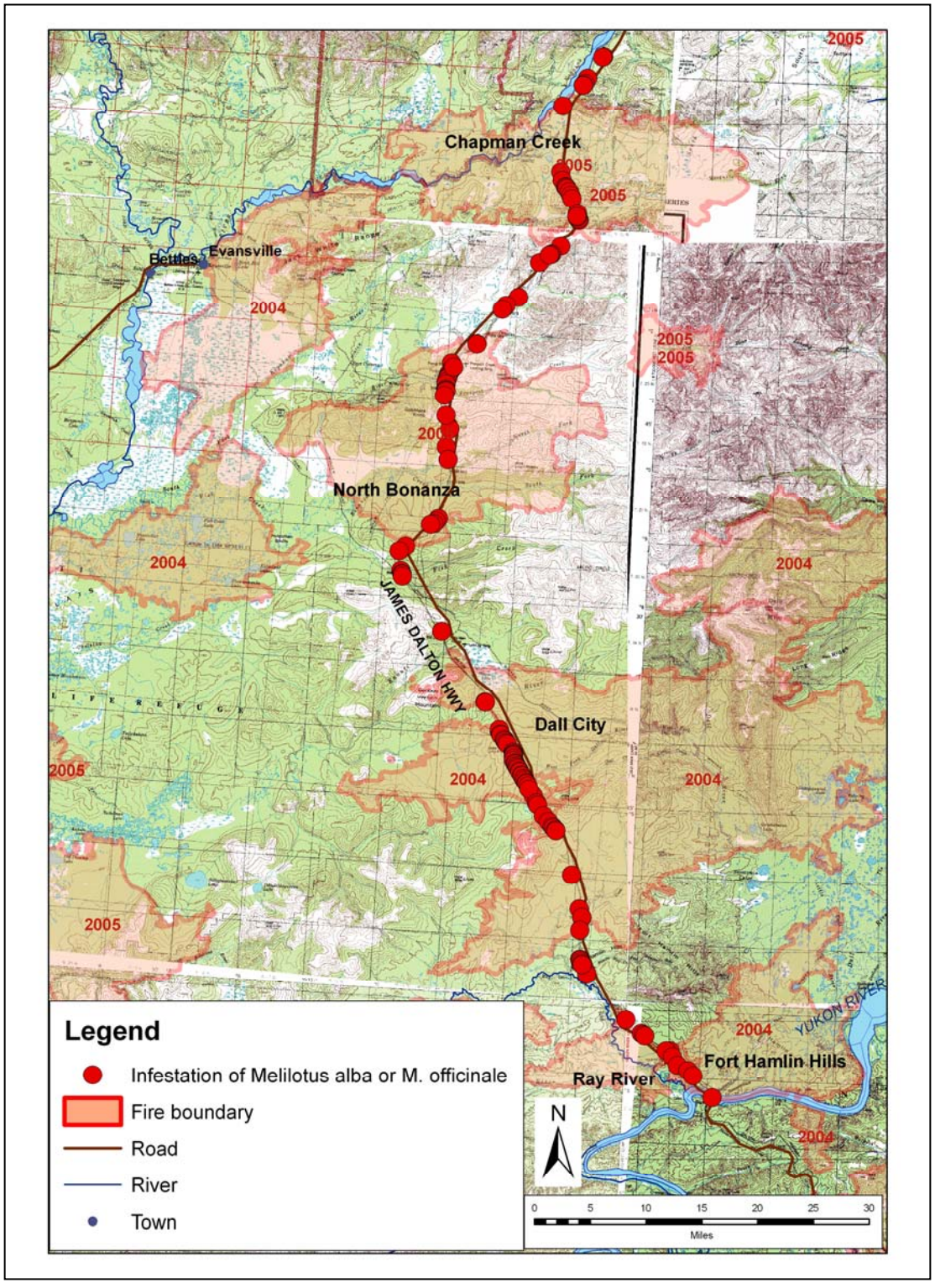
Infestations of narrowleaf hawksbeard (Crepis tectorum) *along the Dalton Highway.*



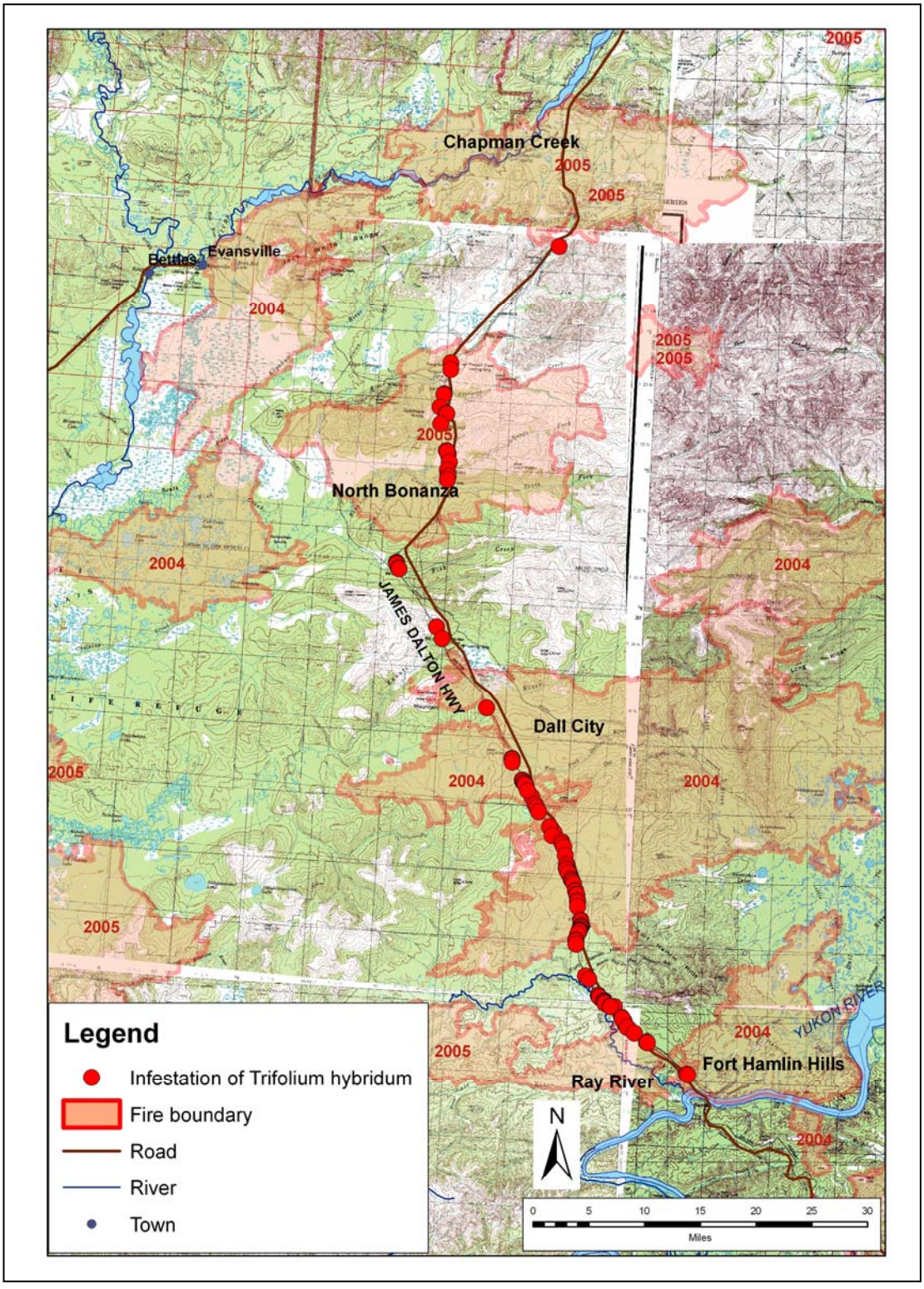
Infestations of narrowleaf hawkweed (Hieracium umbellatum) *along the Dalton Highway*



