APPENDIX A

ANILCA SECTION 810(a) SUBSISTENCE EVALUATION AND FINDING

I. Introduction

Title VIII, Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA) requires Federal agencies having jurisdiction over lands in Alaska to evaluate the potential impacts of proposed actions on subsistence uses needs. This analysis evaluates the potential restrictions to ANILCA Title VIII subsistence uses and needs that could result from implementation of the *Invasive Plant Management Plan* (IPMP) in National Park Service (NPS) areas in Alaska. The NPS is granted broad statutory authority under various acts of Congress to manage and regulate activities in areas of the National Park System, (16 U.S.C. 1a-2(h), 3, and 3120).

II. The Evaluation Process

Section 810(a) of ANILCA states:

> *In determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of public lands . . . the head of the Federal agency . . . over such lands . . . shall evaluate the effect of such use, occupancy, or disposition on subsistence uses and needs, the availability of other lands for the purposes sought to be achieved, and other alternatives which would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes. No such withdrawal, reservation, lease, permit, or other use, occupancy or disposition of such lands which would significantly restrict subsistence uses shall be effected until the head of such Federal agency*
>
> *(1) gives notice to the appropriate State agency and the appropriate local committees and regional councils established pursuant to Section 805;*
>
> *(2) gives notice of, and holds, a hearing in the vicinity of the area involved; and*
>
> *(3) determines that (A) such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands, (B) the proposed activity would involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other disposition, and (C) reasonable steps would be taken to minimize adverse impacts upon subsistence uses and resources resulting from such actions.*

Section 201 of ANILCA created new units of the national park system in Alaska for the following purposes:

Aniakchak National Monument and Preserve, containing approximately one hundred and thirty-eight thousand acres of public lands, was created by ANILCA, section 201(1) for the following purposes:

> The monument and preserve shall be managed for the following purposes, among others: To maintain the caldera and its associated volcanic features and landscape, including the Aniakchak River and other lakes and streams, in their natural state; to study, interpret, and assure continuation of the natural process of biological succession; to protect habitat for, and populations of, fish and wildlife, including, but not limited to, brown/ grizzly bears, moose, caribou, sea lions, seals, and other; marine mammals, geese, swans, and other waterfowl and in a manner consistent with the foregoing, to interpret geological and biological processes for visitors. Subsistence uses by local residents shall be permitted in the monument where such uses are traditional in accordance with the provisions of Title VIII.

Bering Land Bridge National Preserve, containing approximately two million four hundred and fifty-seven thousand acres of public land, was created by ANILCA, section 201(2) for the following purposes:

> To protect and interpret examples of arctic plant communities, volcanic lava flows, ash explosions, coastal formations and other geologic processes; to protect habitat for internationally significant populations of migratory birds; to provide for archeological and paleontological study, in cooperation with Native Alaskans, of the process of plant and animal migration, including man, between North America and the Asian Continent, to protect habitat for, and populations of, fish and wildlife including, but not limited to, marine mammals, brown/grizzly bears, moose and wolves; subject to such reasonable regulations as the Secretary may prescribe, to continue reindeer grazing use, including necessary facilities and equipment, within the areas which on January 1, 1976, were subject to reindeer grazing permits, in accordance with sound range management practices; to protect the viability of subsistence resources; and in a manner consistent with the foregoing, to provide for outdoor recreation and environmental education activities including public access for recreational purposes to the Serpentine Hot Springs area. The Secretary shall permit the continuation of customary patterns and modes of travel during periods of adequate snow cover within a one-hundred-foot right-of-way along either side of an existing route from Deering to the Taylor Highway, subject to such reasonable regulations as the Secretary may promulgate to assure that such travel is consistent with the foregoing purposes.

Cape Krusenstern National Monument, containing approximately five hundred and sixty thousand acres of public lands, was created by ANILCA, section 201(3) for the following purposes:

> The monument shall be managed for the following purposes, among others: To protect and interpret a series of archeological sites depicting every known cultural period in arctic Alaska; to provide for scientific study of the process of human population of the area from the Asian Continent, in cooperation with Native Alaskans, to preserve and

> interpret evidence of prehistoric and historic Native cultures, to protect habitat for seals and other marine mammals; to protect habitat for and populations of, birds, and other wildlife, and fish resources; and to protect the viability of subsistence resources. Subsistence uses by local residents shall be permitted in the monument in accordance with the provisions of Title VIII.

Gates of the Arctic National Park, containing approximately seven million fifty-two thousand acres of public lands, Gates of the Arctic National Preserve, containing approximately nine hundred thousand acres of Federal lands, was created by ANILCA, section 201(4)(a) for the following purposes:

> The park and preserve shall be managed for the following purposes, among others: To maintain the wild and undeveloped character of the area, including opportunities for visitors to experience solitude, and the natural environmental integrity and scenic beauty of the mountains, forelands, rivers, lakes, and other natural features; to provide continued opportunities, including reasonable access, for mountain climbing, mountaineering, and other wilderness recreational activities, and to protect habitat for and the populations of, fish and wildlife, including, but not limited to, caribou, grizzly bears, Dall sheep moose, wolves, and raptorial birds. Subsistence uses by local residents shall be permitted in the park, where such uses are traditional, in accordance with the provisions of Title VIII.

Kenai Fjords National Park, containing approximately five hundred and sixty-seven thousand acres of public lands, was created by ANILCA, section 201(5) for the following purposes:

> The park shall be managed for the following purposes, among others: To maintain unimpaired the scenic and environmental integrity of the Harding Icefield, its outflowing glaciers, and coastal fjords and islands in their natural state; and to protect seals, sea lions, other marine mammals, and marine and other birds and to maintain their hauling and breeding areas in their natural state, free of human activity which is disruptive to their natural processes. In a manner consistent with the foregoing, the Secretary is authorized to develop access to the Harding Icefield and to allow use of mechanized equipment on the Icefield for recreation.

Kobuk Valley National Park, containing approximately one million seven hundred and ten thousand acres of public land, was created by ANILCA, section 201(6) for the following purposes:

> The park shall be managed for the following purposes, among others: To maintain the environmental integrity of the natural features of the Kobuk River Valley, including the Kobuk, Salmon, and other rivers, the boreal forest, and the Great Kobuk Sand Dunes, in an undeveloped state, to protect and interpret, in cooperation with Native Alaskans, archeological sites associated with Native cultures; to protect migration routes for the Arctic caribou herd; to protect habitat for, and populations of, fish and wildlife including but not limited to caribou, moose, black and grizzly bears, wolves, and waterfowl and to protect the viability of subsistence resources. Subsistence uses by local residents shall be permitted in the park in accordance with the provisions of Title VIII. Except at such times

> when, and locations where, to do so would be inconsistent with the purposes of the park, the Secretary shall permit aircraft to continue to land at sites in the upper Salmon River watershed.

Lake Clark National Park, containing approximately two million four hundred thirty-nine thousand acres of public lands and Lake Clark National Preserve, containing approximately one million two hundred and fourteen thousand acres of public lands, was created by ANILCA, section 201(7)(a) for the following purposes:

> The park and preserve shall be managed for the following purposes, among others: To protect the watershed necessary for perpetuation of the red salmon fishery in Bristol Bay; to maintain unimpaired the scenic beauty and quality of portions of the Alaska Range and the Aleutian Range, including active volcanoes, glaciers, wild rivers, lakes, waterfalls, and alpine meadows in their natural state; and to protect habitat for and populations of fish and wildlife including but not limited to caribou, Dall sheep, brown/grizzly bears, bald eagles, and peregrine falcons. …Subsistence uses by local residents shall be permitted in the park where such uses are traditional in accordance with the provisions of Title VIII.

Noatak National Preserve, containing approximately six million four hundred and sixty thousand acres of public lands, was created by ANILCA, section 201(8)(a), for the following purposes:

> To maintain the environmental integrity of the Noatak River and adjacent uplands within the preserve in such a manner as to assure the continuation of geological and biological processes unimpaired by adverse human activity; to protect habitat for, and populations of, fish and wildlife, including but not limited to caribou, grizzly bears Dall sheep, moose, wolves, and for waterfowl, raptors, and other species of birds; to protect archeological resources; and in a manner consistent with the foregoing, to provide opportunities for scientific research. The Secretary may establish a board consisting of scientists and other experts in the field of arctic research in order to assist him in the encouragement and administration of research efforts within the preserve.

Wrangell-Saint Elias National Park, containing approximately eight million one hundred and forty-seven thousand acres of public lands, and Wrangell-Saint Elias National Preserve containing approximately four million one hundred and seventeen thousand acres of public lands, was created by ANILCA, section 201(9), for the following purposes:

> The park and preserve shall be managed for the following purposes, among others: To maintain unimpaired the scenic beauty and quality of high mountain peaks, foothills, glacial systems, lakes, and streams, valleys, and coastal landscapes in their natural state; to protect habitat for, and populations of, fish and wildlife including but not limited to caribou, brown/grizzly bears, Dall sheep, moose, wolves, trumpeter swans and other waterfowl, and marine mammals; and to provide continued opportunities including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities. Subsistence uses by local residents shall be permitted in the park, where such uses are traditional, in accordance with the provisions of Title VIII.

Yukon-Charley Rivers National Preserve, containing approximately one million seven hundred and thirteen thousand acres of public lands, was created by ANILCA, section 201(9), for the following purposes:

> The preserve shall be managed for the following purposes, among others: To maintain the environmental integrity of the entire Charley River basin, including streams, lakes and other natural features, in its undeveloped natural condition for public benefit and scientific study; to protect habitat for, and populations of, fish and wildlife, including but not limited to the peregrine falcons and other raptorial birds, caribou, moose, Dall sheep, grizzly bears, and wolves; and in a manner consistent with the foregoing, to protect and interpret historical sites and events associated with the gold rush on the Yukon River and the geological and paleontological history and cultural prehistory of the area. Except at such times when and locations where to do so would be inconsistent with the purposes of the preserve, the Secretary shall permit aircraft to continue to land at sites in the Upper Charley River watershed.

ADDITIONS TO EXISTING AREAS

Section 202 of ANILCA created new units and additions to the following Alaska NPS areas:

Glacier Bay National Monument was expanded by the addition of an area containing approximately five hundred and twenty-three thousand acres of Federal land. Approximately fifty-seven thousand acres of additional public land was established as Glacier Bay National Preserve. The monument was re-designated as "Glacier Bay National Park". The monument addition and preserve was created by ANILCA, section 202(1), for the following purposes:

> To protect a segment of the Alsek River, fish and wildlife habitats and migration routes and a portion of the Fairweather Range including the northwest slope of Mount Fairweather. Lands, waters, and interests therein within the boundary of the park and preserve which were within the boundary of any national forest are hereby excluded from such national forest and the boundary of such national forest is hereby revised accordingly.

Katmai National Monument was expanded by the addition of an area containing approximately one million and thirty-seven thousand acres of public land. Approximately three hundred and eight thousand acres of additional public land was established as Katmai National Preserve. The monument was re-designated as "Katmai National Park". The park and preserve were created by ANILCA, section 202(2), for the following purposes:

> To protect habitats for, and populations of, fish and wildlife including, but not limited to, high concentrations of brown/grizzly bears and their denning areas; to maintain unimpaired the water habitat for significant salmon populations; and to protect scenic, geological, cultural and recreational features.

Mount McKinley National Park was expanded by the addition of an area containing approximately two million four hundred and twenty-six thousand acres of public land, and

approximately one million three hundred and thirty thousand acres of additional public land was established as Denali National Preserve. The unit was re-designated as Denali National Park and Preserve. The park additions and preserve were created by ANILCA , section 202(3)(a) for the following purposes:

> To protect and interpret the entire mountain massif, and additional scenic mountain peaks and formations; and to protect habitat for, and populations of fish and wildlife including, but not limited to, brown/grizzly bears, moose, caribou, Dall sheep, wolves, swans and other waterfowl; and to provide continued opportunities, including reasonable access, for mountain climbing, mountaineering and other wilderness recreational activities. That portion of the Alaska Railroad right-of-way within the park shall be subject to such laws and regulations applicable to the protection of fish and wildlife and other park values as the Secretary, with the concurrence of the Secretary of Transportation, may determine. Subsistence uses by local residents shall be permitted in the additions to the park where such uses are traditional in accordance with the provisions in Title VIII.

