Non-native plant surveys along the Delta and Gulkana National Wild and Scenic Rivers

Report prepared for:

The Bureau of
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Glennallen Field Office

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Abstract

In 2008 the Alaska Natural Heritage Program conducted non-native plant surveys along the Delta and Gulkana River corridors. The Heritage Program revisited some of the Delta River sites in 2009. Most non-native plant species recorded along these rivers are common of disturbed or high-use areas in remote Alaska, and pose a low threat to the integrity of the surrounding native plant communities.

Of the 35 sites inspected along the Gulkana, 86% contained non-native plant infestations belonging to one of 22 non-native species, only two of which are strongly invasive in Alaska (*Melilotus alba* and *Bromus inermis* ssp. *inermis*) while a third one, *Crepis tectorum*, is potentially problematic as it has been spreading into naturally disturbed sites in other parts of Alaska. We recommend that these species' populations be prioritized for control. Two primary invasive plant hotspots were identified for the Gulkana River: Paxson Lake and Sourdough Creek campgrounds. In contrast, of the 61 sites visited along the Delta between 2008 and 2009, 85% were weed-free, and no strongly invasive plants were found. The boat ramps, the falls' portage trail, and the largest campgrounds are recommended for periodic monitoring work.

Our findings suggest that human activities constitute a major vector for the introduction and spread of invasive plants along the two river corridors. In particular, actions that result in the repeated exposure of mineral soil facilitate the establishment of weedy species more so than human activities per se, or the structures and materials brought in by people. We therefore propose that equally important to monitoring and controlling existing infestations is minimizing soil disturbance. This work also identifies which sites and infestations should be targeted for control, and includes weed management recommendations specific to each river corridor.

Acknowledgments

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Introduction

The establishment, growth, and persistence of non-native[1] plant species pose a serious threat to native ecosystems. Even though not all non-native species cause significant economic or ecological harm, invasive[2] plants are able to alter plant 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 have been a major problem in the Lower 48 states for some time (cf. Randall 1996), Alaska has remained relatively unaffected by non-native plants until recently. Over the last ten years there has been a marked acceleration in the rate of introduction of non-native plants to the state, likely driven by increases in the global movement of people and goods (Carlson and Shephard 2007). In several cases, invasive weeds have been documented moving off the human footprint into natural ecosystems, especially in burned areas or earl-successional ecosystems (Cortés-Burns *et al.* 2007, 2008; Lapina *et al.* 2007; Villano and Mulder 2008). Even so, invasive plant species still do not constitute as great a problem in Alaska as they do in the rest of the country. Consequently, land managers in Alaska have a unique opportunity to be proactive in managing non-native and invasive plants.

In 2008, the Alaska Natural Heritage Program (AKNHP) of the University of Alaska Anchorage entered into an agreement with the Bureau of Land Management (BLM) Glennallen Field Office to conduct a systematic survey of the Delta and the Gulkana National Wild and Scenic River (NWSR) corridors. The abundance and distribution of problematic non-native species that occur along these river corridors is summarized herein and will aid in the prioritization of species and locations for future weed[3] management activities.

[1] Non-native (or non-indigenous) plants are plants whose presence in a given area is due to accidental or intentional introduction by humans.

[2] Invasive plants are non-native plants that produce viable offspring in large numbers and have the potential to establish and spread in natural areas.

[3] A weed is a plant, native or non-native, whose presence is undesirable to people in a particular time or place. In this work, given the potential negative impacts of non-native plants on ecosystem integrity and function, we also refer to non-native plants as weeds.

Methods

BLM Glennallen Field Office staff provided AKNHP botanists with coordinates and site photographs for all campsites maintained by the BLM along the Delta (including Tangle Lakes) and Gulkana Rivers.

AKNHP botanists used this information to establish priority survey sites along both river corridors. Because the susceptibility of native plant communities to invasion is largely a function of the degree of natural or human-caused disturbance to a given habitat (Hobbs and Huenneke 1992), AKNHP prioritized sites according to their proximity to areas of historic and/or present human-use. Such sites were deemed high priority because they represented potential points of non-native plant propagule introduction and would be more vulnerable to non-native plant establishment. Specifically, we aimed to target boat ramps and associated campgrounds, high-capacity campsites, cabins, trails (including ATV, winter, and portage trails), the Gulkana fish-counting tower, and any points where infrastructure (e.g. highway, road, pipeline) crossed the river.

Non-native plant populations were documented following guidelines established for Alaska's statewide non-native and invasive plants database (the Alaska Exotic Plants Information Clearinghouse, or AKEPIC) (see Appendix 1 for a sample datasheet). At every site visited, temporary plots were set up, whether or not non-native plant species were present. Plot size was 10-15 m^2 on average, but plot shape and size was adjusted to match the extent of the disturbed area (e.g. long gravel bars and trails). In addition, we would scout the area around the plots to check for the surrounding area for infestations. We inventoried the plant species diversity (including percent cover for each species) and the amount and type of unvegetated ground within the plot; we also described the surrounding habitat/vegetation classes in rough accordance with the classification system developed by Viereck *et al.* (1992). For non-native taxa, we collected the following information: size of the infestation (area and/or stem count), type of disturbance, and control methods employed, if any.

When plants could not be adequately identified in the field, a voucher specimen was collected. AKNHP botanists identified all vouchers. Vouchers of non-native species and uncommon native species have been mounted and curated at the University of Alaska Anchorage Herbarium (UAAH), which is currently housed at AKNHP, and are available to BLM staff upon request (see Appendix 2 for a voucher list).

In addition, all non-native species records have been formatted and uploaded into AKEPIC by AKNHP staff. The distribution of these infestations will be viewable online at the Alaska Early Detection and Distribution Mapping System (EDDMaps-Alaska) website by summer 2010. AKNHP is also providing BLM staff with shapefiles of all non-native plant infestations recorded, and all associated site information, to enable both the spatial representation and analyses of these data using a Geographic Information System (GIS).

Non-native species recorded along the Gulkana

Overview

From 16-19 August of 2008 AKNHP botanists Helen Cortés-Burns and Mike Duffy, together with hydrologist and rafter Bill MacFarlane, conducted a non-native plant inventory along the Gulkana Wild and Scenic River corridor. Surveys started at the Paxson Lake Campground boat ramp and concluded at Sourdough Creek Campground, covering a total distance of 45.5 river miles. In all, 30 temporary plots were read and cursory surveys were completed at five (5) additional sites (Figure 1). The majority of sites visited (86%) contained one or more populations of non-native plant species. A total of 22 non-native species and 106 infestations were recorded in this effort (Table 1).

Table 1. Frequency of occurrence of non-native plant species recorded** along the Gulkana River.

Scientific name	Common name	Family name	Invasive-ness Rank‡	Frequency of occurrence†
Taraxacum officinale ssp. officinale	common dandelion	Asteraceae	58	0.63
Plantago major	common plantain	Plantaginaceae	44	0.43
Matricaria discoidea	pineapple weed	Asteraceae	32	0.43
Poa annua	annual bluegrass	Poaceae	46	0.37
Polygonum aviculare	prostrate knotweed	Polygonaceae	45	0.31
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	Poaceae	52	0.23
Capsella bursa-pastoris	shepherd's purse	Brassicaceae	40	0.17
Hordeum jubatum	foxtail barley	Poaceae	63	0.06
Melilotus alba	white sweetclover	Fabaceae	81	0.03
Bromus inermis ssp. *inermis*	smooth brome	Poaceae	62	0.03
Trifolium repens	white clover	Fabaceae	59	0.03
Trifolium hybridum	alsike clover	Fabaceae	57	0.03
Crepis tectorum	narrowleaf hawksbeard	Asteraceae	54	0.03
Stellaria media	common chickweed	Caryophyllaceae	54	0.03
Poa pratensis ssp. *irrigata*	spreading bluegrass	Poaceae	52	0.03
Tripleurospermum inodorum	false scentless mayweed	Fabaceae	48	0.03
Poa compressa	Canada bluegrass	Poaceae	39	0.03
Chenopodium album	lambsquarters	Chenopodiaceae	37	0.03
Cerastium glomeratum	sticky chickweed	Caryophyllaceae	36	0.03
Brassica napus	rapeseed mustard, rutabaga	Brassicaceae	NR	0.03
Alopecurus pratensis	meadow foxtail	Poaceae	NR	0.03

‡ Invasiveness Rank refers to the points assigned to a given species by the Invasiveness Ranking System for Non-native Plants of Alaska (Carlson *et al.* 2008). Species are ranked on a scale of 0 to 100, with 100 being an extremely invasive species.

† Calculated as the number of sites infested with a given non-native species divided by the 35 sites surveyed (includes the five observation points).

NR: Not ranked**.** Species that were not ranked by Carlson *et al.* (2008) are designated as 'NR'. The lack of a rank value does not mean that the species is not aggressively invasive.

** *Lepidium densiflorum* (common pepperweed, 25) was recorded near the boat ramp. For reasons indicated under Species whose non-nativeness is questionable we do not consider this species a top management priority for the Gulkana NWSR.

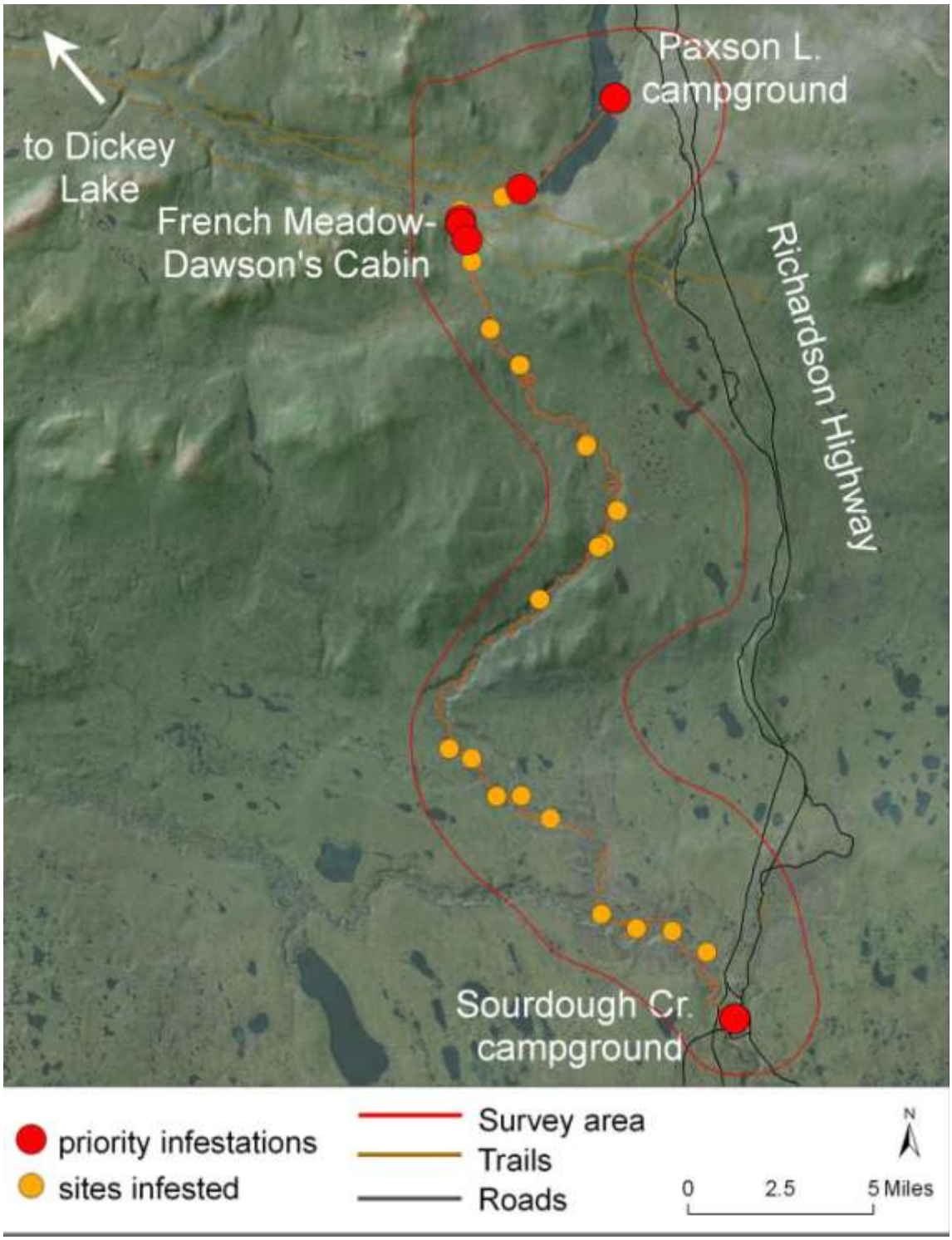

Figure 1. Area surveyed and plots read along the Gulkana NWSR.

Plot data

Plot 1. Paxson Lake Campground and boat ramp

The non-native plant inventory of the main stem of the Gulkana started from Paxson Lake on August 16th, 2008.

The first plot was set up by the boat ramp. Six non-native plant species were recorded at this site growing in fill importation, and along the fringes of a mesic to wet, herbaceous bog (Table 2).

Figure 2. Paxson Lake boat ramp: we recommend that the area around the blue tarp be re-surveyed (see text).

Some development work was taking place by the boat ramp at the time of this survey. No moderately to extremely invasive weeds were noted at that site or along the boat ramp, but we recommend the construction site (location marked by the blue tarp in Figure 2) be revisited to ensure that the materials and fill brought in were clean and that no invasive propagules have since germinated and established.

In addition, a medium sized (50-100 stems) infestation of *Tripleurospermum inodorum* (scentless false mayweed, 48) was observed uphill of the boat ramp, close to the entrance of the campsite.

Table 2. Non-native plant species found at Paxson Lake Campground and boat ramp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Tripleurospermum inodorum§	scentless false mayweed	48	5	50-100	None
Poa annua	annual bluegrass	46	5	N/A	None
Matricaria discoidea	pineapple weed	32	5	N/A	None
Polygonum aviculare	prostrate knotweed	45	1-5	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	1	N/A	None
Plantago major	common plantain	44	trace	N/A	None
Capsella bursa-pastoris	shepherd's purse	40	trace	N/A	None

§*Tripleurospermum inodorum* was found at the main campground, not at the boat ramp, in Paxson Lake Campground.
N/A - Not available
Trace – less than 1% cover

Plot 2. Boundary of private land parcel (vic. Hufman's cabin)

Our second stop was made on river right, at the boundary of a private land parcel located between the outlet of Paxson Lake and Hufman's Haunt campsite. We surveyed the winter trail that leads to L.L. "Doc" Hufman's cabin (to the edge of private property). We did not observe any non-native plants in the area. The footpath surveyed runs through a freshwater graminoid marsh with interspersed low willow shrubs and black spruce trees.

Figure 3. Portion of the winter trail surveyed near Hufman's cabin.

In general, undisturbed wetlands appear to be relatively resistant to weed invasion in remote settings in Alaska. However, in urban centers like Anchorage there are a number of highly invasive species that have been introduced and pose a major threat to native wetland plant communities, as they are able to quickly spread and impede water flow, thereby altering ecosystem function.

Plot 3. TaK' ATS' NA' Cove Camp

TaK'ATS'NA' Cove Campsite, situated in an upland, mesic graminoid-herbaceous meadow, in the middle of a spruce forest, contained five weed species that are common in human-disturbed sites in remote Alaska. A winter trail that follows the Middle Fork and connects the main stem of the Gulkana with Dickey Lake crosses here.

Table 3. Non-native plant species found at TaK' ATS' NA' Cove Campsite.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Capsella bursa-pastoris	shepherd's purse	40	30	N/A	None
Matricaria discoidea	pineapple weed	32	20	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	10	N/A	None
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	52	N/A	N/A	None
Poa annua	annual bluegrass	46	N/A	N/A	None

N/A - Not available

Plot 4. Willow Run Camp

Willow Run Campsite was located on river right, in a white spruce forest clearing. Despite signs of recent brush clearing work and exposed mineral soil, only two modestly invasive weed species were recorded, both at low abundances.

Table 4. Non-native plant species found at Willow Run Campsite.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	N/A	N/A	None
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	52	N/A	N/A	None

Figure 5. TaK'ATS'NA Cove Campsite is located in a grassy clearing.

Figure 4 Willow Run Camp showed signs of recent brush clearing activity

Plot 5. Near Neeley Grove Camp

Less than half a river mile after Neeley Grove Camp we read a plot at a small riverside campsite set in a gravelly clearing among dwarf birch with a low willow understory. The only non-native species recorded here was *Taraxacum officinale* ssp. *officinale* (58), which was present in trace amounts.