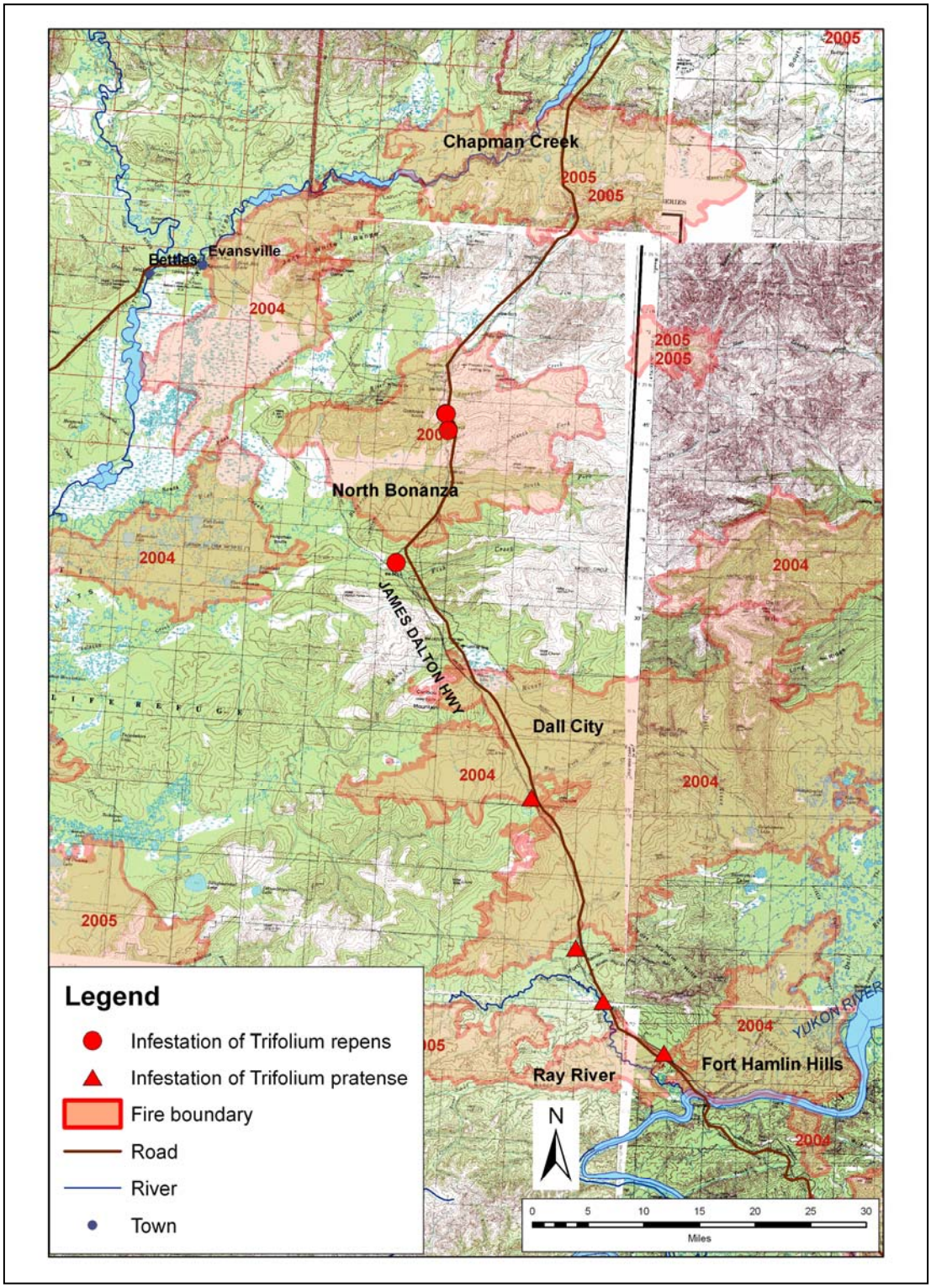
Infestations of white sweetclover (Melilotus alba) *along the Dalton Highway.*



