Non-native Plant Survey of Constantine Metal Resources Palmer Project, Haines Alaska

Photo: Survey on new road construction access to mining site, Red Section.

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Introduction

The establishment, growth, and persistence of non-native plants pose a serious threat to the condition of natural ecosystems. Even though not all non-native species cause measurable ecological or economic harm, the spread of some non-native species (invasive species) is a primary cause of degradation to ecological systems worldwide. Invasive species threaten native biodiversity, plant community structure and composition, and ecosystem processes (Cronk and Fuller 1995, Walker and Smith 1997, Stein et al. 2000). The ecological disturbance caused by invasives translates into economic losses and expenditures each year, measured in billions of dollars, for land manager's nationwide (Schmitz and Simberloff 1997, Westbrooks 1998, Pimentel et al. 2005). Annual spending in 2010 on invasive species in Alaska alone was $6.9 million (Schwörer et al. 2014).

While invasive plants constitute a major problem in the lower 48 states, they have had a relatively low degree of ecological impact in Alaska. The number of non-native plant taxa documented in Alaska (approx. 331) represents roughly 14% of the state's total flora (Carlson et al. 2008, AKEPIC 2015), though new invasive species are recorded every year. Still, this proportion is lower than in most other states. Approximately 18% of California's flora (Hickman 1993), approximately 20% of Oregon's flora, and 49% of Hawaii's flora (Randall and Hoshovsky 2000) are non-native. Additionally, the total biomass of non-native plants relative to native plants is a small fraction of that in regions to the south. Since the year 2000, there has been a marked acceleration in the rate of introduction of non-native plants to Alaska that has not been previously observed in Alaska history (Carlson and Shephard 2007, Flagstad et al. in prep., AKEPIC 2015). This is presumably driven by increases in the movement of goods and people and global awareness of Alaska.

While many of Alaska's non-native species are restricted to high-use and thus disturbed areas, such as transportation routes, urban centers and recreational areas, some species have been documented moving from the human footprint into natural ecosystems. For instance, in interior Alaska, Siberian peashrub (*Caragana arborescens*), narrowleaf hawksbeard (*Crepis tectorum*), narrowleaf hawkweed (*Hieracium umbellatum*), white sweetclover (*Melilotus albus*), and bird vetch (*Vicia cracca*) have been recorded moving off roadsides into adjacent forests, meadows, floodplains, and burned areas (Cortés-Burns et al. 2008, Conn et al. 2008). In Southeast Alaska, thistles (*Cirsium* spp.) and the giant knotweed species complex (*Fallopia* spp.) have invaded undisturbed areas (Borchert 2004, Schrader and Hennon 2005).

The 'Palmer Volcanogenic Massive Sulphide (VMS) Project', led by Constantine Metal Resources Ltd. (CMR), is located approximately 55 km northwest of Haines, Alaska. Their operation facility and mining equipment storage are located on privately owned land at the Big Nugget Camp on Porcupine Road, approximately 10–15 km east of exploratory drill mining operations (Figure 1). Constantine Metal Resources proposed establishing a basic, single-lane supply/access road, branching from Porcupine Road, to create closer access to the core of mining exploration in the vicinity of Glacier Creek. Closer access provides several advantages such as reducing operating cost, reducing helicopter noise to residents living nearby, and avoiding flying/slinging supplies over the Haines Highway. A forest logging road was established in 1977, but abandoned years later. The access road by CMR is to reestablish this abandoned logging road. The road crosses a section of the Haines State Forest Resource Management Area then crosses

Since the year 2000, there has been a marked increase in the arrival of non-native plants to Alaska

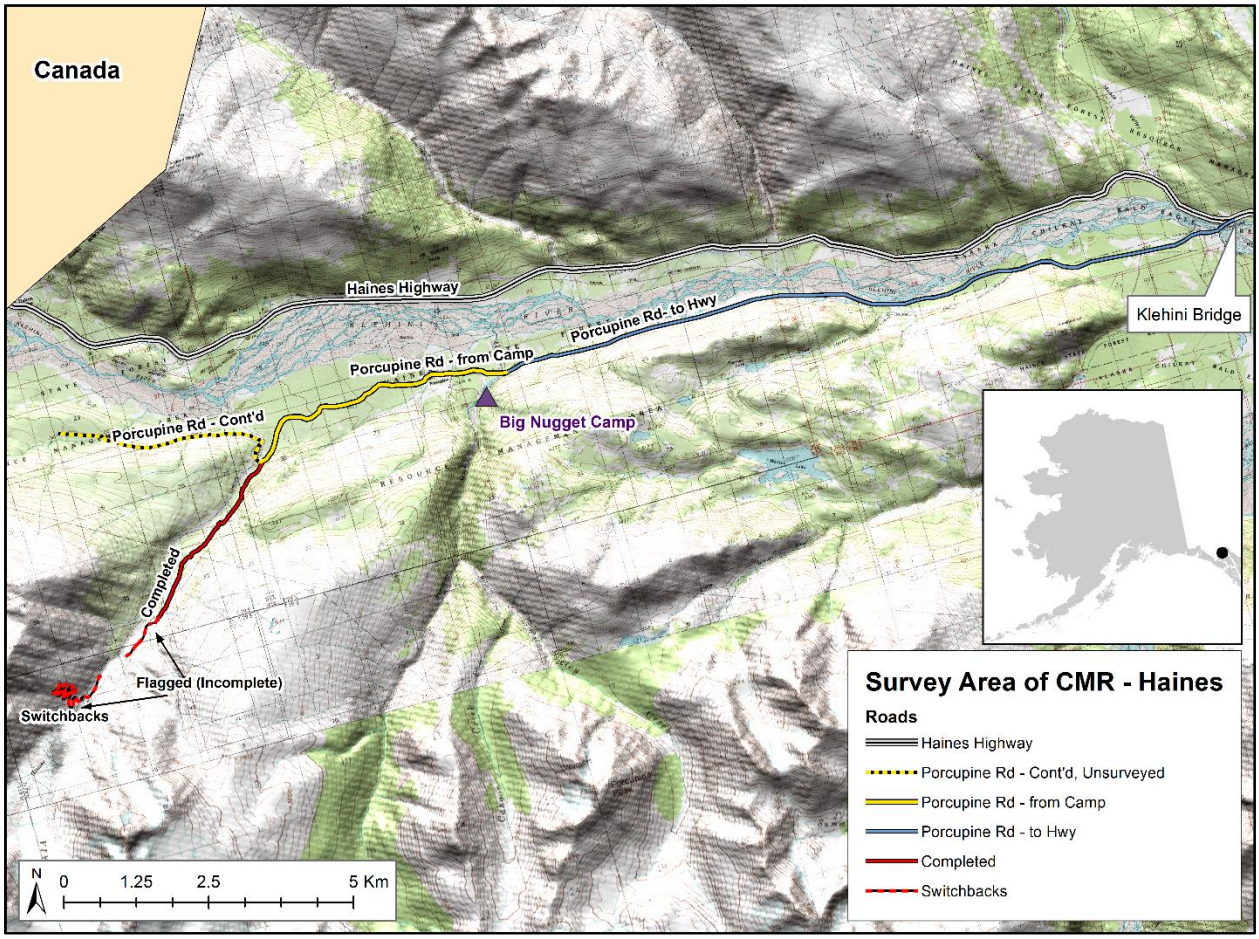

Figure 1. Study area of CMR, Big Nugget Camp and Porcupine Road. Porcupine Road was split into four survey sections: Blue Sites, Yellow Sites, Red Sites, and Switchback Sites.

onto the federal mining claims following the drainage of Glacier Creek. The road corridor starts at an intersection with the current Porcupine Creek Road a few hundred yards from the washed-out bridge over Glacier Creek. The road travels adjacently to Glacier Creek through Haines State Forest land and the length is approximately 1.4 km (Figure 1). The remainder of the road construction is proposed on the west side of Glacier Creek and will be composed of approximately 2.7 km of switchbacks (Figure 1).

Newly disturbed or overturned soil, associated with construction, provides prime habitat for the establishment of invasive plant species, especially when existing populations are located nearby. Executive Order No. 13112 (Invasive Species) directs all federal agencies to "use relevant programs and authorities to: (i) prevent the introduction of invasive species …" and not to "authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species." The BLM entered in a contractual agreement with Alaska Center for Conservation Science, University of Alaska Anchorage, to survey the newly established road for non-native plant species and provide a Best Management Practices for the Palmer VMS Project led by CMR.

Methods

The study area extent consisted of Porcupine Road after the 3-way junction of the Klehini Bridge and Chilkat Lake Road, westward toward the constructed access road (Figure 1). The survey crew consisted of two University of Alaska (UAA) Botanists, one UAA-affiliated Chicago Botanic Garden Intern, and one consultant from Hemmera Environchem Inc. The survey for non-native plants was conducted from June 29 – July 2, 2015, when flowers and/or fruits of plant species were likely to be present for accurate plant identification.

Survey Sections

We surveyed the CMR Camp (Big Nugget Camp), Porcupine Road, and the constructed access road (Figure 1). Porcupine Road is an old established public road (the original Dalton Trail) that passes through state managed land. It is the only road that leads to Big Nugget Camp and the beginning of the constructed access road (Figure 1). The road system was broken into four survey sections: Blue Section, Yellow Section, Red Section, and Switchback Section (Figure 1).

We specifically defined the Blue Section as the section of road that originates at the entry of Big Nugget Camp and extends east to the junction of Haines Highway with the Klehini Bridge (Figure 2). This section cuts through a mixture of habitat such as old growth Sitka spruce forest and braided river gravel bars. Private residences only occur within the first kilometer from the junction of the Haines Highway.

The Yellow Section originated at the entry of Big Nugget Camp and extended west to the gate of the constructed access road (Figure 3). This section of dirt road had open forb and shrub stands to 10 m away from the road before transitioning to open Sitka spruce-western hemlock forest. Timber sales of state forest stands and current harvest activity occur on this road section.

The Red Section was on the constructed access road which junctions with Porcupine Road at a locked gate and parallels Glacier Creek, ending abruptly at a bluff to the creek (Figure 3). At the time of survey, road improvements ended between “Transect Red 7” and “Transect Red 8”. The last three transects occurred on a section of this road not yet cleared for construction. The Switchback Section was located on a steep hillside on the west bank of Glacier Creek with the plan to connect to Red Section (Figure 3). This road section had not been constructed and was only partially cleared of brush at the time of our survey. The

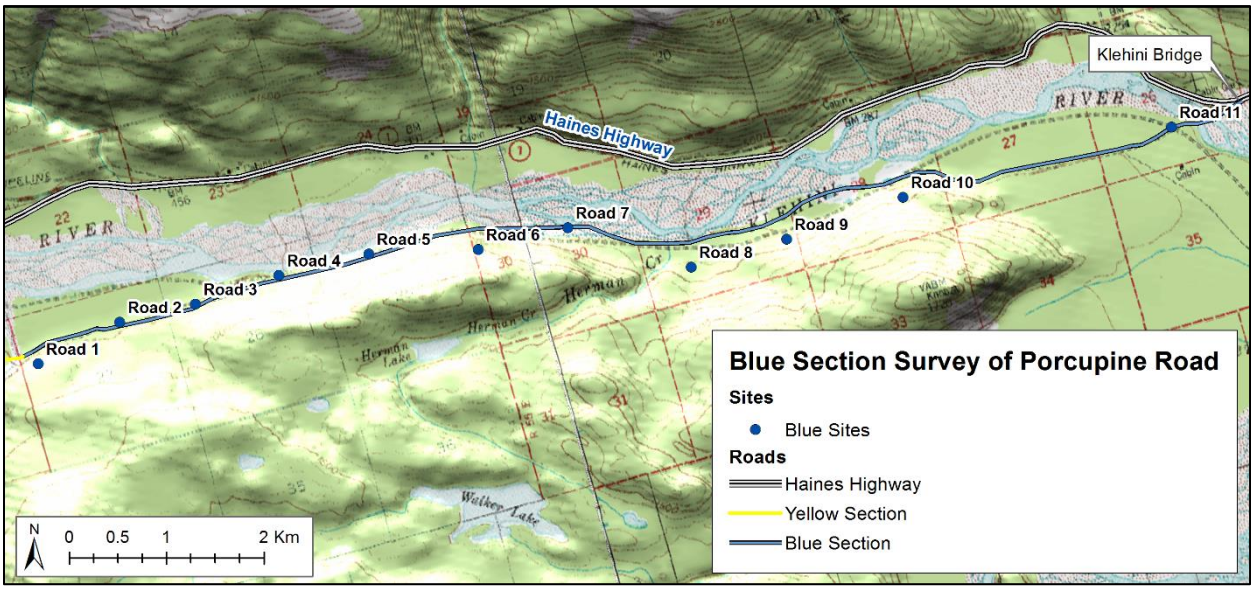

Figure 2. Blue Section of Porcupine Road with survey sites.

remainder of Porcupine Road, west of Glacier Creek, was not surveyed because it was not accessible and out of scope for this agreement (Figure 3).

Survey Methods

Plant species were documented at sites with transects approximately every 500 meters of the road section for the Yellow Section, Red Section, and Switchback Section. Plant species were documented every 1 km on the Blue Section. There were eleven sites on the Blue Section, eleven sites on the Red Section, twelve sites on the Yellow Section, and eleven sites on the Switchback Section (Figure 2, Figure 3).

Yellow and Red sites had two opposing transects perpendicular to the road that were 10 m long (Figure 4). Each transect consisted of up to three 0.5 m × 0.5 m quadrats, placed at 5 m-increments from the road shoulder: 0 m (at the start of rooted vegetation), 5 m, and 10 m (Figure 4). Transects were terminated before 10 m if thick brush, log piles, or other obstacles prevented safe access. Notably, each Switchback Site consisted of only a single quadrat due to the steep terrain and thick brush present along this route, which had not yet been completely cleared. Between sites, the presence and relative abundance of any non-native species were also documented. For each transect, GPS coordinates were recorded, and four to nine photographs were taken to document current vegetation (Table 1). Within each quadrat, all plants were identified to species and their abundances estimated according to the Braun-Blanquet scale (Table 2). The midpoint of the percent cover range for Bran-Blanquet Cover Scale was used to quantify percent cover. Unknown species were collected and later identified and submitted to UAA Herbarium as vouchers (see Appendix 1 for list).