Figure 6. Campsite near Neeley Grove Camp.

Plot 6. French Meadow Camp #1

The first French Meadow campsite is set in a grassy clearing just past a stand of willows on river left. This camp can be accessed by ATV trails and is also connected to a second campsite where Plot 7 was read (see below). Large infestations of two weakly to modestly invasive weeds were recorded here.

Table 5. Non-native plant species found at French Meadow Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Plantago major	common plantain	44	N/A	250	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	N/A	150	None

N/A - Not available

Figure 7. Botanist Mike Duffy at French Meadow campsite #1.

Plot 7. French Meadow Camp #2

A grassy, duff-covered clearing in a white spruce woodland serves as a second campsite[4] and can be accessed on foot or ATV from French Meadow Camp #1 via a multi-use trail. Five non-native species were recorded here. We hand-pulled and bagged all *Capsella bursa-pastoris* and *Matricaria discoidea* plants detected. We suggest that the high diversity and percent cover of non-native weeds at this site, relative to the previous ones, is due to its larger size and greater accessibility (by both boat and ATV).

Table 6. Non-native plant species found at French Meadow Camp #2.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	7.5	N/A	None
Poa annua	annual bluegrass	46	7.5	N/A	None
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	52	5	5	None
Capsella bursa-pastoris	shepherd's purse	40	3	10	Hand pulling
Matricaria discoidea	pineapple weed	32	3	10	Hand pulling

N/A - Not available

[4] This second site may correspond to NitiniTAANI Camp

Figure 8. French Meadow campsite #2 was accessible by ATV (left) as well as boat.

Plot 8. Meier's Roadhouse

Meier's Roadhouse campsite is located in a clearing in a white spruce forest. Ground cover was predominantly duff, leaf litter, and grass.

Meier's Roadhouse was built in 1906 and was a popular starting point for the Middle Fork Trail that left to the Valdez Creek Mining district. The campsite that now occupies the old cabin grounds provides access to the Twelvemile Creek ATV trail and can accommodate large groups. We found tree stumps as well as other signs of past and present human activity (including the remnants of an old outhouse and golf balls). All this suggests high levels of activity, both historically and currently.

Figure 9. Meier's Roadhouse Camp.

Nonetheless, this site did not support unusually large or diverse infestations nor did it have any moderately to extremely invasive plants. It was, however, the only site in the survey that had populations of the weakly invasive non-natives *Stellaria media* (common chickweed, 42) and *Alopecurus pratensis* (meadow foxtail, NR).

Table 7. Non-native plant species found at Meier's Roadhouse Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Poa annua	annual bluegrass	46	35	N/A	None
Plantago major	common plantain	44	25	N/A	None
Matricaria discoidea	pineapple weed	32	25	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	20	N/A	None
Stellaria media	common chickweed	42	15	N/A	None
Capsella bursa-pastoris	shepherd's purse	40	10	N/A	None
Alopecurus pratensis	meadow foxtail	NR	5	N/A	None

NR – Not ranked
N/A - Not available

Plot 9. Dawson's Cabin

This trapper cabin was built in the 1920s by trappers Barney Dawson and Al Norwood and was used for many years as a winter shelter. The cabin and campsite are set in an upland grassy clearing by the river, surrounded by an open white spruce forest. The total non-native plant cover for this campsite was considerable; however, all non-native plants recorded here were observed at other campsites along the river and are only weakly to modestly invasive.

Figure 10. Dawson's Cabin and campsite.

Table 8. Non-native plant species found at Dawson's Cabin and campsite.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	60	N/A	None
Plantago major	common plantain	44	60	N/A	None
Matricaria discoidea	pineapple weed	32	20	N/A	None
Poa annua	annual bluegrass	46	15	N/A	None
Poa pratensis ssp. *irrigata* (?)[5]	Kentucky bluegrass	52	10	N/A	None
Capsella bursa-pastoris	shepherd's purse	40	5	N/A	None

N/A - Not available

Plot 10. Squirrel Run Camp

The AKNHP crew camped at Squirrel Run Camp and surveyed the site on August 17, 2008. This high-capacity camp is set in a clearing in a white spruce forest; ground cover was leaf litter and duff.

The steep and fragile riverbank that is climbed to access the camp is the most susceptible area to invasion at this site. However, the only non-native species detected was *Poa pratensis* ssp. *pratensis*[4] (52), and it was growing in the forest opening, not on the riverbank. It is possible that the frequency of erosion at the river's edge prevents the establishment of plant (non-native and native) species.

Figure 11. The AKNHP crew camped at Squirrel Run Camp.

Plot 11. Monson's Slough Camp

Dawson and Norwood may have used this shady campsite (see Plot 9. Dawson's Cabin) on their trapline, as there are remnants of an old structure nearby. The camp, which can accommodate large numbers of people, is located in an open white spruce forest with a low willow understory and a beaten organic surface (duff, leaf litter). Despite the site's presumed historic and present-day use, no non-native plants were found here.

Figure 12. Monson's Slough Camp.

[5] A question mark by a species' name indicates a tentative identification, often a consequence of only having poor quality specimens. In this case, the quality of the voucher specimen collected is poor, and we therefore cannot make a positive determination.

Plot 12. Beaver Flats Camp

This flat, open, upland is located in a clearing among Canada bluejoint and surrounded by low willow scrub. The camping area consists of wet silt and mud with minimal grass cover. There was an especially large infestation of *Matricaria discoidea* (pineapple weed, 32) at this camp, in addition to several other weakly to modestly invasive non-native weeds.

Table 9. Non-native plant species found at Beaver Flats Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Matricaria discoidea	pineapple weed	32	80	N/A	None
Poa annua	annual bluegrass	46	5	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	3	N/A	None
Polygonum aviculare	prostrate knotweed	45	3	N/A	None

N/A - Not available

Figure 13. Beaver Flats Camp.

Observation 1. Campsite #20

Rafting past Campsite #20 we noted a scattered infestation of *Matricaria discoidea* (pineapple weed, 32), which covered up to 35% of the largely unvegetated, silt-cobble beach.

Plot 13. Caribou Island

Caribou Island has a silt-gravel beach that is unvegetated except for sparse low willow shrubs. Three weakly to modestly invasive weeds were recorded.

Table 10. Non-native plant species found at the Caribou Island plot.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Polygonum aviculare	prostrate knotweed	45	N/A	10	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	N/A	4	None
Poa annua	annual bluegrass	46	2	1-10	None

N/A - Not available

Plot 14. Potty Island

Potty Island is named for an outhouse located here until 1997, when it was removed to avoid water contamination. It is possible that this was a medium to high use site, at least prior to 1997.

The largely unvegetated (duff and some grasses) clearings on the north and south ends of the island are accessed by climbing the steep, silt-sand riverbanks. Erosion along these two access routes makes these points vulnerable to colonization by weedy species. We surveyed the north and south clearings, which serve as camps, as well as the connector trail that runs the length of the island. Although human waste was found scattered along the trail, indicating that it is still used as a rest area, non-native plants were only found at the campsites.

Figure 14. Caribou Island silt-gravel bar.

Figure 15. Potty Island, south clearing.

Table 11. Non-native plant species found at Potty Island.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Plantago major+	common plantain	44	N/A	50	None
Taraxacum officinale ssp. *officinale*+	common dandelion	58	30	35	None
Taraxacum officinale ssp. *officinale**	common dandelion	58	5	5	None

+ Infestation found on the south end of Potty Island, facing River Otter Slough camp
* Infestation found on the north end of Potty Island
N/A - Not available

Plot 15. River Otter Slough Camp

This shaded, upland campsite is situated immediately downstream of Potty Island. It consists of a long, relatively flat, and largely unvegetated (duff, scattered grasses) clearing surrounded by white spruce trees. A well-worn campsite and a fire ring provide evidence of repeated human disturbance in the clearing at River Otter Slough. The same non-native plants that were found on the south end of Potty Island were observed here. Given the proximity of one site to another, it is possible that non-native plant propagules disperse between camps.

Figure 16. River Otter Slough Camp.

Table 12. Non-native plant species found at River Otter Slough Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	N/A	50-100	None
Plantago major	common plantain	44	N/A	5-10	None

N/A - Not available

Plot 16. Room with a View Camp

The last site visited by the AKNHP crew on August 17, 2008 was Room with a View camp. This relatively small campsite is situated atop a small ridge overlooking the river, and the tarp footprint corresponds to small clearings (roots, leaf litter, and duff) in a white spruce forest. No non-native plants were recorded.

Figure 17. Room with a View camp (left) looks out over the Gulkana River (right).

Observation 2. Last Chance Camp

Although we did not read a plot at Last Chance Camp, we observed a small population of *Taraxacum officinale* ssp. *officinale* (58) growing in a grassy clearing by the riverbank when we rafted past this site.

Plot 17. Copper River Basin race route crossing

On August 18, 2008 we stopped before the Canyon Rapids portage trail, on river left, at the intersection of the Copper River Basin 300 mile sled dog race route (and ATV route) with the Gulkana River. We surveyed roughly 20 meters up the winter trail, which runs through muddy seeps and wet meadows in a white spruce forest. No non-native weeds were recorded at this trail crossing.

Observation 3. Portage trail and Smooth Landing Camp

We surveyed the length of the Canyon Rapids portage trail, from the take-out and staging area to the Smooth Landing Camp. This campsite is situated at the end of the rapids, in a large and flat clearing amidst an open white spruce forest.

Although no non-native plants were observed along the portage trail, there were small populations of four weakly to modestly invasive weed species at Smooth Landing.

Table 13. Non-native plant species found at Smooth Landing Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Matricaria discoidea	pineapple weed	32	20	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	10	N/A	None
Poa annua	annual bluegrass	46	10	N/A	None
Plantago major	common plantain	44	5	N/A	None

N/A - Not available

Figure 18. Copper River Basin race/ATV trail.

Plot 18. Salmonberry Stash Camp

Located on river right just downstream of the Canyon Rapids, Salmonberry Stash campsite consists of a barren gravel bar that is likely subject to flooding. The combination of bare ground and fluvial disturbance increases the vulnerability of this site to colonization by non-native weeds. We recorded small, sparsely distributed infestations of three weakly invasive species.

Table 14. Non-native species found at Salmonberry Stash Camp.

Scientific name	Common name	Invasive-ness rank	Percent cover	Stem count	Control method
Matricaria discoidea	pineapple weed	32	10-15	N/A	None
Poa annua	annual bluegrass	46	5-10	N/A	None
Polygonum aviculare	prostrate knotweed	45	5	N/A	None

N/A - Not available

Figure 19. Salmonberry Stash gravel bar.

Plot 19. Alvin's Bar

Figure 20. Alvin's Bar.

Alvin's Bar, located at river mile 20.7, can accommodate multiple tents either on its relatively flat, unvegegated, silty beach or in silt-sand clearings among the tall alder-willow shrub. Seasonal flooding events are also likely to affect this site, which combined with the large amount of bare ground makes it susceptible to invasion by non-native weeds. Two weakly to modestly invasive non-native species were found at this site. Both *Plantago major* and *Taraxacum officinale* ssp. *officinale* are extremely common weeds in Alaska.

Table 15. Non-native plant species found at Alvin's Bar.

Scientific name	Common name	Invasive-ness rank	Percent cover	Stem count	Control method
Plantago major	common plantain	44	7.5	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	1	N/A	None

N/A - Not available

Plot 20. Long Bar

As its name suggests, Long Bar is a long, silt-gravel bar, sparsely vegetated with mosses and surrounded by tall willow-alder scrub. Similar to Alvin's Bar and Salmonberry Stash Camp, this site is vulnerable to invasion by non-native weeds due to the prevalence of bare soil and susceptibility to flooding. As with other campsites located on gravel bars along this river, the non-native species observed here were *Matricaria discoidea* and *Polygonum aviculare*.

Table 16. Non-native plant species found at Long Bar Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Polygonum aviculare	prostrate knotweed	45	20	N/A	None
Matricaria discoidea	pineapple weed	32	5	N/A	None

N/A - Not available

Plot 21. Joe Secondchief Camp

On August 18, 2008 the crew camped at Joe Secondchief Camp, an upland, leaf-litter covered clearing in a white spruce forest. A marsh lies behind the main camping area. The Gulkana Floater's Guide (BLM 2008) indicates that this campsite has a flat, gravel bar landing area. However, the bar was underwater and we were therefore unable to survey it.

The only non-native species found at this site, accounting for less than 5% of total ground cover, was *Poa annua* (46).

Figure 21. Long Bar Camp.

Figure 22. Joe Secondchief Camp.

Plot 22. Wickersham Bar

Wickersham Bar Camp is a large, flat, open silt and gravel bar located at river mile 30.5. Bare soil combined with seasonal flooding makes this site particularly vulnerable to non-native plant establishment.

In addition to the *Matricaria discoidea* and *Polygonum aviculare* species complex that was found on most other infested gravel bars, three other weakly to moderately invasive species were recorded.

Two non-native plant species found at Wickersham Bar represent the farthest upstream populations of these species within the survey area. Moderately invasive *Hordeum jubatum* (foxtail barley, 63) was found in trace amounts at this location (and again downstream at the heavily infested Sourdough Creek Campground). The second species, *Erysimum cheiranthoides* (wormseed wallflower, NR), was found here and downstream of this point, at Tenas Pete Camp and the Sourdough Creek campground. Although *Erysimum cheiranthoides* is no longer being tracked as non-native by the AKEPIC tracking list (see "questionable" for more information), the presence of both these species at and downstream of Wickersham Bar, but not upstream of it, is noteworthy. This area may act as a source of weed propagules.

Figure 23. Wickersham Bar had the farthest upstream infestation of *Hordeum jubatum*.

Table 17. Non-native plant species and nuisance weed species found at Wickersham Bar.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Plantago major	common plantain	44	15-20	N/A	None
Polygonum aviculare	prostrate knotweed	45	10-20	N/A	None
Matricaria discoidea	pineapple weed	32	5	N/A	None
Poa annua	annual bluegrass	46	3	N/A	None
Hordeum jubatum	foxtail barley	63	trace	N/A	None

N/A - Not available
Trace – less than 1% cover

Plot 23. Tenas Pete Bluff Camp

Tenas Pete Bluff campsite can be accessed from a barren silt-gravel bar. The trail from the river leads into a poplar woodland with a tall willow understory where gravel clearings provide tenting areas. In addition to the two weakly to modestly invasive species recorded here, this is the second site at which a small (4 stems) population of *Erysimum cheiranthoides* (See "questionable" for more information on this species' origin) was documented.

Table 18. Non-native plant species found at Tenas Pete Bluff Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	10-20	15	None
Plantago major	common plantain	44	5-10	40	None

N/A - Not available

Observation 4. Monohan Flats

At the gravel landing leading to the large, open upland camp, we observed small infestations of two weakly invasive weeds.

Table 19. Non-native plant species observed at Monohan Flats Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Matricaria discoidea	pineapple weed	32	5	N/A	None
Polygonum aviculare	prostrate knotweed	45	N/A	N/A	None

N/A - Not available

Figure 24. Barren clearings provide tenting areas at Tenas Pete Bluff.

Plot 24. Fish-counting tower

A white spruce forest with a mossy heath understory surrounds the fish-counting tower. Clearings are dominated by duff and leaf litter, with little bare mineral soil. Despite the site's heavy use in the summer months and the presence of equipment and imported materials, no non-native weeds were recorded here. We surveyed for invasive plants in disturbed sites around the cabin, the dismantled tower, and along the trails leading to and from the cabin. The absence of bare, exposed soil may explain the lack of non-native plants at this location.

Figure 25. Cabins used by staff operating the fish-counting tower.

Plot 25. West Fork Confluence

The campsite located at the confluence of the main stem with the west fork of the Gulkana River is located on a long silt-gravel bar. Presumably, this site is vulnerable to colonization by non-native weeds because it is subject to seasonal flooding, the ground is bare and, furthermore, it is a popular stop for motorized boaters. Nonetheless, the area is mostly weed-free, with only a few small and scattered infestations of weakly to modestly invasive species were recorded.

Table 20. Non-native plant species found at the West Fork Confluence.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Taraxacum officinale ssp. *officinale*	common dandelion	58	10-15	N/A	None
Plantago major	common plantain	44	10	N/A	None
Polygonum aviculare	prostrate knotweed	45	3-5	N/A	None
Matricaria discoidea	pineapple weed	32	3-5	N/A	None
Poa annua	annual bluegrass	46	trace	N/A	None

N/A - Not available
Trace – less than 1 percent cover

Figure 26. Gravel bar at the West Fork Confluence.