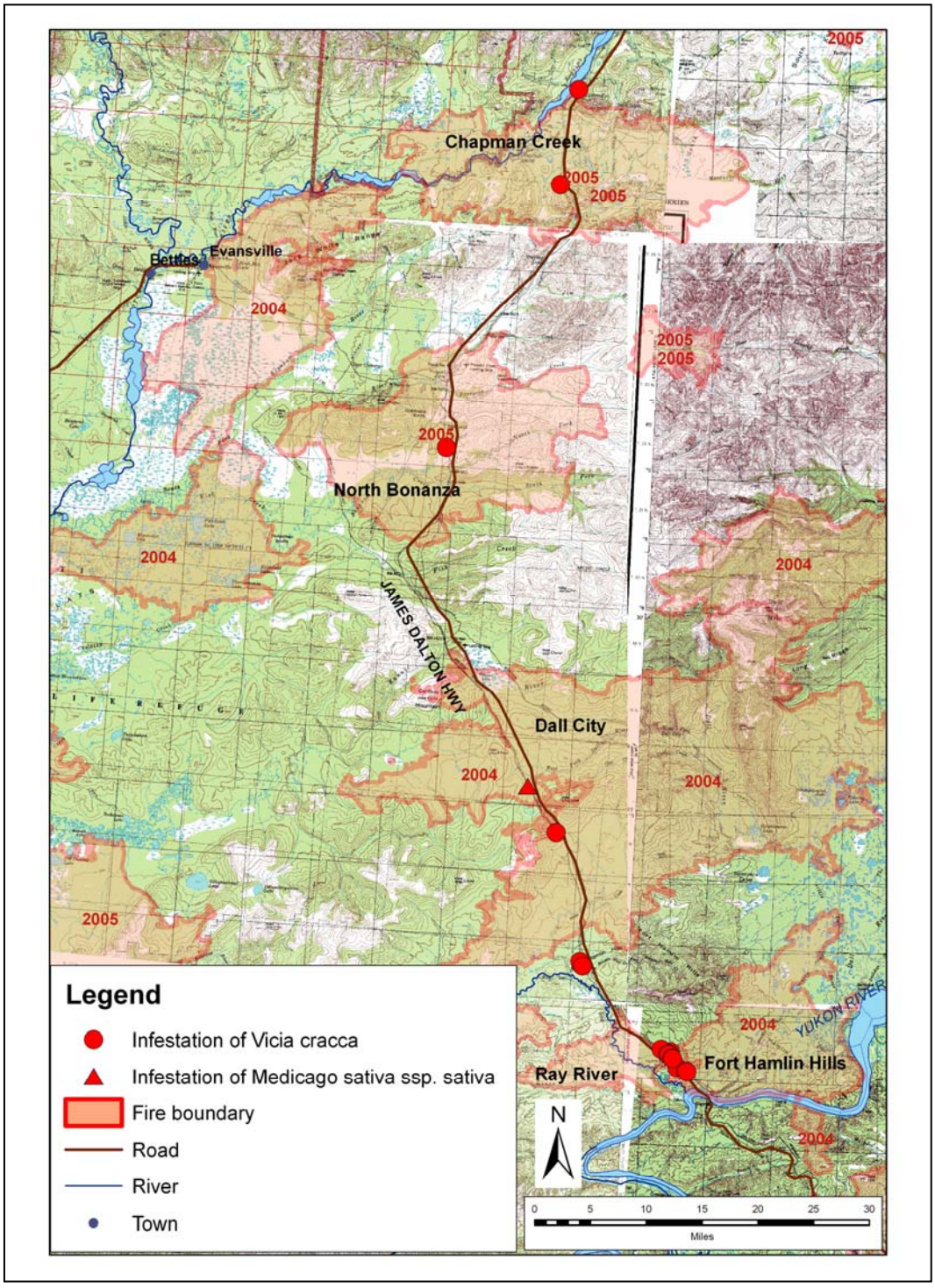
Infestations of alsike clover (Trifolium hybridum) *along the Dalton Highway.*



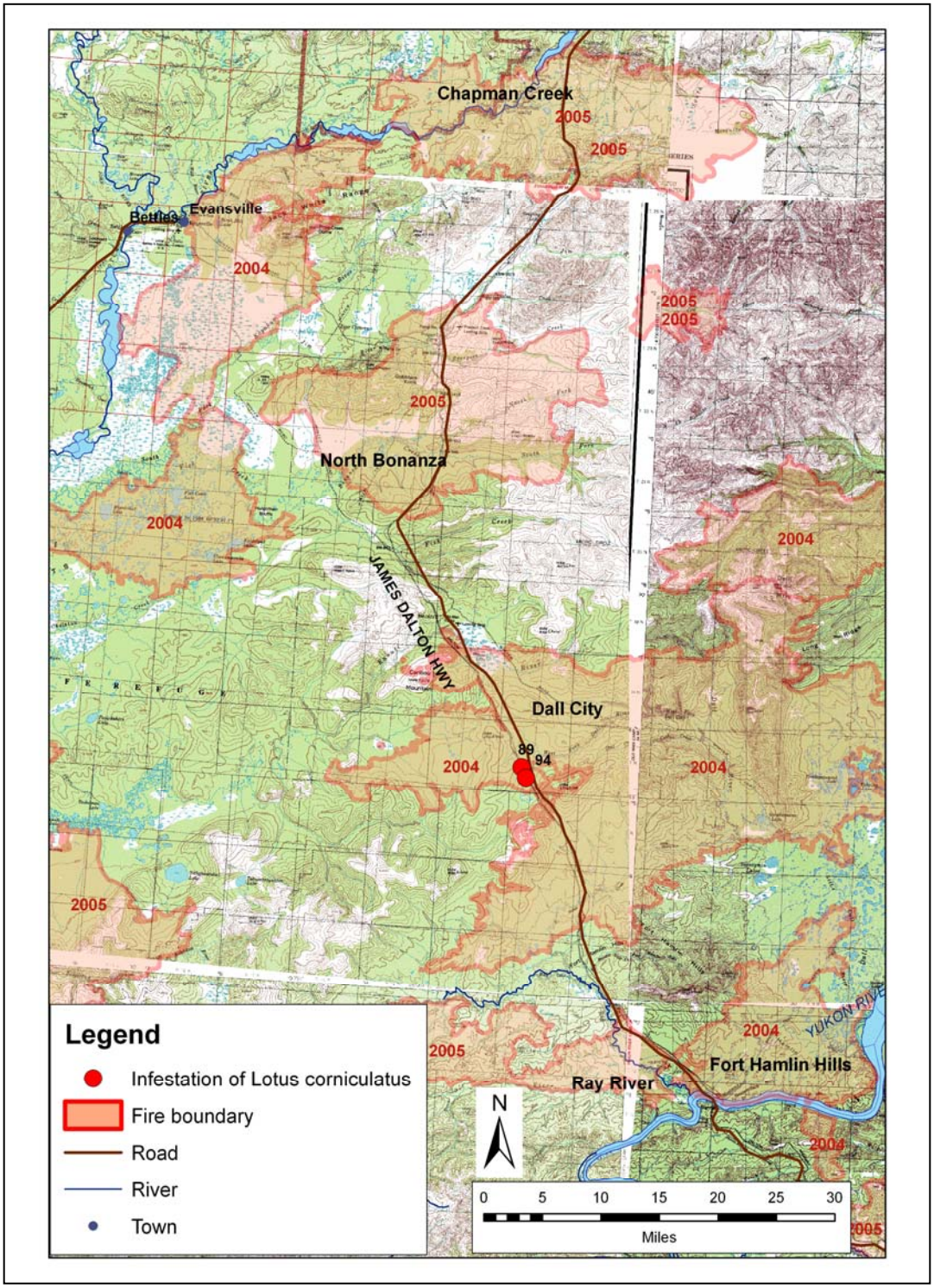
Infestations of white and red clover (Trifolium repens *and* Trifolium pratense) *along the Dalton Highway.*



