Salmon Lake-Kigluaik Special Recreation Management Area
Invasive Plant Management Plan

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Submitted in partial fulfillment of grant #L10AC16419 and #L09AC15872 to:

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Anchorage Field Office
4700 BLM Road
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March 9, 2011

Table of Contents

Figures

Tables

Acknowledgments

We wish to thank Laurie Thorpe (Bureau of Land Management) and the Kawerak Inc. staff and youth for their help and enthusiasm while preparing and conducting this invasive plant study. We are grateful to Matt Carlson for his helpful suggestions on an earlier version of this report. Finally, special thanks to Lindsey Flagstad for helping develop the contents of non-native plant workshop that we gave in Nome.

Introduction

The establishment, growth, and persistence of non-native[1] plant species pose a serious threat to native ecosystems. Even though not all non-native species cause significant economic or ecological harm, *invasive*[2] plants (hereafter also referred to as weeds) are well known to alter community composition, successional pathways, nutrient cycling, hydrology, and fire regimes, as well as to reduce or eliminate threatened and endangered native species populations (U.S. Congress 1993, Busch 1995, Myers 1997, Brooks 1999, Stein *et al*. 2000).

While invasive plants constitute a major problem in the lower 48 states (*cf*. Randall 1996), Alaska has remained largely unaffected by non-native plants. However, over the last ten years there has been a marked acceleration in the rate of introduction of non-native plants to the state, probably driven by increases in population, commerce, development, gardening, and outdoor recreation activities (Carlson and Shephard 2007).

The susceptibility of native plant communities to invasion is largely a function of the degree to which communities are naturally or anthropogenically disturbed (Hobbs and Huenneke 1992). In Alaska, non-native plant occurrence is most strongly correlated with high-use areas, such as transportation routes (roads, trails, and railroads), campgrounds, cabins, and boat ramps. Increased opportunities for introduction and for low competition, disturbed substrates likely both contribute to non-native plant establishment in high-use areas. In some cases, however, invasive weeds have even been documented moving off the human footprint into natural ecosystems (Lapina *et al*. 2007; Cortés-Burns *et al*. 2007, 2008; Conn *et al*. 2008; Villano and Mulder 2008).

Background information and objectives

The Salmon Lake-Kigluaik Special Recreation Management Area (SRMA) is located at the eastern end of the Kigluaik Mountains, near milepost 40 on the Kougarok Road, in the Seward Peninsula. The area consists of a campground, offering six campsites with fire pits and picnic tables, an unimproved boat launch at Salmon Lake, and an outhouse. Salmon Lake constitutes the spawning grounds for the northernmost run of sockeye salmon in the United States. The Bureau of Land Management Anchorage Field Office (BLM-AFO) administers this area.

The BLM-AFO is in the process of developing an off-highway vehicle (OHV) and travel management plan for the Salmon Lake-Kigluaik SRMA. As part of this plan, BLM-AFO wishes to identify the current impacts of off-highway vehicle (OHV) travel on the SRMA's natural resources, and develop measures to mitigate damage from future use. To determine the extent to which the area's existing high-use sites, and roads and OHV trails in particular, are impacting the health and integrity of natural habitats in the SRMA, good baseline information on the abundance, diversity, and distribution of non-native weeds in the area is needed.

[1] Non-native plants are plants whose presence in a given area is due to the accidental or intentional introduction by humans (AKEPIC 2005)

[2] Invasive plants are non-native plants that produce viable offspring in large numbers and have the potential to establish and spread in natural areas (AKEPIC 2005). Some invasive plants have strong negative impacts on native ecosystems, cause important economic losses, or can be detrimental to human health.

In 2010 BLM-AFO entered into an agreement with the Alaska Natural Heritage Program (AKNHP) to conduct a non-native plant[3] study and develop a weed management plan for the area[4]. Additional BLM-AFO funding[5] was secured to help train Nome youth (hired by Kawerak Inc.) in invasive plant species identification, survey, and management techniques. The main objectives of this partnership between BLM-AFO, AKNHP, and Kawerak Inc. were to:

1. survey the Salmon Lake campground for non-native plant infestations, focusing on high-use sites such as the campsites, outhouse, boat launch areas, and OHV trails (namely, the access road and hiking trails)
2. record additional infestations and identify source areas, vectors of dispersal, and weed-free sites
2. have AKNHP assist the Kawerak Inc. youth in the development of a weed management plan for the area
3. encourage long-term stewardship of the area's natural resources
4. provide skills and employment in a region with fewer economic opportunities.

This report primarily describes the findings from the 2010 Salmon Lake non-native plant study, identifies sites and infestations for monitoring or control work, and provides recommendations on partnership and outreach opportunities to help manage existing and new invasive plant infestations in the area more effectively.

[3] Hereafter within this report we use the terms 'weed' and 'non-native plant' interchangeably.
[4] BLM grant # L09AC15872
[5] BLM grant # L10AC16419

2010 Weed training and survey results

Between July 6 and 10, 2010, AKNHP worked with Kawerak Inc. to educate and train four youth from Nome in invasive plant biology, identification, and survey techniques.

Invasive plant identification workshop (Nome)

A weed biology and identification workshop developed by AKNHP was offered to the community of Nome on July 6, 2010. The workshop began with a short introductory section that presented the problems associated with invasive plants in the lower 48 states as well as in Alaska, the threats invasive plants pose to landowners and land managers, and the methods by which the introduction of invasive plants into new areas can be prevented. Subsequently, pressed specimens (and when available, live material) of some of Alaska's most invasive non-native plants and some of the non-native plants that had been reported previously from the Seward Peninsula (Flagstad and Cortés-Burns 2010) were passed around; AKNHP instructors (Mike Duffy and Kelly Walton) pointed out the diagnostic traits that distinguish these species from similar looking native and non-native species also found in Alaska. In all, thirteen people attended the Nome workshop (see Appendix I for list of attendees).