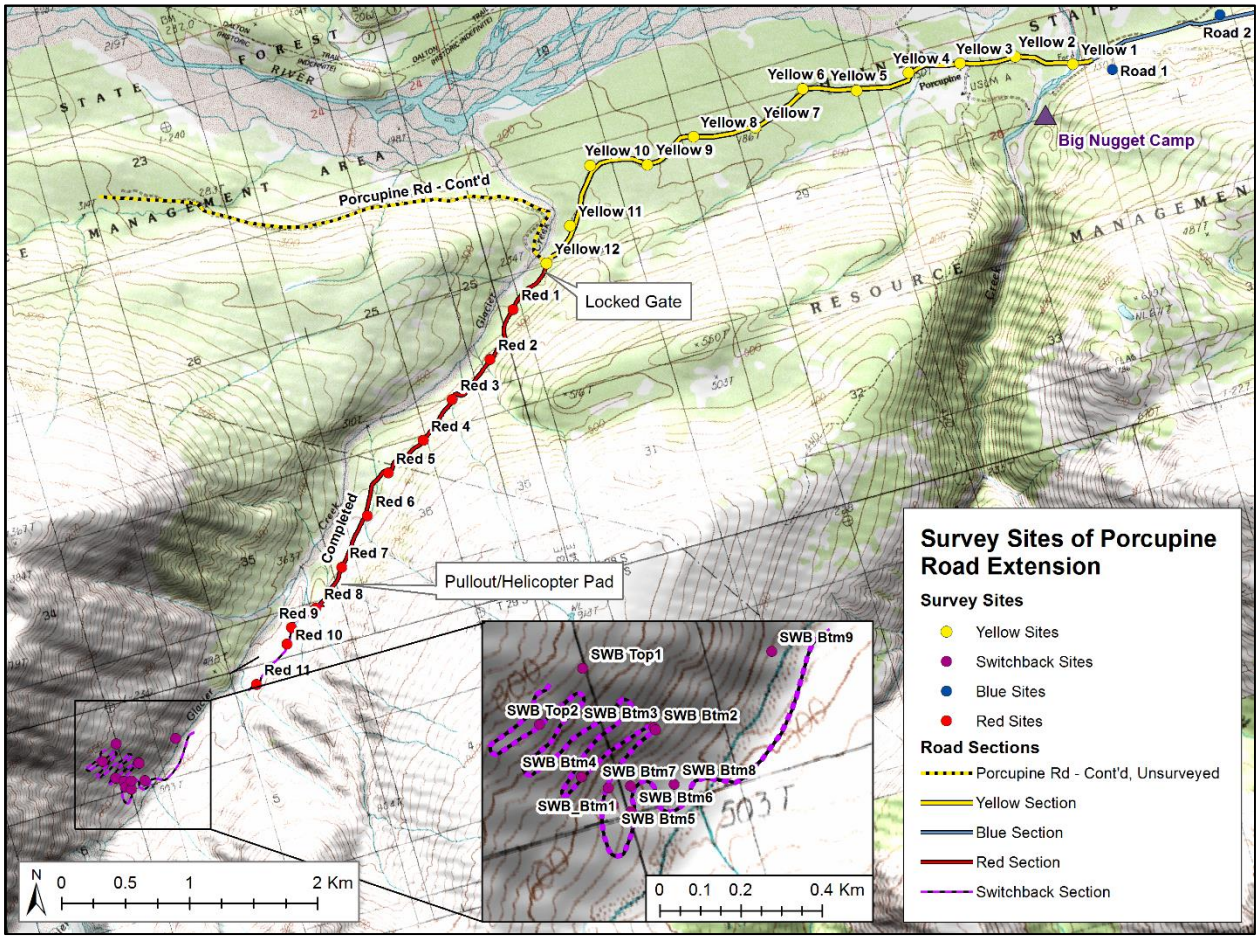

Figure 3. Survey sites of Yellow, Red, and Switchback Sections.

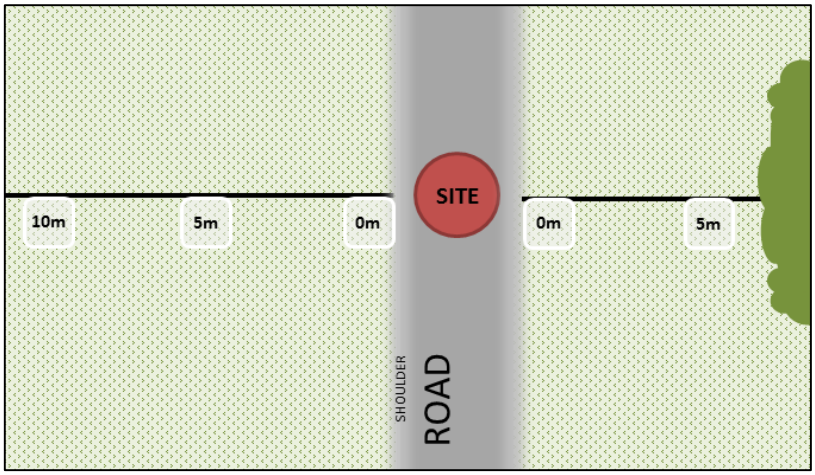

Figure 4. Plot layout with transects on each side of the road. Quadrats placed at 5 m intervals to quantify plant species.

Since the Blue Section is less traveled by CMR crew, this section was not in the original study plan. Survey observations were made every 1 km on the road and between sites if non-natives were opportunistically observed (Figure 2). We recorded the presence and abundance (estimated in acres and cover) of non-native species, photos, and GPS coordinates. The last one-quarter of the Blue Section was not surveyed due to vehicle failure. However, an invasive species was observed near the junction of the Haines Highway and Porcupine Road and counted as a site since it was still within the study area.

General observations regarding non-native species presence and cover within Big Nugget Camp were recorded and abundance estimated in acres. This area encounters heavy traffic and frequent disturbance and includes the main office, dining hall, bunk houses, storage sheds, a helicopter pad, and various parking lots and open gravel areas (Figure 5).

Plant species percent cover and frequency were averaged by plot for all road sections. Plant species encountered between plots were estimated in acre size. Records of non-native species occurrences outside Big Nugget Camp were submitted to the Alaska Center for Conservation Science's AK Exotic Plant Information Clearinghouse (AKEPIC)— a database and mapping application that provides geospatial and other information on non-native plant occurrences across the state (data portal accessible online at http://accs.uaa.alaska.edu/invasive-species/non-native-plants/).

Table 1. List of potential photographs taken at each transect to document the baseline vegetation along that transect.

Photo No.	Photo Description
1	plot card to identify transect and plot
2	transect from the road to the final quadrat
3	transect from the final quadrat to the road
4	0 m quadrat and enclosed vegetation
5	5 m quadrat and enclosed vegetation (if assessed)
6	10 m quadrat and enclosed vegetation (if assessed)
7	canopy above quadrat 0 m (if present)
8	canopy above quadrat 5 m (if present)
9	canopy above quadrat 10 m (if present)

Table 2. Braun-Blanquet Cover-Abundance Scale.

Braun-Blanquet Rank	Percent Cover Range
0	Not present
T	Trace (<1%)
1	1-5% cover
2	5-25% cover
3	25-50% cover
4	50-75% cover
5	75-95% cover
6	>95% cover

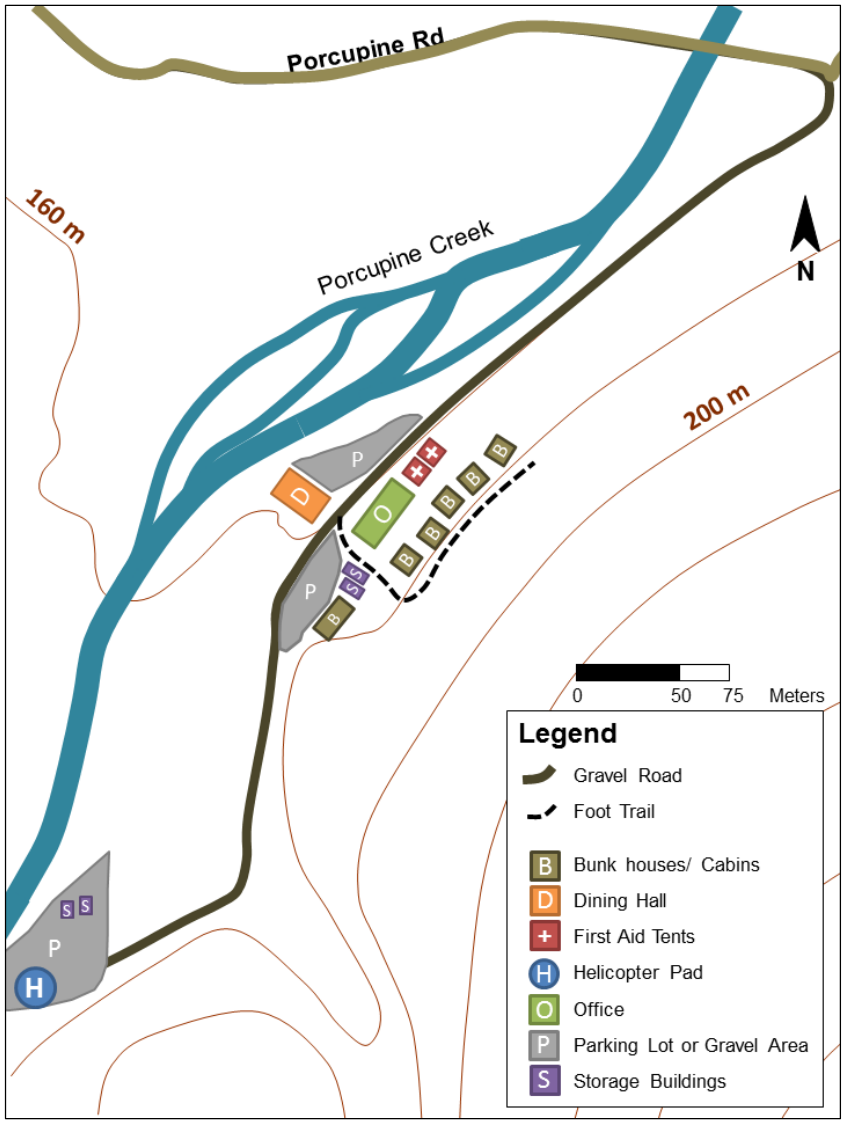

Figure 5. Building layout of Big Nugget Camp, Haines Alaska.

Results

We summarize the observed non-native plants by site locations and include the percent cover or coverage in acres along with their corresponding 'invasiveness rank'. The invasiveness rank is calculated based on a species known or perceived ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to native ecosystems and 100 representing a plant that poses a major threat to native ecosystems (Carlson et al. 2008). The ranking scale is summarized in Table 3. While the threshold level varies between state and federal agencies in Alaska, species with a rank ≥ 70 are considered invasive, where there is a serious threat to the Alaskan ecosystem.

Table 3. Invasiveness Ranking Score for Alaska. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to natural ecosystems and 100 representing a species that poses a serious threat to natural ecosystems (see Carlson et al. 2008 for more details).

Rank Score	Invasiveness	Impacts
100 – 80	Extremely Invasive	Pose serious threats to natural ecosystems in Alaska.
79 – 70	Highly Invasive	Pose serious threats to natural ecosystems in Alaska.
69 – 60	Moderately Invasive	Pose significant threats to natural ecosystems in Alaska but are not as likely to successfully invade.
59 – 50	Modestly Invasive	Pose significant threats to natural ecosystems in Alaska but are not as likely to successfully invade.
49 – 40	Weakly Invasive	Species are unlikely to invade and significantly alter natural ecosystems.
39 – 0	Very Weakly Invasive	Species are unlikely to invade and significantly alter natural ecosystems.

Non-native plant data for the region were downloaded from AKEPIC (2015) to evaluate the regional non-native plant community. There are 71 non-native species known to occur in the vicinity of Haines, defined as all road access of Haines Highway from the Canada/Alaska border to Haines proper (Appendix 2). Of these, six species are considered an Alaska State Prohibited Noxious Weed and 44 species occur < 20 km away from the CMR study area (Table 4). Species that occur closer to the study area are more likely to invade and cause for concern. The invasiveness ranks of these non-native species ranges from 'Very Weakly Invasive,' with a score of 32, to 'Extremely Invasive', with a score of 86. Seven invasive species have been found in the region with four occurring < 20 km from the study area. However, these invasive and noxious species were recorded in 2007 and were treated (AKEPIC 2015), therefore the risk of spread to CMR study area is low.

Of the 71 species that occur in the Haines region, 15 were found in our survey, and no new non-native plants to the region were observed. No species with a rank of ≥ 70 were found in the study area. The species with the lowest invasiveness rank found was pineappleweed (*Matricaria discoidea*) with a rank of 32. The species with the highest invasiveness rank found was yellow sweet clover (*Melilotus officinalis*) with a rank of 69.

No new non-native plant species to the region were observed in the study area

Table 4. Summary of non-native plants found in the Haines region that have been found < 20 km from Big Nugget Camp. These species are more likely to occur in the study area due to proximity. Asterisk (*) indicates AK State Prohibited Noxious Weed. Invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100 (NR indicates No Rank), with 0 representing a plant that poses no threat to natural ecosystems and 100 representing a species that poses a serious threat to natural ecosystems.