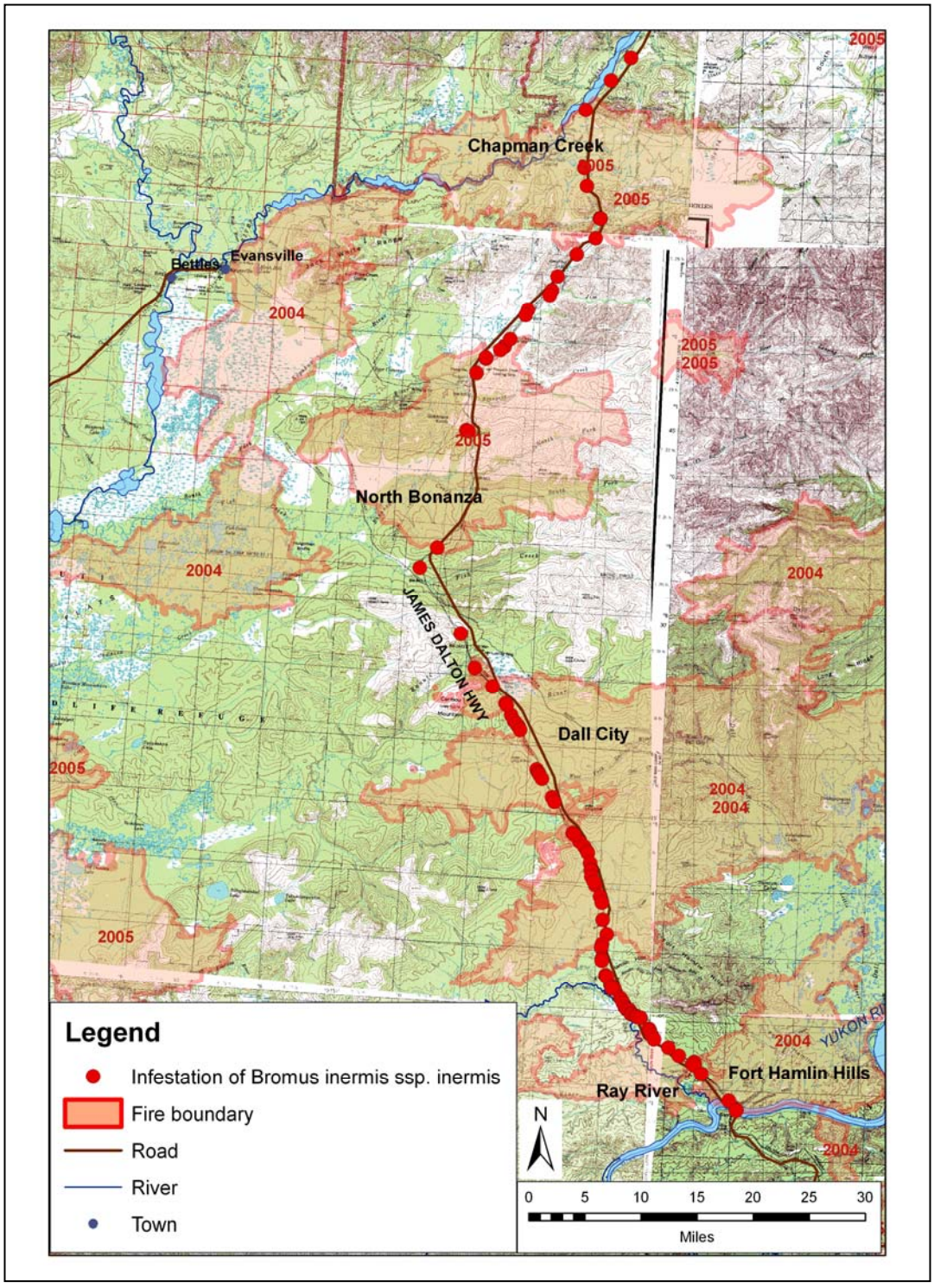
Infestations of alfalfa (Medicago sativa ssp. sativa) *and bird vetch* (Vicia cracca) *along the Dalton Highway.*



Infestations of birdsfoot trefoil (Lotus corniculatus) *along the Dalton Highway.*



Infestations of smooth brome (Bromus inermis ssp. inermis) *along the Dalton Highway.*



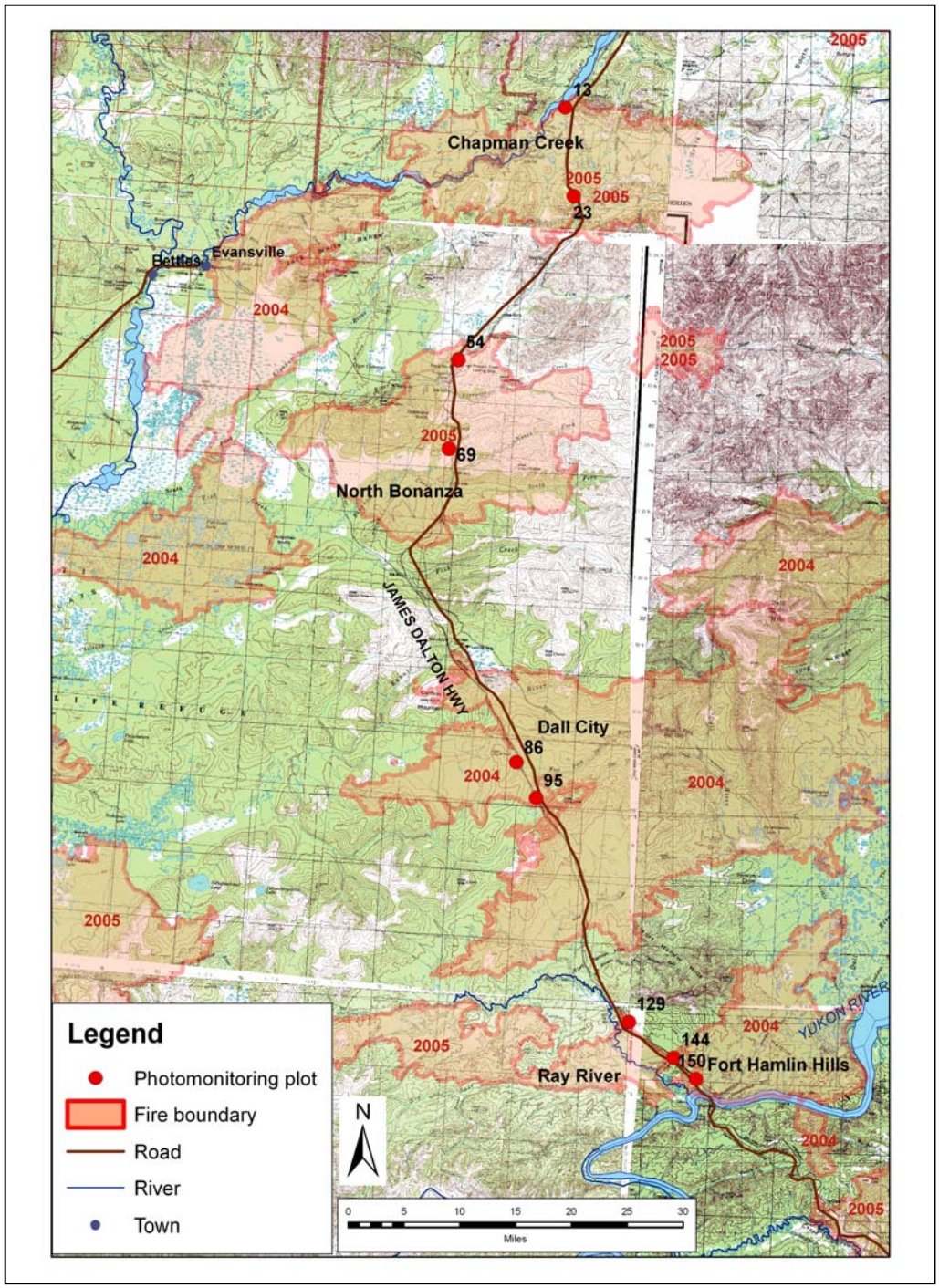
Appendix VI. Records of control work on infestations along the Dalton Highway.