GENERAL ADMINISTRATION

Among other general administrative provisions, section 203 of ANILCA states, "Subsistence uses by local residents shall be allowed in national preserves and, where specifically permitted by this Act, in national monuments and parks."

TITLE VI, PART C – ADDITION TO NATIONAL WILD AND SCENIC RIVERS SYSTEM LOCATED OUTSIDE NATIONAL PARK SYSTEM UNITS

Section 603(a) of ANILCA designated the following wild and scenic river outside the national park system in Alaska:

ALAGNAK, ALASKA. – Those segments or portions of the main stem and Nonvianuk tributary lying outside and westward of the Katmai National Park /Preserve and running to the west boundary of township 13 south, range 43 west; to be administered by the Secretary of the Interior.

ANILCA and NPS regulations do not authorize subsistence use on federal lands within Kenai Fjords National Park, Klondike Gold Rush National Historical Park, Sitka National Historical Park, and areas previously managed as Mt. McKinley National Park, Katmai National Monument, and Glacier Bay National Monument.

III. Proposed Action on Federal Lands

The potential for significant restriction must be evaluated for the proposed action's effect upon ". . . subsistence uses and needs, the availability of other lands for the purposes sought to be achieved and other alternatives which would reduce or eliminate the use." (Section 810(a))

The NPS is considering implementation of an IPMP to address increasing problems with invasive plant control in national parks throughout the Alaska Region.

Alternative 1, the no-action alternative /status quo alternative, employs only physical control methods such as pulling, digging, and cutting. Under this alternative, the NPS would continue current vegetation management activities in Alaska NPS areas following existing laws, regulations, and policies. This alternative is likely to have more impact on subsistence resources than the Preferred Alternative 2 because it may be less effective at controlling invasive plants.

Alternative 2, the preferred action alternative, includes a decision tree to address when to implement various control methods, including physical (pulling, digging, burial, mowing, cutting, burning, and other heat treatments) and chemical (herbicide) applications. The focus of invasive species treatments is to control infestations before they establish and/or spread to areas where they are likely to have negative effects on natural resources and park values, including the use and enjoyment of subsistence resources. Invasive species could displace native plants that are a food source for subsistence users and habitat for wildlife populations utilized by subsistence cultures and individuals.

Alternatives 1 and 2 are described in detail in Chapter 2 of the IPMP. Should larger invasive plant infestations become established in Alaska NPS units in the future requiring more extensive uses of herbicides or massive physical response methods, then additional NEPA and ANILCA 810 compliance would be required, such as an EIS.

IV. Affected Environment

Subsistence uses, as defined by ANILCA, Section 810, means “The customary and traditional use by rural Alaska residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade." Subsistence activities include hunting, fishing, trapping, and collecting berries, edible plants, and wood or other materials.

ANILCA and National Park Service regulations authorize subsistence use of resources in all Alaska national parks, monuments, preserves and components of the Wild and Scenic River System with the exception of Glacier Bay National Park, Katmai National Park, Kenai Fjords National Park, Klondike Gold Rush National Historical Park, “old” Mount McKinley National Park, and Sitka National Historical Park (Codified in 36 CFR Part 13, Subparts A, B, and C). ANILCA provides a preference for local rural residents over other consumptive users should a shortage of subsistence resources occur and allocation of harvest becomes necessary.

Comprehensive descriptions of the affected subsistence environment within each Alaska national park system unit can be found in:

- NPS “General Management and Land Protection Plans” (http:// ww.nps.gov)
- Alaska Department of Fish and Game General and Subsistence Harvest Information and Publications (http://www.state.ak.us/adfg)
- Federal Subsistence Management Regulations, Office of Subsistence Management, FWS, (http://alaska.fws.gov/asm/home.html)

- National Park Service Management Policies, NPS, 2006. Information and Publications (http:// ww.nps.gov/policy)
- Alaska Subsistence, NPS Management History, NPS 2002
- Code of Federal Regulations, Part 13 National Park System Units in Alaska
- Who's Counting, National Parks Conservation Association, 2006.
- Dry Bay ORV Use Management Plan EA, NPS 2007.

The NPS recognizes that patterns of subsistence use vary from time to time and from place to place depending on the availability of wildlife and other renewable natural resources. A subsistence harvest in a given year may vary considerably from previous years because of weather, migration patterns, and natural population cycles.

V. Subsistence Uses and Needs Evaluation

Potential Impacts to Subsistence Users

To determine the potential impacts on existing subsistence activities for the proposed action, three evaluation criteria were analyzed relative to existing subsistence resources.

- the potential to reduce important subsistence fish and wildlife populations by (a) reductions in number, (b) redistribution of subsistence resources, or (c) habitat losses;
- what affect the action might have on subsistence fisherman or hunter access;
- the potential for the action to increase fisherman or hunter competition for subsistence resources.

1. The potential to reduce populations:

(a) Reduction in Numbers:

The proposed actions to implement various invasive plant control methods are not expected to cause a significant decline of wildlife species in the affected areas.

(b) Redistribution of Resources:

The proposed actions are not expected to cause a significant displacement of subsistence resources in the affected areas.

(c) Habitat Loss:

The proposed actions are expected to be beneficial for maintaining preferred habitat for key subsistence resources within the affected areas. Proposed treatment is expected to provide a positive affect on distribution, densities and availability of subsistence resources.

Impacts to subsistence resources and habitat from the proposed actions are expected to have short-term adverse and long-term beneficial effects. The NPS would work closely with subsistence users to minimize impacts to subsistence resources in the affected area.

2. Restriction of Access:

The proposed actions are not expected to significantly restrict current subsistence use patterns. Access for Title VIII subsistence uses within NPS areas is permitted according to Federal and State law and regulations.

3. Increase in Competition:

The proposed actions are not expected to significantly restrict or increase competition for subsistence resources on Federal public lands within the affected area.

VI. Availability of Other Lands

The proposed actions are consistent with NPS mandates and prevent the establishment and spread of invasive non-native plants in NPS areas in Alaska.

VII. Alternatives Considered

No other alternatives were identified that would reduce or eliminate the use of NPS public lands needed for subsistence purposes.

VII. Findings

This analysis concludes that the proposed actions will not result in a significant restriction of subsistence uses.

This page intentionally left blank.

Appendix B.1.
Summary Scores Of Invasiveness Ranking Of 113 Non-native Plants Ordered By Overall Invasiveness Score

Plant species	Common name	Ecological impact	Biological characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Myriophyllum spicatum †	Eurasian watermilfoil	38	20(22)	20	9	87(97)	90	Yes	Yes	Yes
Polygonum cuspidatum *	Japanese knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Polygonum sachalinensis *	Giant knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Polygonum X bohemicum *	Bohemian knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Centaurea biebersteinii	Spotted knapweed	34	22	21	9	86	86	Yes	Yes	–
Spartina alterniflora * †	Smooth cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina anglica * †	Common cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina densiflora * †	Denseflower cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina patens * †	Saltmeadow cordgrass	40	17	23	6	86	86	Yes	–	–
Euphorbia esula †	Leafy spurge	31	21	23	9	84	84	Yes	Yes	–
Lythrum salicaria *	Purple loosestrife	34	20	21	8	83	84	–	Yes	–
Lythrum virgatum *	European wand loosestrife	34	20	21	8	83	84	–	Yes	–
Phalaris arundinacea	Reed canarygrass	33	20	24	6	83	83	Yes	Yes	Yes
Impatiens glandulifera	Ornamental jewelweed	29	22	22	7	80(98)	82	Yes	Yes	–
Heracleum mantegazzianum †	Giant hogweed	33	22	17	9	81	81	Yes	Yes	Yes
Melilotus alba	White sweetclover	29	22	21	9	81	81	Yes	Yes	Yes
Hydrilla verticillata †	Waterthyme	38	17(22)	14	9	78(97)	80	Yes	Yes	Yes
Nymphaea odorata ssp. *odorata*	American white waterlily	36	18	18	6(7)	78(97)	80	Yes	–	–
Hieracium aurantiacum *	Orange hawkweed	29	23	19	8	79	79	Yes	Yes	Yes
Hieracium caespitosum *	Meadow hawkweed	29	23	19	8	79	79	Yes	Yes	Yes
Bromus tectorum	Cheatgrass	34	15	23	6	78	78	Yes	Yes	Yes
Rubus discolor	Himalayan blackberry	38	18	12	9	77	77	Yes	–	–
Cirsium arvense	Canada thistle	26	17	21	10	76	76	Yes	Yes	Yes
Prunus padus	European bird cherry	31	21	17	5	74	74	Yes	Yes	–
Sonchus arvensis	Moist sowthistle	22	21	21	9	73	73	Yes	Yes	–
Vicia cracca	Bird vetch	27	16	21	9	73	73	Yes	Yes	Yes
Lepidium latifolium	Broadleaved pepperweed	28	17(22)	16	6(7)	67(94)	71	–	Yes	Yes
Alliaria petiolata	Garlic mustard	24(30)	16	16	7	63(90)	70	Yes	–	–
Brachypodium sylvaticum †	False slender brome	31	19(23)	14	5	69(98)	70	Yes	Yes	Yes
Cytisus scoparius	Scotch broom	26	17	18	8	69	69	Yes	–	–
Linaria vulgaris	Butter and eggs	22	17	21	9	69	69	Yes	Yes	Yes
Melilotus officinalis	Yellow sweetclover	24	18	19	8	69	69	Yes	Yes	Yes
Caragana arborescens	Siberian peashrub	24	14	21	5(7)	64(97)	66	–	Yes	Yes
Lonicera tatarica	Tatarian honeysuckle	22	19(23)	18	6	65(98)	66	Yes	Yes	–
Campanula rapunculoides	Rampion bellflower	18(40)	16(20)	20(25)	5(7)	59(92)	64	Yes	Yes	Yes
Medicago sativa ssp. *falcata*	Yellow alfalfa	15(30)	17	15(19)	7	54(84)	64	Yes	Yes	Yes
Hordeum jubatum	Foxtail barley	18	16	20	9	63	63	Yes	Yes	Yes
Senecio jacobaea	Stinking willie	20	15	20	8	63	63	Yes	Yes	Yes
Bromus inermis ssp. *inermis*	Smooth brome	20	16	18	8	62	62	Yes	Yes	Yes

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Plant species	Common name	Ecological impact	Biological characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Alnus glutinosa †	European alder	24	16	14	5	59(97)	61	Yes	Yes	Yes
Carduus acanthoides * †	Spiny plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus nutans * †	Nodding plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus pycnocephalus * †	Italian plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus tenuiflorus * †	Winged plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Cirsium vulgare	Bull thistle	20	19(23)	18	3	60(98)	61	Yes	Yes	Yes
Leucanthemum vulgare	Oxeye daisy	20	15	18	8	61	61	Yes	Yes	Yes
Hordeum murinum ssp. *leporinum*	Leporinum barley	18	17	17	8	60	60	–	Yes	–
Elymus repens	Quackgrass	20	15	19	5	59	59	Yes	Yes	Yes
Medicago sativa ssp. *sativa*	Alfalfa	13(30)	17	16	7	53(90)	59	Yes	Yes	Yes
Sorbus aucuparia	European mountain ash	22	14	16	7	59	59	Yes	–	–
Trifolium repens	White clover	22	15	14	8	59	59	Yes	Yes	Yes
Linaria dalmatica	Dalmatian toadflax	16	14	19	9	58	58	–	Yes	–
Taraxacum officinale ssp. *officinale*	Common dandelion	18	14	18	8	58	58	Yes	Yes	Yes
Gypsophila paniculata	Baby's breath	20	14	18	3(7)	55(97)	57	Yes	Yes	Yes
Potentilla recta †	Sulfur cinquefoil	20	13	17	7	57	57	Yes	Yes	–
Tanacetum vulgare	Common tansy	20	15	13	8	56(98)	57	Yes	Yes	Yes
Trifolium hybridum	Alsike clover	22	12	18	5	57	57	Yes	Yes	Yes
Convolvulus arvensis	Field bindweed	18	14	16	8	56	56	Yes	Yes	Yes
Lupinus polyphyllus	Bigleaf lupine	14	16	17	8	55	55	Yes	Yes	Yes
Crepis tectorum	Narrowleaf hawksbeard	9(30)	17	18	3(7)	47(87)	54	Yes	Yes	Yes
Phleum pratense	Timothy	14	14	19	7	56	54	Yes	Yes	Yes
Ranunculus acris *	Tall buttercup	16	13(23)	15	9	53(98)	54	Yes	Yes	Yes
Ranunculus repens *	Creeping buttercup	16	13(23)	15	9	53(98)	54	Yes	Yes	Yes
Stellaria media/sea bird colonies	Common chickweed	14	12	20	8	54	54	Yes	Yes	Yes
Dactylis glomerata	Orchard grass	16	10	22	5	53	53	Yes	Yes	Yes
Trifolium pratense	Red clover	16	12(22)	16	7	51(97)	53	Yes	Yes	Yes
Vicia villosa	Winter vetch	22	11(22)	12(19)	3	48(91)	53	Yes	Yes	–
Zostera japonica †	Dwarf eelgrass	30	10	8	1(3)	49(93)	53	Yes	Yes	–
Hypericum perforatum	Common St. Johnswort	11	15	18	8	52	52	Yes	Yes	Yes
Poa pratensis ssp. *pratensis* *	Kentucky bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Poa pratensis ssp. *irrigata* *	Spreading bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Poa trivialis *	Rough bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Verbascum thapsus	Common mullien	20	9	16	7	52	52	Yes	Yes	–
Digitalis purpurea	Purple foxglove	16	11	19	5	51	51	Yes	Yes	–
Hieracium umbellatum	Narrowleaf hawkweed	13(30)	16(20)	9	4(7)	42(82)	51	Yes	Yes	Yes
Rumex acetosella	Common sheep sorrel	12	16	16	7	51	51	Yes	Yes	Yes
Fallopia convolvulus	Black bindweed	12	16	17	5	50	50	Yes	Yes	Yes
Tragopogon dubius	Yellow salsify	20	11	16	3	50	50	Yes	Yes	–
Glechoma hederacea	Ground ivy	14	12	14	8	48	48	Yes	Yes	Yes
Medicago lupulina	Black medick	10	18	15	5	48	48	Yes	Yes	Yes
Rumex crispus *	Curly dock	10	16	14	8	48	48	Yes	Yes	Yes
Rumex longifolius *	Dooryard dock	10	16	14	8	48	48	Yes	Yes	Yes