Common Name	Scientific Name	Invasiveness Rank	Found in Study Area
alsike clover	*Trifolium hybridum*	57	X
annual bluegrass	*Poa annua*	46	X
big chickweed	*Cerastium fontanum* ssp. *vulgare*	36	X
common dandelion	*Taraxacum officinale*	58	X
common plantain	*Plantago major*	44	X
curly dock	*Rumex crispus*	48	X
foxtail barley	*Hordeum jubatum*	63	X
Kentucky bluegrass	*Poa pratensis* ssp. *pratensis*	52	X
oxeye daisy	*Leucanthemum vulgare*	61	X
pineappleweed	*Matricaria discoidea*	32	X
red clover	*Trifolium pratense*	53	X
spreading bluegrass	*Poa pratensis* ssp. *irrigata*	52	X
timothy	*Phleum pratense*	54	X
white clover	*Trifolium repens*	59	X
yellow sweetclover	*Melilotus officinalis*	69	X
brittlestem hempnettle*	*Galeopsis tetrahit**	50	
Canada bluegrass	*Poa compressa*	39	
Canada thistle*	*Cirsium arvense**	76	
cicer milkvetch	*Astragalus cicer*	NR	
common eyebright	*Euphrasia nemorosa*	42	
common groundsel	*Senecio vulgaris*	36	
common tansy	*Tanacetum vulgare*	60	
corn spurry	*Spergula arvensis*	32	
creeping buttercup	*Ranunculus repens*	54	
garden sorrel	*Rumex acetosa*	NR	
lambsquarters	*Chenopodium album*	37	
meadow foxtail	*Alopecurus pratensis*	52	
narrowleaf hawksbeard	*Crepis tectorum*	56	
orchardgrass	*Dactylis glomerata*	53	
prostrate knotweed	*Polygonum aviculare*	45	
quackgrass*	*Elymus repens**	59	
reed canarygrass	*Phalaris arundinacea*	83	
rugosa rose	*Rosa rugosa*	72	
shepherd's purse	*Capsella bursa-pastoris*	40	

Common Name	Scientific Name	Invasiveness Rank	Found in Study Area
Siberian wildrye	*Elymus sibiricus*	53	
smooth brome	*Bromus inermis*	62	
splitlip hempnettle	*Galeopsis bifida*	50	
spotted knapweed	*Centaurea stoebe*	86	
tall buttercup	*Ranunculus acris*	54	
thymeleaf speedwell	*Veronica serpyllifolia* ssp. *serpyllifolia*	36	
tower rockcress	*Arabis glabra*	NR	
tumbling mustard	*Sisymbrium altissimum*	NR	
white sweetclover	*Melilotus albus*	81	
yellow toadflax	*Linaria vulgaris*	69	

Blue Section

We observed seven non-native plant species on this road section. Common dandelion (*Taraxacum officinale*) was the most commonly observed non-native plant. An infestation of curly dock (*Rumex crispus*) was observed at a single site for the Blue Sites, but with high abundance and covering an area of 0.045 acres (

Table **5**). Non-native plant cover was discontinuous in small patches on this road section (Figure 6). Yellow sweet clover (*Melilotus officinalis*) was observed at the start of Porcupine Road junction (Site Road 11) where we removed 43 stems occupying 0.001 acres (Figure 6). This represents the western most extent of the population where it occurs on Chilkat Lake Road. This population indicates the species is starting to spread into the study area.

Table 5. Summary on non-native plants on Blue Sites.

Common Name	Species	Avg. Acre Occupied	% Frequency	Invasiveness Rank
foxtail barley	*Hordeum jubatum*	0.0002	18	63
yellow sweetclover	*Melilotus officinalis*	0.001	9	69
timothy	*Phleum pratense*	0.0021	45	54
common plantain	*Plantago major*	0.001	18	44
Kentucky bluegrass	*Poa pratensis*	0.002	27	52
curly dock	*Rumex crispus*	0.045	9	48
common dandelion	*Taraxacum officinale*	0.0053	63	58
white clover	*Trifolium repens*	0.0024	18	59

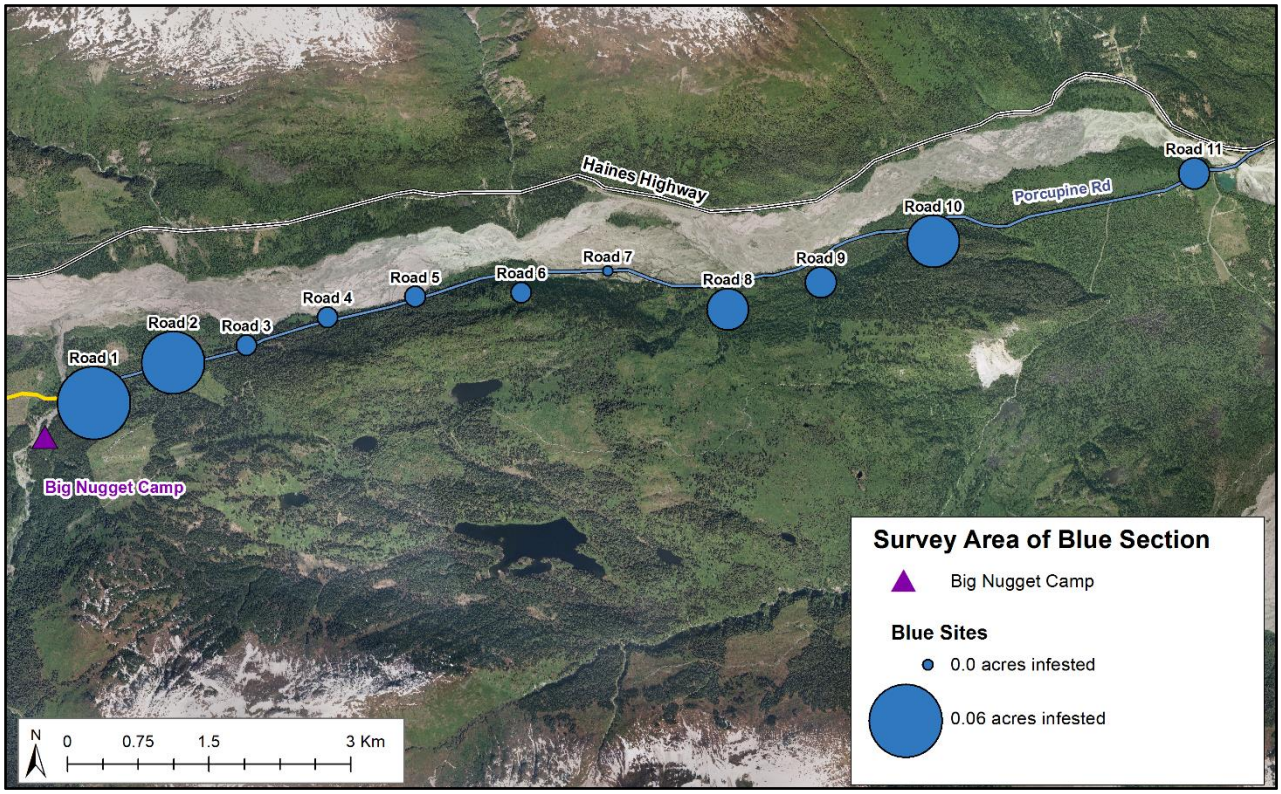

Figure 6. Spatial extent of non-native plant species infested acres at Blue Sites.

Yellow Section

Typically the first 5 m of transects of the Yellow Sites were within the ruderal habitat of the roadside (Figure 7). Anthropogenic vegetation disturbance and alteration occurs frequently on this stretch of road. Non-native plants found at the Yellow Sites are summarized in Table 6 and the entire plant species list is summarized in Appendix 2. Twelve non-native plant species were encountered on this section; however, one clover (*Trifolium* spp.) plant could not be determined at the species level because it was too young; however all *Trifolium* species are non-native to Alaska (Table 6). Nine non-native species were found within the quadrats at the sites and three additional non-native species were found between sites (Table 6). Non-native species found between sites are summarized in Appendix 2.

White clover (*Trifolium repens*) was the most frequently observed non-native plant species, being present at 66.6% of the sites followed by common plantain (*Plantago major*) and big chickweed (*Cerastium fontanum* ssp. *vulgare*) at 50% and 42% of the sites, respectively (Table 6). Average percent cover of non-native plant species ranged from 0.01% to 4.2 % (Table 6). White clover had the highest percent cover among the sites with an average of 4.2% cover, followed by common dandelion (*Taraxacum officinale*) at 1.9% cover (Table 6).

Figure 7. Transect Yellow 6-1 viewing transect start to end. White clover and dandelion species are prominent in the quadrat.

The non-native species with the highest invasiveness rank found was foxtail barley (*Hordeum jubatum*) with a rank of 63, followed by oxeye daisy (*Leucanthemum vulgare*) with a rank of 61. Pineapple weed (*Matricaria discoidea*) had the lowest invasiveness rank (32) of all observed non-native species. We did find speedwell (*Veronica serpyllifolia*) on this road section; however, two subspecies occur in Alaska with one being non-native, thymeleaf speedwell (*Veronica serpyllifolia* ssp. *serpyllifolia*) and the other native, brightblue speedwell (*Veronica serpyllifolia* ssp. *humifusa*). However, due to the age of the plant, the difference could not be distinguished and we observe it here as the native kind since the non-native thymeleaf speedwell has a very low invasiveness rank of 36.

Total average non-native cover by site ranged from 0.5% to 28.9% with an average of 8.8% cover over all Yellow Sites (Table 7; Figure 8). Yellow Site #2 had the highest total average non-native plant cover with 28.9% cover, followed by Yellow Site #5 with 21% cover (Table 7). Percent cover of non-native plants was greater on the first half of the road section, and non-native species frequency and percent cover decreased between and within sites closer to the access road (Red Sites, Figure 8).

Table 6. Summary of non-native species found on Yellow Section. Asterisk species was too young to identify to species, however all *Trifolium* species are non-native to Alaska. Plant species were found within plots or on the road between plots and estimated at acre coverage (see methods).

Common Name	Species Name	Avg. % Cover	% Freq.	Invasiveness Rank	Survey Method
big chickweed	*Cerastium fontanum* ssp. *vulgare*	0.81	41.67	36	Plots
foxtail barley	*Hordeum jubatum*	0.21	8.33	63	Plots
pineapple weed	*Matricaria discoidea*	0.06	8.33	32	Plots
oxeye daisy	*Leucanthemum vulgare*	*.01 acre*	n/a	61	Between Plots
timothy	*Phleum pratense*	0.31	8.33	54	Plots
common plantain	*Plantago major*	0.61	50.00	44	Plots
annual bluegrass	*Poa annua*	0.05	16.67	46	Plots
Kentucky bluegrass	*Poa pratensis*	0.72	33.33	52	Plots
common dandelion	*Taraxacum officinale*	1.92	25.00	58	Plots
alsike clover	*Trifolium hybridum*	*.003 acre*	n/a	57	Between Plots
red clover	*Trifolium pratense*	*.003 acre*	n/a	53	Between Plots
white clover	*Trifolium repens*	4.17	66.67	59	Plots
clover*	*Trifolium* spp.	0.01	8.33	50-59	Plots

Table 7. Total non-native plant cover at Yellow Sites.

Yellow Site #	Total Average Non-native % Cover
1	0.5
2	28.87
3	5
4	10
5	21
6	10.92
7	8.1
8	3.08
9	4.63
10	7
11	6.75
12	0.6

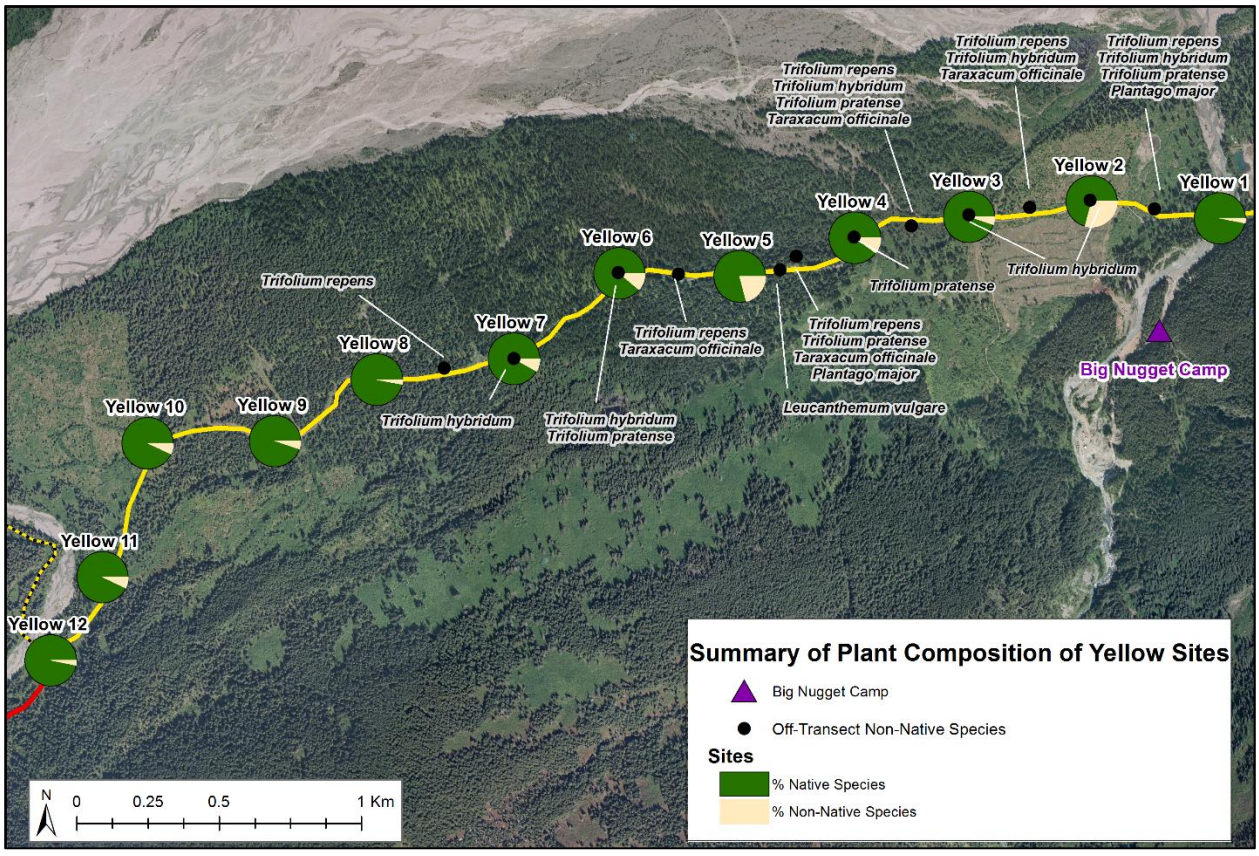

Figure 8. Summary of non-native plant species found at Yellow Sites with location and abundance.