Plot 26. Mud bar near Ole Island

The partially flooded mud bar near Ole Island Camp was weed-free.

Plot 27. Chinook Bar

This large grassy to sparsely vegetated upland area is probably subject to flooding and erosion. Small populations of three weakly to modestly invasive non-native plant species were recorded at this site.

Table 21. Non-native plant species found at Chinook Bar.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Poa pratensis cf. *pratensis*	Kentucky bluegrass	52	5-15	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	10	N/A	None
Plantago major	common plantain	44	3	N/A	None

N/A - Not available

Figure 27. Mud bar near Ole Island Camp.

Figure 28. Chinook Bar Camp.

Plot 28. Allen Bar

Scattered and small populations of four weakly to modestly invasive weed species were recorded at this grassy, sparsely vegetated mud bar.

Table 22. Non-native plant species found on Allen Bar.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	52	15-20	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	10	N/A	None
Matricaria discoidea	pineapple weed	32	1-5	N/A	None
Plantago major	common plantain	44	10-15	N/A	None

N/A - Not available

Plot 29. Yaeger Bar

Yaegar Bar is the last campsite before the take-out at Sourdough Creek Campground. The tent pads are located amidst open tall alder-willow shrub. Its large gravel bar and good fishing access make this camp a high use site. Nonetheless, no new nor moderately to extremely invasive species were recorded.

Table 23. Non-native plant species found at Yaeger Bar Camp.

Scientific name	Common name	Invasiveness rank	Percent cover	Stem count	Control method
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	52	20- 30	N/A	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	10	N/A	None
Polygonum aviculare	prostrate knotweed	45	N/A	N/A	None
Plantago major	common plantain	44	20- 30	N/A	None

N/A - Not available

Figure 29. Yaeger Bar Camp.

Observation 5. Trans-Alaska Pipeline

Even though we did not read a plot at the intersection of the Trans-Alaska Pipeline with the Gulkana, we did pull up close to the bank on river left. The bank was densely vegetated and no invasive plants were observed.

While the crossing of the Trans-Alaska Pipeline over the Gulkana was weed free at the time of the survey, this was once the site of major human disturbances: an aerial view shows the scale of bridge and pipeline work, and views of construction efforts in 1976 show the extent of the anthropogenic disturbances (Figure 30).

Invasive plant surveys on BLM lands along the Dalton Highway documented the presence of modestly to extremely invasive plant species (including *Bromus inermis* ssp. *inermis*, *Crepis tectorum* and *Melilotus alba*) on pipeline pullouts and access roads (Cortés-Burns *et al.* 2007, 2008). Although it is likely that many of the propagules that gave rise to these infestations were brought in as a result of highway use, some were introduced during the construction of the pipeline itself; for instance, *Bromus inermis* ssp. *inermis* was intentionally seeded during post-construction of the pipeline, at least in the section paralleling the Dalton Highway (Flagstad, pers. comm.). Therefore, it is highly likely that some non-native weeds may be growing along the access/maintenance roads at either side of the Trans-Alaska Pipeline Bridge that crosses the Gulkana. However, those areas could not be accessed from the river and were not included within the scope of this project.

Figure 30. Construction work for the bridge over the Gulkana River during the pipeline construction in 1976 (source: Alaska Virtual Library and Digital Archives).

Plot 30. Sourdough Creek Campground

The take-out at Sourdough Creek Campground contains the greatest diversity of non-native species recorded at any one site in this survey. This is a bigger and more developed campground than the one at Paxson Lake, and is almost certainly more heavily used than the latter, as motorized boats can put in here and travel upstream until the confluence of the West Fork with the main stem of the Gulkana.

In all, 18 non-native species were detected on and near the boat ramp (Table 24). Although *Erysimum cheiranthoides* (NR) is no longer tracked on the AKEPIC tracking list, this mustard was recorded here. *Lepidium densiflorum*'s nativity is also questionable, as described under "Species whose non-nativeness is questionable" but, unlike *E. cheiranthoides*, it is still being tracked by AKEPIC. However, given the uncertainty surrounding its origin we do not include it among the species to be tracked, monitored, or controlled in this work (listed in Table 24).

Species of concern include *Melilotus alba* (white sweetclover, 81), *Bromus inermis* ssp. *inermis* (smooth brome, 62), *Trifolium repens* (white clover, 59), *Trifolium hybridum* (alsike clover, 57), *Crepis tectorum* (narrowleaf hawksbeard, 54), and *Brassica napus* (rapeseed mustard, rutabaga, NR). None of these modestly to extremely invasive species were recorded elsewhere along the river.

We consider that containment (or eradication, if possible) of infestations caused by any of these six species should be a top priority for the Gulkana corridor. The goal is to minimize the chances of these species' dispersal up and downstream of the Sourdough campground.

This is especially the case for the *Melilotus alba* infestation. A large and semi-continuous infestation of *Melilotus alba* was observed around the outhouses located shortly uphill of the boat ramp (Figure 31). This white-flowered legume has already colonized glacial river floodplains on a number of Alaskan rivers (e.g. Stikine, Nenana, Yukon) (see Conn *et al.* 2008, AKEPIC Database 2009). Because *Melilotus* spp. prefers alkaline soils, and river floodplains in early successional stages have basic soils, early seral communities at these sites are susceptible to invasion (Conn *et al.* 2008). Furthermore, recent experimental

studies have found that there is 50% greater mortality of native seedlings at floodplain sites with white sweetclover than those that are sweetclover-free (Spellman 2008).

We also recommend that *Crepis tectorum* plants be pulled, because despite its lower invasiveness rank (54) it has also been detected invading native, undisturbed vegetation in Alaska (Cortés-Burns *et al.* 2008). At the time of the survey, the infestation consisted of a few stems, such that hand-pulling and digging efforts may yet succeed at eliminating, or at least containing, the infestation. See Species biographies and control recommendations for detailed control recommendations for both *Crepis tectorum* and *Melilotus alba*.

Table 24. Non-native plant species[6] found at Sourdough Creek campground and boat ramp, sorted by decreasing invasiveness rank (percent covers and stem counts were not recorded at this location).

Scientific name	Common name	Invasiveness rank	Control method
Melilotus alba	white sweetclover	81	None
Hordeum jubatum	foxtail barley	63	None
Bromus inermis ssp. *inermis*	smooth brome	62	None
Trifolium repens	white clover	59	None
Taraxacum officinale ssp. *officinale*	common dandelion	58	None
Trifolium hybridum	alsike clover	57	None
Crepis tectorum	narrowleaf hawksbeard	54	None
Poa pratensis cf. *pratensis*	Kentucky bluegrass	52	None
Poa annua	annual bluegrass	46	None
Polygonum aviculare	prostrate knotweed	45	None
Plantago major	common plantain	44	None
Capsella bursa-pastoris	shepherd's purse	40	None
Poa compressa	flat-stem bluegrass	39	None
Chenopodium album	lambsquarters	37	None
Cerastium glomeratum	sticky chickweed	36	None
Matricaria discoidea	pineapple weed	32	None
Brassica napus	rapeseed mustard, rutabaga	NR	Manual pull

NR – Not ranked

Figure 31. Invasive plants were found near the boat ramp (left). *Melilotus alba* was growing by the outhouses (right). Note: TAPS bridge in background, center photo.

[6] *Lepidium densiflorum* (common pepperweed, 25) was recorded near the boat ramp. For reasons indicated under Species whose non-nativeness is questionable we do not consider this species a top management priority for the Gulkana NWSR.

Conclusions and management recommendations

In all, 30 temporary plots were read and cursory surveys were completed at five (5) additional sites. Of the 35 sites surveyed, five (5) were weed-free, while the remaining 30 (86%) contained one or more populations of non-native plant species. Twenty-two (22) non-native species (representing less than 7% of Alaska's non-native plant flora) and 106 infestations were recorded in this effort (Table 1).

Problematic areas and infestations

Most non-native plant species recorded along the Gulkana River are common to high use areas in remote Alaska, and pose a low threat to the integrity of the surrounding native plant communities. Of the 22 species recorded, only three (3) have the potential of being strongly invasive (ranked greater than 60 points) and six (6) are considered modestly invasive (rank values 50 to 59 points) (Table 25).

Table 25. List of modestly to extremely invasive non-native plants documented along the Gulkana River, sorted by their invasiveness rank

Locality	Disturbance, ground cover	Scientific name	Common name	Family name	Invasive-ness Rank	Frequency of occurrence	Total acres infested†
SCC: road to outhouses	Fill importation, gravel	*Melilotus alba*	white sweetclover	Fabaceae	81	0.03	0.100
SCC, Wickersham Bar	Fill importation, gravel; flooding, gravel	*Hordeum jubatum**	foxtail barley	Poaceae	63*	0.06	0.101
SCC: boat ramp	Fill importation, gravel	*Bromus inermis* ssp. *inermis*	smooth brome	Poaceae	62	0.03	0.100
SCC: boat ramp	Fill importation, gravel	*Trifolium repens*	white clover	Fabaceae	59	0.03	0.010
Multiple plots	trampling	*Taraxacum officinale* ssp. officinale*	common dandelion	Asteraceae	58*	0.63	1.102
SCC: boat ramp	Fill importation, gravel	*Trifolium hybridum*	alsike clover	Fabaceae	57	0.03	0.100
SCC: boat ramp	Fill importation, gravel	*Crepis tectorum*	narrowleaf hawksbeard	Asteraceae	54	0.03	0.010
Multiple plots	multiple	*Poa pratensis* ssp. *pratensis*	Kentucky bluegrass	Poaceae	52	0.23	0.332
Multiple plots	multiple	*Poa pratensis* ssp. *irrigata*	spreading bluegrass	Poaceae	52	0.03	0.010
Paxson L. CG, parking lot	Fill importation, gravel	*Tripleurospermum inodorum**	scentless false mayweed	Asteraceae	48*	0.03	0.001
Meier's Roadhouse	Trampling, ATV, old cabin; leaf litter, duff	*Stellaria media*	common chickweed	Caryophy-llaceae	42	0.03	0.100
Meier's Roadhouse	Trampling, ATV, old cabin; leaf litter, duff	*Alopecurus pratensis*	meadow foxtail	Poaceae	NR	0.03	0.010
SCC: boat ramp	Fill importation, gravel	*Brassica napus*	rapeseed mustard, rutabaga	Brassica-ceae	NR	0.03	0.001

† Total estimated number of acres infested: sum of acres infested with a species per plot, over all plots
SCC: Sourdough Creek Campground
See text for explanation on why *Taraxacum officinale* ssp. *officinale* and *Hordeum jubatum* are not prioritized for control work and why *Tripleurospermum inodorum, Stellaria media, Alopecurus pratensis*, and *Brassica napus* are.
NR – Not ranked.

The most problematic areas were the put-in and take-out locations: Paxson Lake campground had weakly to modestly invasive species; Sourdough Creek campground had moderately and extremely invasive species (Table 25). We recommend that infestations be prioritized for control work as follows:

High priority sites and infestations

Paxson Lake Campground

Although it does not have a high invasiveness rank (48), *Tripleurospermum inodorum* is a garden escapee that has spread into natural areas in other parts of Alaska, forming near monocultures. We therefore recommend complete eradication of the *Tripleurospermum inodorum* infestation at Paxson Lake campground (see "Species bios and control recommendations" for more details on how to eliminate this species). Otherwise, control efforts should be focused at Sourdough Creek Campground, which supported populations for the most aggressively invasive plants recorded in this project.

Sourdough Creek Campground

Invasive plants at Sourdough Creek campground pose a threat to ecosystems not only downstream but also upstream of the area because propagules could be transported up by motorized boats, which are allowed to go as far as the confluence with the West Fork.

We consequently propose that infestations of *Melilotus alba, Bromus inermis* ssp*. inermis*, and *Crepis tectorum* be eradicated as they are highly invasive, have the potential to invade native vegetation, and were not present upstream of Sourdough Creek. We also recommend pulling all *Brassica napus* stems even though this species has not yet been ranked. Most wild mustard infestations recorded in south central and interior Alaska so far have been small and discrete. By extirpating them at this stage we can prevent this species from becoming a more common weed of disturbed sites.

Populations of species that seem to be less aggressively invasive in Alaska that occurred at Sourdough, including those of *Trifolium repens, Trifolium hybridum, Chenopodium album,* and *Cerastium fontanum* are recommended for control (or at least containment) work because they were not present upstream of Sourdough Creek and it is therefore still possible to prevent their spread to the rest of the Gulkana NWSR.

Lower priority sites and infestations

If time and funding allows, we recommend controlling populations of weakly to modestly invasive weeds found at Paxson Lake Campground and along the more remote sections of the river corridor[7].

Priority should be given to infestations for which control work is most likely to be successful. The following guidelines can be used to help make decisions on which infestations should be targeted first:

[7] In this text all plots read along the Gulkana River other than Paxson Lake Campground and Sourdough Creek Campground, which are road-accessible, are referred to as "remote".

- Species that are infrequent (cf. Table 1) and whose infestations are concentrated along a short section of the river corridor should be given priority over those that were recorded throughout the length of the surveyed area
- Infestations that are closest to the riverbanks should be controlled over those located in inland/upland sites, as they could be more easily dispersed (by wind, water, or animals) to other sites
- Given two species with similar frequencies of occurrence and distribution patterns, the species with a higher invasiveness rank should be targeted first
- However, if future surveys document an infestation of an extremely invasive species (ranked greater than 60 points) that is indisputably not indigenous to Alaska (i.e. excluding *Hordeum jubatum*) in the more remote portions of the corridor, this species and all of its populations should be prioritized over any weakly to modestly invasive species for eradication work

Following the above recommendations, infestations in the more remote sections of the river should be targeted for control in this order: first, the Meier's Roadhouse camp *Alopecurus pratensis* and *Stellaria media* populations, and second, the *Capsella bursa-pastoris* populations that were recorded at four remote plots (as well as the two main campgrounds).

Lowest priority infestations

Most of the weakly to modestly invasive species documented in this survey, such as (listed in decreasing order of frequency of occurrence) *Plantago major, Matricaria discoidea*, *Poa annua*, *Polygonum aviculare*, and non-native subspecies of *Poa pratensis* are typical of high-use sites in remote Alaska. Furthermore, these species were present at multiple sites along the Gulkana, and in many cases formed medium to large infestations. Consequently, it is unlikely that they can be successfully eliminated from the river corridor. The approach in this case is to prevent their spread along the corridor by monitoring weed-free sites and extirpating any new, small infestations that may appear. Controlling these low impact non-native species in the high-use areas may be considered after more threatening populations are addressed first.

We do not recommend prioritizing *Taraxacum officinale* ssp. *officinale* for control because it is very frequent and widespread throughout the area surveyed, and it is common across much of Alaska. In general, it is not efficient to target this species for eradication work except at the fringes of its statewide range or in areas where populations are still small to medium-sized (1-100 stems) and highly isolated.

We do not list *Hordeum jubatum* as a priority for control work because its origin is questionable. It is included in this report primarily because it is a nuisance weed for dogs and cattle, rather than because of its impacts on native plant communities. (See "Species whose non-nativeness is questionable" for a more detailed discussion on foxtail barley's origin.)