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Plant species	Common name	Ecological impact	Biological characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Rumex obtusifolius *	Bitter dock	10	16	14	8	48	48	Yes	Yes	Yes
Tripleurospermum perforata	Scentless false mayweed	13	13(23)	15	6	47(98)	48	Yes	Yes	Yes
Persicaria lapathifolia *	Curlytop knotweed	6	16	15(19)	7	44(94)	47	Yes	Yes	Yes
Persicaria maculosa *	Spotted ladysthumb	6	16	15(19)	7	44(94)	47	Yes	Yes	Yes
Achillea ptarmica	Sneezeweed	14	12	15	2(3)	43(93)	46	Yes	Yes	Yes
Poa annua	Annual bluegrass	8	13	18	7	46	46	Yes	Yes	Yes
Polygonum aviculare	Prostrate knotweed	7	15	16	7	45	45	Yes	Yes	Yes
Lappula squarrosa	European stickseed	10	12	17	5	44	44	Yes	Yes	Yes
Plantago major	Common plantain	8	13	16	7	44	44	Yes	Yes	Yes
Cotula coronopifolia	Common brassbuttons	14	11(23)	9	7	41(98)	42	Yes	–	–
Silene dioica *	Red catchfly	13	9	13	7	42	42	Yes	Yes	Yes
Silene latifolia *	Bladder campion	13	9	13	7	42	42	Yes	Yes	Yes
Silene noctiflora *	Nightflowering silene	13	9	13	7	42	42	Yes	Yes	Yes
Stellaria media/non-seabird sites	Common chickweed	10	12	15	5	42	42	Yes	Yes	Yes
Anthemis cotula	Stinking chamomile	8	12	14	7	41	41	Yes	Yes	–
Descurainia sophia	Herb sophia	8	13	18	2	41	41	Yes	Yes	Yes
Hesperis matronalis	Dames rocket	10	10(22)	17	2(7)	39(94)	41	Yes	Yes	–
Lolium perenne ssp. *multiflorum*	Italian ryegrass	14	10	15	2	41	41	Yes	Yes	Yes
Capsella bursa-pastoris	Shepherd's purse	7	11	18	4	40	40	Yes	Yes	Yes
Galeopsis bifida *	splitlip hempnettle	14	9	12(19)	3	38(94)	40	Yes	Yes	Yes
Galeopsis tetrahit *	brittlestem hempnettle	14	9	12(19)	3	38(94)	40	Yes	Yes	Yes
Poa compressa	Canada bluegrass	6	10	17	5(7)	38(97)	39	Yes	Yes	Yes
Chenopodium album	Lambsquarters	5	12	15	5	37	37	Yes	Yes	Yes
Cerastium fontanum ssp. *vulgare* *	Big chickweed	6	8(25)	15(19)	5	34(94)	36	Yes	Yes	Yes
Cerastium glomeratum *	Sticky chickweed	6	8(25)	15(19)	5	34(94)	36	Yes	Yes	Yes
Senecio vulgaris	Old-man-in-the-Spring	4	12	15	5	36	36	Yes	Yes	Yes
Saponaria officinalis	Bouncingbet	5(30)	8(22)	12	2(3)	27(80)	34	Yes	Yes	–
Matricaria discoidea	Disc mayweed	5	9	15	3	32	32	Yes	Yes	Yes
Spergula arvensis	Corn spurry	2	11	14	5	32	32	Yes	Yes	Yes
Mycelis muralis	Wall-lettuce	7	11(23)	8	4	30(98)	31	Yes	–	–
Lepidium densiflorum	Common pepperweed	1(30)	9(23)	8	4	22(88)	25	Yes	Yes	Yes
Centaurea solstitialis	Yellow star-thistle							–	–	–
Crupina vulgaris	Common crupina							–	–	–

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Appendix B.2.
Summary Scores Of Invasiveness Ranking Of 113 Non-native Plants Ordered By Species Name

Plant species	Common name	Ecological Impact	Biological Characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Achillea ptarmica	Sneezeweed	14	12	15	2(3)	43(93)	46	Yes	Yes	Yes
Alliaria petiolata	Garlic mustard	24(30)	16	16	7	63(90)	70	Yes	–	–
Alnus glutinosa †	European alder	24	16	14	5	59(97)	61	Yes	Yes	Yes
Anthemis cotula	Stinking chamomile	8	12	14	7	41	41	Yes	Yes	–
Brachypodium sylvaticum †	False slender brome	31	19(23)	14	5	69(98)	70	Yes	Yes	Yes
Bromus inermis ssp. *inermis*	Smooth brome	20	16	18	8	62	62	Yes	Yes	Yes
Bromus tectorum	Cheatgrass	34	15	23	6	78	78	Yes	Yes	Yes
Campanula rapunculoides	Rampion bellflower	18(40)	16(20)	20(25)	5(7)	59(92)	64	Yes	Yes	Yes
Capsella bursa-pastoris	Shepherd's purse	7	11	18	4	40	40	Yes	Yes	Yes
Caragana arborescens	Siberian peashrub	24	14	21	5(7)	64(97)	66	–	Yes	Yes
Carduus acanthoides * †	Spiny plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus nutans * †	Nodding plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus pycnocephalus * †	Italian plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Carduus tenuiflorus * †	Winged plumeless thistle	22	17	14	8	61	61	Yes	Yes	Yes
Centaurea biebersteinii	Spotted knapweed	34	22	21	9	86	86	Yes	Yes	–
Centaurea solstitialis	Yellow star-thistle							–	–	–
Cerastium fontanum ssp. *vulgare* *	Big chickweed	6	8(25)	15(19)	5	34(94)	36	Yes	Yes	Yes
Cerastium glomeratum *	Sticky chickweed	6	8(25)	15(19)	5	34(94)	36	Yes	Yes	Yes
Chenopodium album	Lambsquarters	5	12	15	5	37	37	Yes	Yes	Yes
Cirsium arvense	Canada thistle	26	17	21	10	76	76	Yes	Yes	Yes
Cirsium vulgare	Bull thistle	20	19(23)	18	3	60(98)	61	Yes	Yes	Yes
Convolvulus arvensis	Field bindweed	18	14	16	8	56	56	Yes	Yes	Yes
Cotula coronopifolia	Common brassbuttons	14	11(23)	9	7	41(98)	42	Yes	–	–
Crepis tectorum	Narrowleaf hawksbeard	9(30)	17	18	3(7)	47(87)	54	Yes	Yes	Yes
Crupina vulgaris	Common crupina							–	–	–
Cytisus scoparius	Scotch broom	26	17	18	8	69	69	Yes	–	–
Dactylis glomerata	Orchard grass	16	10	22	5	53	53	Yes	Yes	Yes
Descurainia sophia	Herb sophia	8	13	18	2	41	41	Yes	Yes	Yes
Digitalis purpurea	Purple foxglove	16	11	19	5	51	51	Yes	Yes	–
Elymus repens	Quackgrass	20	15	19	5	59	59	Yes	Yes	Yes
Euphorbia esula †	Leafy spurge	31	21	23	9	84	84	Yes	Yes	–
Fallopia convolvulus	Black bindweed	12	16	17	5	50	50	Yes	Yes	Yes
Galeopsis bifida *	splitlip hempnettle	14	9	12(19)	3	38(94)	40	Yes	Yes	Yes
Galeopsis tetrahit *	brittlestem hempnettle	14	9	12(19)	3	38(94)	40	Yes	Yes	Yes
Glechoma hederacea	Ground ivy	14	12	14	8	48	48	Yes	Yes	Yes
Gypsophila paniculata	Baby's breath	20	14	18	3(7)	55(97)	57	Yes	Yes	Yes
Heracleum mantegazzianum †	Giant hogweed	33	22	17	9	81	81	Yes	Yes	Yes
Hesperis matronalis	Dames rocket	10	10(22)	17	2(7)	39(94)	41	Yes	Yes	–

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Plant species	Common name	Ecological Impact	Biological Characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Hieracium aurantiacum *	Orange hawkweed	29	23	19	8	79	79	Yes	Yes	Yes
Hieracium caespitosum *	Meadow hawkweed	29	23	19	8	79	79	Yes	Yes	Yes
Hieracium umbellatum	Narrowleaf hawkweed	13(30)	16(20)	9	4(7)	42(82)	51	Yes	Yes	Yes
Hordeum jubatum	Foxtail barley	18	16	20	9	63	63	Yes	Yes	Yes
Hordeum murinum ssp. *leporinum*	Leporinum barley	18	17	17	8	60	60	–	Yes	–
Hydrilla verticillata †	Waterthyme	38	17(22)	14	9	78(97)	80	Yes	Yes	Yes
Hypericum perforatum	Common St. Johnswort	11	15	18	8	52	52	Yes	Yes	Yes
Impatiens glandulifera	Ornamental jewelweed	29	22	22	7	80(98)	82	Yes	Yes	–
Lappula squarrosa	European stickseed	10	12	17	5	44	44	Yes	Yes	Yes
Lepidium densiflorum	Common pepperweed	1(30)	9(23)	8	4	22(88)	25	Yes	Yes	Yes
Lepidium latifolium	Broadleaved pepperweed	28	17(22)	16	6(7)	67(94)	71	–	Yes	Yes
Leucanthemum vulgare	Oxeye daisy	20	15	18	8	61	61	Yes	Yes	Yes
Linaria dalmatica	Dalmatian toadflax	16	14	19	9	58	58	–	Yes	–
Linaria vulgaris	Butter and eggs	22	17	21	9	69	69	Yes	Yes	Yes
Lolium perenne ssp. *multiflorum*	Italian ryegrass	14	10	15	2	41	41	Yes	Yes	Yes
Lonicera tatarica	Tatarian honeysuckle	22	19(23)	18	6	65(98)	66	Yes	Yes	–
Lupinus polyphyllus	Bigleaf lupine	14	16	17	8	55	55	Yes	Yes	Yes
Lythrum salicaria *	Purple loosestrife	34	20	21	8	83	84	–	Yes	–
Lythrum virgatum *	European wand loosestrife	34	20	21	8	83	84	–	Yes	–
Matricaria discoidea	Disc mayweed	5	9	15	3	32	32	Yes	Yes	Yes
Medicago lupulina	Black medick	10	18	15	5	48	48	Yes	Yes	Yes
Medicago sativa ssp. *falcata*	Yellow alfalfa	15(30)	17	15(19)	7	54(84)	64	Yes	Yes	Yes
Medicago sativa ssp. *sativa*	Alfalfa	13(30)	17	16	7	53(90)	59	Yes	Yes	Yes
Melilotus alba	White sweetclover	29	22	21	9	81	81	Yes	Yes	Yes
Melilotus officinalis	Yellow sweetclover	24	18	19	8	69	69	Yes	Yes	Yes
Mycelis muralis	Wall-lettuce	7	11(23)	8	4	30(98)	31	Yes	–	–
Myriophyllum spicatum †	Eurasian watermilfoil	38	20(22)	20	9	87(97)	90	Yes	Yes	Yes
Nymphaea odorata ssp. *odorata*	American white waterlily	36	18	18	6(7)	78(97)	80	Yes	–	–
Persicaria lapathifolia *	Curlytop knotweed	6	16	15(19)	7	44(94)	47	Yes	Yes	Yes
Persicaria maculosa *	Spotted ladysthumb	6	16	15(19)	7	44(94)	47	Yes	Yes	Yes
Phalaris arundinacea	Reed canarygrass	33	20	24	6	83	83	Yes	Yes	Yes
Phleum pratense	Timothy	14	14	19	7	56	54	Yes	Yes	Yes
Plantago major	Common plantain	8	13	16	7	44	44	Yes	Yes	Yes
Poa annua	Annual bluegrass	8	13	18	7	46	46	Yes	Yes	Yes
Poa compressa	Canada bluegrass	6	10	17	5(7)	38(97)	39	Yes	Yes	Yes
Poa pratensis ssp. *pratensis* *	Kentucky bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Poa pratensis ssp. *irrigata* *	Spreading bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Poa trivialis *	Rough bluegrass	12	14	19	7	52	52	Yes	Yes	Yes
Polygonum aviculare	Prostrate knotweed	7	15	16	7	45	45	Yes	Yes	Yes
Polygonum cuspidatum *	Japanese knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Polygonum sachalinensis *	Giant knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Polygonum X bohemicum *	Bohemian knotweed	33	21	23	7(7)	84(97)	87	Yes	Yes	–
Potentilla recta †	Sulfur cinquefoil	20	13	17	7	57	57	Yes	Yes	–