Figure 9. Red Site 1 showing transect start to end. Grass from reclamation is present but too young to identify.

Figure 10. Switchback Site 1 showing recently cut alder.

Red Section

No non-native plant species were observed in this road section (Appendix 2).This road has been reconstructed and passes through old growth western hemlock forest that transitions to alder shrubs near "Transect Red 8". Within 10 meters of the road, the understory was dominated by *Dryopteris expansa*, *Rubus pedatus*, *Oplopanax horridus*, and unidentified mosses. The immediate shoulder of the road section was hydro-seeded with a native grass seed mix, which had an average cover of 0.3% (Appendix 2). At the time of survey, only the first true leaves had emerged, therefore the grasses could not be identified to species (Figure 9). Between "Transect Red 7" and "Transect Red 8" was a large dirt pullout area (Figure 3). This area had heavy vehicle activity as it was a helicopter landing site for loading and unloading of equipment. Vehicles and a trailer were parked in this large pull out area. Red Sites 9 – 11 were not yet cut for road construction, but flagging material marked the potential route. This section was dominated by *Dryopteris expansa*, *Alnus viridis* ssp. *sinuata*, and *Oplopanax horridus* (Appendix 2).

Switchback Section

At the time of survey, the switchback transects were in the process of being clear cut for the future road construction (Figure 10). The sites were on a steep hillside with > 45 degree slope and were composed of an *Alnus viridis* ssp. *sinuata-Oplopanax horridus* plant association. Pockets of *Calamagrostis canadensis* with various forbs were infrequently encountered. A helicopter landing pad is located at the top end of the Switchback Sites for easier future transport of materials to higher elevations. No non-native species were found at these sites, and the data serves as baseline data for future comparison (Appendix 2).

Big Nugget Camp

Seven non-native plant species were observed within Big Nugget Camp and were concentrated near buildings or in lightly disturbed areas such as vegetation strips around parking lots (Table 8). Non-native species were more frequent around the buildings than near the helicopter landing area and distant shed buildings. Abundance and cover of non-native species was low and estimated to be equal to or less than 1% cover of the camp area for each species. Foxtail barley (*Hordeum jubatum*) was the non-native plant with the highest invasiveness rank (63) and big chickweed had the lowest invasiveness rank (36). A majority of the non-native species found are considered 'Modestly Invasive'.

Table 8. Summary of non-native plants within Big Nugget Camp. Percent cover was estimated to be less than 1% of the camp area for each species.

Camp Location	Common Name	Species	Invasiveness Rank
Parking Lot- Bunk House	foxtail barley	*Hordeum jubatum*	63
Parking Lot- Bunk House	timothy	*Phleum pratense*	54
Parking Lot- Bunk House	common plantain	*Plantago major*	44
Parking Lot- Bunk House	Kentucky bluegrass	*Poa pratensis* ssp. *pratensis*	52
Parking Lot- Bunk House	common dandelion	*Taraxacum officinale*	58
Parking Lot- Bunk House	white clover	*Trifolium repens*	59
Between Tool Shed and Office	foxtail barley	*Hordeum jubatum*	63
Between Tool Shed and Office	timothy	*Phleum pratense*	54
Between Tool Shed and Office	common plantain	*Plantago major*	44
Between Tool Shed and Office	Kentucky bluegrass	*Poa pratensis* ssp. *pratensis*	52
Between Tool Shed and Office	common dandelion	*Taraxacum officinale*	58
Between Tool Shed and Office	white clover	*Trifolium repens*	59
Dining Hall	big chickeweed	*Cerastium fontanum* ssp. *vulgare*	36
Dining Hall	timothy	*Phleum pratense*	54
Dining Hall	Kentucky bluegrass	*Poa pratensis* ssp. *pratensis*	52
Dining Hall	common dandelion	*Taraxacum officinale*	58
Dining Hall	white clover	*Trifolium repens*	59
Parking Lot- Dining Hall	common plantain	*Plantago major*	44
Parking Lot- Dining Hall	common dandelion	*Taraxacum officinale*	58
Road to Helipad	big chickeweed	*Cerastium fontanum* ssp. *vulgare*	36
Road to Helipad	common dandelion	*Taraxacum officinale*	58
Helipad ramp	big chickeweed	*Cerastium fontanum* ssp. *vulgare*	36

The Red and Switchback Sections were free of non-native plant species

Discussion

Survey of Road Sites and Big Nugget Camp

We found 15 non-native species in the study area, which all have been previously documented in the Haines region. No non-native species were found in the Red or Switchback Sections, hence areas after the locked gate on Porcupine Road were considered 'weed-free' at the time of observation (Figure 11). The study area can be broken into two 'zones' or 'sections' of weed-free and weeded zones to support invasive species management.

Non-native plant species were found more frequently and in abundance in the Yellow Section of Porcupine Road. This section of road had a significantly different vegetation community than the Blue or Red Sections. The Yellow Section had heavy herbaceous and shrub cover and a high diversity of species within the first 10 to 15 meters of the roadside before transitioning to early growth Western Hemlock forest. In contrast, the Blue Section and Red Section had characteristics of old growth Western Hemlock forest, such as low shrub cover of only a few species and high moss cover. This suggests more frequent or intense habitat disturbance for the Yellow Section of Porcupine Road. Timber sales occur along this stretch of road, resulting in frequent vehicular traffic as well as roadside and forest disturbance by heavy timber-cutting machinery. These activities not only create opportunities for new non-native plants to arrive on vehicles and equipment, but also result in soil disturbance, which further facilitates non-native plant establishment. This road section had the highest number and greatest canopy cover of non-native species. Non-native cover and frequency decreased westward toward the constructed access road (Red Section). This is possibly due to historically lower vehicle traffic in this area as timber activity diminished in this area. While the Blue

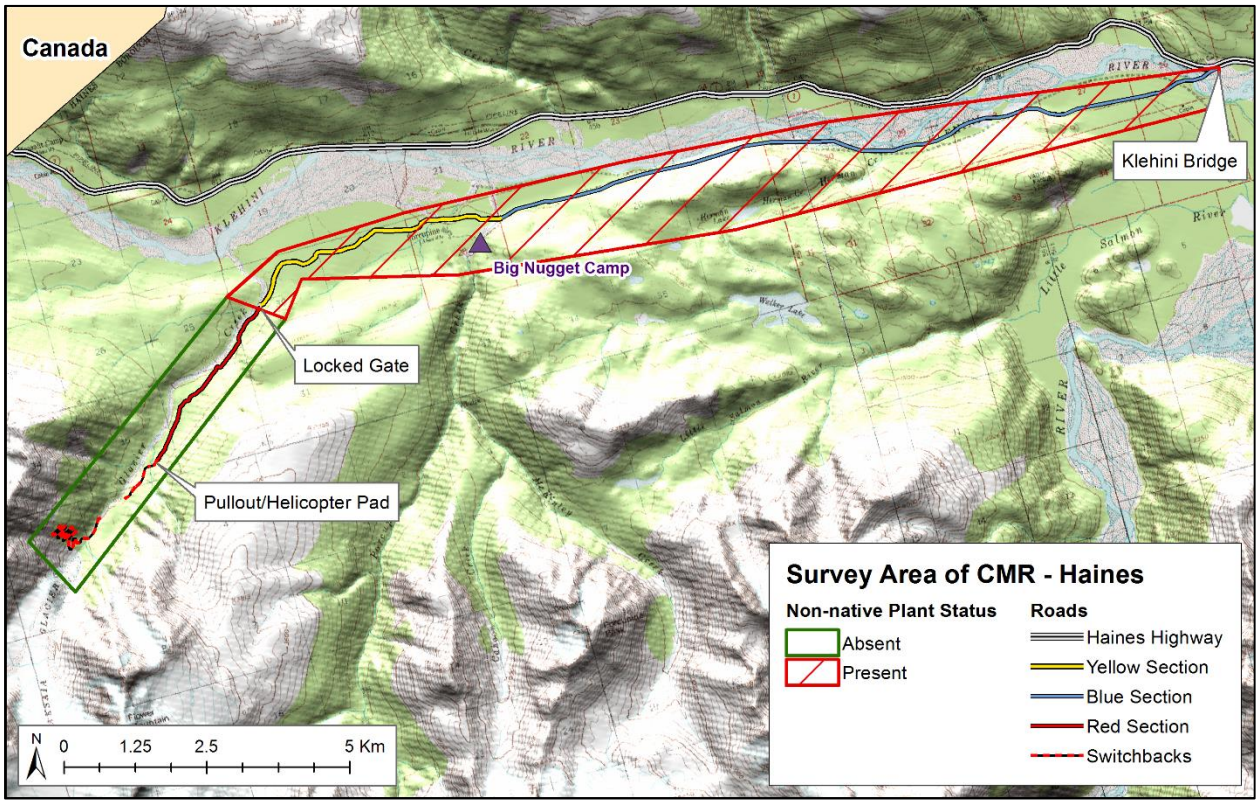

Figure 11. Presence and absence zones of non-native species in the CMR study area. No non-native species were observed on the Red or Switchback Sections after the locked gate. A large pullout working and helicopter pad was located near Red Site 8.

Section did contain non-natives, they were sporadic and had relatively low abundance and diversity compared to the Yellow Section.

Big Nugget Camp had a relatively low abundance and diversity of non-native species compared to the road sites. From the main office buildings in the camp towards the helicopter landing site at camp, the occurrence of non-native species decreases substantially. Either proactive measures have been taken to reduce the presence of non-natives at the helicopter area, or this site is relatively new in disturbance and has not yet had enough time for non-natives to establish. Most non-native species found at Big Nugget Camp are considered "Modestly Invasive;" in Alaska, and are expected to cause some ecosystem impacts. Even though the non-native species observed are considered weakly to modestly invasive, they serve as an indication that current practices facilitate the arrival, dispersal, and establishment of non-native plant species. Practices can be improved to reduce the chance of arrival and establishment of more aggressively invasive species.

Big chickweed was found at the helicopter landing pad in Big Nugget Camp. Big chickweed (*Cerastium fontanum* ssp. *vulgare*) is considered "Very Weakly Invasive;" and unlikely to significantly alter natural ecosystems. Seeds of this species can be transported by sticking to clothing and boots (see Appendix 4 for more detail). Given the species being located at a transportation point to the remote mining area and ability to attach to clothing, there is a reasonable probability this species can be accidentally transported to other areas such as the remote mining location or other helicopter landing site on the constructed access road.

Collectively, all but three non-native species observed had an invasiveness rank < 60. The highest ranked species (69) was yellow sweetclover (*Melilotus officinalis*). While this species was found nearly 12 km away from the Big Nugget Camp, a very closely related species, white sweetclover, is known to spread on rapidly on road corridors and gravel bars in floodplains (see Conn et al. 2011). Yellow sweetclover has the potential to inhibit natural succession processes via a number of effects: it is known to alter soil conditions via nitrogen fixation, to exude allelopathic compounds, to reduce erosion, and to shade out native herbaceous species (Rutledge and McLendon 1996, Townsend 2001, and USDA 2002).Yellow sweetclover is known to degrade natural grassland communities (Wisconsin DNR 2003). Yellow sweetclover is visited by introduced honeybees, native solitary bees, wasps, and flies (Eckardt 1987) and is eaten by elk, deer, and domestic livestock (Sullivan 1992), though it is moderately toxic to animals (Whitson et al. 2000). Foxtail barley (*Hordeum jubatum*) is considered Moderately Invasive (rank of 63) and was found in CMR Camp and Yellow Sites. While the nativity of the species is disputed, it is an aggressive species that outcompetes other plant species, has increased dramatically in abundance and distribution in the state, and can injure wildlife. Oxeye daisy (*Leucanthemum vulgare*) was found at one location at the Yellow Sites and has an invasiveness rank of 61. Oxeye daisy can form dense populations and thereby decrease native plant species diversity (Noxious Weed Control Board 2005). It is able to replace up to 50% of the grass species in pasture (Royer and Dickinson 1999, Warner et al. 2003), and increases the potential for soil erosion in heavily infested areas (Densmore et al. 2001, Noxious Weed Control Board 2005).

No non-native species were observed on the Red Section or Switchback Section (Figure 11). The road extension (Red Section) is relatively new and this is the first year of frequent vehicle use. Non-native species

Though the non-native species observed in Big Nugget Camp are considered weakly to modestly invasive, they serve as an indication that current practices facilitate the arrival, dispersal, and establishment of non-native plant species

are not likely to be present due to the time lag of arrival and establishment, but would most likely begin to appear in the following years. The establishment of non-natives along the new road section and further up the road can be curtailed with best management practices outlined below. Native grasses were hydroseeded on the road shoulder and road banks for this section, and revegetation, such as reseeding, of disturbed sites is generally efficient in combating the arrival of non-native species and erosion control.

Non-native and invasive species can enter weed free areas of the study area by several vectors: vehicles, equipment, materials, and personnel. Specifically at the time of survey, there were two pathways for non-native plants to enter the alpine drill mining area: the helicopter landing site at the Big Nugget Camp and the helicopter landing site located in the Red Section (pullout working area: Figure 11). Non-native seed can attach to tools, equipment, and personnel before leaving the helicopter pad. The drill mining area is located in subalpine to alpine mountains in the Glacier Creek drainage and while not surveyed in this report, is assumed to be free of non-native plant species. Generally non-native plant species establishment and abundance appears to be limited above shrubline; however, climate change has accelerated the process for invasive species establishment in the alpine (Becker et al. 2005, Pauchard et al. 2006, Lenoir et al. 2008). Invasive species, such as orange hawkweed (*Hieracium aurantiacum*), have occurred in disturbed and high traffic areas of alpine habitat in the Anchorage area (AKEPIC 2015). The establishment and ecological impact of non-natives in Alaskan alpine ecosystems has not been fully evaluated. The transport and establishment of non-native plants to the alpine site is suspected to be neglible without the assistance of anthropogenic practices and disturbance of a microsite.