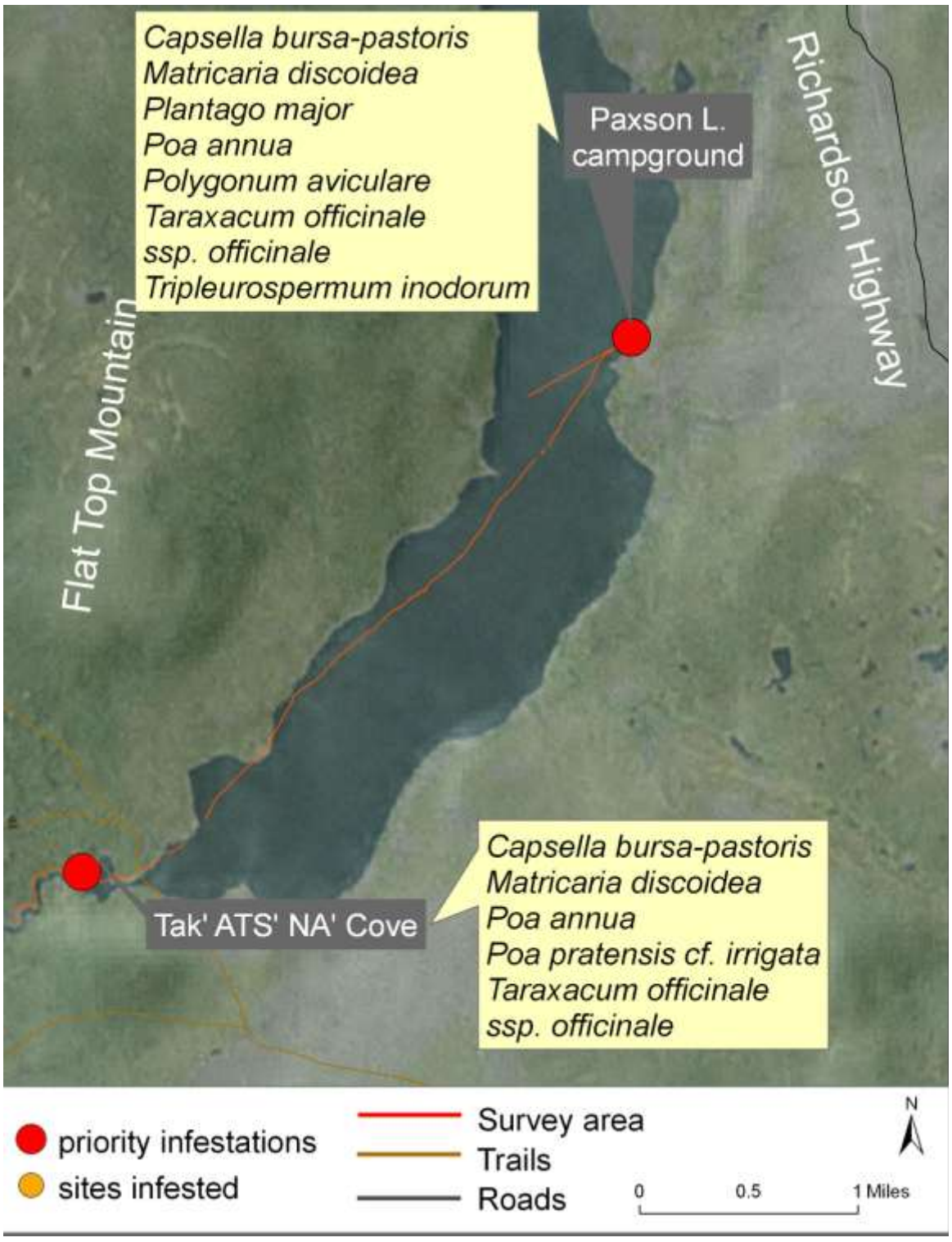

Figure 32. Priority infestations (for control or monitoring work) near Paxson Lake.

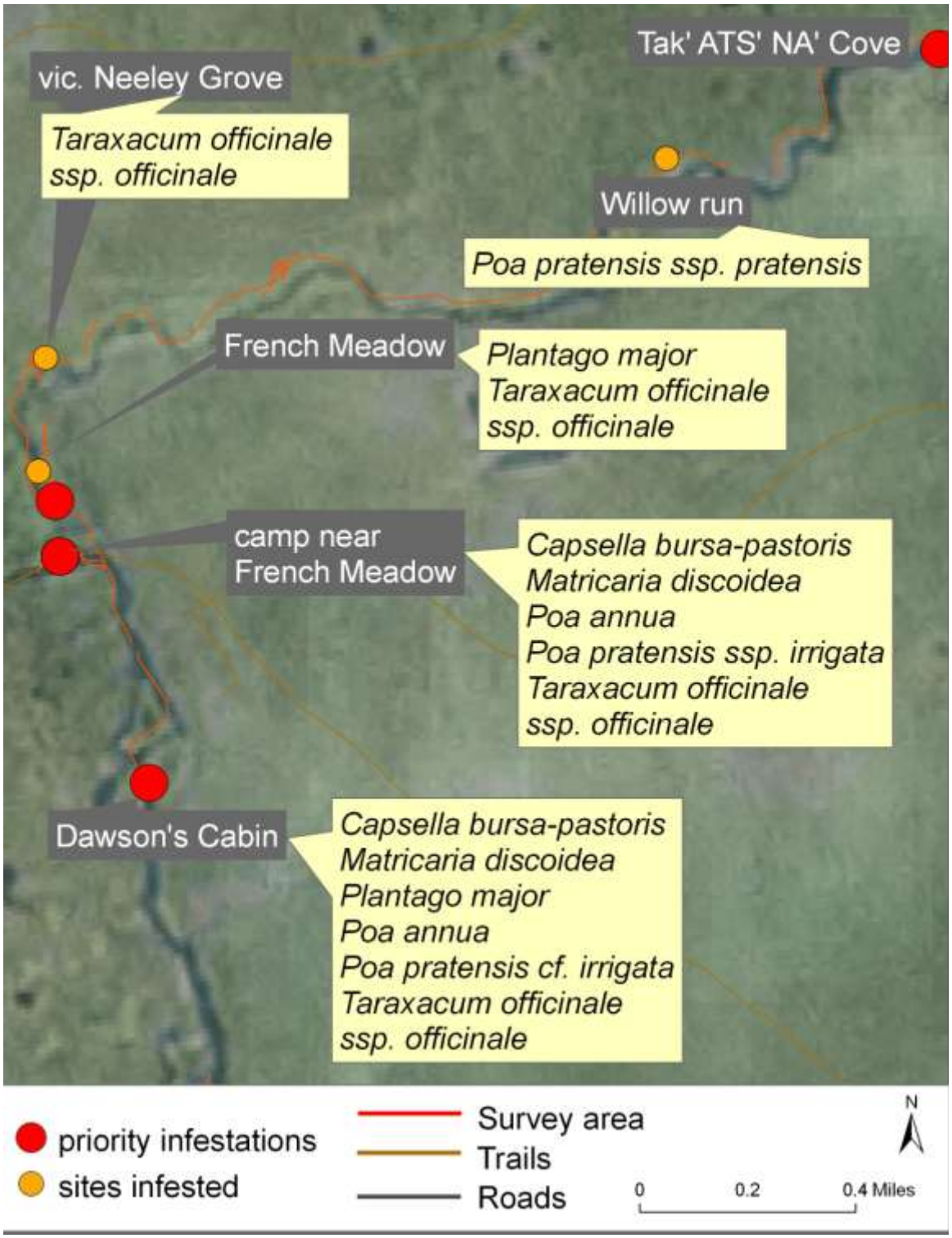

Figure 33. Priority infestations for control or monitoring work along Gulkana's main stem.

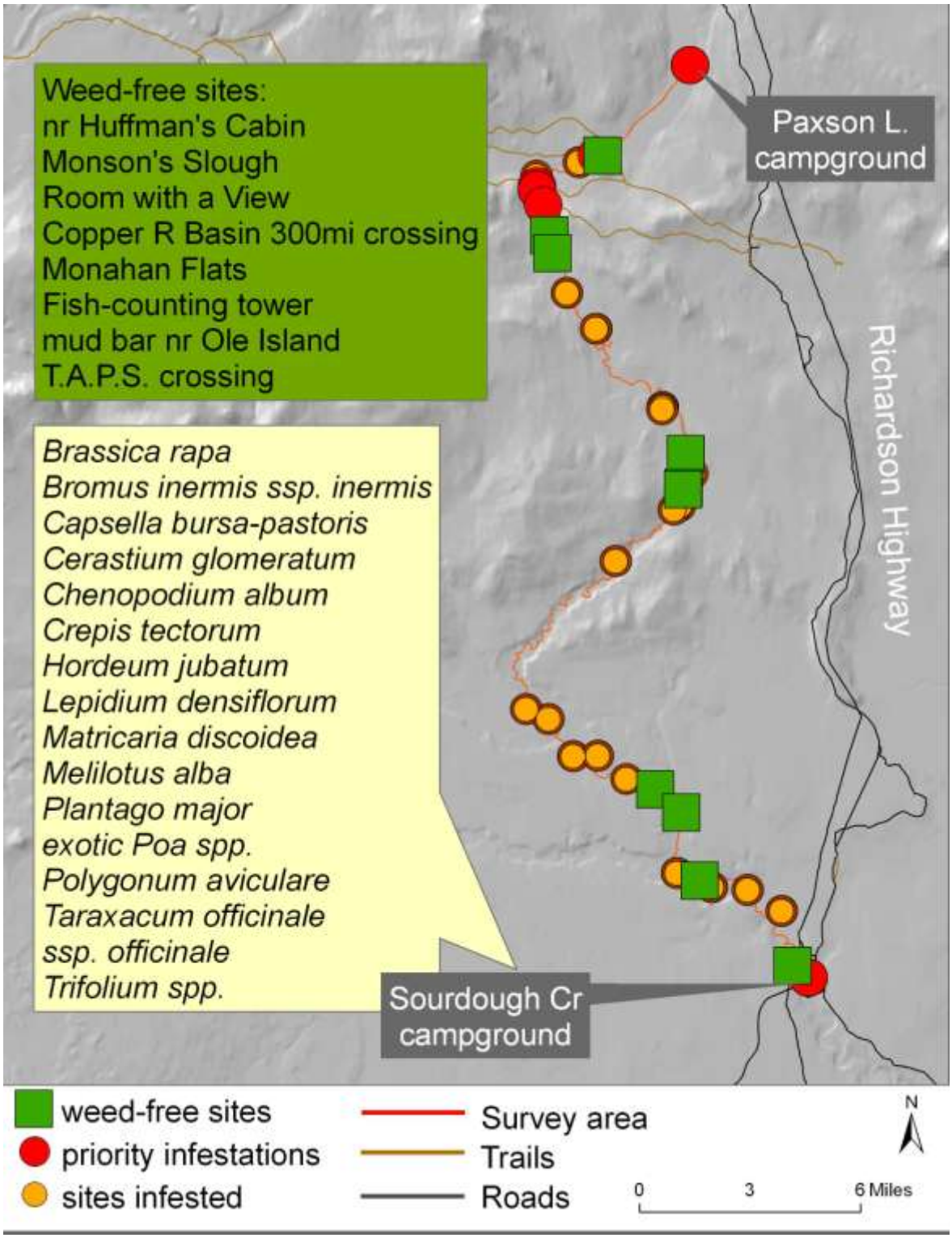

Figure 34. Sites that were weed-free (green box) and weeds recorded at Sourdough Creek campground (yellow box) in 2008.

Factors associated with non-native plant invasion along the Gulkana River

In this section we first analyze the possible introduction routes for non-native plants into the Gulkana River and second, we identify what types of sites are most susceptible to invasion based on two factors: ground cover and disturbance type. In addition, we discuss the correlation that exists between certain types of substrate and disturbance and particular assemblages of non-native species.

Weed propagule source areas and routes of introduction

Although we cannot determine how many invasive plant propagules are brought into the Gulkana NWSR on a yearly basis, we can assume that: (1) invasive plant propagule pressure is greater at the source areas, and (2) that pressure decreases with distance from these sites. Although historic use of cabins and trails may constitute a source for some of the non-native plant populations we detected along the Gulkana NWSR, it is through the present-day use of the river, primarily by boaters (and the gear they bring along) that invasive plant propagules are being introduced and spread.

Identifying which are the main sources of invasive plant propagules within a given area and how these propagules can be dispersed to other locations is crucial in the development of an effective weed management plan. In this section we discuss which sites constitute source areas and describe the various routes by which invasive plant propagules might be being dispersed through the Gulkana NWSR.

Road-accessible campgrounds and boat ramps

Given that the headwaters of the Gulkana start at Paxson Lake, and the proximity of the latter to the Richardson highway, we consider Paxson Lake campground to be a key source of invasive weed propagules for the Gulkana. Sourdough Creek Campground constitutes the second largest source area for weed propagules because (1) it is next to the highway and the pipeline, (2) motorized craft are launched from this point for upstream and downstream travel, and (3) it contains a number of highly invasive species.

The main stem's tributaries

Non-native plant propagules could also be traveling from the Tangle Lakes area, entering the main stem of the Gulkana either by water or through the network of winter trails connecting these areas. Recent non-native plants surveys in and around Tangle Lakes yielded a similar non-native plant species complex to that recorded at the Paxson Lake boat ramp. Listed by decreasing invasiveness rank, these are: *Hordeum jubatum, Taraxacum officinale* ssp. *officinale, Stellaria media, Poa annua, Polygonum aviculare, Plantago major*, and *Matricaria discoidea*. *Hordeum jubatum* and *Stellaria media*, which were not documented at the Paxson Campground, were found at the boat launches for the Round and Upper Tangles lakes, respectively (see "Non-native plants recorded along the Delta" for more information).

Trails: hiking, ATV, and mushing trails

There are five trails that could act as potential dispersal routes for weeds along the Gulkana NWSR corridor:

- Meier's Lake-Middle Fork trail, an ATV and hiking trail that connects the Richardson Highway at mile 169 to the Middle Fork of the Gulkana, and runs through alpine tundra, forests, and bogs. There are other trails near the headwaters of the Gulkana River that were used by the Ahtna people and connect the main stem of the Gulkana with Tangle Lakes and Dickey Lake
- Haggard Creek trail, an ATV trail that connects the highway with the Gulkana, starting at mile 161 of the Richardson, running through bogs and lowlands and intersecting the river at Canyon Rapids
- Gulkana Portage trail
- Canyon Lake trail, a 1 mile long hiking trail that connects the portage area to Canyon Lake
- Copper River Basin 300 trail, a dog-sled race route and ATV trail that runs along the Gulkana corridor approximately from the confluence with the Middle Fork to just before the rapids

We surveyed sections of ATV trails proximal to campsites, the portage trail, a section of the winter trail leading to Hufman's Cabin, and the Copper River Basin 300 winter trail at its intersection with the Gulkana at Canyon Rapids. Although some of these trails are connected to the Richardson Highway, none of the trail sections surveyed contained invasive plant species, even in areas where bare soil was exposed.

Abandoned and active cabins

Dawson's Cabin and Meier's Roadhouse are both abandoned homesites where there could be a large seedbank of invasive plant propagules. Indeed, Meier's Roadhouse Camp is one of two remote sites with a unique non-native weed assemblage (the other being Wickersham Bar, which had the only infestation of *Hordeum jubatum* outside of the Sourdough Creek campground one). Meier's Roadhouse is the only site where *Alopecurus pratensis* and *Stellaria media* were found between Paxson Lake and the Sourdough boat ramp. Their presence at this site is probably a result of historic use (*Alopecurus pratensis* is a common forage grass and *Stellaria media* is primarily a garden weed) and of current accessibility of this site both from the river and by ATV.

The fish-counting tower site and associated cabins and footpaths were weed-free in 2008. Coincidentally, the ground cover for this site consists of mosses, lichens, leaf litter and duff, which appear to be moderately resistant to invasion based on the data collected in this study (see 'Site vulnerability' below for a more detailed discussion). However, it is likely that there are non-native plant propagules at this site given that a lot of equipment and materials have been brought in. Consequently, any activities that could result in exposure of bare, mineral soil should be prevented or mitigated.

Discussion on source areas and dispersal routes

Of the 33 remote, river corridor sites surveyed, only two, Meier's Roadhouse and Wickersham Bar camps, contained non-native species that had not been recorded at the Paxson Lake campground boat ramp[8]. In other words, most of the weeds present in camps and trails along the main stem of the Gulkana were also present at the Paxson Lake boat ramp. Sourdough Creek Campground also contained a number of highly invasive weeds, and motorized boats traveling upstream from Sourdough could act as dispersal vectors. We consider that the campgrounds at Paxson Lake and Sourdough Creek constitute the most important sources of invasive plant propagules in this area. Indirectly, as both campgrounds are accessed from the Richardson Highway, we suggest that any non-native plants occurring along the section of the Richardson Highway that runs from Summit Lake to Sourdough be considered a potential threat to the Gulkana.

As there are no non-native plants in the Tangles area that have not already been recorded along the Gulkana, and they are all only weakly or modestly invasive, we do not consider the middle and west forks of the Gulkana to be major sources of weed propagules.

Both abandoned cabins support a number of weakly to modestly invasive plants; however, most of these plants were already recorded upstream of these sites and/or are weakly invasive. Consequently, we do not consider that these old homesites are important sources of invasive weed propagules for the area. The fish-counting tower site, although weed free in 2008, is nonetheless extensively used each summer; we therefore suggest that it is a potential point of introduction for new, more highly invasive weed propagules. This site and gravel bars downstream of it should be monitored for new infestations.