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Plant species	Common name	Ecological Impact	Biological Characteristics	Distribution	Control	Total	Invasiveness	South Coastal	Interior Boreal	Arctic Alpine
Prunus padus	European bird cherry	31	21	17	5	74	74	Yes	Yes	–
Ranunculus acris *	Tall buttercup	16	13(23)	15	9	53(98)	54	Yes	Yes	Yes
Ranunculus repens *	Creeping buttercup	16	13(23)	15	9	53(98)	54	Yes	Yes	Yes
Rubus discolor	Himalayan blackberry	38	18	12	9	77	77	Yes	–	–
Rumex acetosella	Common sheep sorrel	12	16	16	7	51	51	Yes	Yes	Yes
Rumex crispus *	Curly dock	10	16	14	8	48	48	Yes	Yes	Yes
Rumex longifolius *	Dooryard dock	10	16	14	8	48	48	Yes	Yes	Yes
Rumex obtusifolius *	Bitter dock	10	16	14	8	48	48	Yes	Yes	Yes
Saponaria officinalis	Bouncingbet	5(30)	8(22)	12	2(3)	27(80)	34	Yes	Yes	–
Senecio jacobaea	Stinking willie	20	15	20	8	63	63	Yes	Yes	Yes
Senecio vulgaris	Old-man-in-the-Spring	4	12	15	5	36	36	Yes	Yes	Yes
Silene dioica *	Red catchfly	13	9	13	7	42	42	Yes	Yes	Yes
Silene latifolia *	Bladder campion	13	9	13	7	42	42	Yes	Yes	Yes
Silene noctiflora *	Nightflowering silene	13	9	13	7	42	42	Yes	Yes	Yes
Sonchus arvensis	Moist sowthistle	22	21	21	9	73	73	Yes	Yes	–
Sorbus aucuparia	European mountain ash	22	14	16	7	59	59	Yes	–	–
Spartina alterniflora * †	Smooth cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina anglica * †	Common cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina densiflora * †	Denseflower cordgrass	40	17	23	6	86	86	Yes	–	–
Spartina patens * †	Saltmeadow cordgrass	40	17	23	6	86	86	Yes	–	–
Spergula arvensis	Corn spurry	2	11	14	5	32	32	Yes	Yes	Yes
Stellaria media/non-seabird sites	Common chickweed	10	12	15	5	42	42	Yes	Yes	Yes
Stellaria media/sea bird colonies	Common chickweed	14	12	20	8	54	54	Yes	Yes	Yes
Tanacetum vulgare	Common tansy	20	15	13	8	56(98)	57	Yes	Yes	Yes
Taraxacum officinale ssp. *officinale*	Common dandelion	18	14	18	8	58	58	Yes	Yes	Yes
Tragopogon dubius	Yellow salsify	20	11	16	3	50	50	Yes	Yes	–
Trifolium hybridum	Alsike clover	22	12	18	5	57	57	Yes	Yes	Yes
Trifolium pratense	Red clover	16	12(22)	16	7	51(97)	53	Yes	Yes	Yes
Trifolium repens	White clover	22	15	14	8	59	59	Yes	Yes	Yes
Tripleurospermum perforata	Scentless false mayweed	13	13(23)	15	6	47(98)	48	Yes	Yes	Yes
Verbascum thapsus	Common mullien	20	9	16	7	52	52	Yes	Yes	–
Vicia cracca	Bird vetch	27	16	21	9	73	73	Yes	Yes	Yes
Vicia villosa	Winter vetch	22	11(22)	12(19)	3	48(91)	53	Yes	Yes	–
Zostera japonica †	Dwarf eelgrass	30	10	8	1(3)	49(93)	53	Yes	Yes	–

† = Not known in AK (2006)

* = Congeneric species ranked together

Climate matches to the three ecoregions of Alaska are included (Yes = present or high probability of establishing in the ecoregion, – = absent and low probability of establishment). Scores >80 = "Extremely Invasive", 70-79 = "Highly Invasive", 60-69 = "Moderately Invasive", 50-59 = "Modestly Invasive", 40-49 = "Weakly Invasive", and < 40 = "Very Weakly Invasive".

Source: Carlson, M. L., Lapina, I. V., Shephard, M., Conn, J. S., Densmore, R., Spencer, P., Heys, J., Riley, J. and J. Nielsen. 2008. Invasiveness Ranking System for Non-Native Plants of Alaska. USDA Forest Service, R10, R10-TP-143. 218 pp.

.

Yellow highlighted rows = species observed within NPS units

Orange highlighted rows = species observed within 15 miles of NPS units

Additional Species Documented in Alaska but not Ranked or seen in NPS units

Source: AKEPIC database (6/09) compared to species in Appendix B and NPS data.

Nomenclature follows that used in AKEPIC database.

Agropyron cristatum (crested wheatgrass)
Agrostis stolonifera (creeping bentgrass, red top)
Agrostis tenuis (colonial bentgrass)
Alchemilla mollis (lady's mantle)
Anaphalis margaritacea (western pearly everlasting)
Anthoxanthum odoratum (sweet vernal grass)
Arrhenatherum elatius (tall oatgrass)
Asperugo procumbens (catchweed, mudwort)
Astragalus cicer (chickpea milkvetch, cicer milkvetch)
Avena fatua (wildoats)
Berteroa incana (hoary false madwort)
Betula pendula (European white birch)
Brassica juncea (indian mustard)
Brassica napus (rape)
Bromus hordeaceus (soft brome)
Bromus secalinus (rye brome, cheat)
Calendula officinalis (calendula)
Calystegia sepium ssp. *sepium* (hedge false bindweed)
Capsella rubella (shepherd's purse)
Chaenorhinum minus (dwarf snapdragon)
Chenopodium berlanderieri (pitseed goosefoot)
Cichorium intybus (chicory)
Collomia linearis (tiny trumpet)
Conyza canadensis (Canadian horseweed)
Daucus carota (Queen Anne's lace)
Delphinium sonnei
Deschampsia elongata (slender hairgrass)
Descurainia pinnata (western tansy mustard)
Dianthus deltoides (maiden pink)
Elymus sibiricus (Siberian wild rye)
Elymus trachycaulus (slender wheatgrass)
Erucastrum gallicum (common dogmustard)
Festuca arundinacea (tall fescue)
Fragaria ananassa [*chiloensis* × *virginiana*] (domestic strawberry)
Geranium robertianum (herb Robert)
Gnaphalium palustre (marsh cudweed)
Gnaphalium uliginosum (marsh cudweed)
Hedera helix (English ivy)
Helianthus annuus (annual (common) sunflower)
Hieracium lachenalii (common hawkweed)
Hieracium pilosella (mouseear hawkweed)
Holcus lanatus (Common velvetgrass)
Holcus mollis (creeping velvet grass)
Hordeum vulgare (common barley)
Ilex aquifolium (English holly)
Iris pseudacorus (yellow flag iris)
Lactuca serriola (prickly lettuce)
Lapsana communis (common nipplewort)
Leontodon autumnalis (fall dandelion)
Leontodon hirtus (rough hawkbit)
Lepidium ramosissimum (manybranched pepperwood)
Leucanthemum maximum (shasta daisy)
Linaria pinifolia (pineneedle toadflax)
Lolium arundinaceum (tall fescue)
Lolium pratense (meadow fescue)
Lotus corniculatus (bird's foot trefoil)
Lysimachia nummularia (creeping jenny)
Madia glomerata (mountain tarweed)
Medicago minima (burr medic)
Mycelis muralis (wall lettuce)
Myrrhis odorata (anise)
Neslia paniculata (ball mustard)
Papaver rhoeas (corn poppy)
Plantago lanceolata (ribgrass, buckhorn, English plantain)
Poa angustifolia (Kentucky bluegrass)
Poa glauca (glaucous bluegrass)
Poa subcoerulea (spreading bluegrass)
Polygonum lapathifolium (willow weed)
Polygonum persicaria (lady's-thumb)
Potentilla anserina (silverweed)
Raphanus sativus (cultivated radish)
Rorippa sylvestris (creeping yellowcress)
Rumex acetosa spp. *acetosa* (garden sorrel)
Securigera varia (crownvetch)
Setaria virdis (green bristlegrass)
Silene armeria (sweet William silene)
Sinapis alba (white mustard)
Sinapsis arvensis (charlock)
Sisymbrium altissimum (tumbling mustard)
Sonchus asper (spiny sowthistle)
Sorbaria sorbifolia (false spiraea)
Spergularia rubra (purple sand spurry)
Trifolium aureum (golden clover)
Trifolium dubium (suckling clover)
Veronica peregrina ssp. *peregrina* (neckweed)
Viburnum opulus (American cranberrybush)

APPENDIX C Relative Aquifer Vulnerability Evaluation (RAVE)

As adapted from the Users Guide for the Vegetation Management
Risk Assessment for Herbicide Use in Forest Service
Regions 1, 2, 3, 4, and 10 and on
Bonneville Power Administration Sites
December 1992
The USFS adapted their RAVE from the Montana Department of Agriculture,
Environmental Management Division.

Introduction

To help Alaska parks reduce the potential for contaminating groundwater with herbicides, an aquifer vulnerability scoring system – Relative Aquifer Vulnerability Evaluation (RAVE) – was adapted to the Region. This numeric scoring system will help the parks evaluate herbicide selection for on-site groundwater contamination potential. RAVE is designed only as a guidance system and does not replace the need for safe and judicious herbicide application required in all situations.

Wetlands, rivers, streams and lakes, and areas of parks where groundwater is within 20 feet of the surface are particularly vulnerable to herbicide contamination and thus require special consideration prior to making an application. The use of the score card may indicate whether an alternative herbicide should be used within a given area, or if the area is not suited to herbicide applications. If the area is not suitable for herbicide use, other control methods should be used.

Several major factors in a particular area determine the relative vulnerability of groundwater to herbicide contamination. Nine of these factors have been incorporated into the RAVE score card and are defined below. A value for most of these factors can be determined by a simple on-site inspection. Soil and water level information exists for the park in areas where an herbicide might be used. Herbicide leaching potential is based on the persistence and mobility of an herbicide in the soil. A list of leaching and surface runoff potentials for herbicides proposed for use in Alaska parks is given on the attached table.