Non-native plant study

Following the weed identification workshop, the AKNHP crew, with Michael Sloane and the four youth hired through Kawerak Inc., conducted an invasive plant study at Salmon Lake-Kigluaik Special Recreation Management Area (SRMA). Nearby sites that had been identified as potential weed propagule source areas were also cursorily surveyed for non-native plants (land owners' permission was obtained when needed).

Plots were set up where non-native plants were most likely to occur: at high-use sites (e.g.: roads, campsites, summer camps, abandoned structures) or in naturally disturbed sites (e.g. along the lakeshore, in sparsely vegetated areas). Plot area varied between 0.5 and 1 acre, and was adjusted to the shape of the disturbance or site that was being surveyed. Data collected within each plot included the following: percent covers of dominant native and all non-native species, vegetation type (e.g. open white spruce forest), disturbance type (e.g. imported fill, brush cutting/mowing), percent cover and description of substrate type (e.g. percent cover of unvegetated ground composed of small rocks), and weed control action (if any). If non-native plant species were observed, we documented the number of stems for that species within the plot, as well as the estimated number of acres infested by it. Estimated number of infested acres was not restricted to the plot. At a minimum, one voucher specimen was collected for each non-native plant recorded during the survey. If the specimens were in good condition, they were subsequently mounted and are housed at the University of Alaska Anchorage Herbarium (UAAH). A list of native and non-native plant specimens collected during the Salmon Lake campground study is provided in Appendix II.

A total of twelve plots were read during the fieldwork: seven at Salmon Lake campground and five at nearby areas that seemed especially vulnerable to non-native plant invasion (Figs. 1, 2). Helen Cortés-Burns (AKNHP) and Laurie Thorpe (BLM-AFO) documented the presence of additional non-native plants during a separate trip to Nome in 2010 (Fig. 1).

In all, seven acres of land were exhaustively inventoried[6] for invasive species (predominantly within high-use or naturally disturbed sites). Since many of the invasive species' populations extended beyond the plots the total infested[7] acreage was substantially greater (13.5). More than 90 percent of the infested acreage corresponds to infestations at Pilgrim Hot Springs, while the remaining 10 percent correspond to weed populations recorded in Nome (Table 1).

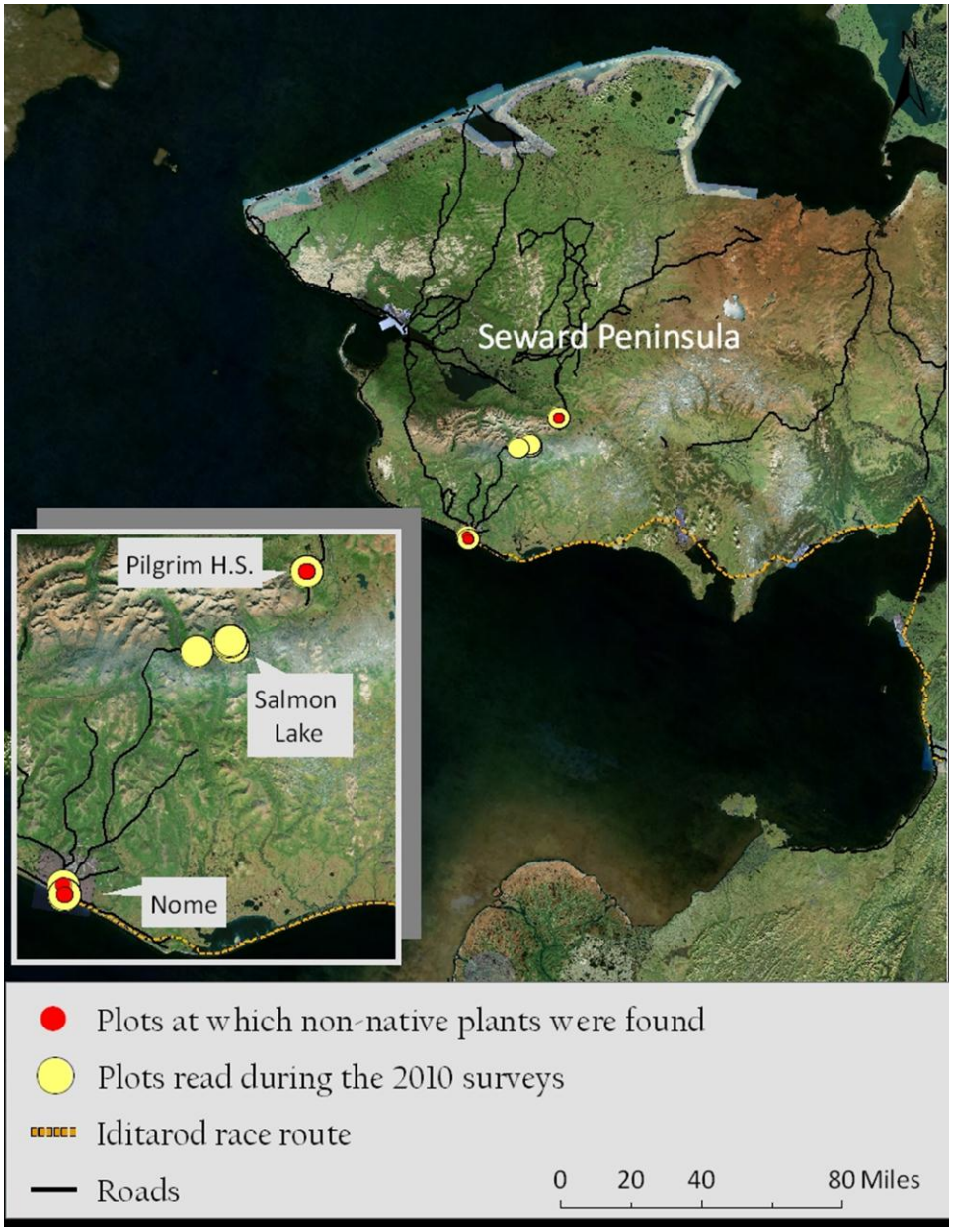

Figure 1. Distribution of the three areas visited in 2010.

[6] Exhaustive inventories are those in which all non-native plant populations observed within a plot are recorded.