Finally, although all the sections of ATV, winter, and hiking trails surveyed were weed-free, those that are heavily used during the growing season (e.g. Canyon Lake and the portage trails) or connect the river with the highway (i.e. high-use ATV trails) should be monitored to prevent new invasives from dispersing into the river corridor. In addition, surveys on a winter trail in Yukon Flats Refuge (Cortés-Burns and Carlson 2006a) and along the Iditarod National Historic Trail (Flagstad and Cortés-Burns 2010) found that *Hordeum jubatum* is a contaminant of and germinates from straw used by dog-mushers in Alaska (see Fig. 68). Therefore, the route used for the "Copper River Basin 300" race should be monitored for new weeds on an annual or biennial basis.

[8] The non-native subspecies of *Poa pratensis* are not included in this analysis. Subspecies *pratensis* and ssp. *irrigata* were found at eight (8) river camps but not at the Paxson Lake boat ramp; however, it is possible that these two subspecies were overlooked if they were growing in small numbers or were not in the immediate vicinity of the boat ramp.

Site vulnerability

Our findings show that unvegetated areas (sites where sand, mud, or gravel constitute the majority of ground cover) were the most frequently infested sites. Almost all sites (94%) of these habitats had one or more infestations. There were also a large number (88%) of grassy clearings and meadows, especially those that are sparsely vegetated, that contained one or more infestations. Clearings composed primarily of leaf litter and duff, on the other hand, appear to be more buffered from invasion, with 60% of sites having non-native populations, even in the presence of cabins and trails (e.g.: fish-counting tower) (Fig. 35).

The two types of disturbance that appear to be most strongly correlated with the presence of non-native plant populations are gravel fill importation[9] (100% of plots infested) and river action (flooding, erosion; 92% of sites infested). A majority (82%) of plots in which trampling was the main source of disturbance also had one or more non-native plant populations. Sites in which old cabins and trails constitute the primary source of disturbance appear to be moderately and strongly resistant to invasion, respectively (Fig. 36).

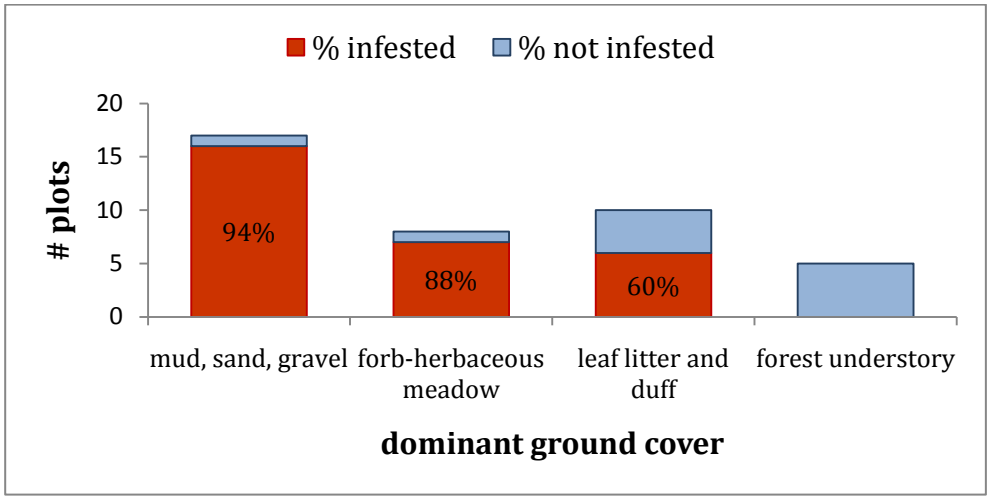

Figure 35. The presence of non-native plant populations is most strongly correlated with the presence of exposed mineral soil.

[9] Gravel and fill importation is one of the disturbance classes available in the statewide weeds database, AKEPIC. It is often associated with areas that have undergone recent construction or maintenance work.

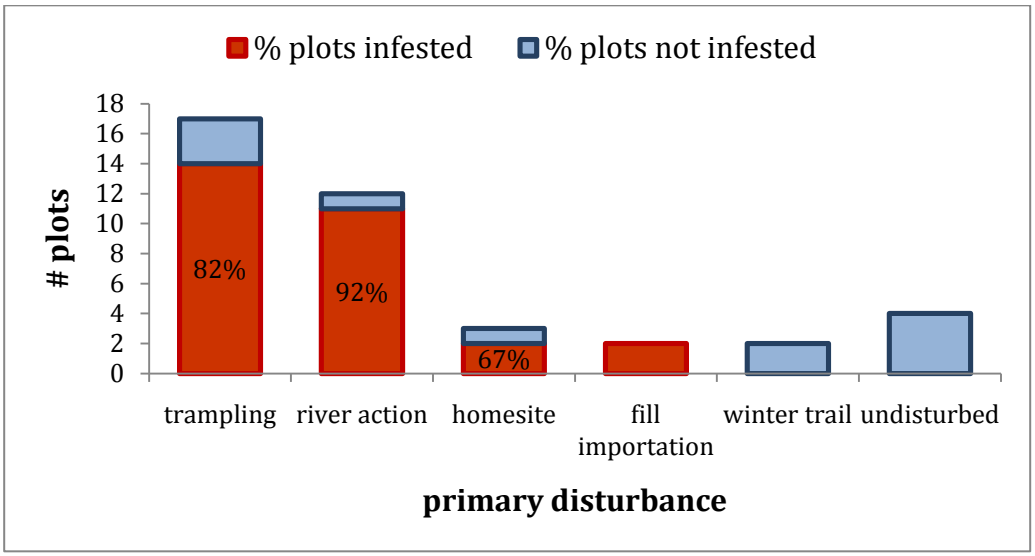

Figure 36. All sites with imported gravel contained one or more infestations. Second to this, river flooding and erosion and trampling were the two types of disturbance most frequently associated with weedy infestations.

Therefore, although human activities are likely the primary vector for the introduction of non-native plant propagules, our findings suggest that it is actions that result in the repeated exposure of mineral soil, either through human-induced (e.g. imported gravel) or natural erosion processes (e.g. mud, sand, and gravel bars), that appear to facilitate the establishment of the non-native species observed.

This conclusion is supported by other remote Alaska invasive plant studies. For instance, non-native weed surveys the Iditarod National Historic Trail (Flagstad and Cortés-Burns 2010) indicated that non-native plant establishment along the trail and race checkpoints is more strongly correlated with the presence of exposed mineral soil than with that of straw and cabins; similarly, weed surveys in National Wildlife Refuges across Alaska following the 2004 and 2005 fires concluded that infestations were most strongly correlated with high use and/or high-severity burn areas where the mineral layer of soil had been exposed (Cortés-Burns and Carlson 2006a, b).

Consequently, equally important to controlling existing infestations, is minimizing soil disturbance, as exposed mineral soil is a ripe medium for the establishment of non-native plants. Furthermore, given that human-driven (e.g. trampling) and natural disturbances (e.g. river action) are integral to the study area, camps and gravel bars must be monitored frequently enough that any new invasive plant populations of species that are particularly damaging can be detected and eradicated quickly, while they are still small and discrete.

Weed distribution patterns

The study area can be roughly divided into two sections according to ground cover class and disturbance type. Camps upstream of Salmonberry Stash are often set among alder-willow scrub in grassy-gravely clearings where the primary source of disturbance is trampling. Downstream of this point, camps are generally located on mud and gravel bars where the primary source of disturbance is river action (flooding and erosion).

Tracking this change in substrate type and primary disturbance, the assemblage of weedy species most commonly recorded on downstream river bars (Salmonberry Stash, Long Bar, Wickersham Bar, Monohan Flats, and the West Fork Confluence camp) differed from those often observed in the drier, upland sites. In particular, the frequency of *Matricaria discoidea* and *Polygonum aviculare* infestations increased with distance downstream, while populations of *Poa annua*, *Poa pratensis* sspp., *Capsella bursa-pastoris*, and *Taraxacum officinale* ssp. *officinale* became less prevalent.

It appears, therefore, that based on the different types of ground cover and disturbance found upstream versus downstream, there are two broadly distinct invasive species assemblages:

1. Seasonally flooded gravel and mud bars, frequently infested by *Matricaria discoidea* and *Polygonum aviculare* populations
2. Grassy meadows and forest clearings, where human activities are the main source of disturbance, often infested with a combination of *Taraxacum officinale* ssp. *officinale, Poa pratensis* sspp*., Poa annua, Plantago major,* and *Capsella bursa-pastoris*

In the future, if new species invade but an overall distinction in species complexes can still be made between upstream and downstream sites, we recommend that weed management plans take these local distribution patterns into account.

Weed management recommendations

Our findings suggest that the two major source areas of weed propagules for the Gulkana NWSR are the campgrounds at Paxson Lake and Sourdough Creek, both of which are high use areas connected to the Richardson Highway.

For reasons indicated above, the hiking, mushing, and ATV trails that intersect the river corridor and its tributaries, and old homesites such as Dawson's Cabin and Meier's Roadhouse do not appear to constitute major routes for the introduction of new, invasive non-native plants along the Gulkana. The fish-counting tower is more likely to contain seedbanks of invasive plant propagules due to its high use during the growing season; however, if the soil is not disturbed, it is probably less of a problem than the two campgrounds.

More critically, the introduction of non-native plant propagules through any of the above routes does not pose a major threat if the conditions that facilitate weed establishment and colonization are lacking. Non-native plant establishment in this and other remote regions

of Alaska is primarily driven by the availability of bare mineral soil (Flagstad and Cortés-Burns 2010, Cortés-Burns and Carlson 2006a, b). Therefore, best management practices should aim to mitigate human activities resulting in soil disturbance as well as prevent propagule introductions.

Finally, based on the results and conclusions presented in this report, we recommend that BLM adopt the following weed management and prevention actions:

- *Monitor the two campgrounds regularly* (annually to bi-annually) for the early detection of new invasive plant species (if any) to prevent their spread along the corridor (this could be done in conjunction with other river maintenance tasks, for e.g., by the BLM river crews)
- Eradicate or contain high priority infestations at the two campgrounds
- *Avoid and minimize exposing the mineral layer* of the soil through human activity, and *monitor sites where mineral soil has been exposed* (either through natural disturbances like erosion and flooding or through human activities like the removal of old structures, tree cutting, burning, or construction of new cabins) to detect and eradicate any new non-native plants
- Continue to *train BLM river crews and campground managers in non-native plant identification*, to increase the chances of spotting new infestations before they spread
- *Educate visitors (mushers, snow-machiners, boaters, and ATV users) about invasive plants*. For instance, encourage users to *thoroughly clean* their footwear, clothing, equipment, and machines prior to beginning their activities. Also, include information on invasive plants in the Gulkana NWSR Floater's Guide (BLM 2008) could aid early detection and rapid response efforts.]
- Recommend or require *weed-free, Alaska-grown straw* for the Copper River Basin sled dog race
- Require that construction projects use gravel from *weed-free gravel pits* in construction projects, when this becomes commercially available. [Gravel transport can be an important intrastate vector of invasive plant propagules such as seeds and rhizomes. In cooperation with the Bureau of Land Management, the Department of Natural Resources-Plant Materials Center plans to inventory existing BLM pits, and develop a weed free gravel certification program based on national standards.]

Non-native plants recorded along the Delta

Overview

Between July 25th and 28th 2008 AKNHP botanist Helen Cortés-Burns, with the assistance of AKNHP research technician and rafter Jeff Jessen, conducted a non-native plant inventory along the Delta NWSR corridor. Surveys started at the Upper Tangle Lake boat ramp and concluded at Mile 212.5 of the Richardson Highway, covering a total distance of 20 miles. In all, 31 temporary plots were read in 2008 (Figure 37).

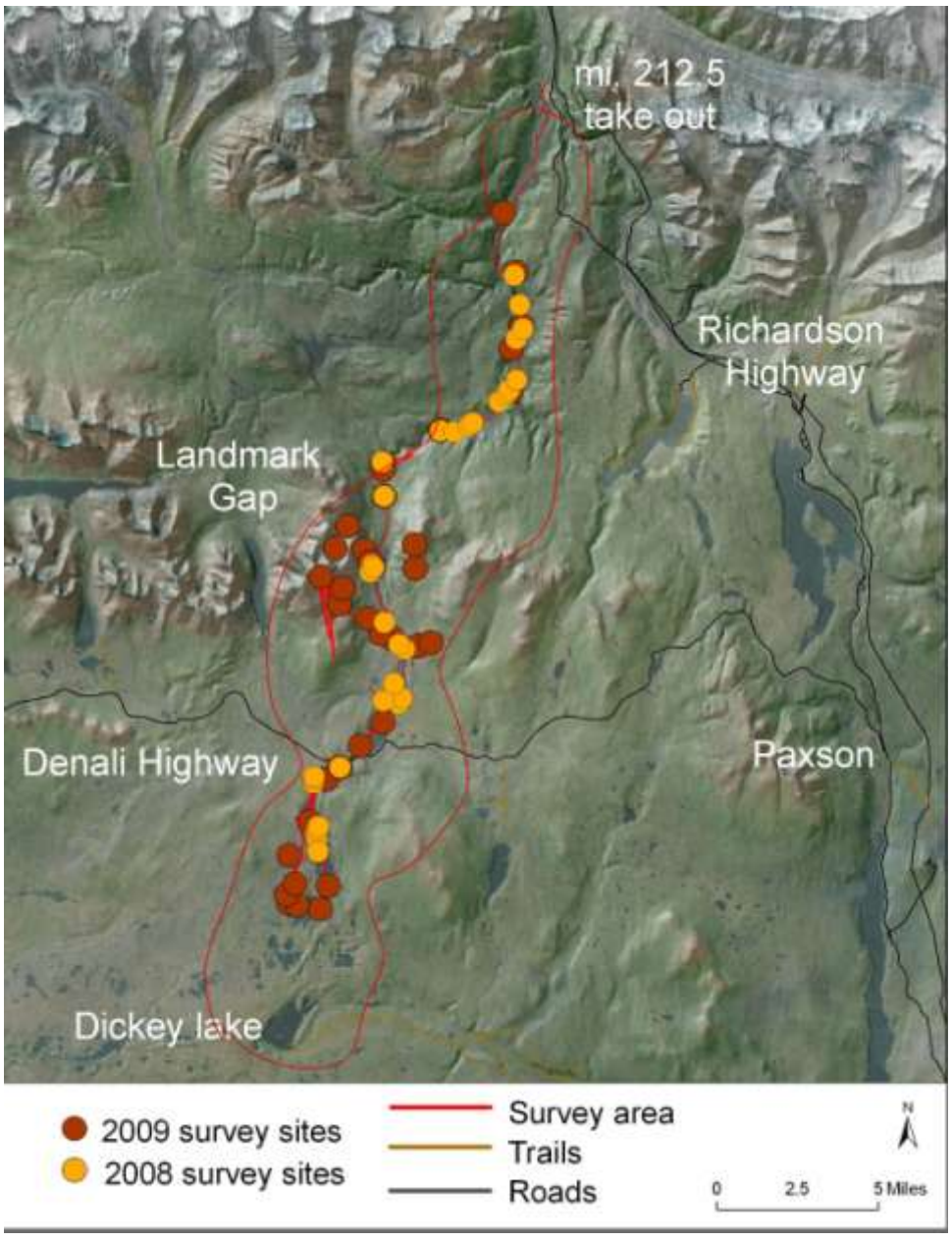

Figure 37. Survey area and plots read along the Delta NWSR in 2008 and 2009.

In 2009 AKNHP revisited the Delta NWSR corridor, including Tangle Lakes, to conduct rare plant surveys. Surveys were carried out in two phases: Dr. Matt Carlson (AKNHP Program botanist) and botanist Matt Blakeley-Smith scouted the area around Tangle Lakes between July 24 and 27; AKNHP ecologist Tina Boucher and botanist Helen Cortés-Burns surveyed the rest of the Delta River to Mile 212.5 from 3-6 August, putting in at Round Lake. The first team read detailed plots at 21 locations in/around Tangle Lakes, while the second team read a total of 15 plots. Both teams read some plots in sites that had already been surveyed in 2008. Sites revisited in 2009 were: Upper Tangle Lake boat ramp; portage trail in Upper Tangle Lake from camp #15 to #25 (including #17); campsite #47 at the end of the fall's portage trail; campsites #50, 55, and 59-60; and Krebs' old cabin site.