There are three potential pathways for non-natives to enter the weed-free zone of Red and Switchback Sections (Figure 11): natural advancement and dispersal, vehicle and equipment traffic, and helicopter transport. First, non-natives plants can naturally spread on the road system toward the Red and Switchback Sections without human assistance, however this would take a few years as the Yellow Section had fewer non-native species closest to the Red Section (Figure 8). The reclamation of the roadside will keep non-native plant species contained to a narrow strip of the shoulder and the dirt road itself. Natural dispersal to remote drill sites has a lower probability as described above.

Secondly, personnel, vehicles and equipment entering the weed-free zone can act as vectors, dispersing seeds attached to wheels and undercarriage that are sourced from Porcupine Road, Big Nugget Camp, or Haines. Washing vehicles before entering weed free areas according to standard practices is highly recommended (*see* DiVittorio et al. 2012). The most effective location for vehicle washing is at the gate of the new road construction (Red Section), but would require footprint disturbance to the area (Figure 11). However, alternatives must be weighed with economics and practicality.

Thirdly, seed that may have been attached to equipment and/or personnel clothing may be dispersed to the weed free areas by helicopter transport. Specifically in this scenario, seeds would have attached from Big Nugget Camp and transported to the drill sites and/or the Red Section helicopter pad. Generally, equipment and personnel footwear and clothing located in weed areas should be cleaned before entering weed-free locations.

Early Detection and Rapid Response (EDRR)

Early Detection and Rapid Response (EDRR) is the process of locating, assessing, and eliminating invasive species populations before they have a chance to spread to unmanageable levels. Proactive measures, such as preventing the introduction of new species, provide the best and most cost-effective management of invasive species. Since invasive plant populations often exhibit a lag time before they begin to spread, EDRR management practices focus on locating, assessing, and eliminating invasive species populations before they reach unmanageable levels. Early Detection and Rapid Response measures increase the probability that new invasions will be addressed and that local invasive populations are within the ability to be controlled. Such measures provide a cost effective solution because they address invasive species before they become established (Figure 12). Once populations are established, negative impacts may have already occurred and the only action remaining are partial mitigation measures (Figure 12). Instances in which EDRR is not employed often result in substantial financial commitment to keep populations managed (Rejmánek and Pitcairn 2002). Minimizing the introduction and spread of non-native species and populations can be accomplished by following Best Management Practices (BMPs) and EDRR measures, by monitoring known and susceptible areas of infestation, and involving mine staff in weed management and education.

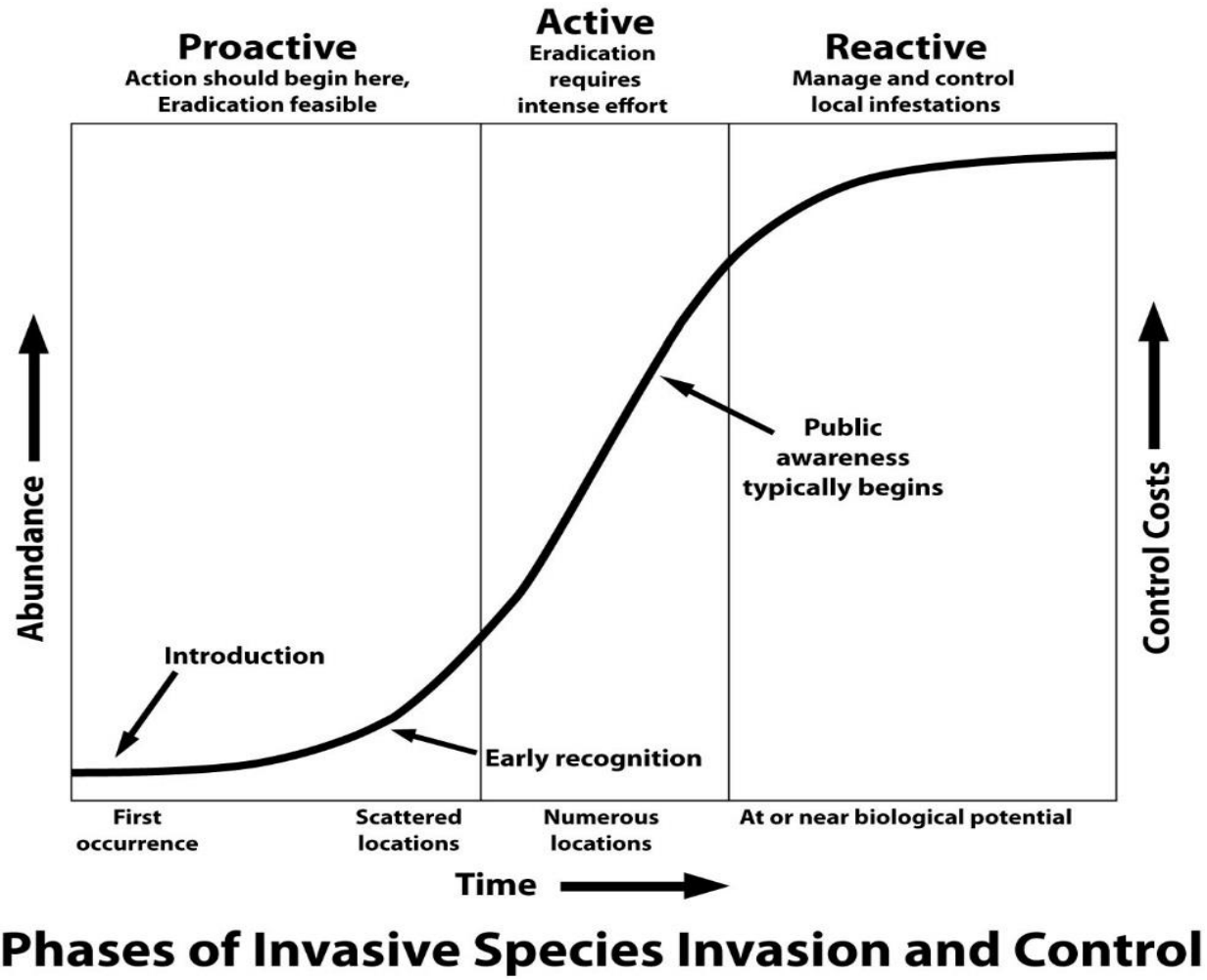

Figure 12. Phases of invasive species invasion. As time increases, the invasive species populations increase and make it more difficult and costly to control. Being proactive with early detection reduce operation costs and reduce ecological harm. Graph adapted from Agriculture and Natural Resources, University of California (2015).

This strategy includes surveys for monitoring, assessment, and control of new and emerging non-native species. Early detection of new infestations requires vigilance and regular monitoring of the managed area and surrounding ecosystem. EDRR efforts at Palmer VMS Project should focus on areas of high traffic and disturbance (e.g. construction sites, roads, and trails) and timing is outlined below. Populations identified through EDRR should be submitted to the Alaska Exotic Plants Information Clearinghouse (AKEPIC) database at the Alaska Center for Conservation Science to augment the knowledgebase of new infestations and movements of known populations within Alaska. A comprehensive picture of the distribution of non-native species and infestations is important for the development and adaptation of effective management strategies.

Proactive measures, such as preventing the introduction of new species, provide the best and most cost-effective management of invasive species

Inventory and monitoring

Monitoring involves periodic observation and documentation. It is an ongoing and dynamic process and is an integral part of a successful weed control program. Monitoring includes gathering information to gauge the effectiveness of management actions in meeting predetermined objectives. A monitoring program can elucidate objectives that are not being met, actions that need to be modified, and actions that are not working and should be stopped. The inventory and monitoring plan should be evaluated annually, if possible, or at least every three years, so that its efficacy can be assessed, and modifications can be implemented where appropriate to increase the plan's success.

Non-native plant surveys at Big Nugget Camp and Palmer VMS Project are recommended to be conducted once a year and concentrated on the new road construction areas and Big Nugget Camp. Surveys are recommended be conducted in late June or early July when most non-native plant species are easily identifiable but have not yet produced seed. Intensive monitoring, as performed in this report, is most effective when repeated every three to five years. Identifying and prioritizing infestations before seed set will decrease the risk of inadvertently spreading plant propagules and thereby improve the efficiency of control measures. Ideally, early detection would be enhanced if some member(s) of mine staff are on the lookout for new or unfamiliar plants. Big Nugget Camp, helicopter landing/loading areas, and vehicle/equipment wash station control points are high priorities for observation by staff for non-native species. The most common non-native species to the region and how to identify and report them are compiled in Appendix 4. If the identification of the species is uncertain, photos can be taken and submitted to University of Alaska Fairbanks Extension Services website, appropriate BLM contacts, or the AK Weeds ID App for verification. Control methods can then be assessed.

Sources and dispersal vectors to prioritize for monitoring

Areas that should be top priority for monitoring include potential points of introduction, dispersal corridors, material source areas, material storage sites, and other high-use or high-disturbance locations. Specific sites for survey work include:

1. Airstrip and unloading zone.
2. Roadsides and trails.
3. Gravel quarries.
4. Snow and soil storage sites.

5. Natural aquatic habitats; these are often more susceptible to invasive plant introductions and spread than terrestrial habitats.

Control methods

Effective control relies on a number of factors. First, it is essential to clearly establish treatment goals (e.g. does a species need to be eradicated or just contained?). It is also necessary to understand the biology of the target species (e.g., whether it reproduces vegetatively or sexually, or by both plant propagules and seed). It is important to recognize the pathways associated with a species introduction and to understand the ecosystem that has been invaded. It is also critical to know which control methods are effective for which species, as there is no single panacea for treating all infestations and the most effective control often combines manual, mechanical, chemical and biological techniques over several years. Control options for invasive species can be viewed in species biographies in Appendix 4 and online at the University of Alaska Fairbanks Extension Services website.

Prioritizing infestations for control work

Prioritization for control work is most effective when based on weed distributions and abundance, known or perceived risk to natural ecosystems, and government mandates for control (e.g. presence on the State of Alaska Noxious Weed List).

Control of invasive species that are locally uncommon are recommended to take precedence over invasive species that are widespread on regional and local scales. Control of such incipient populations are recommended to take place regardless of perceived invasiveness. Similarly, populations that are small and disjunct, or that are actively invading – or capable of invading – undisturbed native vegetation, are suggested to be prioritized over populations that are continuous and large, or that tend to remain restricted to anthropogenically disturbed habitats. See the *Prioritization Tool* appendix in AKEPIC (2005) for a quantitative method to prioritize management based on distribution, abundance, and invasiveness.

When prioritizing species with similar distributions and abundances, control first those species present on the State of Alaska Noxious Weed List, with higher invasiveness ranks, or demonstrated aggressiveness. In general, species with invasiveness ranks of >50 represent species considered modestly to extremely invasive (Carlson et al. 2008) and are reasonable targets for control in areas with low levels of infestation and non-native plant diversity.

Although top priority at the mine is preventing the introduction of new, more aggressive species, it is recommended that removing populations of common dandelion (*Taraxacum officinale*), Kentucky bluegrass (*Poa pratensis* ssp. *pratensis*), white clover (*Trifolium repens*), and timothy (*Phleum pratense*) be a secondary priority. These species are ranked as modestly invasive and could move off the human footprint into surrounding areas; they are not likely to cause great ecosystem disruption, but the mine operations should not be a source for weed introduction into surrounding environments. At minimum, areas that can serve as vectors such as helicopter landing areas, should be frequently monitored and controlled for non-native species.

Integrated weed management

A single technique is rarely adequate for successful control of multiple species or infestations; under an integrated approach, all control methods are considered and often applied in combination. Specific treatment prescriptions are determined by the biology of the particular plant species, site characteristics, management objectives, and resources available. Management techniques fall into three categories:

1. **Manual/Mechanical:** Hand pulling, mowing, tilling, and burning are commonly used to physically destroy weeds or interfere with their reproduction and can be used on small infestations of annual

or biennial species. To be most effective, treatment should take place before seed production. Plants that have flowered must be removed from the site and destroyed. Plants can be double bagged and transported to a designated disposal site; if possible, they should be incinerated. Repeated mowing or tilling during the growing season can effectively control or contain many weed species. Generally, manual/mechanical methods are not recommended as the sole approach for control of species that spread vegetatively.

All weeds should be collected (prior to fruiting) in contractor bags or doubled-up garbage bags and flown off site for disposal. On site disposal by burning bags of weeds in a contained unit, such as a burn barrel may be an acceptable alternative if transportation costs and volume of weeds are too high and if low-risk conditions for wildfire are present.

2. **Chemical:** Herbicides are likely to be the best option for larger infestations and for perennial species that do not respond well to manual and mechanical methods. The particular herbicide used and its rate of application depend on specific site characteristics, target plants, non-target vegetation, and land use. Herbicides are a particularly important method of treatment when complete eradication of a population is the management objective. Treatment at the earliest stage of invasion will greatly reduce the future need for additional herbicide applications. Herbicides often provide the only effective and feasible control of rhizomatous species, and species for which hand pulling or cutting is not effective. If applied in a specific manner and according to the label, herbicides can be extremely efficient in selectively removing weeds that are mixed in with native vegetation. This approach can reduce the amount of revegetation needed after the treatment is complete.
3. **Biological:** This method involves the use of herbivores and pathogens that are known to attack or eat the non-native species of interest in its native range. Introduced biological control species often have few natural enemies and consequently have the potential to become invasive themselves and attack non-target species. Permitting release of biological control agents requires many years of host specificity testing and evaluation by the U.S. Department of Agriculture's Animal and Plant Health Agency.

Education and outreach

Developing active awareness regarding threats posed by invasive species through educational programs and outreach activities helps promote effective weed management. We recommend that at least one CMR environmental compliance official attend a non-native plant identification workshop. To raise awareness among the staff, educational materials covering topics such as threats posed by, and diagnostic characteristics of, EDRR species could be shared with the staff and posted in common areas. Incentives could be offered, providing a reward for being the first to spot a new plant invader on the premises to encourage involvement and foster stewardship of the natural resources at the Mine.