[7] The number of acres estimated infested for a given non-native plant population can be smaller or larger than the size of the plot at which the population is observed. The former reflects the actual size of the infestation, while the latter captures the characteristics of the infestation within a given plot's boundaries.

Salmon Lake SRMA

Salmon Lake campground was surveyed from July 8 to 10, 2010. A total of seven plots were read at sites that appeared most susceptible to infestation. These sites included: trails leading to the hillock in the campground, campsites and associated structures, a gravel beach, an earthworks site, an abandoned cabin, the road connecting the campground to the Kougarok Highway, and the Kougarok Highway right of ways on either side of the campground entrance (Fig. 2).

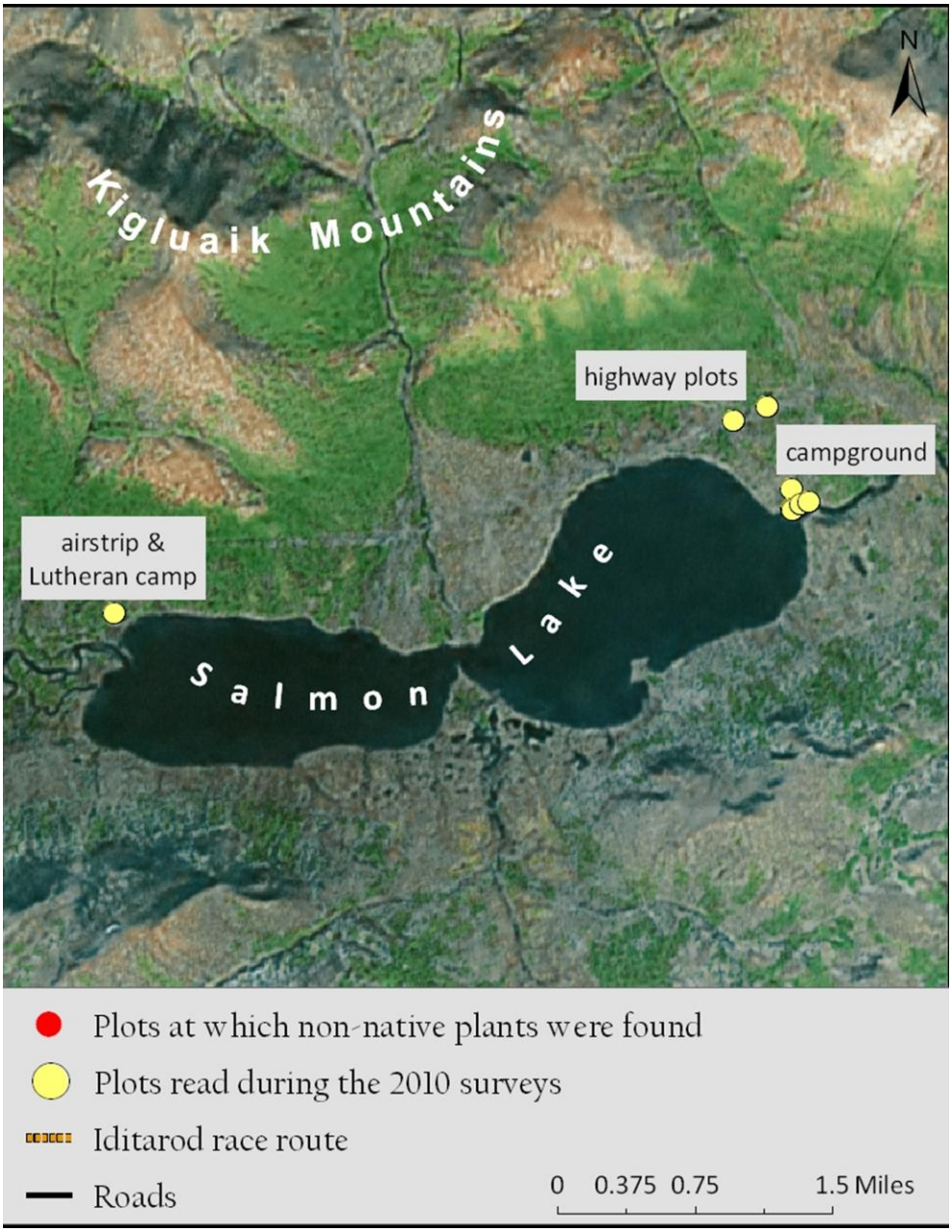

Figure 2. Distribution of non-native plant plots read at Salmon Lake.

1. **Plot "Salmon_Lake_10_001"**
   The crew surveyed the trails leading to a gravelly hilltop with sparse shrub cover (30% unvegetated) (Fig. 3). No non-native species were found within the 1-acre plot.

2. **Plot "Salmon_Lake_10_002"**
   A long, narrow plot (0.5 acres) was read along the gravelly lakeshore (90% unvegetated), including the small, natural boat launch (Fig. 4). No non-native species were found.

Figure 3. View of the campground taken from the hilltop.

Figure 4. Campground gravelly lakeshore.

3. **Plot "Salmon_Lake_10_003"**
   This plot was read at the campground proper (six campsites, including the associated fire pits, picnic tables, and outhouse, were considered as one single plot, Fig. 5). Campsites were situated in 100% unvegetated, recently re-graveled clearings. No non-native plants were found within the 0.7 acres inventoried.

Figure 5. Campsites and associated structures.

4. **Plot "Salmon_Lake_10_004"**

A plot was located along the length of an exposed, disturbed section of barren ground (possibly consisting of mine tailings) that ran parallel to the campground and backed up to some of the campsites (Fig. 6). The earthworks site was sparsely vegetated (60% unvegetated) by dwarf and low shrubs. No non-native plants were recorded within the 0.5 acres surveyed.

Figure 6. Barren, exposed earthworks.

5. **Plot "Salmon_Lake_10_005"**

A fifth plot was set up around the old, abandoned cabin and included the surrounding graminoid meadow (Fig. 7). The creek banks and outlet were also surveyed. The area surveyed (0.5 acres) was weed-free.

Figure 7. The abandoned cabin and nearby creek.