Species name	Site code	Latitude	Longitude	% cover	Stem count	Aggressiveness	Phenology	Control action	Control hours
Leucanthemum vulgare	1	67.2400121170	-150.216419222	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Leucanthemum vulgare	2	67.2310997895	-150.220803276	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	4	67.2251184243	-150.228563287	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	5	67.2242681491	-150.231801348	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	8	67.1890963918	-150.286609301	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	9	67.1866376186	-150.291537766	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	12	67.1583201383	-150.355349311	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Bromus inermis ssp. *inermis*	14	67.0822813496	-150.352538068	Trace (<1%)	6-25	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	15	67.0725998566	-150.350303112	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	16	67.0616883360	-150.344115290	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	21	67.0516106020	-150.326998515	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	23	67.0428315304	-150.313559114	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins

Appendix VI (contd'.). Records of control work on infestations along the Dalton Highway.

Species name	Site code	Latitude	Longitude	% cover	Stem count	Aggressiveness	Phenology	Control action	Control hours
Crepis tectorum	26	67.0346649059	-150.304426782	Trace (<1%)	6-25	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	27	67.0192987270	-150.288231989	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	32	67.0116313736	-150.283813548	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	36	66.9758978383	-150.337144999	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	40	66.9529508039	-150.404589178	Trace (<1%)	1-5	Very low	Flowering	Manual pull	5-10 mins
Melilotus alba	75	66.5384043401	-150.793859815	Trace (<1%)	1-5	--	Flowering	Manual pull	5-10 mins
Lotus corniculatus	89	66.2798344870	-150.3605373170	Trace (<1%)	1-5	--	Flowering	Manual pull	5-10 mins
Medicago sativa ssp. *sativa*	90	66.2739313246	-150.351380465	Trace (<1%)	1-5	--	Flowering	Manual pull	5-10 mins
Lotus corniculatus	94	66.2671752682	-150.345131322	Trace (<1%)	6-25	--	Flowering	Manual pull	5-10 mins

Appendix VII. Map of photo-monitoring points along the Dalton Highway.



Appendix VIII. Location of problematic infestations along the Dalton Highway recommended for control and monitoring.

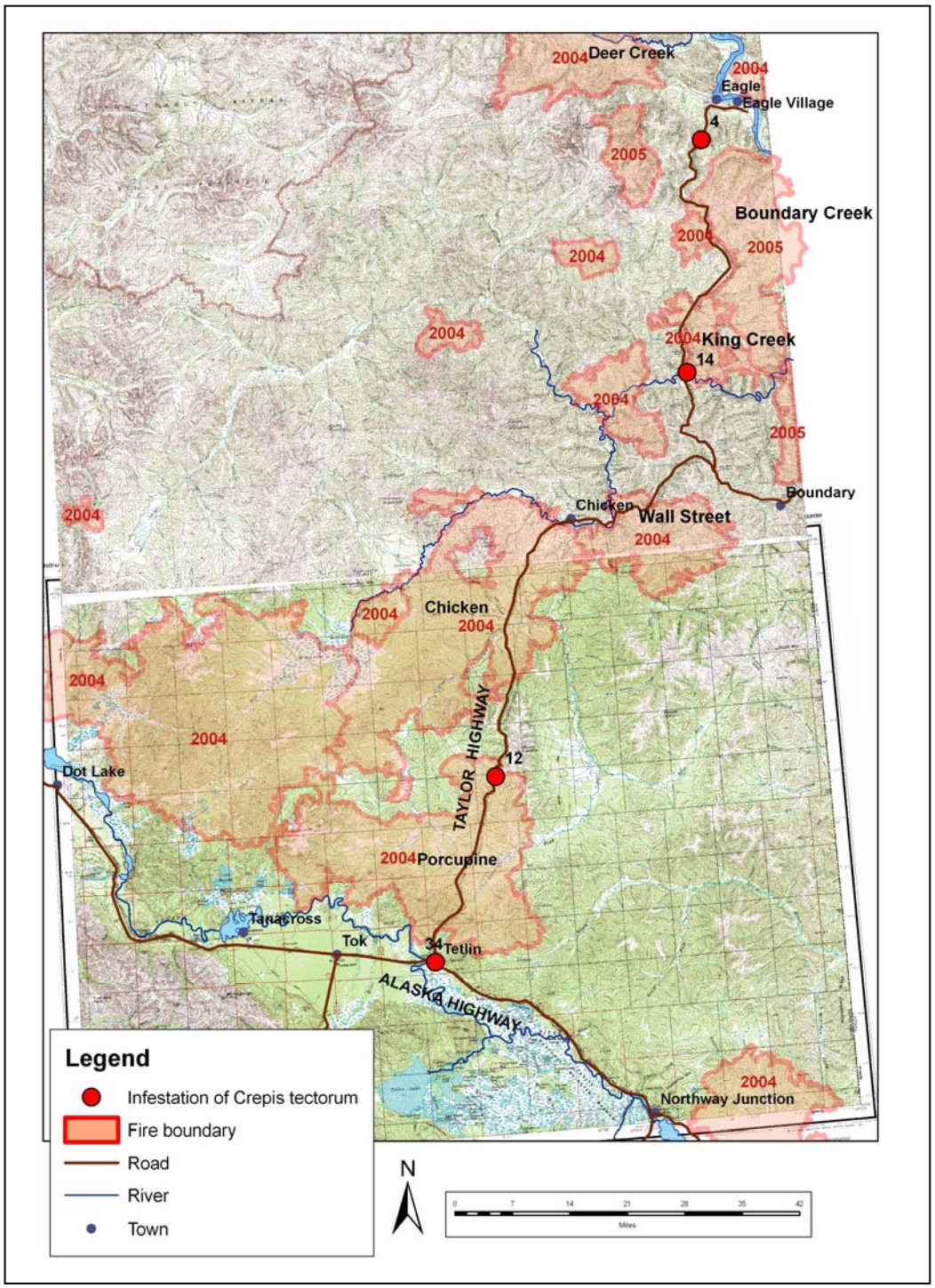
Fire	Site code	Location notes	Latitude	Longitude	Species name	Recommended methods of control
Fort Hamlin Hills	447		65.912291	-149.794946	*Trifolium hybridum*	Mechanical: hand pulling, digging, cutting
Fort Hamlin Hills	448		65.911066	-149.790749	*Trifolium hybridum*	Mechanical: hand pulling, digging, cutting
Fort Hamlin Hills and Ray River	136	BLM camp and DOT station	65.937828	-149.867187	*Trifolium pratense*	Mechanical: hand pulling, cutting
Fort Hamlin Hills	144	Fort Hamlin Hills Creek	65.933015	-149.852656	*Vicia cracca*	Mechanical; mowing, hand pulling or digging
Fort Hamlin Hills	150	Fort Hamlin Hills Creek	65.906983	-149.779104	*Melilotus alba*	Mechanical: hand pulling, cutting
Dall City	89	Between two forks of West Fork Dall River (somewhere btwn mile markers 91 and 93, recently seeded with grasses	66.279834	-150.360537	*Lotus corniculatus*	Mechanical; mowing, hand pulling or digging
Dall City	94	At the one of forks of West Fork Dall River, at Mile 91	66.267175	-150.345131	*Lotus corniculatus*	Mechanical; mowing, hand pulling or digging
Dall City	90	Between two forks of West Fork Dall River, somewhere btwn mile markers 91 and 93, recently seeded with grasses	66.273931	-150.35138	*Medicago sativa ssp. sativa*	Mechanical; mowing, hand pulling
Dall City	101	Across from pipeline pullout	66.215723	-150.25254	*Vicia cracca*	Mechanical; mowing, hand pulling or digging
Dall City	95	0.6 north of crossing of West Fork Fall River with highway	66.260409	-150.331254	*Trifolium hybridum and Melilotus alba*	Mechanical containment: mowing or cutting
Dall City	86	At the one of forks of West Fork Dall River, at Mile 93	66.305984	-150.400036	*Melilotus alba*	Mechanical: hand pulling, cutting
North Bonanza	222	Just north of Gobblers Knob pullout & picnic area	66.75052	-150.677	*Trifolium repens*	Mechanical: digging
North Bonanza	229	Between Prospect Creek and North Fork of Bonanza Creek	66.729236	-150.667	*Trifolium repens*	Mechanical: digging