Best Management Practices (BMPs)

Many of the less invasive species (such as *Plantago major*) found at the Big Nugget Camp are widespread in Alaska. These type of species are an indication that current practices facilitate the arrival, dispersal, and establishment of non-native plant species. Similarly, highly invasive species can arrive to the area in the same way as the weakly invasive species, such as on unwashed vehicles and equipment or through contaminated fill. These small populations pose low threat to ecosystem structure and function, but the likelihood of reintroduction from people, vehicles, and equipment is high. For these reasons, we recommend that efforts should be placed first on preventing the introduction of new, more aggressive species (e.g. yellow sweetclover) to the site and second on controlling the more widespread and less invasive non-native species. Preventing the introduction of new species also prevents the reintroduction of the current species.

Not all weed management actions are appropriate for all sites; management plans need to be site-specific. Prevention practices should be evaluated to ensure they meet project-specific goals and stipulations, can be feasibly implemented, and are cost-effective. The latter should compare the costs associated with implementing a project, versus the cost associated with doing nothing and dealing with the consequent ecological damage (USFS 2001).

A new preventative approach for invasive species management, adopted by federal agencies and soon to be required of federal contractors, is following a Hazard Analysis and Critical Control Points (HACCP). This is a flow chart approach that breaks down steps of normal operating activities, identifies where contamination by an invasive species can occur, and specifies procedures to minimize those risks. For example, a normal operating procedure might be for mining personnel and equipment to be transported to remote mining locations. A HACCP would breakdown of each step of transport, from start to finish, and analyze each step to identify points of 'hazard'—i.e. where and how invasive species might be dispersed during this activity. The HACCP may then implement an extra step from BMP, such as brushing off equipment or clothing before loading the helicopter/establishing a boot-brush station (as at USFS trailheads). A suggested HACCP of a single activity for CMR is located in Appendix 3. The HACCP can be rewritten and adapted as work procedures and goals of CMR change, or if alternative cost-saving methods become available. HACCP are meant to be written for activities that differ in execution and goals. Therefore different HACCPs are recommended to be written for: personnel and equipment transport within a helicopter, equipment transport slung by helicopter, and vehicle entry to weed free zones.

Highly invasive plant species can arrive to the area the same pathway as the weakly invasive species

Indeed, the most effective, economical, and ecologically sound approach to managing invasive plants is to prevent their introduction. It is recommended that those responsible for environmental compliance at the mine implement the following BMPs, which are central to actively preventing the introduction of weeds into the remote mining area as well as managing infestations (modified from USFS 2001):

Ground disturbing activities and maintenance projects

1. Incorporate weed prevention and management into project design, evaluation, and decisions. The HACCP included in Appendix 3 falls under this objective.
    a. Assess the risks of possible introduction and spread, analyze treatment options for high-risk sites, and identify prevention practices.

    b. Determine necessary actions to control weeds at the start of project planning (e.g. determine how to obtain herbicide permits, if needed).
    c. Manage sources of weed propagules and seeds to prevent and limit their spread.
2. Prior to ground-disturbing actions, inventory weed populations at the project site and along access routes, and prioritize populations for control. Take control actions where necessary.
    a. Start projects in areas not infested, or minimally infested with weeds, then move into weed-infested areas later, as necessary.
    b. Use staging areas that are weed-free. Restrict or minimize travel through weed-infested areas, or move through these areas only when propagules and seeds are not likely to spread (e.g. before plants begin to flower and produce seed).
    c. Identify sites for equipment cleaning. Plant parts, mud, and dirt are advised to be removed from equipment before moving into the project area, when exiting the project area if the site has weeds, or traveling to weed-free sites. Where practical, seeds and plant parts should be incinerated.
    d. Consider closing off access to sensitive areas to allow native vegetation to reestablish.
3. Clean equipment and gear.
    a. Workers are recommended to inspect their clothing, boots, tool bags, and other gear. These should be free of plant parts, seeds, and mud; debris should be removed and double bagged for later incineration.
        i. Clothing, hats, socks, shoes, gloves, and jackets should be thoroughly inspected for above-listed materials. Pockets should be turned inside out to remove debris. Shoelaces and shoe tongues should be checked. Upon inspection, pre-clean personal gear by physical removal of contaminated material with a stiff brush, adhesive roller, compressed air, or pressurized hot water. Particular attention must be given to places where foreign material could become accidentally trapped, such as in the cuffs and folds of clothing, treads of boots or waders, or closures such as zippers, velco grips, ties, and shoe laces. Boot-brush stations at entry points to weed-free areas are a cheap and effective tool for reducing the spread of weed seeds on footwear and is a good reminder for invasive species awareness.
        ii. If weeds are removed from parking areas and building areas within camp, then we recommend placement of cleaning stations in easily accessible sites such as at the dining area or below the helicopter loading area.
    b. Inspect and clean equipment, vehicles, machinery, and other gear. High pressure washing is recommended to clean heavy equipment and vehicles. A manual for standard practices is covered by DiVittorio et al. (2012). In some cases, air pressure is sufficient to remove light debris.
    c. Cleaning gear is particularly important when moving from a site infested with non-native plants to a weed-free site. Attention should be paid when vehicles and gear are moved from outside regions that have high non-native plant densities and diversity (e.g. Anchorage, Fairbanks, Mat-Su, and Kenai). Heavy equipment, pallets, and other materials should be inspected and cleaned prior to transport to the mine to prevent new introductions.
4. Prevent weed introduction and dispersal via gravel, sand, or other fill materials.
    a. Maintain stores of materials in weed-free condition. Regularly inspect material source areas for weeds. As necessary, treat these sites and strip off contaminated material before use of pit material. Do not use any materials contaminated with weeds.

   b. During construction activities, do not dump invasive plant-contaminated waste on established, desired vegetation; instead, dispose of waste and invasive plant contaminated soil at a designated disposal site.
   c. Where soil has been disturbed and/or where weed treatment takes place, continue monitoring and control actions for at least five years after project completion.
5. Minimize sources of non-native plant seed along roadsides to limit transportation to other areas.
   a. Roads and right-of-ways should be inspected periodically for weeds. Inventory, document, and schedule treatment for infestations.
   b. When decommissioning a road, treat weeds on the road before they become impassible. Monitor and do follow-up treatments as necessary.
   c. Consult a professional before pulling or cutting weeds to ensure effective methods are used. Schedule treatment for when propagules and seeds are least viable and likely to be spread. Work from areas with fewer weeds to areas more densely infested. Minimize soil disturbance. Properly dispose of weed waste or keep it contained on-site.
6. Maintain intact ecosystems as much as possible.
   a. In areas with a naturally dense canopy cover, maintain this cover as much as possible to inhibit the establishment of weeds. Keep as much native vegetation as possible in and around the project area.
   b. Minimize soil disturbance as much as possible to avoid causing conditions in which weeds thrive.

Revegetation

Revegetation can include planting, seeding, mulching, fertilizing, liming, and topsoil replacement.

1. Restore disturbed sites in a timely manner. Site reclamation should take place immediately after a soil-disturbing project is completed.
2. Where practical, set aside sod and/or topsoil before projects commence on weed-free sites, and use the sod or topsoil to restore disturbed ground.
3. Where sod and/or topsoil are not set aside for site restoration, reseed with weed-free perennial grasses and forbs that are quick to establish; this encourages the growth of native species and provides competition for non-native species.
4. All revegetation projects should use certified weed-free products; weed-free, locally sourced material is recommended. Use of locally-produced certified weed-free straw and plant materials will decrease the potential for seed contaminants. More information about sources of these materials and planting guidelines can be found at the Alaska Plant Materials Center website.

Education

1. Raise awareness among staff and visitors regarding non-native plants. A particular emphasis should be placed on measures to prevent introduction from off-site sources.
2. Provide training and educational materials regarding plant identification, impacts, and preventative actions to staff.
3. Designate at least one weed management expert on staff.
4. Create incentives for workers to look out for new weeds.
5. Post educational displays, including prevention practices, at housing facilities and offices.
6. Lead by example. Prevent and treat weeds around administrative sites.

Conclusion

The invasive plant survey of the CMR study area highlights several findings. First, those species presently found at Big Nugget Camp that were unintentionally introduced are of low invasiveness and pose low threat to the surrounding ecosystem, but still have the potential to spread off the human footprint. Although these are not very aggressive species, it is recommended that an effort be made to control and eliminate populations to the extent practicable. Second, newly constructed road areas have no non-native species and a high effort should be given to keep them weed free. These areas should be surveyed by mining staff yearly to ensure BMPs are effective, otherwise BMPs should be revised as needed. Third, personnel and equipment/vehicles should follow BMPs when possible to keep weed free areas intact. Implementing comprehensive weed monitoring and management measures is the best way to avoid future financial expenses and to defend against long-term degradation of native plant communities and wildlife that depend on them.

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Appendix 1. Herbarium Vouchers

The following table is a list of herbarium vouchers collected during the survey along with their associated location. Specimens are housed at the University of Alaska Anchorage Herbarium (UAAH). Specimen data are viewable online at www.pnwherabria.org. Coordinates of collections occurring on Big Nugget Camp are obscured to protect private property.

Scientific Name	Collector Number	UAAH Accession	Latitude	Longitude	Date	Locality
Elymus hirsutus	JRF 2015-004a	7947	59.42275	-136.25304	6/29/2015	Porcupine Road, 2.8km east of Glacier Creek.
Arnica chamissonis ssp. *foliosa*	JRF 2015-001	7944	59.42296	-136.24547	6/29/2015	Porcupine Road, 2.8km east of Glacier Creek
Poa palustris	JRF 2015-003	7946	59.42299	-136.24547	6/29/2015	Porcupine Road, 2.8km east of Glacier Creek
Antennaria pulcherrima	JRF 2015-002	7945	59.42387	-136.26019	6/29/2015	Porcupine Road, 2.8km east of Glacier Creek
Aster modestus	JRF 2015-004b	7948	59.42210	-136.26782	6/30/2015	Porcupine Road, 2.8km east of Glacier Creek
Arabis eschscholtziana	JRF 2015-011	7952	59.38900	-136.37600	7/1/2015	West mountain side of Glacier creek.
Ribes laxiflorum	JRF 2015-010	7951	59.39072	-136.37305	7/1/2015	West mountain side of Glacier creek.
Arabis lyrata ssp. *kamchatica*	JRF 2015-012	7953	59.38900	-136.37600	7/2/2015	West mountain side of Glacier creek.
Calamagrostis canadensis	JRF 2015-009	7950	59.39072	-136.37305	7/2/2015	West mountain side of Glacier creek.
Poa pratensis	JRF 2015-020	7960	59.41416	-136.08297	7/2/2015	Porcupine Road, 2.2km east of Herman creek.
Veronica americana	JRF 2015-018	7958	59.42091	-136.18772	7/2/2015	Porcupine Road, 2km east of Porcupine creek.
Poa palustris	JRF 2015-004c	7949	59.42275	-136.25301	7/2/2015	Porcupine Road, 2.5km east of Glacier Creek.
Elymus hirsutus	JRF 2015-017	7957	59.42275	-136.25301	7/2/2015	Porcupine Road, 2.5km east of Glacier Creek.
Erigeron acris ssp. *politus*	JRF 2015-019	7959	59.4206	-136.1364	7/2/2015	Porcupine Rd, 4.8km east of Glacier Creek.
Cinna latifolia	JRF 2015-013	7954	59.4	-136.2	7/3/2015	Big Nugget Camp on Porcupine road.
Melilotus officinalis	JRF 2015-023	7963	59.412752	-136.007424	7/3/2015	Porcupine Road, approx. .25km west of Y intersection.

Appendix 2. Sites Species List

Summary of all non-native plant species known to occur in the Haines region (AKEPIC 2015). Species in **bold** have been found less than 20 km from Big Nugget Camp and would be most likely to occur within the study area. Asterisk (*) indicates AK State Prohibited Noxious Weed. Invasiveness rank is calculated based on a species' ecological impacts, biological attributes, distribution, and response to control measures. The ranks are scaled from 0 to 100, with 0 representing a plant that poses no threat to natural ecosystems and 100 representing a species that poses a major threat to natural ecosystems.

Common Name	Scientific Name	Invasiveness Rank	Found in Study Area
alsike clover	***Trifolium hybridum***	57	X
annual bluegrass	***Poa annua***	46	X
big chickweed	***Cerastium fontanum* ssp. *vulgare***	36	X
bigleaf lupine	*Lupinus polyphyllus* ssp. *polyphyllus*	71	
birdsrape mustard	*Brassica rapa*	50	
black bindweed	*Fallopia convolvulus*	50	
bladder campion	*Silene latifolia*	42	
brittlestem hempnettle*	***Galeopsis tetrahit****	50	
bromegrass	*Bromus secalinus*	NR	
bull thistle	*Cirsium vulgare*	61	
Canada bluegrass	***Poa compressa***	39	
Canada thistle*	***Cirsium arvense****	76	
cicer milkvetch	***Astragalus cicer***	NR	
common chickweed	*Stellaria media*	42	
common comfrey	*Symphytum officinale*	48	
common dandelion	***Taraxacum officinale***	58	X
common eyebright	***Euphrasia nemorosa***	42	
common groundsel	***Senecio vulgaris***	36	
common plantain	***Plantago major***	44	X
common sheep sorrel	*Rumex acetosella*	51	
common tansy	***Tanacetum vulgare***	60	
corn spurry	***Spergula arvensis***	32	
creeping buttercup	***Ranunculus repens***	54	
crested wheatgrass	*Agropyron cristatum*	NR	
crownvetch	*Coronilla varia*	68	
curly dock	***Rumex crispus***	48	X
European forget-me-not	*Myosotis scorpioides*	54	
European mountain ash	*Sorbus aucuparia*	59	
fall dandelion	*Leontodon autumnalis*	51	
field bindweed*	*Convolvulus arvensis**	56	
field pennycress	*Thlaspi arvense*	42	
foxtail barley	***Hordeum jubatum***	63	X

Common Name	Scientific Name	Invasiveness Rank	Found in Study Area
garden sorrel	***Rumex acetosa***	NR	
Kentucky bluegrass	***Poa pratensis* ssp. *pratensis***	52	X
lambsquarters	***Chenopodium album***	37	
low cudweed	*Gnaphalium palustre*	NR	
low cudweed	*Gnaphalium uliginosum*	NR	
meadow foxtail	***Alopecurus pratensis***	52	
mountain tarweed	*Madia glomerata*	NR	
narrowleaf hawksbeard	***Crepis tectorum***	56	
orange hawkweed*	*Hieracium aurantiacum**	79	
orchardgrass	***Dactylis glomerata***	53	
ornamental jewelweed	*Impatiens glandulifera*	82	
oxeye daisy	***Leucanthemum vulgare***	61	X
perennial sowthistle*	*Sonchus arvensis**	73	
pineappleweed	***Matricaria discoidea***	32	X
prostrate knotweed	***Polygonum aviculare***	45	
purple foxglove	*Digitalis purpurea*	51	
quackgrass*	***Elymus repens****	59	
rampion bellflower	*Campanula rapunculoides*	64	
red clover	***Trifolium pratense***	53	X
red sandspurry	*Spergularia rubra*	34	
reed canarygrass	***Phalaris arundinacea***	83	
rugosa rose	***Rosa rugosa***	72	
shepherd's purse	***Capsella bursa-pastoris***	40	
Siberian wildrye	***Elymus sibiricus***	53	
smooth brome	***Bromus inermis***	62	
splitlip hempnettle	***Galeopsis bifida***	50	
spotted knapweed	***Centaurea stoebe***	86	
spreading bluegrass	***Poa pratensis* ssp. *irrigata***	52	X
sticky chickweed	*Cerastium glomeratum*	36	
sticky ragweed	*Senecio viscosus*	NR	
tall buttercup	***Ranunculus acris***	54	
thymeleaf speedwell	***Veronica serpyllifolia* ssp. *serpyllifolia***	36	
timothy	***Phleum pratense***	54	X
tower rockcress	***Arabis glabra***	NR	
tumbling mustard	***Sisymbrium altissimum***	NR	
white clover	***Trifolium repens***	59	X
white sweetclover	***Melilotus albus***	81	
yellow sweetclover	***Melilotus officinalis***	69	X
yellow toadflax	***Linaria vulgaris***	69	

Summary of all plant species observed on the Yellow Section with average percent cover and percent frequency. Non-native plant species have an associated Invasive Rank.