6. **Plot "Salmon_Lake_10_006"**

The road connecting the campground to the Kougarok highway was surveyed (Fig. 8). Plot #6 consisted of eight subplots (c. 50 x 50 meters each) separated at intervals of 0.1 mile. No non-native plants were recorded along the section of the road surveyed.

Figure 8. Road connecting the campground to the Kougarok highway.

7. **Plot "Salmon_Lake_10_007"**

The highway's right-of-way on either side of the campground cutoff was also surveyed (Fig. 9). In all, four subplots were erected, two on either side of the cutoff road. Plots were set up at 0.1-mile intervals from each other and measured c. 50 m x 50 m. The crew also looked at the area surrounding the Salmon lake campground sign, as the soil there was markedly churned up. No weeds were found in this stretch of the highway.

Figure 9. Right-of-ways on either side of the campground cutoff were surveyed.

Additional sites

Five sites were visited extra-officially during the July 2010 fieldtrip. Another two plots were read in Nome by Laurie Thorpe (BLM-AFO) and Helen Cortés-Burns (AKNHP).

8. Plot "Salmon_Lake_10_008"

The crew surveyed 1.5 acres of the private airstrip located at Salmon Lake (Fig. 10). The area is sparsely vegetated (70% unvegetated) and dominated by dwarf and low shrubs (40% cover). No non-native plants were recorded there.

Figure 10. Salmon Lake airstrip.

9. Plot "Salmon_lake_10_009"

A nearby Lutheran outdoor camp was also inventoried on July 10, 2010. The crew inspected a clearing, which was used as a parking area, by the dining hall, as well as the outhouse, the cabins, and the path leading to the boat launch by the lake. The area surveyed totaled 0.25 acres. All sites were weed-free.

10. Plots "Salmon_Lake_10_010" and "Salmon_Lake_10_011"

The crew visited Pilgrim Hot Springs, located on the Pilgrim River 13 miles northeast of Salmon Lake.

In the early 1900s, during the gold rush, this site was a resort that provided miners with spa baths, a saloon, a dance hall, and a roadhouse. In 1917-18, the property was turned into a Catholic mission and orphanage to care for large number of orphaned children following a series of influenza epidemics that struck the region, and was run as such until 1941. The orphanage and mission maintained a farm and grew a substantial amount of their vegetables in the geothermally warmed soils. Among other crops, oats, barley, potatoes, and alfalfa (*Medicago sativa* ssp. *sativa*, which has been ranked as moderately invasive, http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-biographies/) have been planted there. Therefore the site has a long history of agriculture and potential exposure to weed seed contaminants.

Currently, people visit the site for its hot springs, arriving either by charter air service from Nome (there is a small airfield at the hot springs) or by car (on an 8-mile gravel road that branches off the Kougarok Highway). In 2009 the Alaska Center for Energy and Power at the University of Alaska Fairbanks applied for a grant to conduct an assessment of the geothermal resource at the hot springs (http://www.uaf.edu/acep/projects/geothermal-resource-asses/). Exploratory work is scheduled to start in the summer of 2011. The hot springs therefore constitute a historic and present-day high-use site.

In addition, the vegetation at the hot springs (dominated by cottonwoods and birches) is markedly different from that at Salmon Lake (dwarf shrub tundra) because of the warmer, moister microenvironment created by the springs. Its warmer microclimate combined with high levels of present and historic anthropogenic disturbance make this site highly vulnerable to weed invasion.

The first infestation detected was while en route to the hot springs, at the turnoff from Kougarok Road (Plot "Salmon_Lake_10_010"). A medium sized (151-501 stems) and sparsely distributed population of *Taraxacum officinale* ssp. *officinale*[8] (invasiveness rank 58, common dandelion) was recorded there.

A second plot was located at Pilgrim Hot Springs, having first obtained permission from Mr. Lou Green, who was the keeper of the grounds at the time of the survey. Mr. Green showed the crew around, including stops at the old church/orphanage, the springs, the Jesuit cemetery, and some abandoned fields where Mr. Green used to grow potatoes.

The following non-native species were recorded on these grounds: *Bromus inermis* ssp. *inermis* (62, smooth brome), *Capsella bursa-pastoris* (40, shepherd's purse), *Chenopodium album* (37, common lambsquarters), *Elymus repens* (59, quackgrass), *Galeopsis tetrahit* (50, hempnettle), *Hordeum jubatum* (63, foxtail barley), *Matricaria discoidea* (32, pineapple weed), *Phleum pratense* (54, timothy grass), *Plantago major* (44, common plantain), *Poa annua* (46, annual bluegrass), *Polygonum aviculare* (45, prostrate knotweed), *Ranunculus repens* (54, creeping buttercup), *Rumex crispus* (48, curly dock), *Stellaria media* (42, common chickweed), *Taraxacum officinale* ssp. *officinale* (58, common dandelion), *Tripleurospermum inodorum* (48, scentless false mayweed), and

Figure 11. Pilgrim Hot Springs, and some of the infestations recorded there.

Trifolium repens (59, white clover).

11. Plot "Salmon_Lake_10_012"

The survey crew also stopped and quickly surveyed the road that leads to the dog lots. AKNHP Botanist Mike Duffy noted that it would be worth doing a more detailed inventory at this site. The only weed recorded during this cursory survey was *Hordeum jubatum*.

[8] The information summarized in brackets refers to the species' invasiveness rank and its common name. Rank refers to the points assigned to a given species by the Invasiveness Ranking System for Non-native Plants of Alaska (Carlson *et al*. 2008). This method ranks species on a scale of 0 to 100, with 100 being an extremely invasive species. Hereafter, whenever a species is first mentioned in the report, its common name and invasiveness rank will be provided in brackets in a similar fashion.

12. **Plot "Salmon_Lake_10_013"**

    This small plot (0.005 acres) was read at the old Armory site, which now consists of a largely unvegetated vacant lot and the remains of the old building. Four non-native plant species were recorded here: *Hordeum jubatum*, *Matricaria discoidea*, *Taraxacum officinale* ssp. *officinale*, and *Trifolium repens*.