Non-native plant populations recorded

Upper Tangle Lake

Upper Tangle Lake wayside and boat ramp

Five weakly invasive species were recorded in and around the Upper Tangle boat ramp on compacted gravel: *Matricaria discoidea* (32, pineapple weed), *Plantago major* (44, prostrate knotweed), *Poa annua* (annual bluegrass, 46), *Stellaria media* (42, common chickweed), and *Taraxacum officinale* ssp*. officinale* (58, common dandelion). AKNHP crews recorded all of these species in 2008 and 2009 except for *Taraxacum officinale* ssp. *officinale*, which was only documented (in trace amounts) in 2008.

Figure 38. Upper Tangles boat ramp (left) and infestations (*Matricaria discoidea, Poa annu*a; right).

In addition, **no non-native plants** were found when conducting an informal survey of the **road** section between Tangle Lakes River Inn and the Upper Tangle boat ramp in 2008.

Portage trail from camp #15 to #25

AKNHP crews surveyed the portage trail between lakes in 2008 and in 2009. At the start of the portage trail, which is **near camp #17**, there were a few, very discrete populations of non-native plants growing in compacted glacial till.

In both years small infestations of *Poa annua* were documented. In addition, one stem of *Taraxacum officinale* ssp*. officinale* was found in 2008. The plant was dug out, and no stems were found in 2009. Also, small amounts (5% cover) of *Matricaria discoidea* were detected in 2009, but not in 2008.

At the **other end of the trail**, near **camp #14,** *Polygonum* cf. *aviculare* was detected in trace amounts, growing in the largely (80%) unvegetated sand and gravel beach by the lake.

Figure 40. Start of portage trail in Upper Tangle Lakes.

Figure 39. End of portage trail in Upper Tangle Lakes.

Round Tangle Lake

In 2009 AKNHP botanists surveyed the Round Tangle Lake **campground** and **boat launch**. A small infestation (<50 stems) of *Hordeum jubatum* (63, foxtail barley) was recorded at the boat launch site, growing in imported gravel. We also recorded the presence of a few *Polygonum* cf. *aviculare* stems both at the boat launch and at the water pump uphill of the ramp.

Figure 41. Boat ramp and water pump surveyed at Round Tangle Lake (left, center). *Polygonum aviculare* plant (right).

Long and Lower Tangle Lakes

No invasive plants were recorded at any of the campsites and areas surveyed in the Long and Lower Tangle Lakes.

Falls portage trail and camps

The portage trail around the falls was surveyed in 2008 and 2009. No invasive plants were detected in the first year, but most of the trail and the take out and put in beaches on either side of it were flooded in 2008. In 2009, which was a much drier season, the **beach** at the end of the portage trail was exposed. One stem of *Plantago major* (44, common plantain) and two of *Poa* cf. *annua* (46, annual bluegrass) were detected here. All three plants were dug out and bagged.

Figure 42. The beach at the end of the portage trail: flooded (2008, left) and dry (2009, right).

Delta NWSR

The first infestation recorded along the Delta River after the waterfalls was at **campsite #50**. This camp is situated in a white spruce forest clearing, and was accessed from a rock and gravel beach.

In 2008 water levels were so high that most of the rock-gravel landing was under water. We did, nonetheless, find and remove an immature basal rosette that closely resembled a *Taraxacum officinale* ssp. *officinale* plant. However, a final determination cannot be made without a flowering or fruiting specimen. We also found a few, scattered individuals of *Poa* cf. *annua* (tentative identification), all of which were hand pulled and removed.

In 2009 we surveyed the camping area and the beach exhaustively. The only species recorded, however, was *Poa* cf. *annua* (c. 600 stems), which was again restricted to the rock-gravel beach. The camping area itself (white spruce forest clearing, ground cover mainly leaf litter and duff) was weed-free.

Figure 43. *Poa annua* was growing on the rock-gravel beach at campsite #50 (2008, left; 2009, right).

Further downstream, at **campsites 53** (or #0, surveyed in 2008) and **55** (surveyed in 2008 and 2009), we observed small infestations of *Poa* cf. *annua*. Because the specimens collected were in poor condition we were unable to make a final determination. In both cases, the campsites were set in a white spruce forest with a low willow understory, the ground was dominated by gravel and leaf litter, and the grass was found growing around the camps' fire rings.

Figure 44. Camps #53 (left) and 55 (right) in 2008.

The next site at which non-native plants were found was **Kreb's Cabin**. We surveyed this site in 2008 but most of the ground was covered with snow at that point, and no non-native weeds were observed. In 2009 we revisited the site and recorded large infestations of *Taraxacum officinale* ssp. *officinale* (1,000 stems) as well as of *Poa annua* (750 stems). Both species were growing along the trail that extends from the river through a clearing in the

woods to the old cabin site. This site had the biggest amount of acres infested within the entire survey area (including Tangle Lakes). The *Taraxacum officinale* ssp. *officinale* population was especially large, covering at least one acre of land. Although we conducted some control work at this site in 2009 (hand pulling and digging common dandelion plants) we estimate it would take one person 2-3 days to completely pull all the plants at this site.

Figure 45. The trails and clear-cuts around Kreb's Cabin camp support a large infestation of *Taraxacum officinale* ssp. *officinale*.

The last two campsites at which non-native plants were recorded were **camps 59** and **60**. *Poa* cf. *annua* was detected along the ATV trail that runs parallel to the river at this point in both 2008 and 2009. In 2009 we also recorded the only infestation of *Chenopodium album* (37, lambsquarters) found in the entire survey: a single stem of this plant was growing in silt and sand that had accumulated on the floor of a boat that had been abandoned there earlier in the summer. We removed and bagged the stem. This finding emphasizes the role that boats and people can and do play in the introduction and dispersal of invasive plants across the state.

Figure 46. ATV trail (left), camp (middle), and stem of *Chenopodium album* growing in an abandoned boat at campsites 59-60.

Finally, at the take out point (**Mile 212.5 of the Richardson Highway**) we found a medium sized (100 stems) infestation of *Hordeum jubatum* (63, foxtail barley) growing along the portion of the dirt road closest to the highway. These plants were only observed in 2009, as the ground was partially flooded and the vegetation was covered with snow on the last day of our float trip in 2008.

Conclusions and recommendations for the Delta NWSR

The Delta NWSR corridor remains largely weed-free, and the few infestations that exist were discrete and belong to weakly invasive species or species that are very widespread in Alaska for which eradication is no longer a realistic goal.

The majority of sites visited **in 2008 (77%) were weed free**: only 7 of the 31 plots contained one or more populations of non-native plant species. Of the 21 plots read by the first team in 2009 only 10% (2) had non-native plants. Both plots, however, had already been visited in 2008 and the same infestations had been recorded. In contrast, of the 15 plots read by Tina Boucher and Helen Cortés-Burns in 2009, almost 50% (7) had non-native plants: one of these was located at Round Tangle Lake while the remaining six (6) were downriver of the Portage Trail.

In all, between **2008 and 2009 61** sites were visited by AKNHP crews. While the majority of sites (**85%**) were **weed-free**, 9 plots (located at boat ramps, campsites, and portage trails) supported non-native plant populations belonging to one of the **eight (8) weakly to modestly invasive weeds** recorded in the survey area (listed in Table 26).

Table 26.Frequency of occurrence of non-native plant species recorded along the Delta River.

Scientific name	Common name	Family name	Invasive-ness Rank‡	Frequency of occurrence†
Poa annua	annual bluegrass	Poaceae	46	0.13115
Taraxacum officinale ssp. officinale	common dandelion	Asteraceae	58	0.06557
Hordeum jubatum	foxtail barley	Poaceae	63	0.03279
Polygonum aviculare	prostrate knotweed	Polygonaceae	45	0.03279
Plantago major	common plantain	Plantaginaceae	44	0.03279
Matricaria discoidea	pineapple weed	Asteraceae	32	0.03279
Stellaria media	common chickweed	Caryophyllaceae	42	0.00002
Chenopodium album	lambsquarters	Chenopodiaceae	37	0.00002

‡ Invasiveness Rank refers to the points assigned to a given species by the Invasiveness Ranking System for Non-native Plants of Alaska (Carlson *et al.* 2008). Species are ranked on a scale of 0 to 100, with 100 being an extremely invasive species.
† Calculated as the number of sites infested with a given non-native species divided by the 61 sites surveyed (includes 2008 and 2009 survey data).

Problematic areas and infestations

Most non-native plant species recorded along the Delta River are common to high use areas in remote Alaska, and pose a low threat to the integrity of the surrounding native plant communities. The only species that has the potential of being strongly invasive (ranked greater than 60 points) recorded along the Delta River was *Hordeum jubatum*. However, as described later in this report (see "Species whose non-nativeness is questionable"), it is unclear whether or not *Hordeum jubatum* is indigenous to Alaska, and it is included in this report primarily because it is a nuisance weed for dogs and cattle, rather than because of its impacts on native plant communities. The remaining seven (7) species are considered

weakly to modestly invasive (rank values lower than 59 points) and are widespread across the state. They are found frequently in disturbed areas but have not yet been observed spreading beyond the anthropogenic footprint (Table 26).

Although none of the species found pose an immediate threat to the health of the corridor's ecosystems, we recommend, if time and funding allows, controlling the infestations at the **boat ramps** and at **Krebs Cabin**. The overall management goal for this area, however, should be to **prevent** future introductions as well as the further spread of the existing small infestations throughout the river corridor by monitoring weed-free sites and extirpating any new, small infestations that may appear. In particular, we strongly suggest that the **put in sites**, the **falls' portage trail** (which was going to be redone at the end of 2009), and the **largest campgrounds** (e.g. camp # 50) be monitored every one to two years by BLM river crews to detect and quickly control any new species that may have been introduced. Finally, the presence of a *Chenopodium album* plant growing in silty soil at the base of an abandoned boat demonstrates that human activities are a primary vector for the introduction and spread of invasive plants along the river corridor. To effectively limit the impacts of recreational activities on this river's ecosystem function and integrity, long term monitoring and public education will be needed.

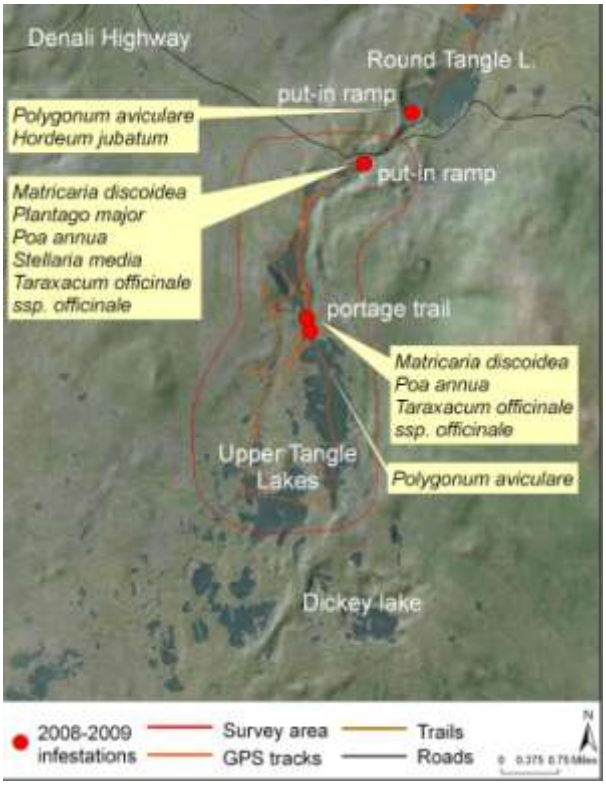

Figure 47 Non-native plant infestations recorded in Upper and Round Tangle Lakes.

Figure 48 Non-native plants recorded along the Delta River corridor.

Weed management recommendations

Best management practices should aim to mitigate human activities resulting in soil disturbance as well as prevent propagule introductions. Based on the findings from our surveys along the Delta NWSR, we recommend that BLM adopt the following weed management and prevention actions:

- *Minimize weed propagule introduction* by monitoring high-use campground and any road-accessible points within the area surveyed (e.g.: Upper and Round Tangles boat ramps), and *eradicate* or *contain* all new or else highly invasive infestations
- *Avoid and minimize exposing the mineral layer* of the soil through human activity (maintenance and construction work on the fall's portage trail, removal of old structures, controlled burns, tree cutting, etc.) and *monitor sites where mineral soil is exposed* to detect and eradicate any invasive plants that might have been introduced
- Continue to *train BLM river crews and campground managers in non-native plant identification*, to increase the chances of spotting new infestations before they spread
- *Educate visitors (boaters, ATV users) about invasive plants*. [For instance, by including informational brochures on invasive plants in information kiosks at all major boat ramps. Encourage users to clean their footwear, clothing, and gear prior to using the Delta NWSR.]
- Require that construction projects use gravel from *weed-free gravel pits* in construction projects (once it becomes commercially available). [Gravel transport can be an important intrastate vector of invasive plant propagules such as seeds and rhizomes. In cooperation with the Bureau of Land Management, the Department of Natural Resources-Plant Materials Center plans to inventory existing BLM pits, and develop a weed free gravel certification program based on national standards]

Species factsheets

The following provides brief descriptions of the biology, ecological impact, local distribution and appropriate control methods for non-native species of concern encountered in this study. Species rejected from consideration and taxonomic concerns are also discussed. More detailed biographies can be found for ranked non-native species at the AKEPIC website (http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm) and, for selected non-native species, in the Invasive Plants of Alaska field guide (Carlson *et al.* 2005). The mechanical and chemical control recommendations presented are based on management practices shown to be effective in similar ecogeographic regions and on invasive species control research conducted in Alaska.

Species bios and control recommendations

Alopecurus pratensis (meadow foxtail, NR)

Species biography

Alopecurus pratensis is a perennial grass with a compact, oblong panicle. It is distinguished from other *Alopecurus* species by its upright habit and long-exerted awns. It is distinguished from also non-native *Phleum pretense* (common timothy, 54) by the location of its awns; *Alopecurus pratensis* is awned from its lemmas whereas *Phleum pretense* is awned from its glumes.

Figure 49. *Alopecurus pratensis* © 2005 Steve Matson

Alopecurus pratensis was introduced from Europe and has been widely cultivated in North America for hay and pasture since the 1800s. In remote Alaska, its occurrence is strongly associated with cabins and homesteads (Cortés-Burns and Carlson 2006a). *Alopecurus pratensis* is not expected spread beyond human- or naturally disturbed areas or to persist in absence of regular disturbance.

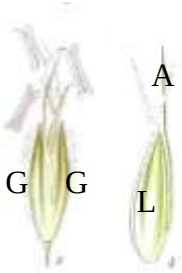

Figure 50. Awn (A), lemma (L) and glumes (G) from *A. pratensis*. The floret on the right has been removed from the spikelet ,- image from Linderman's 1906 *Bilder av Nordens Flora*

Control methods and management recommendations

Meadow foxtail was only recorded at Meier's Roadhouse campsite (Gulkana NWSR). Given its low aggressiveness in the Lower 48 states and Canada, and the restriction of this species to high-use areas or early-successional habitats in Alaska, we do not suggest this species be prioritized for control work. If time and funding allows, populations could be hand-pulled at Meier's Roadhouse Camp.

Brassica napus (rapeseed mustard or rutabaga, NR)

Species biography

Brassica napus is a yellow-flowered mustard with clasping upper stem leaves. This species is mainly distinguished from also non-native *Brassica rapa* (birdsrape or turnip, NR) by its flowers: **buds overtop or equal** open flowers, and **petals** are golden to **creamy or pale yellow**, **large**, and broadly egg-shaped (10-16 mm long x 6-9 mm wide). In comparison, *Brassica rapa* has **flowers that, when open, overtop or equal** buds, and petals that are **deep yellow** to yellow, **smaller and narrower** (on average, 6-11 mm long x 3-6 mm wide). Globally, *Brassica napus* is an important oil (rapeseed or canola oil) and vegetable crop (rutabaga) that easily escapes cultivation. In temperate North America, it is a widespread and naturalized weed (Warwick 1997).

Figure 51. *Brassica rapa* © Steve Dewey, Utah State University, Bugwood.org

Control and management recommendations

A small infestation of wild mustard was detected in the roadside ditch by the boat ramp at Sourdough Creek Campground (Gulkana NWSR). Most wild mustard infestations recorded in south central and interior Alaska have been small and discrete. By extirpating populations at this manageable stage we can prevent *Brassica napus* from potentially becoming a common weed of disturbed sites. *Brassica napus* is primarily recognized as a crop and as such, little research exists on the invasive potential of this species. To prevent upstream dispersal of this species, we recommend that the populations of *Brassica napus* at the Sourdough Campground be hand-pulled and that the surrounding area be monitored for reestablishment or further dispersal.