Common Name	Species	Avg. % Cover	% Freq.	Invasiveness Rank
boreal yarrow	*Achillea borealis*	0.31	8.33	
rough bentgrass	*Agrostis scabra*	0.1	16.67	
bentgrass	Agrostis spp.	0.01	8.33	
Sitka alder	*Alnus viridis* ssp. *sinuata*	1.08	16.67	
green alder	*Alnus viridus*	2.92	16.67	
lyrate rockcress	*Arabis lyrata*	0.04	8.33	
Chamisso arnica	*Arnica chamissonis*	0.38	8.33	
Tilesius' wormwood	*Artemisia tilesii*	0.08	8.33	
giant mountain aster	*Aster modestus*	0.05	8.33	
alpine milkvetch	*Astragalus alpinus*	0.42	8.33	
common ladyfern	*Athyrium filix-femina*	4.01	25	
bluejoint	*Calamagrostis canadensis*	0.06	8.33	
silvery sedge	*Carex canescens*	0.31	8.33	
big chickweed	*Cerastium fontanum* ssp. *triviale*	0.81	41.67	36
fireweed	*Chamerion angustifolium*	2.69	50	
small enchanter's nightshade	*Circaea alpina*	0.05	8.33	
bunchberry dogwood	*Cornus canadensis*	1.82	16.67	
redosier dogwood	*Cornus sericea*	2.69	33.33	
Bering's tufted hairgrass	*Deschampsia beringensis*	0.05	8.33	
northern ryegrass	*Elymus hirsutus*	0.51	41.67	
Hornemann's willowherb	*Epilobium hornemannii*	0.06	8.33	
field horsetail	*Equisetum arvense*	1.55	41.67	
horsetail	*Equisetum* spp.	4.89	50	
stickywilly	*Galium aparine*	0.86	41.67	
northern bedstraw	*Galium boreale*	0.04	8.33	
woolly geranium	*Geranium erianthum*	0.26	16.67	
largeleaf avens	*Geum macrophyllum*	0.89	41.67	
western oakfern	*Gymnocarpium dryopteris*	2.25	25	
oakfern	Gymnocarpium spp.	1.26	16.67	
foxtail barley	*Hordeum jubatum*	0.21	8.33	63
disc mayweed	*Matricaria discoidea*	0.06	8.33	32
devilsclub	*Oplopanax horridus*	2.76	25	
timothy	*Phleum pratense*	0.31	8.33	54
common plantain	*Plantago major*	0.61	50	44
annual bluegrass	*Poa annua*	0.05	16.67	46
fowl bluegrass	*Poa palustris*	0.55	50	
Kentucky bluegrass	*Poa pratensis*	0.72	33.33	52

Common Name	Species	Avg. % Cover	% Freq.	Invasiveness Rank
balsam poplar	*Populus balsamifera*	2.66	41.67	
largeflowered wintergreen	*Pyrola grandiflora*	0.15	16.67	
woodland buttercup	*Ranunculus uncinatus*	1.04	16.67	
Nootka rose	*Rosa nutkana*	2.49	16.67	
salmonberry	*Rubus spectabilis*	0.21	8.33	
blackberry, dewberry, raspberry	*Rubus* spp.	0.06	8.33	
Barclay's willow	*Salix barclayi*	1.56	16.67	
undergreen willow	*Salix commutata*	0.21	8.33	
Sitka willow	*Salix sitchensis*	0.52	8.33	
willow	*Salix* spp.	1.41	16.67	
arrowleaf ragwort	*Senecio triangularis*	0.21	8.33	
russet buffaloberry	*Shepherdia canadensis*	0.08	8.33	
claspleaf twistedstalk	*Streptopus amplexifolius*	0.7	33.33	
northern dandelion	*Taraxacum alaskanum*	0.06	8.33	
common dandelion	*Taraxacum officinale*	1.92	25	58
dandelion	*Taraxacum* spp.	1.27	50	
bigflower tellima	*Tellima grandiflora*	0.21	8.33	
western meadow-rue	*Thalictrum occidentale*	0.04	8.33	
long beechfern	*Thelypteris phegopteris*	1.39	8.33	
threeleaf foamflower	*Tiarella trifoliata*	0.05	8.33	
arctic starflower	*Trientalis europaea*	0.13	16.67	
white clover	*Trifolium repens*	4.17	66.67	59
clover	*Trifolium* spp.	0.01	8.33	50-59
western hemlock	*Tsuga heterophylla*	0.01	8.33	
mountain hemlock	*Tsuga mertensiana*	1.77	33.33	
stinging nettle	*Urtica dioica*	1.46	16.67	
oval-leaf blueberry	*Vaccinium ovalifolium*	0.32	16.67	
blueberry	*Vaccinium* spp.	0.31	8.33	
thymeleaf speedwell	*Veronica serpyllifolia*	0.04	8.33	
American alpine speedwell	*Veronica wormskjoldii*	0.52	16.67	
squashberry	*Viburnum edule*	3.22	33.33	
-	Bare Ground	7.45	25	
-	Unidentified Forb	0.19	50	
-	Unidentified Grass	0.31	8.33	
-	Unidentified Moss	0.01	8.33	

Summary of non-native plant species found between Yellow Sites on Yellow Section of Porcupine Road.

Lat	Long	Scientific Name	Common name	Area Cover (acres)	%Cover
59.421330	-136.226985	*Trifolium pratense*	red clover	0.005	1
59.421330	-136.226985	*Plantago major*	common plantain	0.025	5
59.421330	-136.226985	*Trifolium hybridum*	alsike clover	0.005	1
59.421330	-136.226985	*Trifolium repens*	white clover	0.005	1
59.422408	-136.234460	*Taraxacum officinale*	common dandelion	0.025	5
59.422408	-136.234460	*Trifolium repens*	white clover	0.005	1
59.422408	-136.234460	*Trifolium hybridum*	alsike clover	0.005	1
59.422833	-136.241845	*Trifolium pratense*	red clover	0.001	trace
59.422833	-136.241845	*Trifolium hybridum*	alsike clover	0.001	trace
59.422833	-136.241845	*Trifolium repens*	white clover	0.001	trace
59.422833	-136.241845	*Taraxacum officinale*	common dandelion	0.001	trace
59.422863	-136.249248	*Trifolium repens*	white clover	0.025	5
59.422863	-136.249248	*Trifolium pratense*	red clover	0.005	1
59.422863	-136.249248	*Taraxacum officinale*	common dandelion	0.005	1
59.422863	-136.249248	*Plantago major*	common plantain	0.005	1
59.422594	-136.250438	*Leucanthemum vulgare*	oxeye daisy	0.01	2
59.423303	-136.256605	*Taraxacum officinale*	common dandelion	0.005	1
59.423303	-136.256605	*Trifolium repens*	white clover	0.005	1
59.422405	-136.272199	*Trifolium repens*	white clover	0.01	2
59.422125	-136.230700	*Trifolium hybridum*	alsike clover	0.02	1
59.422690	-136.238220	*Trifolium hybridum*	alsike clover	0.02	trace
59.423855	-136.260185	*Trifolium hybridum*	alsike clover	0.02	1
59.422110	-136.267860	*Trifolium hybridum*	alsike clover	0.02	5
59.422975	-136.245470	*Trifolium pratense*	red clover	0.02	1
59.423855	-136.260185	*Trifolium pratense*	red clover	0.02	1

Summary of plants observed on Red Section. *No non-native species were observed*.

Common Name	Species	Avg. % Cover	% Frequency
green alder	*Alnus viridis*	11.66	45.45
common ladyfern	*Athyrium filix-femina*	1.41	18.18
bunchberry dogwood	*Cornus canadensis*	1.9	45.45
spreading woodfern	*Dryopteris expansa*	20.15	72.73
-	Grass spp. (Hydroseed mix)	0.35	63.64
western oakfern	*Gymnocarpium dryopteris*	3.54	72.73
rusty menziesia	*Menziesia ferruginea*	0.34	18.18
devilsclub	*Oplopanax horridus*	10.72	63.64
Sitka spruce	*Picea sitchensis*	0.27	9.09
Schreber's big red stem moss	*Pleurozium schreberi*	0.57	9.09
knights plume moss	*Ptilium crista-castrensis*	0.08	18.18
goose neck moss	*Rhytidiadelphus loreus*	0.27	9.09
robust rhytidiopsis moss	*Rhytidiopsis robusta*	0.01	9.09
trailing black currant	*Ribes laxiflorum*	1.07	18.18
American red raspberry	*Rubus idaeus*	0.57	18.18
strawberryleaf raspberry	*Rubus pedatus*	2.95	45.45
salmonberry	*Rubus spectabilis*	1.89	9.09
red elderberry	*Sambucus racemosa*	0.23	9.09
claspleaf twistedstalk	*Streptopus amplexifolius*	1.53	45.45
threeleaf foamflower	*Tiarella trifoliata*	0.05	9.09
western hemlock	*Tsuga heterophylla*	3.41	18.18
stinging nettle	*Urtica dioica*	0.34	9.09
oval-leaf blueberry	*Vaccinium ovalifolium*	0.77	36.36
-	Bare ground	9.16	36.36
-	Unidentified forb	0.15	27.27
-	Unidentified Moss	3.74	36.36

Summary of plants observed at Switchback Section. *No non-native species were observed*.

Common Name	Plant Species	Avg. % Cover	% Frequency
Sitka alder	*Alnus viridis* ssp. *sinuata*	66	81.82
bride's feathers	*Aruncus dioicus*	1.36	9.09
common ladyfern	*Athyrium filix-femina*	6.41	36.36
bluejoint	*Calamagrostis canadensis*	13.41	9.09
fireweed	*Chamerion angustifolium*	3.18	27.27
spreading woodfern	*Dryopteris expansa*	10.08	27.27
stickywilly	*Galium aparine*	0.27	9.09
western oakfern	*Gymnocarpium dryopteris*	1.36	9.09
devilsclub	*Oplopanax horridus*	20.35	54.55
trailing black currant	*Ribes laxiflorum*	9.09	18.18
red currant	*Ribes triste*	7.73	9.09
salmonberry	*Rubus spectabilis*	6.14	18.18
red elderberry	*Sambucus racemosa*	3.41	9.09
arrowleaf ragwort	*Senecio triangularis*	0.27	9.09
green false hellebore	*Veratrum viride*	0.45	9.09

Appendix 3. Example Hazard Analysis and Critical Control Points (HACCP) for Palmer VMS Project led by Constantine Metal Resources (CMR).

Hazard Analysis and Critical Control Point (HACCP) is planning for risk management and was originated in the food industry, but has been useful in other industry applications. Recently, federal agencies have adopted HACCP for risk management of invasive species.

The analysis examines activities to determine if invasive species can be inadvertently moved or introduced during the activity. It can identify steps in an activity where there are opportunities to reduce the risk of invasive species introduction by implementing a control measure. Corrective actions are used to when control measures are not successful. HACCP's can be rewritten as needed when activities, goals, procedures, change or when alternative control measure methods are more practical.

All routine activities at the study area should be examined and addressed if they provide a potential for invasive species dispersal. While a HACCP can be written for any biological invasive species, the one provided below is only focused on terrestrial plant species. An online tool is available to assist with the design and input of a HACCP available at: http://www.haccp-nrm.org/. Further resources to build tailored plans are available below.

There are seven principles for writing a HACCP to suit an activity or procedure. These have been adapted from the American Society for Testing and Materials (ASTM) International standard under the Standard Guide for Conducting Hazard Analysis-Critical Control Point Evaluations (ASTM E2590-15).

- **Principle 1**: *Conduct a hazard analysis*.
  Determine the invasive species (hazards) and identify all steps of a procedure. Identify the area of occurrence and potential control methods. For example: Learn the known invasive species in the vicinity of a work area, transportation corridors, and airstrips. Learn the risks and treatment options associated with each species.

- **Principle 2:** *Identify critical control points (CCP).*
  A critical control point is a point or step in a procedure at which control can be applied and, as a result, invasive species infestations can be prevented, eliminated, or reduced to an acceptable level. For example: Have invasive species become prevalent along roadsides and have potential to move into adjacent disturbed or bare ground? Where does cleaning occur for vehicles, machinery and tools that may have invasive species propagules on them from working in weed-infested areas? The point of origin would be the critical control point to take action on.