13. **Plot "Salmon_Lake_10_014"**

    Some non-native species that have been introduced into Alaska as ornamentals and have escaped cultivation in other parts of the state were only detected in plant pots and flowerbeds in Nome. However, given their ability to become naturalized in other parts of the state (e.g.: *Leucanthemum vulgare* now forms near monocultures along the Coastal Trail in Anchorage; Cortés-Burns and Flagstad 2009), we decided to record these species. Three non-native ornamentals were detected on this trip: *Papaver nudicaule* (39, Icelandic poppy), *Trollius europaeus* (NR, European globeflower), and *Leucanthemum vulgare* (61, oxeye daisy).

Weed management at Salmon Lake SRMA

Existing conditions

The 2010 study results indicate that the Salmon Lake-Kigluaik SRMA and other high-use sites around the lake (the airstrip and the Lutheran summer camp) were weed-free in 2010. A few non-native plants were detected north of the campground, en route to Pilgrim Hot Springs, as well as in and around Nome. Most of the non-native species recorded during the 2010 study do not pose a serious management concern, either because they are only mildly invasive and rarely are observed growing in undisturbed native vegetation, or because they are so widespread across Alaska that local elimination would require significant resources over time to maintain a weed-free state (Table 1).

Table 1. List of non-native plant species recorded on the Seward Peninsula in 2010.

Scientific name	Invasiveness Rank*	Salmon Lake	Pilgrim Hot Springs	Nome		
				Dog lots	cultivars	Old Armory
Hordeum jubatum‡	63		X	X		X
Bromus inermis ssp. *inermis*	62		X			
Leucanthemum vulgare	61				X	
Elymus repens	59		X			
Trifolium repens	59		X			X
Taraxacum officinale ssp. *officinale*	58		X			X
Phleum pratense	54		X			
Ranunculus repens	54		X			
Galeopsis tetrahit	50		X			
Rumex crispus	48		X			
Tripleurospermum inodorum	48		X			
Poa annua	46		X			
Polygonum aviculare	45		X			
Plantago major	44		X			
Stellaria media	42		X			
Capsella bursa-pastoris	40		X			
Papaver nudicaule	39				X	
Chenopodium album	37		X			
Matricaria discoidea	32		X			X
Trollius europaeus	NR†				X	

***Management recommendations are only provided for non-native species with invasiveness ranks greater than or equal to 50 points**.

†NR: Not ranked. Species that have not yet been ranked using the Alaska Invasive Plant Ranking System (Carlson *et al*. 2008) are designated as 'NR'. The lack of a rank value does not mean that the species is not aggressively invasive.

‡Nativity of this species to western Alaska is unknown (see AKNHP biography for this species, *http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-biographies/)*. The species is clearly native to northwestern Canada and potentially the eastern interior of Alaska, but populations have expanded dramatically across the state in the last half century.

Sources and dispersal vectors of invasive plant propagules

Through discussions with Kawerak Inc. staff and youth (notes from the meeting are provided in a separate PDF file) and an analysis of the 2010 survey results, the following sites are identified as possible propagule source areas and weed dispersal vectors for Salmon Lake-Kigluaik SRMA.

Source areas

1. Nome
2. Pilgrim Hot Springs

Routes and vectors of propagule dispersal into Salmon Lake campground

1. OHV trail construction at Salmon Lake-Kigluaik SRMA:
    - Propagules arriving in fill
    - Propagules arriving on vehicles, machinery or on construction workers' gear
    - Increased susceptibility to invasion due to an increase in mechanical disturbance resulting in exposed mineral soil
2. Kougarok Highway:
    - Propagules transported on vehicles traveling to and from Nome and Pilgrim Hot Springs
    - road maintenance work could facilitate both the introduction and spread of propagules, as well as their establishment (importation of infested fill and increased soil disturbance)
3. Salmon Lake airstrip
    - Propagules brought in on aircraft
4. Salmon Lake recreational and subsistence users
    - All subsistence and recreation activities that involve the movement of people (locals or visitors) and gear from Nome (and elsewhere in the state and Outside) to Salmon Lake have the potential to result in the accidental transport of weed propagules from infested to uninfested sites. Hunters and berry pickers tend to go to sites that can be accessed by air or from roads, as is the case for Salmon Lake, and outdoor recreationists arriving from outside the region could be vectors for very long distance dispersal events, where seeds may get transported on tents, boots, and other gear.

Proposed management strategies

Prevention and Best Management Practices (BMPs)

The most effective, economical, and ecologically sound approach to managing invasive plants is to prevent their invasion in the first place. Although control work may be necessary to limit the spread of existing infestations, a weed management plan that focuses on prevention or early detection of new invasions is the most efficient use of limited resources.

The following BMPs are central to actively preventing the introduction of weeds into the Salmon Lake-Kigluaik SRMA area:

1. Raise awareness among Salmon Lake visitors and subsistence users on invasive non-native plants, focusing on weed identification and prevention (see below for more details)
2. Unify landowners in implementing proactive weed management measures as a cooperative group to maintain common weed-free areas (discussed in greater detail under 'Partnerships')
3. During construction and maintenance projects, as well as in resource exploration and extraction projects (e.g. the proposed OHV trail development at Salmon Lake SRMA, and the geothermal exploration work that will be conducted at Pilgrim Hot Springs starting 2011)*
    - Minimize soil disturbance
    - Inspect and clean gear and equipment of weeds and their seeds at a controlled site, prior to moving it to the SRMA or nearby sites that are also under BLM jurisdiction
    - monitor any sites disturbed by the exploration or construction activities for the establishment of new weed populations for at least one to two growth seasons during and after completion of the project
    - if infestations are recorded in the future, avoid moving gear and equipment used in an infested area to weed-free areas
4. Implement an "Early Detection and Rapid Response" (EDRR) program for the area (especially for high-risk areas such as the campground's entrance and connector road, any boat launch sites, and areas of disturbed or bare ground) to detect and eliminate new patches of weeds before they become established (discussed in greater detail below)
5. Evaluate the effectiveness of the prevention and control plan on an annual basis, so appropriate modifications can be implemented the following year

* Best management practices and mitigations for invasive species should be incorporated early on in the planning and development stage for resource research and development activities such as the geothermal exploration activities at Pilgrim Hot Springs. Prior to seeking permission for the occupancy or use from the multiple jurisdictions, exploration proponents should develop environmentally sound proposals incorporating the best management practices and mitigations that would meet or exceed the various jurisdictional requirements relative to invasive species. For example: In requests for proposals to prospective contractors to conduct drilling, exploration, or construction activities, proponents should incorporate the need for invasive species "Best Management Practices and Mitigations" into the "Scope of Work" regardless of land owner or jurisdiction.