Direction for Use of the RAVE Score Card

The RAVE score card can be completed in a matter of minutes. On a separate sheet of paper write down the appropriate value for each of the nine factors listed on the score card. Once all of the factors have been assigned a value, the values should be totaled.

Interpretation of RAVE Score

Higher numbers indicate high vulnerability of groundwater to contamination by the herbicide used in the evaluation. RAVE scores greater than or equal to 65 indicate a potential for groundwater contamination. RMNP will always be evaluating information to determine herbicides that maybe appropriate. A RAVE score of 80 or greater indicate that herbicide applications should not be made at this location with the proposed product. Scores between 45 and 65 indicate a moderate to low potential for groundwater contamination and scores less than 45 indicate a low potential for groundwater contamination by the herbicide being evaluated. Even in such cases, careful use of herbicides and adherence to label instructions is imperative to protect groundwater.

Note: Some products such as Telar are used in very small quantities. In cases where less than ½ pound AI per acre is applied, it would be reasonable to reduce the final RAVE score by 2-5 points.

Factor Definitions	
Depth to Groundwater	Distance in vertical feet below the soil surface to the water table.
Soil Texture	Soils predominately gravelly, sandy, loamy, or clayey.
Percent Organic Matter	The relative amount of decayed plant residue in the soil may be estimated by soil color; darker soil generally indicates higher organic matter (most of the soil in the park is less than 3 percent).
Topographic Position	Physical surroundings of the location where the herbicide application is to be made. ▪ Flood Plain = within a river, stream or lake valley, with vegetation composed of wetland species ▪ Alluvial Fan or Bench = lands immediately above a river or lake valley but may still have some riparian vegetation ▪ Upland Habitat = uplands above a floodplain or alluvial bench ▪ Transition zone = land not immediately affected by open water
Distance to Surface Water	Distance in feet from treatment boundary to the nearest flowing or stationary surface water.
Annual Precipitation	60” annual precipitation. 30-60” annual precipitation. < 30” annual precipitation on the treatment site.
Herbicide Application Frequency	Number of times the particular herbicide is applied during one growing season.
Herbicide Application Method	Whether the herbicide is applied to the soil or to the plant.
Herbicide Leachability	A relative ranking of the potential for an herbicide to move downward in soil and ultimately contaminate groundwater based upon the persistence and mobility of the herbicide.

Herbicides and their Properties (for use with the Rave Scorecard)						
Common Name	**Trade Name**	**Solubility in Water ppm**	**Soil Sorption Index (Koc)**	**Half Life in Soil (days)**	**Surface Runoff (Loss) potential**	**Leaching**
Chlorsulfuron	Telar	300 (pH 5); 28,000 (pH 7)	40 @ pH 7 (avg.)	30- acid soil; 30+ alkaline	Small	Large
Clopyralid	Transline	1,000 (acid); 300,000 (salt)	1.4	20	Small	Large
2,4-D Amine		890	20	10	Small	Medium
2,4-D Ester		900	100 (Estimated)	10	Medium	Small
Glyphosate	Roundup & Rodeo	12,000	24,000	30	Large	Small
Metsulfuron-methyl	Escort	548 @ pH 5; 2,790 @ pH 7; 213,000 @ pH 9	35 @ pH 7	120	Medium	Large
Triclopyr	Garlon	430	780	46	Large	Medium
Imazapyr	Arsenal & Habitat	15,000	5 (Estimated)	90	Small	Large
Aminopyralid	Milestone	According to Jerry McCrea (IPM Coordinator for the Intermountain Region of the NPS), the Montana Dept. of Agriculture determined that due to the relatively non-toxic nature of this chemical, it does not need to be evaluated for groundwater contamination.				

THE RAVE SCORE CARD (circle one of each category)

Depth to Groundwater	**Annual Precipitation**
* 2-10 ft. 20	>60" 5
10-25 ft. 12	30-60 " 2
25-50 ft. 5	<30" 0
> 50 ft. 0	
Soil Texture	**Herbicide Application Frequency**
Gravelly 15	>1/yr 5
Sandy 15	1/yr 2
Loamy 10	<1/yr 1
Percent Soil Organic Mater	**Herbicide Application Method**
0-1% 5	Applied to Soil 5
**1-3% 3	Applied to Foliage 2
>3% 2	
Topographic Position	***Herbicide Leaching Potential**
Flood Plain 15	Large 20
Alluvial Bench 10	Medium 10
Upland Habitat 5	Small 5
Transition Zone 2	
Distance to Surface Water	**Total all Rankings**
0-100 ft. 5	_____ = Rave Score
100-500 ft. 3	
>500 ft. 2	

* If water table is less than 2 feet deep applications should not be made or possibly done with a wick or wand applicator, but only for a herbicide that can be used with that method in wetland habitat.
** If unknown use this value
*** See attached Table (Herbicides and their Properties) for leaching potential for the pesticide in question.

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
passerine-omnivore	Passeriformes	Blackpoll Warbler	No	Rarely	No
raptorial birds	Falconiformes	Gyrfalcon	No	Rarely	No
raptorial birds	Falconiformes	Red-tailed Hawk	No	Rarely	No
wader	Ciconiiformes	American Bittern	No	Sometimes	Yes
passerine-omnivore	Passeriformes	American Robin	No	Sometimes	No
raptorial birds	Falconiformes	Bald Eagle	No	Sometimes	Yes
passerine-omnivore	Passeriformes	Brewer's Blackbird	No	Sometimes	No
passerine-omnivore	Passeriformes	Brown-headed Cowbird	No	Sometimes	No
waterfowl	Anseriformes	Common Merganser	No	Sometimes	Yes
passerine-omnivore	Passeriformes	Common Redpoll	No	Sometimes	No
passerine-omnivore	Passeriformes	Common Redpoll	No	Sometimes	No
seabird	Pelecaniformes	Double-crested Cormorant	No	Sometimes	Yes
passerine-omnivore	Passeriformes	European Starling	No	Sometimes	No
raptorial birds	Falconiformes	Golden Eagle	No	Sometimes	No
wading bird	Ciconiiformes	Great Blue Heron	No	Sometimes	Yes
wading bird	Ciconiiformes	Great Egret	No	Sometimes	Yes
waterfowl	Anseriformes	Hooded Merganser	No	Sometimes	Yes
seabird	Charadriiformes	Marbled Murrelet	No	Sometimes	Yes
raptorial birds	Falconiformes	Merlin	No	Sometimes	No
passerine	Passeriformes	Northern Shrike	No	Sometimes	No
passerine-omnivore	Passeriformes	Northwestern Crow	Yes	Sometimes	Yes, scavenging
raptorial birds	Falconiformes	Osprey	No	Sometimes	Yes
raptorial birds	Falconiformes	Peregrine Falcon	No	Sometimes	No
passerine-omnivore	Columbiformes	Rock Pigeon	No	Sometimes	No
raptorial birds	Falconiformes	Rough-legged Hawk	No	Sometimes	No
bird-piscivore	Coraciiformes	Belted Kingfisher	No	uses burrows	Yes
waterfowl	Anseriformes	Bufflehead	No	Very rarely	Yes
Seabird-tern	Charadriiformes	Aleutian Tern	No	Yes	Yes
waterfowl	Anseriformes	American Black Duck	No	Yes	No
wader	Gruiformes	American Coot	No	Yes	Yes
passerine-insectivore	Passeriformes	American Dipper	No	Yes	Yes
shorebird	Charadriiformes	American Golden-Plover	No	Yes	Yes
passerine-insectivore	Passeriformes	American Pipit	No	Yes	No
passerine-omnivore	Passeriformes	American Tree Sparrow	No	Yes	No
waterfowl	Anseriformes	American Wigeon	No	Yes	No

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
seabird	Charadriiformes	Ancient Murrelet	No	Yes	Yes
waterfowl	Gaviiformes	Arctic Loon	No	Yes	Yes
passerine-omnivore	Passeriformes	Arctic Warbler	No	Yes	No
seabird	Charadriiformes	Auklet*	No	yes	Yes
shorebird	Charadriiformes	Baird's Sandpiper	No	Yes	No
shorebird	Charadriiformes	Bar-tailed Godwit	No	Yes	Occasionally
seabird	Charadriiformes	Black Guillemot	No	yes	Yes
shorebird	Charadriiformes	Black Oystercatcher	No	Yes	Occasionally
waterfowl	Anseriformes	Black Scoter	No	Yes	Yes
shorebird	Charadriiformes	Black Turnstone	No	Yes	No
shorebird	Charadriiformes	Black-bellied Plover	No	Yes	No
seabird	Charadriiformes	Black-footed Albatross	No	Yes	Yes
seabird	Charadriiformes	Black-headed Gull	Possible	Yes	Yes
gallinaceous birds	Galliformes	Blue Grouse	No	Yes	No
passerine-insectivore	Passeriformes	Bluethroat	No	Yes	No
waterfowl	Anseriformes	Blue-winged Teal	No	Yes	Yes
Seabird-gull	Charadriiformes	Bonaparte's Gull	Possible	Yes	Yes
waterfowl	Anseriformes	Brant	No	Yes	No
shorebird	Charadriiformes	Bristle-thighed Curlew	No	Yes	No
seabird	Charadriiformes	Brown-backed Tern*	No	Yes	Yes
shorebird	Charadriiformes	Buff-breasted Sandpiper	No	Yes	No
waterfowl	Anseriformes	cackling goose	No	Yes	No
Seabird-gull	Charadriiformes	California Gull	Yes	Yes	Yes
waterfowl	Anseriformes	Canada Goose	No	Yes	No
waterfowl	Anseriformes	Canvasback	No	Yes	Yes
seabird	Charadriiformes	Caspian Tern	No	Yes	Yes
seabird	Charadriiformes	Cassin's Auklet	No	Yes	Yes
wading bird	Ciconiiformes	Cattle Egret	No	Yes	Yes
waterfowl	Anseriformes	Cinnamon Teal	No	Yes	No
waterfowl	Gaviiformes	Common Loon	No	Yes	Yes
seabird	Charadriiformes	Common Murre	No	Yes	Yes
bird-insectivore	Caprimulgiformes	Common Nighthawk	No	Yes	No
shorebird	Charadriiformes	Common Snipe	No	Yes	No
passerine-omnivore	Charadriiformes	Common Tern	No	Yes	Yes
seabird	Charadriiformes	Crested Auklet	No	Yes	Yes

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
shorebird	Charadriiformes	Curlew Sandpiper	No	Yes	No
passerine-omnivore	Passeriformes	Dark-eyed Junco	No	Yes	No
shorebird	Charadriiformes	Dunlin	No	Yes	No
passerine-insectivore	Passeriformes	Eastern Yellow Wagtail	No	Yes	No
waterfowl	Anseriformes	Emperor Goose	No	Yes	No
shorebird	Charadriiformes	Eurasian Dotterel	No	Yes	No
waterfowl	Anseriformes	Eurasian Wigeon	No	Yes	No
seabird	Procellariiformes	Fork-tailed Storm Petrel	No	Yes	Yes
passerine-omnivore	Passeriformes	Fox Sparrow	No	Yes	No
Seabird-gull	Charadriiformes	Franklin's Gull	No	Yes	Yes
waterfowl	Anseriformes	Gadwall	No	Yes	No
Seabird-gull	Charadriiformes	Glaucous Gull	Yes	Yes	Yes
Seabird-gull	Charadriiformes	Glaucous-winged Gull	Yes	Yes	Yes
passerine-omnivore	Passeriformes	Golden-crowned Sparrow	No	Yes	No
passerine-omnivore	Passeriformes	Gray-crowned Rosy-Finch	No	Yes	No
waterfowl	Anseriformes	Greater Scaup	No	Yes	No
waterfowl	Anseriformes	Greater White-fronted Goose	No	Yes	No
shorebird	Charadriiformes	Greater Yellowlegs	No	Yes	No
waterfowl	Anseriformes	Green-winged Teal	No	Yes	Sometimes fish eggs
waterfowl	Anseriformes	Harlequin Duck	No	Yes	Yes
passerine-omnivore	Passeriformes	Harris's Sparrow	No	Yes	No
passerine-insectivore	Passeriformes	Hermit Thrush	No	Yes	No
Seabird-gull	Charadriiformes	Herring Gull	Yes	Yes	Yes
passerine-omnivore	Passeriformes	Hoary Redpoll	No	Yes	No
passerine-omnivore	Passeriformes	Horned Lark	No	Yes	No
seabird	Charadriiformes	Horned Puffin	No	Yes	Yes
shorebird	Charadriiformes	Hudsonian Godwit	No	Yes	No
Seabird-gull	Charadriiformes	Ivory Gull	No	Yes	Yes
shorebird	Charadriiformes	Killdeer	No	Yes	No
waterfowl	Anseriformes	King Eider	No	Yes	No
seabird	Charadriiformes	Kittlitz's Murrelet	No	Yes	Yes
passerine-omnivore	Passeriformes	Lapland Longspur	No	Yes	No
seabird	Procellariiformes	Laysan Albatross	No	Yes	Yes
seabird	Procellariiformes	Leach's Storm Petrel	No	Yes	Yes
seabird	Charadriiformes	Least Auklet	No	Yes	Yes