- **Principle 3**: *Establish critical limits for each CCP*.
  A critical limit is the maximum or minimum value to which a physical, biological, or chemical hazard must be controlled at a critical control point to prevent, eliminate, or reduce to an acceptable level. For example: Low risk species such as common dandelions might be present and ignored due to the low environmental impact, however they can indicate a lack of prevention or contamination. A few individuals may not cause alarm, however large abundances have significant impact. The presence of high risk species such as white sweetclover, orange hawkweed, or spotted knapweed should cause concern because these species are highly invasive and can be easily transported.

- **Principle 4**: *Establish critical control point monitoring requirements.*
  Monitoring activities are necessary to ensure the prevention process is effective at each critical control point. For example: Are cleaning techniques effective at removing all mud, debris and materials that may contain invasive species propagules or seeds? Conduct EDRR.

- **Principle 5**: *Establish corrective actions*.
  If monitoring indicates a CCP is not working, an alternative method should be implemented. A HACCP plan should identify the corrective actions to be taken if a critical limit is not met. For example: Do you need to implement different equipment cleaning techniques? Dry brushing versus high-pressure washing? Conduct EDRR to contain invasive species infestations.

- **Principle 6**: *Establish record keeping procedures*.
  Maintain records of invasive species occurrence, treatment methods and frequency, treatment effectiveness, and results of monitoring and treatment activities. For example: Keep notes about where invasive species are occurring and have contractors provide details on control methods.

- **Principle 7**: *Establish procedures to verifying the HACCP system is working*. Validation ensures that the plans are successful in reducing or eliminating invasive species spread. Permittees can validate their own HACCP plans. Validation procedures may include such activities as review of HACCP plans, CCP records, monitoring and control activities.

The HACCP below is provided as an example, not a recommendation, and should be revised as needed by onsite managers to meet their goals. Resources are available for managers to create suitable HACCP that meet their goals.

Resources:

- Managing Natural Resources Pathway: http://haccp-nrm.org/default.asp
- ASTM E2590-15, Standard Guide for Conducting Hazard Analysis-Critical Control Point (HACCP) Evaluations, ASTM International, West Conshohocken, PA, 2015, http://www.astm.org/Standards/E2590.htm
- USDA Managers Toolkit, Best Management Practices. http://www.invasivespeciesinfo.gov/toolkit/preventionbmp.shtml
- DiVittorio, J., Grodowitz, M., Snow, J., & Manross, T. (2012). Inspection and cleaning manual for equipment and vehicles to prevent the spread of invasive species (No. DIBR-TM-86-68220-07-05).

HACCP Step 1 – Activity Description

Management Objective & Contact Information	
HACCP Plan Title: Palmer VMS CMR Ltd. EXAMPLE DRAFT HACCP 2016	
Management Objective: Reduce the risk of non-native plant species entry into mining project sites operated by CMR Ltd.	**Contact Person:** Darwin Greene
	Phone: 604-629-2348
	Email: darwin@constantinemetals.com

Activity Description i.e. Who; What; Where; When; How; Why
Who: CMR employees, contractors, and government inspectors who access project sites for mining related activities. What: Mining related activities at the project site. Where: Glacier Creek watershed. Mining activities occur in subalpine and alpine locations of surrounding mountains. Housing and operations originate at Big Nugget Camp located on Procupine Road. When: Daily during seasonal operating schedule. How: Retrieve appropriate personal and professional gear before leaving Camp. Transport by helicopter to and from project sites. Gear is unloaded and stored at Camp. Why: To transport employees to remote project sites that are not accessible by vehicle. Not all individuals who access the project site are performing the same activities. However, all individuals currently access the project site the same pathway, via helicopter. This plan is intended for individuals and gear carried inside the helicopter to minimize the risk of introduction of non-native plant species. Non-native aquatic plant species are not a risk factor.

HACCP Step 2 – Activity Flow Chart

Outline Sequential Tasks of Activity

Task 1	Title: Gather equipment and materials for site visit.
	Description: Employees gather personal and professional gear and materials for the site visit before heading to helicopter pad. Visually inspect and clean gear and clothing before loading helicopter.

Task 2	Title: Load helicopter.
	Description: Helicopter is loaded with all gear/equipment, materials, and personnel. Transport to site.

Task 3	Title: Arrive at project site, unload.
	Description: Arrive at site, unload gear and personnel. Perform job functions at work site. Transport may occur between sites.

Task 4	Title: Gather gear and materials. Load helicopter and return to base.
	Description: Employees gather gear and materials from work site. Load helicopter and return to base.

Task 5	Title: Arrive at base, unload.
	Description: Gear, materials, and personnel are unloaded at base. Travel and work completed.

HACCP Step 3 – Identify Potential Non-Targets

Non-Targets That May Potentially Be Moved/Introduced
Vertebrates: none
Invertebrates: none
Plants: All non-native and invasive plant species. High priority species to watch include: brittlestem hempnettle (*Galeopsis tetrahit*), Canada thistle (*Cirsium arvense*), quackgrass (*Elymus repens*), yellow sweetclover (*Melilotus officinalis*).
Other Organisms (pathogens, parasites, etc.): none

HACCP Step 4 – Non-Target Analysis Worksheet

1 **Tasks** (From Step 2)	2 **Potential Non-targets** (From Step 3)	3 **Risk Assessment** Are any non-targets significant? Yes or No	4 **Justification** Justify your answer in Column 3	5 **Control** What control measures can be applied during this task to reduce the risk of non-targets?	6 **CCP?** Is this task a CCP? Yes or No	7 **Justification** Justify your answer in Column 6
Task # _1_ Title: Gather equipment and materials for site visit.	Vertebrates none					
	Invertebrates none					
	Plants All non-native and invasive species.	Yes	Moderate risk that seeds and soil material could be in gear and clothes after contact in known weed areas.	Visually inspect clothes and gear for non-targets. Remove non-targets by hand, brush, adhesive roller, compressed air, or wash methods in a designated cleaning staging area.	Yes	If gear is not cleaned at this task, then non-target species will be loaded into helicopter.
	Others N/A	N/A	N/A	N/A	N/A	N/A
Task # _2_ Title: Load helicopter.	Vertebrates none					
	Invertebrates none					
	Plants All non-native and invasive species.	Yes	Low risk that seeds and soil material could attach to clothes after cleaning.	Monitor and control non-native plant species that occur between designated cleaning staging area and helicopter loading area.	No	Gear and clothing cleaning/inspection is better done well prior to helicopter loading and well away from helicopter area. This allows personnel to load helicopter safely and quickly.
	Others N/A	N/A	N/A	N/A	N/A	N/A
Task # _3_ Title: Arrive at project site, unload.	Vertebrates none					
	Invertebrates none					
	Plants All non-native and invasive species.	No	Risk is low because all gear/clothing was cleaned before arrival.	N/A	No	There are no significant non-targets associated with this task.

HACCP Step 4 – Non-Target Analysis Worksheet

1 **Tasks** (From Step 2)	2 **Potential Non-targets** (From Step 3)	3 **Risk Assessment** Are any non-targets significant? Yes or No	4 **Justification** Justify your answer in Column 3	5 **Control** What control measures can be applied during this task to reduce the risk of non-targets?	6 **CCP?** Is this task a CCP? Yes or No	7 **Justification** Justify your answer in Column 6
Task # _4_ Title: Gather gear and materials. Load helicopter and return to base.	Vertebrates none					
	Invertebrates none					
	Plants All non-native and invasive species.	No	Risk is low because all gear/clothing was cleaned before arrival.	N/A	No	There are no significant non-targets associated with this task.
	Others N/A	N/A	N/A	N/A	N/A	N/A
Task # _5_ Title: Arrive at base, unload	Vertebrates none					
	Invertebrates none					
	Plants All non-native and invasive species.	No	Risk is low because all gear/clothing was cleaned before arrival.	N/A	No	There are no significant non-targets associated with this task.
	Others N/A	N/A	N/A	N/A	N/A	N/A

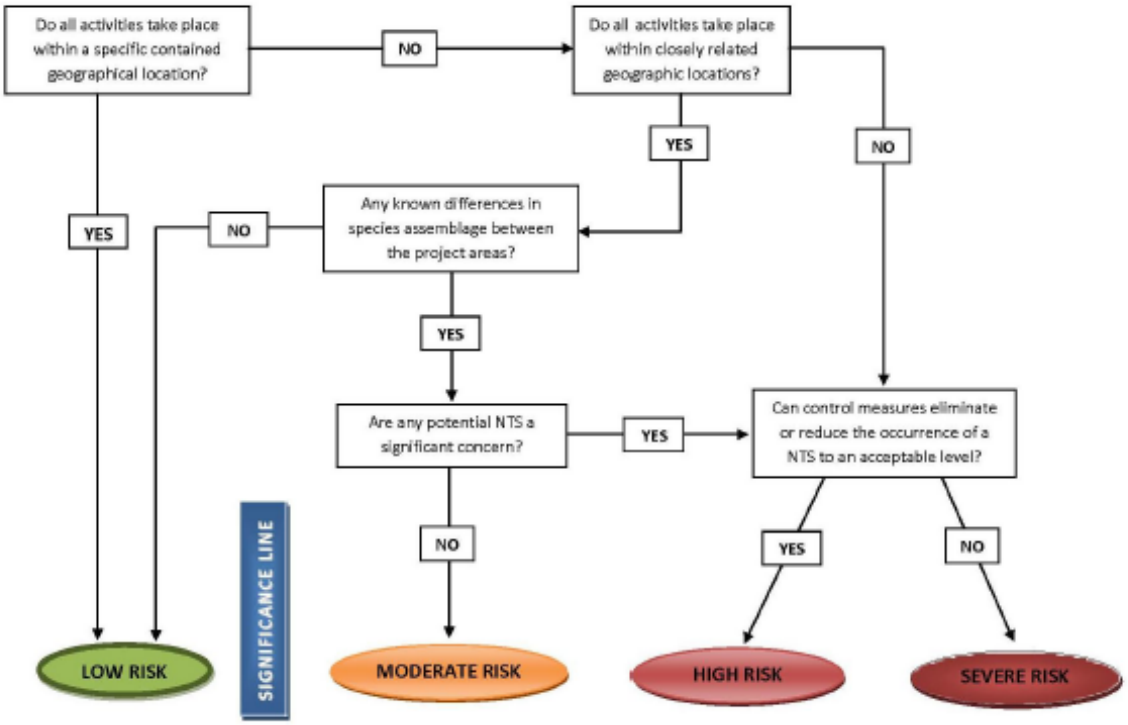
HACCP Step 5 – Non-Target Risk Action Plan (NTRAP)

(Use this form for any "Yes" from Column 6 of HACCP Step 4 - Non-Target Analysis Worksheet) **One page for each Critical Control Point**			
Mangement Objective **From Step 1**		Reduce the risk of non-native plant species entry into mining project sites operated by CMR Ltd.	
Critical Control Point: Task #	**1**	**Title:**	Gather equipment and materials for site visit.
Significant Non-Target(s) **(Step 4, Column 2)**		All non-native and invasive species.	
Control Measure(s) **(Step 4, Column 5)**		Visually inspect clothes and gear for non-targets. Remove non-targets by hand, brush, adhesive roller, or wash methods in a designated cleaning staging area.	
Precribed ranges, limits, or citeria for control measure(s): **(PRLC)**		No evidence of seed or soil material after initial inspection	
Monitoring the Control Measure(s)	**Who?**	Any personnel entering weed free areas operated by CMR Ltd.	
	How?	Visiual inspection of gear and clothing. Remove any seed material from clothes, remove soil from bottom of boots and gear/equipment.	
	Where?	At designated staging area that supplies brushes, adhesive rolers, compressed, and/or washing gear.	
	How often?	Every time gear/clothing will enter into weed free areas via helicopter.	
Corrective Action(s) **if Control Measures Fail** **(or PRLC cannot be met)**		Clothing or materials quaranteened for additional effort into seed removal with all control measures to remove non-targt material. If clothing cannot be cleaned of non-target material, then clothing should only be used in Camp or weeded areas.	
Supporting Documents **(*For example, Management Plan, Checklist, Decontamination Techniques, SOPs, Scientific Journal Articles, etc.*)**			
Alsaka State Noxious Weed List, AKEPIC Weed List, USFS 2001 Guide to Noxious Weed Prevention Practices, Hazard Analysis and Critical Control Point Planning for Natural Resource Management			
Development Team Members			
Date Developed:	**1/20/2016**	**Date(s) Reviewed:**	

** all gray fields are required*

HACCP Planning to Prevent Invasive Species

RISK ASSESSMENT DIAGRAM FOR TERRESTIAL MANAGEMENT ACTIVITIES



Appendix 4. EDDR Guide for Palmer VMS Project, Haines

The following pages are to help personnel recognize invasive species that occur within the region and their environmental impacts. Both sections are available online along with all invasive species tracked in the state by AKEPIC at: http://accs.uaa.alaska.edu/invasive-species/non-native-plants/

The first section will help individuals to identify invasive species from natives ones. We recommend mining staff to be aware of the general look of these species and report them to an authorized manager or 'weed expert' on staff. The 'weed expert' should determine if the questionable plant matches the description in the guide. If so, the 'weed expert' should get verification if it is a high priority species or if they are uncertain of the identification. Photos, details of distinguishing plant parts (e.g., flower color, number of leaves, smells, thorns, etc.), general details of the surrounding area (e.g. roadside, parking lot, etc.) and approximate GPS location should be collected for verification of the questionable plant. These data can be submitted online to the University of Alaska Fairbanks Cooperative Extension Service (http://www.uaf.edu/ces/ipm/cmp/sample-submission/) for identification help.

An alternative and easy method for identification help is the use of the Alaska Weeds ID mobile app available for smartphones (http://apps.bugwood.org/apps/alaska/). This all in one feature app provides identification help and assists with data collection. Data be automatically submitted to UAF Cooperative Extension Service.

The second section is composed of species biographies for invasive plants of the region. These species biographies provide detailed information on the environmental impacts of the species and justification for their invasiveness rank.

Alaska Weeds ID app available for Android and iPhone IOS.