This proactive and practical approach would assure land managers that exploration activities are integrating prevention and mitigation measures in all phases and activities of the exploration, thus reducing the risk of inadvertent invasive species introduction and spread to the maximum extent feasible. ***Approaching invasive species concerns early on in the planning phase for exploration activities provides the best opportunity for preserving the integrity of relatively pristine and intact ecosystems in the region***.

Early Detection and Rapid Response

Early detection and rapid response (EDRR) is the process of locating, assessing, and eliminating invasive species populations before they have a chance to spread beyond an initial foothold or grow to unmanageable levels. Invasive plant populations often exhibit a lag time before they cause serious ecological impacts. EDRR enables land managers to find incipient populations of invasive plants and eradicate them before they begin to spread, thus reducing environmental and economic impacts.

This strategy includes surveys for collection, identification, and risk assessment of, and response to new and emerging species that have established self-perpetuating populations. Early detection of new infestations requires vigilance and regular monitoring of the managed area and surrounding ecosystem. BLM is well suited to improve its early detection capabilities through the collaborative and coordinated efforts of numerous agency programs, field offices, and partners (see Partnerships). Finally, populations identified through EDRR should be submitted to the AKEPIC database to maintain our knowledge of new infestations and movements of known populations within Alaska. Up-to-date knowledge of infestations is important for the development and adaptation of effective management strategies within and across agencies.

EDRR efforts at the Salmon Lake-Kigluaik SRMA should be focused on:

1. Any sites that undergo construction work in the future in/near Salmon Lake
2. Nearby high-use sites (boat launches, the airstrip, the summer camp, and the highway)

The species listed below are recommended for EDRR based on their *likelihood* to become established if introduced into the SRMA and/or the Seward Peninsula, and their *potential* to alter the health and function of arctic ecosystems (Table 2). In addition, we highlight which of the EDRR species should be given top priority for control efforts if weed management funds are limited. This subset of species were selected because of their demonstrated ability to aggressively invade multiple kinds of habitats in other parts of Alaska and/or because of the considerable efficiencies that can be gained by controlling these species before they become well established, i.e. before they form multiple infestations and/or a seed bank.

Table 2. EDRR watch list of non-native plant species for Salmon Lake campground.

Scientific name	Invasiveness Rank*	Control priority	Salmon Lake	Pilgrim Hot Springs	Nome		
					Dog lots	cultivars	Old Armory
Melilotus alba	81	X					
Bromus tectorum	78	X					
Hordeum jubatum	63			X	X		X
Bromus inermis ssp. *inermis*	62	X		X			
Leucanthemum vulgare	61					X	
Elymus repens	59	X		X			
Trifolium repens	59			X			X
Taraxacum officinale ssp. *officinale*	58			X			X
Phleum pratense	54			X			
Ranunculus repens	54			X			
Galeopsis tetrahit	50			X			
Tripleurospermum inodorum	48			X			

*Management recommendations are only provided for non-native species with invasiveness ranks greater than or equal to 50 points.

We identify another five species as being highly likely to be introduced and become established in the SRMA area given their widespread distributions across Alaska, including the Seward Peninsula (Table 3). However, they are not listed for EDRR work because they appear to have a restricted or negligible impact on the health and function of Alaska's ecosystems.

Table 3. Non-native plants most likely to be introduced at Salmon Lake campground.

Scientific name	Invasiveness Rank*	Salmon Lake	Pilgrim Hot Springs	Nome		
				Dog lots	cultivars	Old Armory
Poa annua	46		X			
Polygonum aviculare	45		X			
Plantago major	44		X			
Chenopodium album	37		X			
Matricaria discoidea	32		X			X

*Management recommendations are only provided for non-native species with invasiveness ranks greater than or equal to 50 points.

Implementation of an EDRR program for the Salmon Lake area that follows the above guidelines will aid in keeping Salmon Lake's "clean" lands free of weeds.

Inventory and monitoring

Monitoring (periodic observation and documentation) is vital to a successful weed control program and, like education, EDRR, and control it is an ongoing and dynamic process. It is the collection of information (data) to determine the effectiveness of management actions in meeting the prescribed objectives. A monitoring program can determine which objectives are not being met, which actions need to be modified, and which actions should be ceased because they are not working.

An effective and informed weed management plan for Salmon Lake must promote inventory and monitoring efforts of neighboring weed propagule source areas (e.g. Nome, Pilgrim Hot Springs). In particular, we recommend that the following sites be given priority for weed inventory and monitoring work:

1. White Alice site, Wind propeller site, and Rock Creek Mine
   A cursory inventory at these locations would be very valuable. It might reveal the presence of aggressively invasive species, such as *Crepis tectorum*, which was found at similar sites near Unalakleet in 2010 (Cortés-Burns *et al*. 2011), that have not yet been reported from the Seward Peninsula.
2. Nome Airport, and Bering Air/Twin Peaks LZs in Nome
   The Nome Airport is used by commercial planes, small, fixed-wing aircraft, and helicopters (e.g. Twin Peaks from Bering Air). The aircraft fly to and from other towns and villages in the state, as well as to remote parts of the Seward Peninsula. The airport therefore constitutes a nexus between invasive plant populations that are known to occur at other airports and airstrips across the state and areas of the Seward Peninsula that are currently weed-free, like Salmon Lake campground. Knowledge of Nome airport's non-native plant flora is essential in the development of weed prevention and management plans for remote areas in the Seward Peninsula that can be reached by fixed-wing aircraft or helicopters.