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
shorebird	Charadriiformes	Least Sandpiper	No	Yes	No
waterfowl	Anseriformes	Lesser Scaup	No	Yes	No
shorebird	Charadriiformes	Lesser Yellowlegs	No	Yes	No
passerine-omnivore	Passeriformes	Lincoln's Sparrow	No	Yes	No
shorebird	Charadriiformes	Long-billed Dowitcher	No	Yes	No
waterfowl	Anseriformes	Long-tailed Duck	No	Yes	No
seabird	Charadriiformes	Long-tailed Jaeger	Sometimes	Yes	Yes
waterfowl	Anseriformes	Mallard	No	Yes	No
shorebird	Charadriiformes	Marbled Godwit	No	Yes	No
passerine-omnivore	Passeriformes	McKay's Bunting	No	Yes	No
Seabird-gull	Charadriiformes	Mew Gull	Yes	Yes	Yes
passerine-omnivore	Columbiformes	Mourning Dove	No	Yes	No
seabird	Procellariiformes	Northern Fulmar	No	Yes	Yes
raptorial birds	Falconiformes	Northern Harrier	No	Yes	No
waterfowl	Anseriformes	Northern Pintail	No	Yes	No
waterfowl	Anseriformes	Northern Shoveler	No	Yes	No
passerine-omnivore	Passeriformes	Northern Waterthrush	No	Yes	No
passerine-insectivore	Passeriformes	Northern Wheatear	No	Yes	No
passerine-omnivore	Passeriformes	Orange-crowned Warbler	No	Yes	No
shorebird	Charadriiformes	Pacific Golden-Plover	No	Yes	No
waterfowl	Gaviiformes	Pacific Loon	No	Yes	Yes
seabird	Charadriiformes	Parakeet Auklet	No	Yes	Yes
Seabird	Charadriiformes	Parasitic Jaeger	Yes	Yes	Yes
shorebird	Charadriiformes	Pectoral Sandpiper	No	Yes	No
seabird	Charadriiformes	Pigeon Guillemot	No	Yes	Yes
seabird	Pelecaniformes	Pink-footed Shearwater	No	Yes	Yes
Seabird	Charadriiformes	Pomarine Jaeger	Yes	Yes	Yes
shorebird	Charadriiformes	Red Knot	No	Yes	No
shorebird	Charadriiformes	Red Phalarope	No	Yes	No
waterfowl	Anseriformes	Red-breasted Merganser	No	Yes	Yes
waterfowl	Anseriformes	Redhead	No	Yes	No
seabird	Charadriiformes	Red-legged Kittiwake	No	Yes	Yes
waterbird	Podicipediformes	Red-necked Grebe	No	Yes	Yes
shorebird	Charadriiformes	Red-necked Phalarope	No	Yes	Sometimes
shorebird	Charadriiformes	Red-necked Stint	No	Yes	No

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
waterfowl	Gaviiformes	Red-throated Loon	No	Yes	Yes
passerine-insectivore	Passeriformes	Red-throated Pipit	No	Yes	No
seabird	Charadriiformes	Rhinoceros Auklet	No	Yes	Yes
Seabird-gull	Charadriiformes	Ring-billed Gull	Yes	Yes	Yes
waterfowl	Anseriformes	Ring-necked Duck	No	Yes	No
gallinaceous birds	Galliformes	Rock Ptarmigan	No	Yes	No
shorebird	Charadriiformes	Rock Sandpiper	No	Yes	No
Seabird-gull	Charadriiformes	Ross's Gull	Yes	Yes	Yes
waterfowl	Anseriformes	Ruddy Duck	No	Yes	Yes
shorebird	Charadriiformes	Ruddy Turnstone	No	Yes	No
shorebird	Charadriiformes	Ruff	No	Yes	No
gallinaceous birds	Galliformes	Ruffed Grouse	No	Yes	No
Seabird-gull	Charadriiformes	Sabine's Gull	Rarely	Yes	Yes
shorebird	Charadriiformes	Sanderling	No	Yes	No
Crane	Gruiformes	Sandhill Crane	No	Yes	No
passerine-omnivore	Passeriformes	Savannah Sparrow	No	Yes	No
shorebird	Charadriiformes	Semipalmated Plover	No	Yes	No
shorebird	Charadriiformes	Semipalmated Sandpiper	No	Yes	No
gallinaceous birds	Galliformes	Sharp-tailed Grouse	No	Yes	No
shorebird	Charadriiformes	Sharp-tailed Sandpiper	No	Yes	No
shorebird	Charadriiformes	Short-billed Dowitcher	No	Yes	No
raptorial birds-owl	Strigiformes	Short-eared Owl	No	Yes	No
seabird	Pelecaniformes	Short-tailed Shearwater	No	Yes	Yes
passerine-omnivore	Passeriformes	Sky Lark	No	Yes	No
passerine-omnivore	Passeriformes	Smith's Longspur	No	Yes	No
passerine-omnivore	Passeriformes	Snow Bunting	No	Yes	No
waterfowl	Anseriformes	Snow Goose	No	Yes	No
raptorial birds-owl	Strigiformes	Snowy Owl	No	Yes	No
shorebird	Charadriiformes	Solitary Sandpiper	No	Yes	No
passerine-omnivore	Passeriformes	Song Sparrow	No	Yes	No
seabird	Pelecaniformes	Sooty Shearwater	No	Yes	Yes
Gruiformes	Gruiformes	Sora	No	Yes	No
seabird	Pelecaniformes	South Polar Skua	Yes	Yes	Yes
waterfowl	Anseriformes	Spectacled Eider	No	Yes	No
shorebird	Charadriiformes	Spotted Sandpiper	No	Yes	Occassionally

Appendix D. Birds in Alaska Parks potentially more susceptible to herbicide effects

Category	Order	Common Name	Egg predator?	Ground nester?	Eats fish as part of its diet?
gallinaceous birds	Galliformes	Spruce Grouse	No	Yes	No
waterfowl	Anseriformes	Steller's Eider	No	Yes	No
shorebird	Charadriiformes	Stilt Sandpiper	No	Yes	No
waterfowl	Anseriformes	Surf Scoter	No	Yes	No
shorebird	Charadriiformes	Surfbird	No	Yes	No
passerine-omnivore	Passeriformes	Tennessee Warbler	No	Yes	No
seabird	Charadriiformes	Thick-billed Murre	No	Yes	Yes
waterfowl	Anseriformes	Trumpeter Swan	No	Yes	No
waterfowl	Anseriformes	Tufted Duck	No	Yes	Yes
seabird	Charadriiformes	Tufted Puffin	No	Yes	Yes
waterfowl	Anseriformes	Tundra Swan	No	Yes	No
shorebird	Charadriiformes	Upland Sandpiper	No	Yes	No
shorebird	Charadriiformes	Wandering Tattler	No	Yes	No
passerine-insectivore	Passeriformes	Water Pipit	No	Yes	No
waterbird	Passeriformes	Western Grebe	No	Yes	Yes
shorebird	Charadriiformes	Western Sandpiper	No	Yes	No
shorebird	Charadriiformes	Whimbrel	No	Yes	No
passerine-insectivore	Passeriformes	White Wagtail	No	Yes	No
passerine-omnivore	Passeriformes	White-crowned Sparrow	No	Yes	No
shorebird	Charadriiformes	White-rumped Sandpiper	No	Yes	No
gallinaceous birds	Galliformes	White-tailed Ptarmigan	No	Yes	No
passerine-omnivore	Passeriformes	White-throated Sparrow	No	Yes	No
waterfowl	Anseriformes	White-winged Scoter	No	Yes	No
gallinaceous birds	Galliformes	Willow Ptarmigan	No	Yes	No
shorebird	Charadriiformes	Wilson's snipe	No	Yes	No
passerine-omnivore	Passeriformes	Wilson's Warbler	No	Yes	No
passerine-insectivore	Passeriformes	Yellow Wagtail	No	Yes	No
waterfowl	Gaviiformes	Yellow-billed Loon	No	Yes	Yes
Seabird-gull	Charadriiformes	Thayer's Gull	Yes	Yes, cliffs, ledges	Yes

Appendix E - Non-native species detected in or near Alaska National Park units through 2008. Acreages derived from Exotic Plant Management Team geodatabase. AKNHP rankings from http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm as of 12/2008.

		Species Detected in or around NPS unit												Units	Total Mapped	AKNHP
Taxon	**Common Name**	**BELA**	**CAKR**	**DENA**	**GAAR**	**GLBA**	**KATM**	**KEFJ**	**KLGO**	**LACL**	**SITK**	**WRST**	**YUCH**	**Detected**	**Acreage**	**Ranking**
Aegopodium podagraria	bishop's goutweed			X		X								2	0.942	
Agrostis gigantea	red top							X						1		
Alopecurus geniculatus	marsh meadow-foxtail									X				1		
Alopecurus pratensis	meadow foxtail					X			X					2	0.023	
Amaranthus retroflexus	pigweed									X				1	0.078	
Arabis glabra	tower rockcress											X		1	0.001	
Arctium minus	common burdock					X								1	0.001	
Beckmannia syzigacene	slough-grass											X		1		
Brassica rapa	field mustard			X				X		X				3	0.466	
Bromus inermis and similar	smooth brome grass			X		X	X	X	X	X		X	X	8	211.214	62
Campanula medium	Canterberry bells					X								1	0.001	
Capsella bursa-pastoris	shepherd's purse			X		X	X		X	X	X	X	X	8	10.589	40
Caragana arborescens	Siberian peashrub											X		1	0.026	66
Centaurea montana	perennial cornflower					X					X			2	0.544	
Cerastium fontanum and similar	mouse-ear chickweed					X	X	X	X		X	X		6	348.916	36
Cerastium tomentosum	snow in summer										X			1	0.110	
Chenopodium album	common lambsquarters			X					X	X	X	X	X	6	23.947	37
Cirsium arvense	Canada thistle					X								1	0.815	76
Collomia linearis	narrowleaf-mountain trumpet											X		1		
Crepis tectorum	narrowleaf hawksbeard			X			X	X	X	X		X	X	7	22.017	54
Dactylis glomerata	orchard grass					X		X						2	0.146	53
Descurainia sophia	flixweed	X	X	X								X		4	1.044	41
Digitalis purpurea	foxglove										X			1	0.592	51
Dodecatheon jeffreyi	Sierra shooting-star									X				1		
Elymus repens	quackgrass			X		X		X	X			X	X	6	198.483	59
Erodium cicutarium	redstem stork's bill									X				1		
Erysimum cheiranthoides	wormseed mustard			X			X		X			X		4	3.245	
Eschscholzia californica	California poppy											X		1		
Euphrasia nemorosa	common eyebright								X					1	1.521	
Fragaria virginiana	common strawberry									X				1		
Galeopsis tetrahit/G. bifida	hempnettle					X		X	X			X		4	0.469	40
Glechoma hederacea	ground ivy									X				1		48
Hieracium aurantiacum	orange hawkweed			X		X		X		X				4	0.276	79
Hordeum jubatum	foxtail barley			X		X		X	X			X		5	11.857	63
Hypochaeris radicata	hairy cat's ear					X								1	4.945	
Impatiens glandulifera	ornamental jewelweed								X			X		2	0.049	82
Lamium album	white deadnettle					X								1	0.009	
Lappula squarrosa	European stickseed			X								X		2	2.326	44
Leontodon autumnalis	fall dandelion							X						1		