Appendix VIII (contd.'). Location of problematic infestations along the Dalton Highway recommended for control and monitoring.

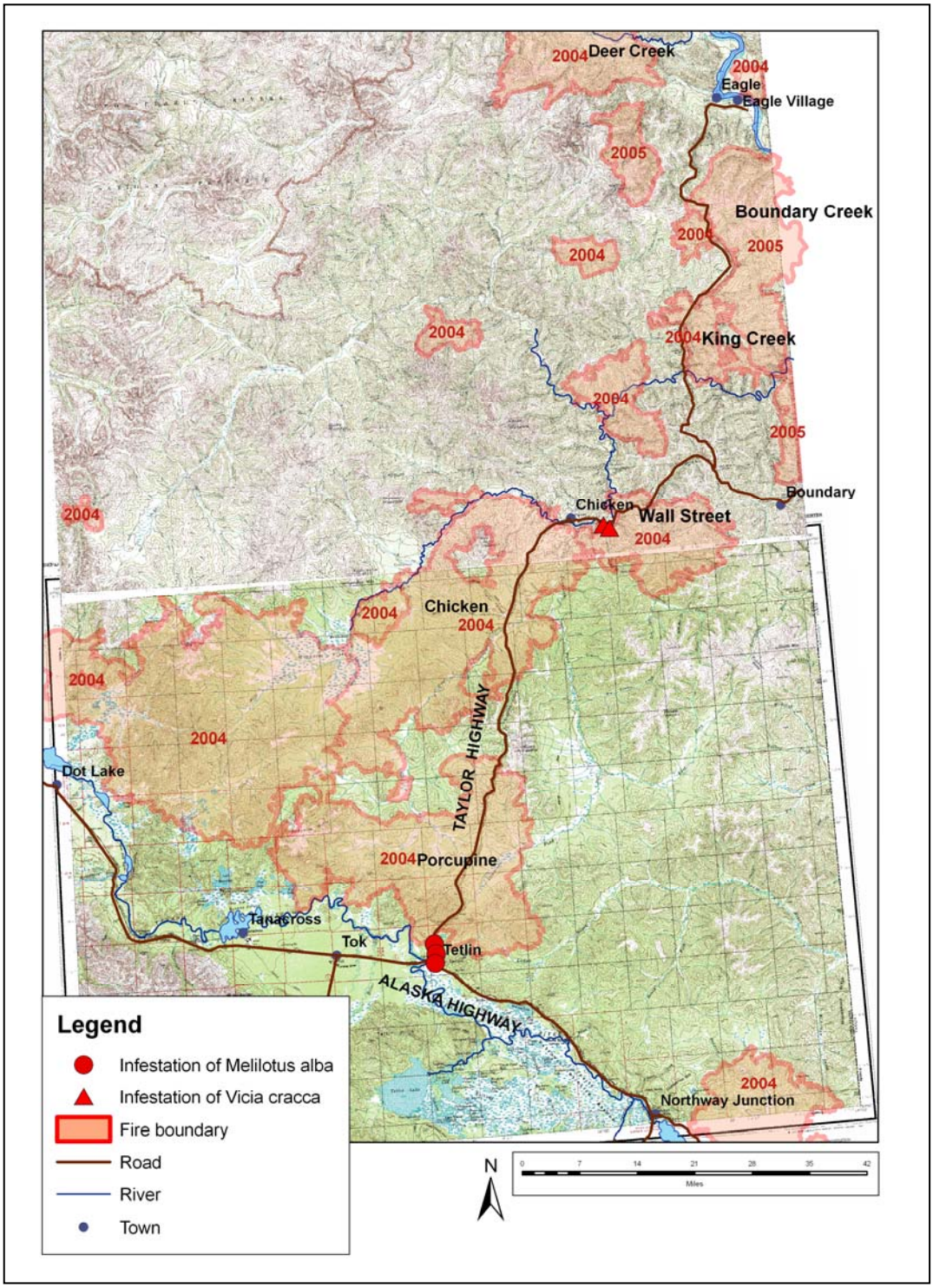
Fire	Site code	Location notes	Latitude	Longitude	Species name	Recommended methods of control
North Bonanza	69	On blind curve north of Bonanza Fire	66.731326	-150.667192	*Vicia cracca*	Mechanical; mowing, hand pulling or digging
North Bonanza	63	On long downhill	66.731326	-150.667192	*Hieracium umbellatum*	Integrated Pest Management. Complex of Mechanical: digging Chemical: spot treatment. Fertilizing, revegetation.
North Bonanza	67	Gravel pit	66.718057	-150.670958	*Hieracium umbellatum*	Integrated Pest Management. Complex of Mechanical: digging Chemical: spot treatment. Fertilizing, revegetation.
North Bonanza	230	four mile north of North Fork Bonanza Creek	66.727754	-150.667311	*Hieracium umbellatum*	Integrated Pest Management. Complex of Mechanical: digging Chemical: spot treatment. Fertilizing, revegetation.
North Bonanza	231	four mile north of North Fork Bonanza Creek	66.718288	-150.666955	*Hieracium umbellatum*	Integrated Pest Management. Complex of Mechanical: digging Chemical: spot treatment. Fertilizing, revegetation.
North Bonanza	54	Jim River DOT station	66.822731	-150.662952	*Crepis tectorum*	Mechanical: hand pulling
Chapman Creek	18	Road across from pipeline access in burn, near Mile 158	67.055936	-150.350407	*Vicia cracca*	Mechanical; mowing, hand pulling or digging
Chapman Creek	37	About two mile north of Grayling Lake	66.97558	-150.338362	*Trifolium hybridum*	Mechanical: hand pulling, digging, cutting