Other sites that should be monitored periodically to help prevent weed invasion at Salmon Lake are:

1. Nome's road system
2. developed sites around Salmon Lake (e.g. Salmon Lake airstrip, boat launches, Lutheran summer camp)
3. road cutoff to Pilgrim Hot Springs
4. Nome's barge dock

Control

When invasive species become established in an ecosystem, a strategic approach for control is required to minimize their effects or limit their spread. Effective control relies on a clear understanding of the target species, including its biology, the ecosystem it has infested, pathways associated with its introduction, and effective control tools. Effective control also relies on persistent follow-through with monitoring of control efficacy. Successful management and eradication of invasive plant infestations typically require several years of treatment and follow-up monitoring.

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, resulting in greater success. Specific treatment prescriptions are determined by the biology of the particular plant species, site characteristics, and management objectives. The following management techniques for weed control should be considered on a site- and species-specific basis:

- *Physical/Mechanical*: The use of physical or mechanical methods for weed control can be effective on small infestations of annual or biennial species. Hand grubbing, mowing, tilling, and burning are commonly used to physically destroy weeds or interfere with their reproduction. To be effective, treatment must typically take place before seed production. Plants that have flowered must be removed from the site and destroyed (plants can be placed in double bags 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, physical/mechanical methods are not recommended as the sole approach for control of species that spread vegetatively.

- *Chemical:* Herbicides are an effective and efficient tool for the control of weeds. Chemical control methods are likely to be the best option for larger infestations and for tough to control perennial species. The particular herbicide used and its rate of application depend on specific site characteristics, target plant, location, non-target vegetation, and land use. Herbicides are a particularly important method of treatment when complete eradication of a plant 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, infestations in remote areas, and species for which hand pulling or cutting is not effective or feasible. If applied in a specific manner and according to the label, herbicides can be extremely effective in selectively removing weeds that are mixed in with native vegetation. This approach reduces the amount of revegetation needed after the treatment is complete.

- *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; therefore, they have the potential to become invasive themselves and attack non-targeted species. Permitting release of biological control agents requires many years of host specificity testing and evaluation by APHIS. This type of control is only used on very large infestations (big enough to support the insect or pathogen population) and to date, has not been used on any species in Alaska.

Prioritizing infestations for control work

Infestations of non-native plant species are prioritized for control work based on a number of factors, including placement on the State of Alaska Noxious Weed List or an invasiveness rank of 50 or more (or a suspicion that the species is highly invasive even if it is unranked).

Control of invasive species that are still uncommon in Alaska should take precedence over invasive species that are widespread on state and local scales. Similarly, populations that are small and disjunct or that are invading (or capable of invading) undisturbed native vegetation should be prioritized over populations that are continuous and large, or that tend to remain restricted to anthropogenically disturbed habitats.

The results from the 2010 non-native plant study indicate that the Salmon Lake-Kigluaik SRMA is free of non-native weeds. We therefore suggest that weed management efforts for this area focus on:

1. Identifying and implementing a suite of BMPs that will be acceptable to and therefore adopted by the various land owners in the area
2. Developing a strong EDRR program (produce brochures, recruit volunteers, etc.)
3. Establishing strong partnerships with other landowners in the area to raise awareness on weeds and obtain permission and assistance to periodically monitor the propagule source areas identified above

Education and Outreach

Developing an active awareness on the threats posed by invasive species through educational programs and outreach activities helps ensure a successful defense against weeds by engaging the stakeholders in the management process. Education and outreach should encompass all aspects of the weed management plan, including prevention, detection, control, and monitoring. Education on weed management will help bridge the gap between different landowners and user groups. Internal training programs and public involvement in weed management is essential for a successful long-term program. A partnership between agencies and organizations and active involvement with different user groups is necessary to ensure the success of the weed management plan.

Educational Displays

Education of the general public outlining problems caused by non-native plant species can be achieved by making the information widely available to the community. Educational activities that help engage local school students and Lutheran summer camp participants in invasive species science and socio-economic impacts can be developed or adapted from existing resources (e.g. Villano and Villano 2008).

In addition, posters, flyers, and informational materials on EDRR species that include diagnostic traits, biological characteristics, and ecological impacts should be created for the general public. Informational materials posted at high-use sites in Salmon Lake and throughout the Nome community will increase awareness about invasive species known or expected to occur in the area. Highly visible locations for informational materials include:

1. At Salmon Lake:
    - Campground entrance
    - Lutheran summer camp
2. In Nome:
    - Post office
    - Airport
    - Schools
    - Professional gardeners and horticulturalists (e.g. Cheryl Thompson)
    - Local stores
    - Pet shop
    - The University of Alaska Northwest campus
    - Kawerak Inc. building
    - BLM/Natural Resources Conservation Service (NRCS) offices
    - Nome visitor's center
    - Businesses providing transportation for research (e.g. research vessels) or recreation (e.g. Twin Peaks) to remote parts of the Seward Peninsula
    - Wildlife viewing, gold-panning or adventure tour companies

Informational materials should be provided on or linked from the BLM Nome Field Station website. Additionally, informational materials can be provided alongside recreation permits, reindeer grazing permits, and hunting and fishing licenses.

Community Outreach

The BLM could provide basic training on local and state invasive species threats to federal and state field staff in the area. The BLM could develop additional incentive programs for its employees that encourage weed awareness, detection, and reporting, as well as identification of new invaders. Knowledgeable BLM-AFO employees functioning as "weed trainers" can work with other BLM employees, volunteers, and the public to increase knowledge about invasive species.

Community Involvement

Any community weed prevention and weed pull events should be advertised on local radio, through the Nome Nugget, and on the Nome Announce list-serve if possible. For example, this could include announcements during the Iditarod race on the risks posed by using straw and hay that is not certified weed-free for Alaska, or letting the public know that certain ornamental plant species can escape cultivation and become a problem while suggesting similar-looking, non-invasive species that they could plant instead.

Partnerships

Developing broad networks with many partners is beneficial to preventing weed introduction at the Salmon Lake-Kigluaik SRMA and to detecting and eradicating new invasive species in the broader area before they establish.