Taxon	Common Name	Species Detected in or around NPS unit												Units Detected	Total Mapped Acreage	AKNHP Ranking
		BELA	CAKR	DENA	GAAR	GLBA	KATM	KEFJ	KLGO	LACL	SITK	WRST	YUCH			
Lepidium densiflorum	common pepperweed			X								X	X	3	2.515	25
Leucanthemum vulgare	oxeye daisy			X		X	X	X	X	X	X	X		8	212.325	61
Linaria vulgaris	yellow toadflax			X		X		X	X		X	X		6	201.800	69
Lolium perenne and similar	perennial ryegrass					X		X		X		X		4	11.885	41
Lupinus polyphyllus	bigleaf lupine			X		X		X						3	388.196	55
Lychnis chalcedonica	maltesecross					X								1	0.001	
Malus pumila	apple										X			1	0.001	
Matricaria discoidea	pineapple weed	X	X	X		X	X	X	X	X	X	X	X	11	434.517	32
Medicago lupulina	black medic							X				X		2	0.034	48
Medicago sativa ssp. *falcata*	yellow alfalfa							X						1	0.480	64
Melilotus alba	white sweetclover			X		X		X	X			X		5	53.064	81
Melilotus officinalis	yellow sweetclover			X				X				X		3	0.891	69
Mentha sp.	mint					X								1	0.003	
Myosotis scorpioides	forget-me-not					X					X			2	0.480	
Neslia paniculata	ball mustard							X						1		
Papaver nudicale	Icelandic poppy							X						1	0.001	
Papaver somniferum	opium poppy											X		1	0.001	
Persicaria lapathifolia	curlytop knotweed						X			X				2		
Phalaris arundinacea	reed canarygrass					X			X	X	X			4	7.181	83
Phleum pratense	common timothy			X		X		X	X	X	X	X		7	54.771	56
Plantago major	common plantain			X		X	X	X	X	X	X	X	X	9	772.517	44
Poa annua	annual bluegrass					X	X	X		X	X		X	6	7.042	46
Poa palustris	fowl bluegrass					X								1		
Poa pratensis and similar	Kentucky bluegrass					X	X	X	X	X	X	X		7	0.157	52
Polygonum aviculare	prostrate knotweed			X		X	X		X	X		X	X	7	200.961	45
Polygonum convolvulus	black bindweed			X							X	X		3	0.469	50
Polygonum cuspidatum	Japanese knotweed			X							X			2	0.183	87
Prunus avium	sweet cherry										X			1	0.268	
Ranunculus acris	tall buttercup					X		X	X		X			4	5.072	54
Ranunculus repens	creeping buttercup			X		X			X		X			4	18.790	54
Rheum rhabarbarum	rhubarb					X						X		2	0.807	
Rosa rugosa	rugosa rose					X					X			2	0.281	
Rosa sp.	rose					X								1	0.001	
Rubus idaeus	red raspberry					X								1	3.605	
Rumex acetosella	common sheep sorrel					X	X	X	X	X	X		X	7	14.461	51
Rumex crispus	curled dock					X		X	X		X			4	1.282	48
Rumex obtusifolius	bitter dock										X			1		48
Sagina procumbens	birdseye pearlwort										X			1	0.216	
Secale cerale	wild rye											X		1		
Senecio viscosus	sticky ragwort								X					1		
Senecio vulgaris	common groundsel								X					1	0.198	36
Silene latifolia	bladder campion											X		1	0.001	42

Taxon	Common Name	Species Detected in or around NPS unit												Units Detected	Total Mapped Acreage	AKNHP Ranking
		BELA	CAKR	DENA	GAAR	GLBA	KATM	KEFJ	KLGO	LACL	SITK	WRST	YUCH			
Silene noctiflora	night-blooming cockle			X					X			X		3	0.743	42
Silene vulgaris	bladder campion								X					1	0.143	42
Sonchus arvensis	perennial sowthistle					X					X			2	2.421	73
Sonchus oleraceus	annual sowthistle			X										1	0.001	
Sorbus aucuparia	European mountain-ash					X					X			2	13.135	59
Spergula arvensis	corn spurry			X				X		X				3	0.466	32
Stellaria media	common chickweed			X		X			X	X		X	X	6	10.931	42/54
Symphytum officinale	common comfrey					X								1	1.987	
Tanacetum vulgare	common tansy					X			X	X				3	0.047	57
Taraxacum officinale ssp. *officinale*	common dandelion	X	X	X	X	X	X	X	X	X	X	X	X	12	1290.442	58
Thlaspi arvense	field pennycress								X			X		2	0.001	
Trifolium hybridum	alsike clover			X		X		X	X	X	X	X	X	8	219.974	57
Trifolium pratense	red clover			X		X		X	X		X	X		6	19.162	53
Trifolium repens	white clover			X		X	X	X	X	X	X	X		8	384.013	59
Tripleurospermum maritima	false mayweed			X										1	0.001	
Tripleurospermum perforata	scentless false mayweed			X				X				X	X	4	2.083	48
Triticum aestivum	common wheat			X		X		X						3	22.876	
Veronica serpyllifolia and similar	thyme-leaf speedwell									X		X		2	0.006	
Vicia cracca	bird vetch			X				X	X			X	X	5	2.418	73
Vicia sativa	common vetch											X		1		
Viola tricolor	Johnny-jump-up violet					X			X					2	0.015	
	Grand Total	3	3	37	1	51	15	37	38	30	32	45	16			

Appendix F: Ecosystem Effects of Invasive Plants found in Alaska NPS Units

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Annual sowthistle	A common weed of cultivated crops, grain fields, and orchards. It acts as an alternate host to aphids, several viral diseases, and nematodes (Hutchinson et al. 1984). Invades both native plant communities and disturbed sites. Rapid germination and establishment combined with wind dispersal of seeds over great distances allow annual sow thistle to colonize new areas rapidly.[5]	Adapted to a wide range of environmental conditions but are most competitive in temperate climates with abundant moisture (Zollinger and Parker 1999). They tolerate saline soils but are better adapted to slightly acid to alkaline soils (Hutchinson et al. 1984). This weed tolerates saturated soils and can be a problem in marshes, ponds, and other riparian areas.[5]	
Bigleaf lupine	*Lupinus polyphyllus* is native to western North America, but is introduced to eastern North America, including the northeastern U.S. and it is thought by most to be exotic in Alaska (USDA, ARS 2006, Alaska Natural Heritage Program 2006). *Lupinus polyphyllus* has escaped from gardens to roadsides, fields, and open woods in the northeastern U.S. and adjacent Canada (GLIFWC 2006). In Alaska, *Lupinus polyphyllus* is well established in open to dense forest (Alaska Natural Heritage Program 2006). [3]	The species is a nitrogen fixer which has been found in Lithuania to alter soil fertility to the extent that there are fast, irreversible changes of plant communities and entire ecosystems in native habitats (Gudzinskas 2005). [3]	*Lupinus polyphyllus* does not seem to be a major threat to healthy, high quality natural areas currently however it does seem to be developing as a problem in Alaska. It does have great opportunity for spread into natural areas because it is so widely seeded and planted as an ornamental and it also has potential as a nitrogen fixer to alter local nutrient levels where it colonizes. This species should be monitored for future spread.[3]
Bird vetch	The plant can overgrow herbaceous vegetation and climb over shrubs, such as alder and willow. It has a symbiotic relationship with certain soil bacteria (*Rhizobium*). It is highly palatable to grazing and browsing animals. Flowers are visited by native bees and may alter pollination ecology of the surrounding area (Aarssen et al. 1986, Klebesadel 1980).	Bird vetch alters edaphic conditions due to fixation of atmospheric nitrogen.	Bird vetch aggressively climbs fencing, trees, bushes, and other vegetation, monopolizing sunlight, space, and moisture. Spreads along roadsides, trails, and other disturbed areas.[2]

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Canada thistle	Canada thistle threatens natural communities by directly competing for water and nutrients and displacing native vegetation, decreasing species diversity. It produces allelopathic chemicals that assist in displacing competing plant species (Evans 1984, Hayden 1934). Pollinating insects appear to be drawn away from native species to visit Canada thistle (Zouhar 2001). This species has been reported to accumulate nitrates that cause poisoning in animals and the spiny leaves scratch animal skin, causing infection, at a minimum. It is a host for bean aphid and stalk borer, and for sod-web worm (Nuzzo 1997).	Canada thistle can increase fire frequency and severity due to its abundant and readily ignited litter (Zouhar 2001).	Forms colonies via an extensive horizontal and vertical root system; can eventually cover acres. Also spreads by wind-blown seeds. Young plants appear as basal rosettes that bolt in late summer. Grows in fields, pastures, forests, and along roadsides, ditches, and river banks. Does best in disturbed upland areas but also invades wet areas with fluctuating water levels including stream bank sedge meadows.[2]
Common dandelion	Dandelion competes with native plants for moisture and nutrients. It is commonly eaten by moose, bears, sharp-tailed grouse, pocket gophers, deer, elk, and bighorn sheep. Sage grouse and deer populations benefit from increased production of dandelion (Esser 1993). This species is important source of nectar and pollen for bees in Alaska (Esser, 1993). Its presence may therefore alter pollination ecologies of co-occurring plants. It is also an alternate host for a number of viruses (Royer and Dickinson 1999).	Dandelion is one of the earliest colonizers after disturbances and likely causes modest impacts in natural succession. It may achieve a peak in dominance within two to three years (Auchmoody and Walters 1988). In Alaska it often establishes in existing herbaceous layer, changing the density of the layer. It also can form a new herbaceous layer on nearly mineral soil along banks and roadsides.	
Common sheep sorrel	Sheep sorrel is able to form dense stands and displace native grasses and forbs. This plant contains oxalic acid which can be poisonous to livestock and may be toxic to wildlife species (Cal-IPC 2005). Sheep sorrel is grazed by mule deer (Nixon et al. 1970, Kruger and Donart 1974). Sheep sorrel seeds are a rich source of food for birds (Schmidt 1936, Swenson 1985, Wilson et al. 1999).	Sheep sorrel is documented as one of the common colonizers of the burned areas (Hall 1955, Fonda 1974, Weaver et al. 1990). This species may impede the reestablishment of the native species and affect natural successional processes.	

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Common timothy	Timothy provides habitat and nesting cover for game birds, small mammals, and waterfowl. It is highly palatable and nutritious forage for big game animals, and the seeds are consumed by birds. (Esser 1993, Forage Information System 2004, USDA 2002). Timothy seedlings may hinder conifer seedlings establishment through resource competition, allelopathy, attraction of harmful insects and animals, and increased fire potential (Esser 1993). Pollen of timothy is known as allergen (Ohio State University 2004). Timothy is a host for number of plants diseases and nematodes, which may be a problem for other species (Forage Information System 2004).	The plants have potential to inhibit secondary successional processes, and may modify native communities (Rutledge and McLendon 1996).	
Creeping buttercup	The secondary compound protoanemonin released in the sap of creeping and tall buttercups is poisonous and can cause death to grazing animals if consumed. Geese and other birds readily eat leaves and seeds of buttercup (Lovett-Doust et al. 1990). The flowers are visited by honey bees, butterflies, moths, bugs, and beetles for pollen or nectar. Buttercups host microorganisms and viruses, insects, and nematodes (Harper 1957, Lovett-Doust et al. 1990, Royer and Dickinson 1999).	Buttercup readily occupies open areas and may hinder colonization by native species.	
European mountain-ash	Unknown – however, this species is able to integrate into largely undisturbed coastal rainforest communities and dominate (e.g., Sitka Nat. Historic Park). It has been reported to invade forest communities in Wisconsin (Wisconsin Department of Natural Resources 2003).	Unknown. Fruits are highly desirable to birds, so there is a potential for alterations in abundance and composition of avian fauna (Gilman and Watson 1994). European mountain ash hybridizes with native *S. scopulina* and *S. sitchensis* where ranges overlap (Pojar and MacKinnon 1994).	