Appendix IX. Infestation maps for key species recorded along the Taylor Highway.

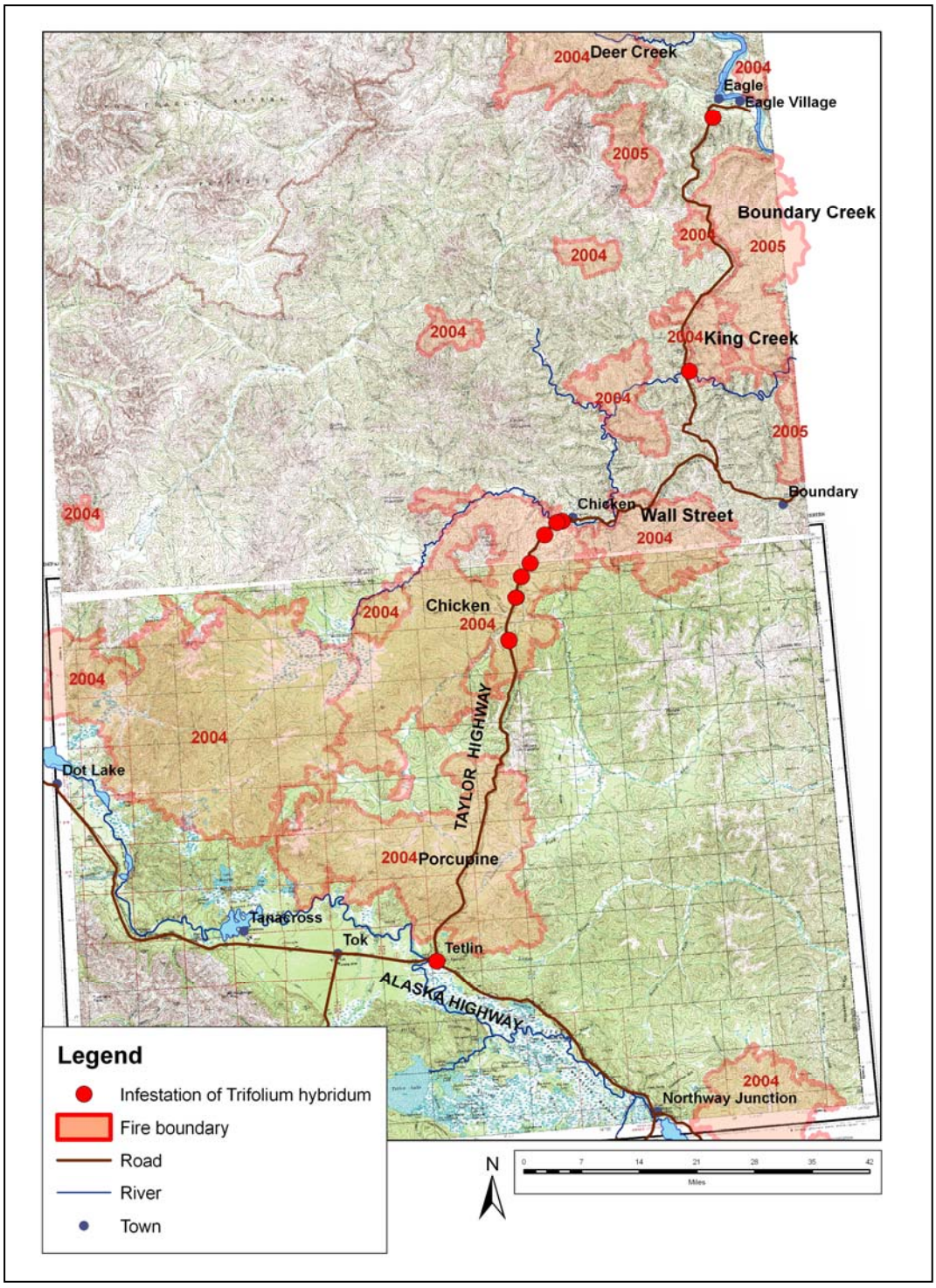
Infestations of narrowleaf hawksbeard (Crepis tectorum) *along the Taylor Highway.*