To ensure full monitoring and control of invasive species and provide effective weed management for BLM lands, BLM may find it necessary to suggest the creation of a Cooperative Weed Management Area (CWMA) for the Seward Peninsula. The purpose of a CWMA is to provide a partnership among agencies, organizations, and interests to prevent the reproduction and spread of weeds into and within the CWMA. The boundaries of the CWMA thus replace jurisdictional boundaries and allow weeds to be managed within natural boundaries instead. Partners jointly prioritize weed management efforts based on species or geographic area and work together to manage infestations, pooling labor and resources. Partners may include those who hold easements, special use permits, and private property, as well as state and federal land managers.

Among others, we suggest that a CWMA for the Seward Peninsula include the following agencies and businesses:

a. BLM
b. NRCS
c. Kawerak, Inc.
d. University of Alaska Northwest campus
e. National Park Service (Bering Land Bridge National Preserve)
f. Department of Defense (Army National Guard Stewart River Training Area, White Alice site, Corps of Engineers)
g. Department of Transportation
h. Nome Rotary Club
i. The Salmon Lake Lutheran Camp

Through the CWMA, land managers and owners interested in maintaining the Seward Peninsula's undeveloped lands (including Salmon Lake) weed-free, and in preventing the establishment of aggressively invasive species in Nome, could collaboratively develop and follow best management practices (BMPs) aimed at minimizing the spread of existing infestations and preventing the introduction of new, more highly invasive plants into the Peninsula. This will provide the most efficient use of labor and resources in managing weeds in the area.

Concluding remarks

The Seward Peninsula remains an area of outstanding ecological integrity, with minimal habitat fragmentation and non-native plant establishment. Land managers and land owners in the region should aim to (1) **prevent the introduction** of new invasive plants into the area and (2) **minimize the spread** of existing infestations, using an approach that combines:

- **increasing awareness** among the public on invasive plant issues
- identifying and implementing **best management practices** that are accepted by a majority of landowners and stakeholders
- **inventorying** the land to find and eradicate new invasive species before they become established
- **monitoring and/or controlling** existing infestations to ensure that they do not spread into more remote or sensitive areas

The BLM's efforts to survey its lands on the Seward Peninsula for non-native plant species, and to use the data collected to develop weed prevention and management recommendations are evidenced by this and past reports (Flagstad and Cortés-Burns 2010). This approach, which places the emphasis on weed prevention and early detection and eradication efforts (as opposed to control), constitutes an encouraging example of how to be proactive in managing non-native invasive plants effectively and efficiently.

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Appendix I

List of participants at the Nome community invasive plant identification workshop

Name	Agency	Department	Position
Mike Duffy (instructor)	AKNHP	Botany	Botanist
Kelly Walton (assistant instructor)	AKNHP	Zoology	Assistant Botanist
Michael Sloan	Kawerak, Inc.	Natural Resources	Fisheries Biologist
Adem Boeckmann	Kawerak, Inc.	Natural Resources	ARRA youth intern
Andrew Cockerham	Kawerak, Inc.	Natural Resources	ARRA youth intern
Heather Sinnok	Kawerak, Inc.	Natural Resources	ARRA youth intern
Nick Vandergraft	Kawerak, Inc.	Natural Resources	ARRA youth intern
Rose Fosdick	Kawerak, Inc.	Natural Resources	Resources Director President of the Reindeer Herder's Association
Pauline Noyakuk	Kawerak, Inc.	Natural Resources	Administration
Marlene "Opik" Ahkinga	Kawerak, Inc.	N/A	N/A
Kathy Marx	Kawerak, Inc.	N/A	planner
Diego Ayala	Natural Resources Conservation Service	District Conservationist	N/A
Dana Warnke	Natural Resources Conservation Service	N/A	N/A
Sheryl Cavota	Nome Eskimo Community	N/A	Executive Assistant
Richley Abbott	N/A	N/A	N/A

Appendix II

List of voucher specimens collected during the Salmon Lake non-native plant study.

Collection date	Species name	UAAH #	Locality Name	Latitude	Longitude
7/8/2010	*Agrostis mertensii*	1410	Summer camp for children (campground with buildings)	64.899590	-165.081770
7/8/2010	*Hordeum jubatum*	1412	Nome dog lots	64.510437	-165.412671
7/8/2010	*Poa pratensis*	1413	Highway at intersection with campground road; four plots read along the highway right of way, two on either side of intersection	64.924060	-164.968960
7/8/2010	*Artemisia norvegica*	1423	Campground	64.916420	-164.961150
7/8/2010	*Barbarea orthoceras*	1416	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Chamerion latifolium*	1417	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Comarum palustre*	1407	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Eurybia sibirica*	1424	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Juncus arcticus*	1418	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Leymus mollis*	1414	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Poa alpina*	1419	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Silene acaulis*	1409	Campground	64.916420	-164.961150
7/8/2010	*Solidago multiradiata*	1426	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/8/2010	*Spiraea stevenii*	1408	Campground	64.916420	-164.961150
7/8/2010	*Therorhodion glandulosum*	1425	Gravelly hilltop with sparse shrub cover (dry alpine, trampling disturbance, no non-natives on trails leading to site)	64.918010	-164.961880
7/8/2010	*Trisetum spicatum*	1420	Campground	64.916420	-164.961150
7/8/2010	*Wilhelmsia physodes*	1421	Long narrow plot read along the gravelly lakeshore (trampling and vehicle disturbance)	64.916510	-164.961470
7/9/2010	*Anthoxanthum monticola*	1422	Exposed, disturbed barren ground, gravel, possibly some mine tailings (dry alpine)	64.916950	-164.959780
7/9/2010	*Descurainia sophioides*	1411	Road connecting highway with campground; roadside plot was read as a series of 8 subplots, at 0.1 mi intervals from outhouse to intersection	64.922550	-164.974690
7/9/2010	*Festuca altaica*	1415	Exposed, disturbed barren ground, gravel, possibly some mine tailings (dry alpine)	64.916950	-164.959780