Bromus inermis ssp. *inermis* (smooth brome, 62)

Species biography

Bromus inermis ssp. *inermis* was introduced from Europe to the United States in the late 1800s as a forage grass and for hay production. In Alaska, it has been used as a planting for erosion control, specifically along the Trans-Alaska Pipeline, and is also a contaminant in topsoil (Densmore *et al.* 2001). This grass reproduces by rhizomes (horizontal belowground stems) and seed, with seeds remaining viable in the soil for up to10 years (AKEPIC 2005). In Alaska it forms dense stands that exclude native species and consequently may inhibit natural successional processes (AKEPIC 2005, Cortés-Burns pers. obs.).

Figure 52. *Bromus inermis* ssp. *inermis.* © Jim Pisarowicz, National Park Service

The non-native subspecies *Bromus inermis* ssp. *inermis* is differentiated from the native subspecies *Bromus inermis* ssp.

pumpellianus by its short awn (absent or less than 3 mm; Royer and Dickinson 1999) and by its glabrous to faintly hairy stem, leaves and lemmas. In comparison, *Bromus inermis* ssp. *pumpellianus* has distinctly hairy lemmas (pubescent to villous), as well as pubescent stem nodes and leaf blades, and the awns are 1-6 mm long (Butterfield *et al.* 1996, Hultén 1968). *Bromus tectorum* (cheatgrass, 78) is also non-native to Alaska but is distinguished from *Bromus inermis* ssp. *inermis* by its long (10-30 mm) awns.

Control and management recommendations

The only smooth brome infestation found was growing along the sides of the road leading to the Sourdough Creek campground boat ramp. We recommend that this infestation be eradicated or at least contained to prevent further upstream dispersal. Areas proximal to the Trans-Alaska Pipeline should be monitored for establishment of this highly invasive grass. At a minimum control work should focus on containing existing infestations by preventing plants from going to seed. Populations should be mowed, cut, or hand weeded before the inflorescence can be felt at the top of the elongating stem. Mowing monthly during the growing season over a four-year period can greatly reduce the persistence of *Bromus inermis* ssp. *inermis* (Marten and Hovin 1980).

Table 27. Control recommendations for *Bromus inermis* ssp. *inermis* in Alaska (Seefeldt unpubl.)

Bromus inermis* ssp. *inermis	**Human-disturbed, naturally-disturbed, and unaltered sites**
Small infestation	• Hand weed and cut before the inflorescence appears • Repeat monthly during the growing season for up to 4 years
Large infestation	• Cut or mow before the inflorescences appear • Repeat monthly during the growing season for up to 4 years

Capsella bursa-pastoris (shepherd's purse, 40)

Species biography

Capsella bursa-pastoris is an annual to biennial forb that originates from Europe and is considered a weakly invasive weed across much of North America. Shepherd's purse has four small, white, undivided petals, and four green sepals half the length of the petals; the fruit pod is very distinct, consisting of greenish-brown heart-shaped capsules (6-9 mm long) on long stalks. The plant arises from a basal rosette of entire to deeply lobed leaves; stem leaves are stalkless, arrow-shaped and toothed, and have ear-like projections clasping the stem. The leaves, even on small seedlings, have scattered, star-shaped hairs, visible with a hand lens. Shepherd's purse is a pioneer colonizer of disturbed areas and will not persist more than for 2-5 years unless the site is repeatedly disturbed. *Capsella bursa-pastoris* reproduces from seed, with buried seeds shown to remain viable for at least 35 years (Baskin and Baskin 1998).

Figure 53. *Capsella bursa-pastoris* basal rosette and heart-shaped seed pod © Walter Obermayer

Control and management recommendations
Within the Gulkana NAWSR corridor, *Capsella bursa-pastoris* populations were found at Paxson Lake campground, at the remote campsites of TaK'ATS'NA Cove, French Meadow Camp #2, Meier's Roadhouse and Dawson's Cabin, and also at Sourdough Creek campground (growing in the roadside ditch by the boat ramp). It was not detected along the Delta NWSR corridor.

As plants can be easily pulled by hand (Densmore *et al.* 2001), we recommend controlling these infestations (if time and funding allows) and subsequently monitoring the controlled sites to detect its reestablishment and to prevent its spread.

Cerastium fontanum (mouse-ear chickweed, 36)

Species biography
Cerastium fontanum is introduced and common in most of Canada and the United States (Burke Museum of Natural History and Culture 2006). Stems and leaves are **distinctly hairy** (but mostly not gland-tipped), and leaves are arranged in pairs and opposite along the stem. The flower stalks are dichotomously branched, with 5 green, hairy sepals (**hairs do not exceed the tip** of the sepals) and 5 white, **bi-lobed petals**. There are generally 10 but can be 5 stamens per flower. *Cerastium fontanum* reproduces from rooting at the nodes and by seed; disturbance is necessary for establishment from seed (AKEPIC 2005).

Figure 54. *Cerastium fontanum* © Norman Hagen

Although all Alaska *Cerastium* species are characterized by having notched or two-lobed petals, *C. fontanum*'s **petals equal** the length of the **sepals** (1-1.5 times the sepals), while native *Cerastium* species have **petals longer than sepals**. There is another invasive *Cerastium* in Alaska, *Cerastium glomeratum* (sticky chickweed), which can be distinguished by the presence of (1) **gland—tipped** hairs on its stems and leaves, (2) **long white hairs** (as well as **glandular** hairs) on the sepals that extend beyond the tips of the sepals, and (3) petals that are deeply notched and are usually **shorter than the sepals**.

Control and management recommendations
Because this species was only recorded at Sourdough Creek campground, we recommend that this species be controlled by hand-pulling to prevent its spread along the river corridor.

Chenopodium album (lambsquarters, 37)

Species biography

Chenopodium album is a near-cosmopolitan weed that is thought to originate from Europe that is characterized by its often rhombic-oval to lance-shaped leaves that are green above and mealy-white below. The small, greenish flowers are clustered into dense panicles. Stems are branched and grooved. *Chenopodium album* is relatively distinct from most *Chenopodium* species but can only be differentiated from the native *C. berlandieri* by smooth (*C. album*) rather than pitted (*C. berlandieri*) seed coats. An individual plant can produce over 500,000 seeds and seeds remain viable in soil for up to 40 years (Royer and Dickinson 1999). This species has not been observed invading native plant communities in Alaska and is not expected to persist more than three years in sites that are not regularly disturbed (Densmore *et al.* 2001).

Figure 55. *Chenopodium album*'s grooved stems, rhombic leaves, and white mealy texture © Steve Matson

Control and management recommendations

The only established population of this species was found at Sourdough Creek campground (Gulkana NWSR). On the Delta NWSR a single stem was found (and pulled) in the floor of an abandoned boat by camp #59-60. We recommend that the Sourdough campground infestation be controlled to prevent its dispersal upstream. This species is reportedly unable to withstand clipping, and cutting plants during early stages of growth will provide good control (US Forest Service Pacific Islands Ecosystems at Risk 2010).

Crepis tectorum (narrowleaf hawksbeard, 54)

Species biography

Crepis tectorum is a yellow-flowered member of the sunflower family. It originates from Europe and is listed as a noxious weed in some states and provinces (Bogler 2006).

Crepis species in Alaska can be distinguished from many other yellow-flowered asters by the presence of leaves on the stem, lack of prickles on the leaf margins, and by having ray flowers only.

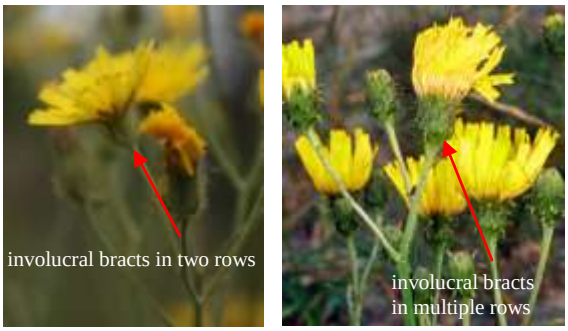

Figure 56. *Crepis tectorum* (left) and *Hieracium umbellatum* (right) © AKNHP

This genus closely resembles the also invasive *Hieracium umbellatum* (narrowleaf hawkweed), but while *Crepis tectorum* has green involucral bracts arranged in two distinct

rows, *Hieracium umbellatum* has dark green to black involucral bracts of variable lengths (Bogler 2006; Figure 56).

Crepis tectorum is a yellow, ray-flower only annual that can grow 1 to 3 feet tall, has a basal rosette of leaves as well as leaves clasping at the stem, and its involucral bracts are **hairy on the inside**. Native species of *Crepis* (*Crepis nana* and *Crepis elegans*) are more slender than *C. tectorum*, and the involucral bracts are **not hairy on the inside**.

Crepis tectorum only reproduces by **seed**, but each plant is capable of producing over 49,000 seeds (Royer and Dickinson 1999), which allows this species to rapidly colonize disturbed and open areas. Although it is most commonly found along roadsides and in waste areas, *Crepis tectorum* is increasingly found invading native plant communities in remote locations. In Anchorage, this species has been found growing in relatively undisturbed parts of the Chugach foothills (Cortés-Burns *et al.,* pers. obs.). In interior Alaska, *Crepis tectorum* is one of two non-native plants that invaded burned areas along the Dalton Highway (Cortés-Burns *et al.* 2008). It was also observed growing in a native fireweed-Canada bluejoint meadow at Rohn Cabin, on the Iditarod Trail (Flagstad and Cortés-Burns 2010).

Control and management recommendations

Due to its aggressive nature and absence from sites upstream of Sourdough Creek Camp, we recommend that *Crepis tectorum* populations at Sourdough Creek campground be eradicated. Fairbanks-based Agricultural Research Station weed scientist Seefeldt (unpubl.) suggests that small populations (less than 50 stems) of *Crepis tectorum* growing on human-disturbed sites, such as those at the Sourdough campground, can be removed by repeated cycles of hand-pulling. As plants can resprout easily from the caudex (underground woody stem), the entire plant must be removed prior to seed set. All plants should be bagged and removed from the site to prevent further dispersal. Because seedlings are hard to find and difficult to pull by hand, large (more than 50 stems) or persistent (those not reduced after one year of hand-pulling) populations of *Crepis tectorum* are best controlled using chemical methods (Table 28). Depending on the control method implemented, sites should be monitored for one to three years to confirm that no new plants have established; the area within at least a 200-meter radius and any disturbed areas within 0.8 km should be scouted for new plants (Seefeldt unpubl.).

Table 28. Control recommendations for *Crepis tectorum* in Alaska (Seefeldt unpubl.)

Crepis tectorum	**Human-disturbed site (*e.g.* material source areas)**	**Naturally-disturbed and unaltered sites**
Small infestation	• Hand pull, including underground parts • Bag and remove plants • Monitor for 1 year, if unsuccessful, start herbicide application	• Hand pull, including underground parts • Bag and remove plants • Monitor for 3+ years
Large infestation	• Herbicide application • Monitor annually for 3+ years	

Melilotus alba (white sweetclover, 81)

Species biography

Melilotus alba is a short-lived, generally biennial forb with white, fragrant flowers that grows two to five feet tall. Leaves are trifoliate with a toothed margin extending two-thirds down the leaflet margin. *Melilotus alba* is distinct from most other trifoliate legumes in Alaska. It is separated from *Melilotus officinalis* by flower color; *M. alba* is white-flowered and with much smaller flowers, whereas *M. officinalis* is yellow and large-flowered.

Figure 57. *Melilotus alba* © Trevor Roberts, AKNHP

Melilotus alba is arguably the most invasive and rapidly spreading non-native species in Alaska. It readily establishes and often proliferates to monoculture in disturbed, fine-grained mineral soils typical of roadsides, trails and river bars. The affinity of *Melilotus alba* for these environments is of special concern as they often act as dispersal corridors.

This species is notoriously difficult to eradicate because it produces copious seed (up to 350,000 per plant) that are easily dispersed by wind and remain viable in the soil for many decades (Rutledge and McLendon 1996).

It has been observed moving off roadsides into native vegetation along the Dalton Highway (Cortés-Burns *et al.* 2008) and is quickly spreading along glacial river gravel bars in southeast (Stikine River) and interior (Nenana) Alaska (see Conn *et al.* 2008, AKEPIC Database 2009). Because *Melilotus* spp. prefers alkaline soils, and river floodplains in early successional stages have basic soils, early seral communities at these sites are susceptible to invasion (Conn *et al.* 2008). However, plants will reach reproductive maturity in low pH, highly organic substrates (Rzeczcki unpubl. data).

Furthermore, recent experimental studies have found that there is 50% greater mortality of native seedlings at floodplain sites with white sweetclover than those that are sweetclover-free (Spellman 2008). It seems likely that once established this species reduces the diversity of native plant communities by overtopping and shading native vegetation.

Finally, as a member of the pea family, *Melilotus alba* is able to fix atmospheric nitrogen; this likely alters the soil nutrient status and favor the establishment of other weedy species, which are often nitrophilic.

Figure 58. *Melilotus alba* infestation along the Dalton Highway © Matthew Carlson

Figure 59. *Melilotus alba* infestation along the Stikine River © Michael Shephard

Control and management recommendations

Eradication of *Melilotus alba* from the Sourdough Creek Campground is the highest control priority for the Gulkana River. This species is extremely invasive, known to spread along river corridors and at the time of survey was not yet observed upstream of Sourdough Creek. We recommend that plants at Sourdough Creek be hand-pulled early in the season when the soil is moist and plants have not yet flowered. [Flowering typically occurs in June or early July (Seefeldt unpubl., Carlson pers. obs.). Hand-pulling can disturb the soil, which may result in another flush of plants. For this reason controlled sites should be revisited every other week. At a minimum, a second session of hand-pulling is recommended in the fall (Cole 1991). All plant parts must be removed and bagged. Long-term control programs are necessary to guarantee that the seedbank is depleted (Densmore *et al.* 2001).

Table 29. Control recommendations for *Melilotus alba* in Alaska (Seefeldt unpubl.).

Human-disturbed site	Naturally-disturbed and unaltered sites
1. **Small populations and infestations near waterways**: • Hand pull, roots included, when soil is moist and before flowering (June). Revisit every 2 weeks. Additional pull in the Fall **2. Medium to large populations that are not close to waterways:** • Spray infestation + 50 ft radius with selected chemical (different herbicides for different types of habitat/location) • Monitor annually	**1. Infestations growing near waterways or >150 ft from human-altered sites:** • Hand pull, roots included, when soil is moist and before flowering (June). Revisit every 2 weeks. Additional pulls may also be conducted in the Fall **2. Infestations growing on naturally disturbed sites, <150 ft from human altered sites, and not near waterways:** • Spray infestation + 20 ft radius with Telar • Monitor annually

Stellaria media (common chickweed, 42)

Species biography

Stellaria media is a cosmopolitan weed. It is an annual trailing forb, and its stems, which can root at the nodes, have a diagnostic line of white hairs. *Stellaria media*'s **lower leaves are stalked**, while all **native** *Stellaria* species have **sessile** upper and lower leaves. *Stellaria* species can be separated from *Cerastium* species (see *Cerastium fontanum*, this section) because their petals are deeply notched, almost to the base, so that there seem to be 10 instead of 5 petals (while in *Cerastium* the petals are lobed but not to the base).

Figure 61. *Stellaria media*'s diagnostic line of hairs on stem © *www.missouriplants.com*

Figure 60. *Stellaria media* showing deeply cleft petals © *www.missouriplants.com*

Control and management recommendations

This species is fairly widespread across the state, but generally restricted to human-disturbed sites. Because there was only one infestation of common chickweed on the Gulkana NWSR (Meier's Roadhouse), and one in the Delta River study area (Upper Tangle Lakes boat ramp), we suggest hand-pulling the plants to prevent their further dispersal, if time and funding permits.

Trifolium hybridum (alsike clover, 57)

Species biography

Trifolium hybridum is an upright clover with pinkish to white globular flower clusters. Stems are six to 20 inches tall and do **not root at the nodes;** leaves are trifoliate, a diagnostic trait for this genus. Alsike clover reproduces by seed only, but seeds can remain viable in the soil for more than 3 years (AKEPIC 2005).