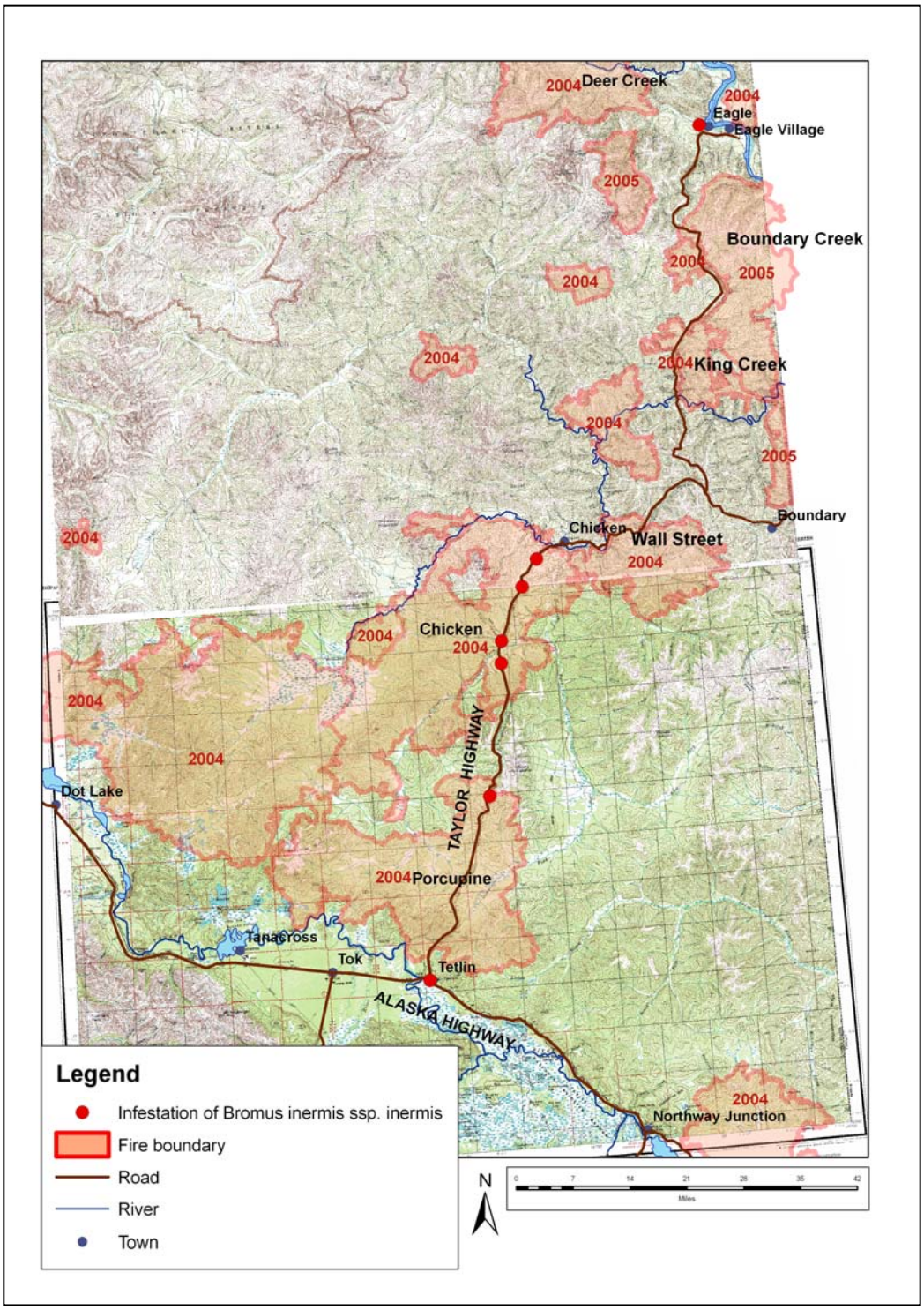
Infestations of white sweetclover (Melilotus alba) *and bird vetch* (Vicia cracca) *along the Taylor Highway.*



Infestations of alsike clover (Trifolium hybridum) *along the Taylor Highway.*



Infestations of smooth brome (Bromus inermis ssp. inermis) *along the Taylor Highway.*



Appendix X. Records of control work on small infestations along the Taylor Highway.

Species name	Site code	Latitude	Longitude	Location notes	Stem count	Aggressiveness	Phenology	Control action	Control hours
Vicia cracca	1	64.056813	-141.809232	6.5 miles N of Chicken burn	1000	Medium	Flowering	Manual pull	1
Polygonum aviculare	24	63.403102	-142.470528	trail; Porcupine burn	25	Very Low	Seedling	Manual pull	0.25
Melilotus alba	25	63.344945	-142.601168	mp 2.5	200	Very Low	Flowering	Manual pull	1
Melilotus alba	27	63.328065	-142.596629	mp 1.1, near parking sign	700	Very Low	Flowering	Manual pull	1

Appendix XI. Location of problematic infestations along the Taylor Highway recommended for control and monitoring.

Species name	Site code	Latitude	Longitude	Burn	Location notes	Recommended methods of control
Melilotus alba	25	63.344946	-142.601168	Outside or fire		Mechanical: hand pulling, cutting
Melilotus alba	26	63.344889	-142.601039	Outside or fire	At Mile 2.5 of highway	Mechanical: hand pulling, cutting
Melilotus alba	27	63.328065	-142.59663	Outside or fire		Mechanical: hand pulling, cutting
Melilotus alba	28	63.328467	-142.596738	Outside or fire	At Mile 1.1, near a parking sign	Mechanical: hand pulling, cutting
Melilotus alba	29	63.311692	-142.602427	Outside or fire	At the junction of the Taylor and Alaska highways	Mechanical: hand pulling, cutting
Bromus inermis ssp. *inermis*	TAY06-0006	63.59794	-142.34946	Porcupine	At mile marker 25	Mechanical: mowing
Bromus inermis ssp. *inermis*	TAY06-0007	63.64768	-142.2888	Porcupine	At mile marker 30	Mechanical: mowing
Bromus inermis ssp. *inermis*	13	63.631731	-142.313992	Porcupine		Mechanical: mowing
Crepis tectorum	12	63.631412	-142.314083	Porcupine		Mechanical: hand pulling
Bromus inermis ssp. *inermis* *Trifolium hybridum*	23	64.04641	-142.054339	Chicken	Approximately five miles west of Chicken	Mechanical: mowing, cutting
Trifolium hybridum	6	63.865919	-142.228878	Chicken		Mechanical: mowing, cutting
Vicia cracca	3	64.0503	-141.785981	Wall Street	South Fork DOT station	Mechanical; mowing, hand pulling or digging
Vicia cracca	1	64.056813	-141.809232	Wall Street	one mile west of South Fork DOT station	Mechanical; mowing, hand pulling or digging
Bromus inermis ssp. *inermis*	1	64.792036	-141.236519	Outside of Deer Creek	Beginning	Mechanical: mowing

Appendix XII. Blank copy of the datasheet used for the AKEPIC-based inventories.

AKEPIC Mapping Project Inventory Field Data Sheet: Year 2006

*****Survey Date ____/____/____ *Observers:
mm / dd /yyyy

Observers Affiliation: BLM NPS UAF USFS USGS CES **AKNHP** ARS PSWCD other

Site information

Site Code: _____ Visit Type: Recon Is this a Revisit: No
Area Surveyed _____acres
Note: 1/10 acre=37ft radius, ½ acre=83 ft radius, 1acre=118ft radius
Site Vegetation Community Description: (Vierek Code) _____
Disturbance Type: _____
Estimated Age of Disturbance: _____years

B. Location information

*****Latitude: _____ *Longitude:_____ Elevation: _____m
****Note: Datum is NAD 27 and Coordinate Format is decimal degrees (60.123456°)****
*****Collection Method (circle and complete details)
GPS precision _____ft (0-5, 0-30, 0-100, 0-1000, 1000+)
15 min Topographic Map source _____scale _____date_____
quad name _____quad number_____
Notes (location):

C. Survey information

	Exotic Plant Species Code	*Infested Area (acres)	*Canopy Cover (%)	Stem Count	Collection Location	Control Action	Aggressiveness
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							