Figure 62. *Trifolium hybridum* © Trevor Roberts, AKNHP

This species, as many members of the Fabaceae plant family (pea family), has nitrogen-fixing abilities and can therefore alter ecosystem processes by affecting the chemical composition of the soils it colonizes. It is also an effective colonizer of unvegetated ground, and appears to delay natural succession by native plants (Rutledge and McLendon 1996). However, nodulation (the symbiotic relationship whereby bacteria associated with the legume nodules can fix atmospheric nitrogen) is frequently negatively affected by one or more of the deficiencies or toxicities

commonly associated with acid soils (Cregan 1981). The low pH in much of Interior Alaska's soils, and the high sensitivity of clovers (*Trifolium* spp.) to acid soil conditions (Cregan 1981) may help explain why this species' distribution in the state is limited to areas of human disturbance and has not been observed spreading into (burned or unburned) native vegetation (e.g. Cortés-Burns and Carlson 2006a, b; Cortés-Burns *et al*. 2007, 2008).

Control and management recommendations

The only alsike clover infestation recorded was located by the boat ramp at Sourdough Creek Campground (Gulkana NWSR). We suggest containing or extirpating this population by digging the plants up in their entirety (including below ground parts) or by cutting at ground level to prevent regeneration from adventitious buds (Seefeldt, pers. comm.). Because this species reproduces by seed, all control work must be done at the beginning of the flowering period, to prevent seed set. It is advised that the combination of digging/cutting and monitoring work be repeated for at least four to five years, to detect and extirpate any new individuals arising from the seed bank.

There are herbicides that kill alsike clover, but given the risk of off-target impacts, mechanical methods should still be considered (Seefeldt, pers. comm.), especially given that only one infestation was recorded.

Trifolium repens (white clover, 59)

Species biography

Trifolium repens is a decumbent clover with white to pink-flowers. Stems are creeping and root at the nodes. Leaflets often have V-shaped marks. White clover reproduces by **seeds and creeping stems** (rhizomes) that root at the nodes. 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).

Figure 63. *Trifolium repens* creeping habit and V-shaped marks on leaves © *www.missouriplants.com*

Like alsike clover, red and white clovers increase soil nitrogen levels by fixing atmospheric nitrogen, and by altering edaphic conditions these species may have the ability to delay the establishment of native species (Rutledge and McLendon 1996). However, as noted in the previous section (*T. hybridum*), clovers are especially sensitive to low pH soils because the formation of nitrogen-fixing nodules is negatively affected by the mineral deficiencies associated with acid soils. This could partially explain why the alsike, red, and white clover infestations recorded were restricted to areas of human disturbance.

Control and management recommendations
White clover is particularly difficult to remove since it roots at each node. To prevent it from spreading into native vegetation or upstream, the infestation detected at Sourdough Creek campground should at least be contained by digging all individuals out, including underground parts to avoid resprouting, and the site should be monitored for new individuals coming up from the seed bank. It is especially critical that the extirpated plant fragments be bagged and removed from the site, as stem fragments can produce new, viable individuals (Seefeldt, pers. comm.). [National Park Service weed management crews have had some success pulling white clover mats up with a hoe or cultivator, even though this created significant soil disturbance and disruption of all neighboring plants (Rapp 2005).

Tripleurospermum inodorum (scentless false mayweed, 48)

Figure 64. *Tripleurospermum inodorum* © Trevor Roberts AKNHP

Species biography
Tripleurospermum inodorum originates from Europe and is an annual to biennial forb with daisy-like flowers. Leaves are finely divided into thread-like segments (Fig. 64) that are odorless when crushed.

Tripleurospermum inodorum can be separated from the native species *T. maritima* ssp. *phaeocephalum* by habitat and the color of its involucral bract margin. Native *Tripleurospermum maritima* ssp. *phaeocephalum* is restricted to the Bering and Beaufort Sea shores and has dark-brown involucral bract margins, whereas *T. inodorum* is a species of disturbed areas with light-brown involucral bract margins. *Tripleurospermum inodorum* is superficially similar to non-native *Anthemis cotula* (stinking chamomile, 41); however the latter's leaves produce a strong odor when crushed.

Tripleurospermum inodorum reproduces prolifically by seed, which remain viable for at least 15 years and can be dispersed by wind, water and drifting snow (Juras *et al.* 2004). In Alaska, this species is commonly found on human-disturbed mineral soils and it is likely being spread as a contaminant in gravel (Cortés-Burns *et al.* 2008).

Control and management recommendations
Scentless false mayweed was only recorded at the entrance to the Paxson lake campground. Given that it is able to invade natural habitats we recommend complete eradication of this infestation.

Because it produces so much seed, the first step in any management plan for this weed is to conduct the work prior to seed set. Small (<50 stems) infestations could be controlled and even eradicated by hand-pulling.

Mowing can be effective but (1) it must be carried out before the flowers are fully formed and (2) at least two mowings will be necessary per year. Unfortunately, scentless chamomile will form new flowers below the cutting height of mower in the leaf axils. Scentless chamomile needs to be mowed early and often, with each successive mowing lower than the previous one. However, repeated mowing can remove the forage competition and make the problem worse (Agrifacts 2007).

Low priority species

Taraxacum officinale ssp. *officinale* (common dandelion, 58)
Poa annua (annual bluegrass, 46)
Poa pratensis spp. *pratensis* (Kentucky bluegrass, 52)
Poa pratensis ssp. *irrigata* (spreading bluegrass, 52)

Taraxacum officinale ssp. *officinale, Poa annua, P. pratensis* ssp. *pratensis* and *Poa pratensis* ssp. *irrigata* are considered as low priorities for treatment for the following reasons. *Taraxacum officinale* ssp. *officinale, Poa annua* and the subspecies of *P. pratensis* are some of the most abundant and widely distributed non-native plant species present in Alaska. Because weed management is most efficient when directed towards species that are uncommon or present as small outlier populations, attempting to control well-established and large populations such as these would be an inefficient use of resources.

Figure 65. Involucral bracts are reflexed on the common dandelion (left), but erect on native ones (right).

Additionally, the *Poa pratensis* subspecies *P. pratensis* ssp. *pratensis* and ssp. *irrigata* are rejected from consideration due to: 1) the difficulty to separate the non-native subspecies (*P. pratensis* ssp. *pratensis*, *P. pratensis* ssp. *irrigata* and *P. pratensis* ssp. *colpodea*) from the native subspecies (*P. pratensis* ssp. *alpigena*) in the field, 2) the existence of multiple cultivated varieties present in Alaska, (*cf.* http://dnr.alaska.gov/ag/PMCwebsite/pmcweb/chapter5/5-bluegrass.htm#merion), and 3) the lack of knowledge on what subspecies the cultivars were derived from, or whether there is any potential for hybridization between the cultivated and wild taxa.

Species whose non-nativity is questionable:

The origin of the following three species recorded during the Delta and Gulkana river surveys is questionable: *Erysimum cheiranthoides, Lepidium densiflorum*, and *Hordeum jubatum.* None of these three species is able to invade native vegetation in Alaska (low invasiveness); consequently, we do not recommend that these species be prioritized for control.

The nativity of *Erysimum cheiranthoides* and *Hordeum jubatum* to Alaska is a matter of debate and requires taxonomic and phylogenetic work. *Erysimum cheiranthoides* is no longer tracked as a non-native species in Alaska (AKEPIC tracking list) and although we continue to track *Hordeum jubatum*, there is little consensus on the nativity of this species. Furthermore, neither of these species is particularly invasive. *Erysimum cheiranthoides* does not appear to spread beyond human- or naturally-disturbed areas and does not persist without regular disturbance. *Hordeum jubatum* is widely distributed in Alaska, but its moderately invasive rank is largely due to its categorization as a nuisance weed opposed to a species capable of invading natural plant communities. For these reasons, *Erysimum cheiranthoides* and *Hordeum jubatum* are not recommended for treatment in this report.

Erysimum cheiranthoides (wormseed wallflower)

Erysimum cheiranthoides is a yellow-flowered mustard with long siliques and entire leaves. Recent surveys suggest that it does not spread beyond human- or naturally-disturbed areas and does not persist without regular disturbance (Cortés-Burns and Carlson 2006 a, b).

Figure 66. *Erysimum cheiranthoides* .

Hultén (1968) divided *Erysimum cheiranthoides* into two subspecies: ssp. *cheiranthoides*, introduced from Europe, and ssp. *altum,* native to Alaska. Both have 3-forked hairs along their stems, leaves, and fruits (unlike the native species, which are chiefly covered by 2-prongued hairs) but the introduced subspecies is listed as an **annual** and having **5-10 nodes**, while the native subspecies is described as a **biennial** with **20-40 nodes** (Hultén 1968). Cody (1996), on the other hand, treats this species as a single entity in the Yukon Territory (*Erysimum cheiranthoides*) and considers that it is native. Based on the specimens we have collected in the field over the past five years across the state, we do not find that Hultén's (1968) differentiation holds. Furthermore, we find that Cody's *Flora of the Yukon Territory* (1996)

is often a more, up-to-date, pragmatic, and accurate guide to the plants of Interior Alaska than Hultén's (1968) *Flora of Alaska and Neighboring Territories*.

In addition, the occurrence of this species in remote areas of the Yukon Flats National Wildlife Refuge (Cortés-Burns and Carlson 2006a) and along the Iditarod Trail (Flagstad and Cortés-Burns 2010) leads us to conclude that the '*Erysimum cheiranthoides* ssp. *cheiranthoides-altum*' complex is most likely native to Alaska (and the two subspecies simply reflect different growth habits), and/or represents a melding of native and non-native genotypes. For these reasons populations found at Wickersham Bar, Tenas Pete Camp, and the Sourdough Creek Camp are not recommended for control.

Lepidium densiflorum (common pepperweed, 27)

Species biography

Although *Lepidium densiflorum* has been described as **native to North America** [to Canada by Cody (1996) and to North America by Al-Shehbaz and Gaskin (2010)], Hultén (1968) indicates that it is **introduced to Alaska** and indicates uncertainty over its nativity to North America. It is currently being tracked in AKEPIC. The early collections in Alaska appear to be associated with anthropogenically disturbed sites in eastern to central Alaska, such as railroad stations and towns. It can be recognized in the field by the dense arrangement of its seed pods, its green-white flowers, and a basal rosette of toothed leaves growing from a taproot. All other *Lepidium* species in Alaska are unquestionably introduced (Hultén 1968). *Lepidium densiflorum* can be distinguished from *L. sativum* by having only 2 stamens (6 in *L. sativum*) and narrowly winged seed pods (as opposed to broadly winged), and from *L. virginicum* by having no petals or else petals shorter than sepals (longer in *L. virginicum*).

Figure 67. *Lepidium densiflorum* © www.biomi.org

Control and management recommendations

This species was only recorded at Sourdough Creek campground. *Lepidium densiflorum* is easily pulled by hand but may require several control cycles to ensure that the seed bank in depleted (Densmore *et al.* 2001). We do not consider this species to be a top priority for control work.

Hordeum jubatum (foxtail barley, 63)

Hordeum jubatum is considered a nuisance weed as its barbed awns can burrow into an animal's mouth or skin causing infected sores (US Forest Service 1937). It is currently thought that there may be native and non-native genotypes of *Hordeum jubatum* in Alaska. Some authors believe that humans introduced this species to the arctic regions of the world

(Elven 2007) while others propose that it is native to our region (von Bothmer *et al.* 2007). It was present in Alaska at least by 1931 (Arctos Database) although it is difficult to tell if the few early collections were exclusively associated with human activity. The taxonomy of *Hordeum jubatum* is further complicated by the inability to distinguish native and non-native genotypes phenotypically. Also, hybridization may occur between genotypes, further blurring the distinction between these two (potential) taxa. Due to the taxonomic uncertainty surrounding *Hordeum jubatum*, populations at Wickersham Bar and Sourdough Creek Camp are not recommended for control.

Figure 68. *Hordeum jubatum* (close-up, left) is a contaminant of bedding straw used in dog-mushing races in Alaska (Iditarod Trail, right) © Trevor Roberts, AKNHP

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Appendix 1. Example field datasheet used for the 2008 Gulkana National Wild and Scenic River non-native plant survey

Gulkana NWSR Non-native Plant Survey

Plot #	Surveyors:		Date:	Landcover class name:
GPS used:		WP:		
Lat:		Elevation (ft):		
Long:		Error ±		Slope (0-100°):
Camera used:	Photos taken:			Aspect (0-360°): true magnetic
	Air Photo #			Plot Size: ______ x ______ (ft)

Vegetated	% Cover	Height (ft)	**Unvegetated**	% Cover	**Draw schematic below:**
Needleleaf			Litter, duff		
Broadleaf			Wood (>0.4")		
Tall shrub (>5 ft)			Silt (feel on tongue)		
Low (8" > 5 ft)			Sand (feel b/w fingers)		
Dwarf (<8")			Small rocks (gravel <3")		
Forb			Large rocks		
Grass			(cobbles 3-8", boulders >8")		
Sedge			Bedrock		
Moss			Trunks of trees		
Lichen			(basal area)		
Unvegetated			Other (describe):		
Water					
Other					

Biome:	**Hydrologic Regime:**	**Landform**
Alpine	Dry	
Subalpine	Mesic	
Forest	Wet	**Notes:**
Bog	Aquatic - FW	
Herb meadow	Aquatic - brackish	
Riparian	Aquatic - SW	

AKEPIC Site Info:

Area Surveyed ______ acres

Disturbance type ______

Species	% Cover	Height (ft)	collected?	**Species**	% Cover	Height (ft)	collected?

Appendix 2.

List of voucher specimens collected in 2008 along the Delta National Wild and Scenic River

Origin	Scientific name	Accession #	Collection Date	Locality	Latitude	Longitude	Elev.
Native	*Alopecurus aequalis*	1178	07/26/2008	Campsite 25	63.041920	-146.053390	882
Native	*Hierochloe alpina*	1179	07/26/2008	Campsite 28	63.069790	-145.961610	874
Native	*Rumex arcticus*	1169	07/25/2008	Campsite 23A	63.039470	-146.054320	877
Native	*Rorippa palustris* ssp. *palustris*	1168	07/25/2008	Campsite 23A	63.039470	-146.054320	877
Native	*Polemonium pulcherrimum*	1167	07/28/2008	Campsite 59/60	63.228690	-145.794110	793
Native	*Chamerion latifolium*	1166	07/25/2008	Campsite 23A	63.039470	-146.054320	877
Native	*Arnica angustifolia* ssp. *angustifolia*	1165	07/26/2008	Campsite 28	63.069790	-145.961610	874

List of voucher specimens collected in 2008 along the Gulkana National Wild and Scenic River

Origin	Scientific name	Accession #	Collection Date	Locality	Latitude	Longitude	Elev.
Non-native	*Alopecurus pratensis*	1164	08/16/2008	Meier's Roadhouse campsite	62.845630	-145.670030	763
Non-native	*Brassica napus*	1177	08/19/2008	Sourdough Creek Campground, boat ramp	62.526560	-145.524550	577
Non-native	*Capsella bursa-pastoris*	1171	08/16/2008	another campsite by French Meadow	62.847120	-145.669890	754
Non-native	*Crepis tectorum*	1173	08/19/2008	Sourdough Creek Campground, boat ramp	62.526560	-145.524550	577
Non-native	*Matricaria discoidea*	1172	08/16/2008	another campsite by French Meadow	62.847120	-145.669890	754
Non-native	*Poa annua*	1162	08/16/2008	another campsite by French Meadow	62.847120	-145.669890	754
Non-native	*Poa annua*	1331	08/17/2008	Caribou Island campsite, silty pebbly beach	62.788700	-145.635120	751
Non-native	*Poa pratensis* ssp. *pratensis*	1163	08/16/2008	TaK' ATS' NA' Cove campsite	62.856100	-145.615110	792
Non-native	*Poa pratensis* ssp. *pratensis*	1330	08/16/2008	Willow Run campground	62.854120	-145.631840	785
Non-native	*Polygonum aviculare*	1161	08/19/2008	Sourdough Creek Campground, boat ramp	62.526560	-145.524550	577
Non-native	*Stellaria media*	1160	08/16/2008	Meier's Roadhouse campsite	62.845630	-145.670030	763
Native	*Calamagrostis lapponica*	1170	08/16/2008	TaK' ATS' NA' Cove campsite	62.856100	-145.615110	792
Native	*Cardamine oligosperma* var. *kamtschatica*	1174	08/16/2008	Campsite by French Meadow	62.847120	-145.669890	754
Native	*Elymus alaskanus* ssp. *alaskanus*	1159	08/16/2008	Dawson's cabin campsite	62.839350	-145.666490	748
Native	*Limosella aquatica*	1176	08/19/2008	West Fork Confluence campsite, recently flooded bar	62.573540	-145.624930	593
Native	*Rumex salicifolius* var. *salicilifolius*	1175	08/19/2008	West Fork Confluence campsite, recently flooded bar	62.573540	-145.624930	593