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Japanese knotweed	Japanese knotweed forms single-species stands, reducing of biodiversity through shading out native vegetation. This species clogs waterways and lowers the quality of habitat for wildlife and fish. It reduces the food supply for juvenile salmon in the spring. Japanese knotweed hybridizes with the introduced giant knotweed, *Polygonum sachalinense* (Saiger 1991).	There is an increased risk of soil erosion due to the presence of this species. Dead stems and leaf litter decompose very slowly and form a deep organic layer, which prevents native seeds from germinating, thus altering the natural succession of native plant species. During dormant periods, dried stems and leaves can create a fire hazard.	Herbaceous perennial. Dies back, turning bright yellow before dropping leaves in the fall. Reproduces from extensive spreading rhizomes or broken-off pieces of stem. Found on roadsides, stream banks, and beach meadows. Clogs waterways and lowers quality of habitat for wildlife, fish, and the insects on which fish depend. Displaces native salmonberries and thimbleberries along shorelines.[2]
Lambsquarters	Lambsquarters has not been observed in undisturbed areas in Alaska. In other regions it has little or no effect on native plant communities. Plants are reported to be poisonous to sheep and pigs. It is an alternate host for a number of viral diseases of barley, beet, potato, turnip, and tobacco.	It is unlikely that measurable impacts to ecosystem processes occur due to lambsquarters presence. This weed invades disturbed habitats such as roadsides and abandoned fields and is common on logged-over lands, especially on burned slash-piles. It does not usually invade native plant communities.[5]	Lamb's-quarters is a naturalized annual herb found in disturbed soils across Canada. This plant can cause sickness and death in livestock if large quantities are ingested. The plants can accumulate both nitrates and soluble oxalates. Cattle and sheep have been poisoned. Humans who consume large quantities of the plant and are subsequently exposed to sunlight suffer photo-sensitization (Whitehead and Moxon 1952, Cooper and Johnson 1984).[4]
Narrowleaf hawksbeard	Unknown	Unknown	Often found on disturbed soil; waste places, river bars, or roadsides. Thrives in dry, coarse soil. Competes with seedlings, forages, cereals and oilseeds. The most serious infestations of this weed occur in weak crop stands. Spreads into riparian areas.[2]

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Orange hawkweed	Orange and meadow hawkweed form monocultures by establishing a dense mat of plants, lowers biodiversity, and reduces the forage value of grasslands for grazing animals. These plants are successful competitors, crowding out native, pasture and range species (Pratcher et al. 2003). Hawkweed species are allelopathics (Murphy and Aarssen 1995). It hybridizes freely with native and non-native hawkweeds (Rinella and Sheley 2002).	These plants likely reduce soil moisture and nutrient availability (J. Snyder – pers.com.).	Spreads by stolons, rhizomes, and seed. A favorite flower of unwary gardeners and wildflower enthusiasts. Found along roads, riparian areas and beaches. Moves into forb meadows where it spreads aggressively. Forms dense mats, crowding out native plants.[2]
Oxeye daisy	Oxeye daisy forms dense colonies, decreasing overall vascular plant diversity. It can quickly replace up to 50% of the grass species in pastures. The entire plant has a disagreeable odor and grazing animals avoid it. Moreover, the plant contains polyacetylenes and thiophenes that are generally highly toxic to insect herbivores. Oxeye daisy can host chrysanthemum stunt, aster yellows, tomato aspermy viruses, and several nematode species (Royer and Dickinson 1999). There is no known allelopathy potential.	In heavy infestations there is an increase in the potential for soil erosion.	Common on roadsides, disturbed areas, beach meadows, and landscaped areas. Frequently a component of wildflower seed mixes. Forms dense colonies, is unpalatable to grazing animals and insects, and hosts several plant viruses. Heavy infestations can cause soil erosion.[2] In Rocky Mountain National Park: Currently has an intermediate number of known populations with patchy distribution in RMNP. When added together, all populations would cover an estimated area less than 5 hectares. Oxeye daisy appears to be having little impact on natural processes. However, in other natural areas plant has been observed to invade and modify communities.[6]
Perennial sowthistle	At high densities *Sonchus arvensis* has drastically reduced water resources and possibly decreased number of plants in communities (Butterfield et al. 1996). It is also a host of number of plant pests. This plant is acceptable feed for rabbits and other foraging animals (Noxious Weed Control Board 2003).	Perennial sowthistle may modify or retard the successional establishment of native species (Butterfield et al. 1996).	Commonly found in waste areas, meadows, woods, lawns, roadsides, beaches, ditches, and river and lake shores. Can drastically reduce crop yields in agric areas by competing with desired plants for nutrients.[2]

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
(Purple) foxglove	Foxglove readily colonizes disturbed areas, forming dense patches that displace natural vegetation (Harris 2000). It is toxic to human and animals (CUPPID 2004, Harris 2000, USDA 2002, Whitson et al. 2000). Rabbits and deer avoid the leaves of foxglove (Floridata 2002).	As an invader of disturbed sites it is likely hinder natural successional processes.	
Red clover	Red clover is capable of creating very dense stands (Gettle et al. 1996a) and large biomass (Gettle et al. 1996b, Hofmann and Isselstein 2004), which influences the structure of the community. Red clover can also reduce the number of individual of grass species in the community (Gettle et al. 1996a). Moose and mule deer can graze on red clover. The leaves of red clover are also eaten by beaver, woodchuck, muskrat, meadow mice, and sharp-tailed grouse. Seeds are eaten by crow, horned lark, and ruffed and sharp-tailed grouse. Red clover is visited by bumblebees and sometimes by introduced honeybees (Graham 1941).	Red clover increases soil nitrogen levels by fixing atmospheric nitrogen (USDA, NRCS 2006). The alteration of soil condition may delay establishment of native species Rutledge and McLendon 1996) and facilitate colonization by other exotic plant species.	Nitrogen fixer (FCPS, No Date) but appears to primarily be doing it in already disturbed places or areas that already have nitrogen fixers. In crowded areas the species will stand upright competing for sun otherwise it sprawls on the ground (Schneider, 2005). Its upright nature when competing for sun and its sprawling nature otherwise would seem to indicate that it would inhibit some native species but there are no indications that it competes heavily or that the typical places it grows has many native species.[3]
Reed canarygrass	This grass forms dense, persistent, monotypic stands in wetlands; these stands exclude and displace other plants. In Montana reed canarygrass poses a threat to the endangered aquatic plant *Howellia aquatilis*. Invasive populations of reed canarygrass are believed to be the result of crosses between cultivated varieties and native North American strains (Merigliano and Lesica 1998). Reed canarygrass grows too densely to provide adequate cover for small mammals and waterfowl. When in flower, it may case hay fever and allergies.	It promotes silt deposition and the consequent constriction of waterways and irrigation canals. Reed canarygrass may alter soil hydrology.	Highly variable species preferring moist sites. Begins growing early in the season. Forms dense, persistent, monospecific matted stands. Difficult to impossible to eradicate once established. Spreads within sites by creeping rhizomes, effectively excluding all other vegetation. Found along roadsides, ditches, wetlands, riparian areas, beaches, and growing into lakes.[2]

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Siberian peashrub	Siberian peashrub decreases light availability and reduces tree and shrub regeneration (I. Lapina – pers. obs., O. Baranova – pers. com.). Plants have been extensively damaged by browsing deer (Duke 1983).	As a nitrogen-fixer, it likely alters soil conditions (USDA 2002).	A popular ornamental shrub, it forms a dense spreading root system, and is now moving into natural areas. A known invader of woodlands and riparian areas in Canada and the northern United States.[2]
Smooth brome (grass)	Smooth brome is highly competitive. It forms a dense sod that often excludes other species, thus contributing to the reduction of species diversity in natural areas (Butterfield et al. 1996, Rutledge and McLendon). Smooth brome is an alternate host for the viral diseases of crops (Royer and Dickinson 1999, Sather 1987). It has high palatability for grazing animals (USDA 2002). In south Alaska hybrid swarms with *B. inermis* ssp. *pumpelliana* occur (Hultén 1968).	Smooth brome may inhibit natural succession processes (Densmore et al. 2001, Rutledge and McLendon 1996).	Sather (1987) says the following, "it forms a dense sod that often appears to exclude other species, thus contributing to the reduction of species diversity in natural areas." Cully et al. (2003) say, "exotic perennial, rhizomatous grass invaders may compete for nutrients and moisture with species of similar life form or phenology".[3] In Rocky Mountain National Park: Currently believed to be expanding from road shoulders to cover a combined area of greater than 50 hectares. Found in some areas disturbed within the last 11-50 years, and may be inhibiting natural succession processes.[6]
White sweetclover	White sweetclover degrades natural grassland communities by overtopping and shading native species. It contains coumarin which is toxic to animals. Plants are visited by introduced honeybees, native solitary bees, wasps, and flies (Eckardt 1987). Sweetclover is associated with over 28 viral diseases (CUPPID 2003, Royer and Dickinson 1999). It is also reported as being allelopathic (USDA 2002).	This species alters edaphic conditions due to nitrogen fixation (USDA 2002); and also has potential to alter sedimentation rates of river ecosystems (M. Shephard – pers. comm.).	Rapidly colonizes open waste areas, and spreads quickly along riparian areas and riverbanks. Already growing aggressively along several major Alaskan rivers.[2] In Rocky Mountain National Park: An intermediate number of patchy distributed populations in RMNP. Plants currently do not appear to be affecting native plant communities.[6] In contrast, another study in RMNP found that areas invaded by white sweetclover had altered soil nitrogen availability and different plant assemblages compared to native plant communities.[7]

Invasive plant	Impact on community composition, structure, and interactions[1]	Impact on ecosystem processes[1]	Wildlife and habitat effects data from other sources
Yellow toadflax	Yellow toadflax is a persistent, aggressive invader, capable of forming dense colonies; it can suppress native grasses and other perennials, mainly by intense competition for limited soil water. This species contains a poisonous glucoside that is reported to be unpalatable and moderately poisonous to livestock. Toadflax is an alternate host for tobacco mosaic virus.	This toadflax species and others do affect the abiotic processes in the ecosystems where they are found. Specifically, the Yellow Toadflax increases erosion where it invades (Kadrmas and Johnson) and probably changes the soil characteristics in other ways too.[3]	Common in roadsides, waste areas, lake shores, beach meadows, pastures, and edges of forests. A persistent, aggressive invader, capable of forming dense colonies. Toxic to grazing animals.[2] In Rocky Mountain National Park: several widespread and dense populations in park…together would cover an estimated area of 11-50 hectares. Found in high quality areas with no known disturbance for last 100 years. Potential to invade and modify/replace existing native communities.[6]

Sources:

[1] AKNHP. (Alaska Natural Heritage Program). 2000. Non-native Plant Species of Alaska, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501

[2] USDA Forest Service. 2007. Selected invasive plants of AK.

[3] Natureserve profile http://www.natureserve.org/explorer/

[4] Canadian poisonous plants information system: http://www.cbif.gc.ca/pls/pp/poison?p_x=px Derek B. Munro Biological Informatics Specialist

[5] Weeds BC website http://www.weedsbc.ca/weed_desc/ann_sow.html

[6] Rutledge, Chris R., and Dr. Terry McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www.npwrc.usgs.gov/resource/plants/explant/index.htm (Version 15DEC98)

[7] Wolf, JJ, SW Beatty, G Carey. 2003. Invasion by Sweet Clover (Melilotus) in Montane Grasslands, Rocky Mountain National Park. Annals of the Association of American Geographers, 93(3), 2003, pp. 531–543.

Appendix G: Summary of Potential Environmental Fate and Effects of Proposed Herbicides (Summarized from USFS Risk Assessments at *http://www.fs.fed.us/ foresthealth/pesticide/risk.shtml*)

Active Ingredient	Persistence in Soil	Residual Soil Activity	Volatility and Burning By-Products	Solubility	Leaching Potential	Surface Waters	Toxicity
2,4-D (Basic Solutions, Lawn Weed Killer, Eliminator, Grass Roots Weed Killer, Brush Buster, Spectracide, Crossbow)	At the highest application rate 2,4-D persists 30 days	May remain active for 1 to 6 weeks in soil.	Oil-soluble amine forms are least volatile. Burning vegetation treated with 2,4,-D has not generated detectable amounts of 2,4-D by-products in the field.	Low solubility in water.	Binds to organic matter in soil over time. 2,4-D ranges from being mobile to highly mobile in sand, silt, clay loam, and sandy loam, but potential ground water contamination is low due to rapid degradation in soils and rapid uptake by plants.	2,4-D residues dissipate rapidly, especially in moving water. Do not apply to water or wetlands, except as specified for certain uses.	No effect at recommended field application rates to soil microorganisms. At higher levels, 2,4-D can suppress soil fungi and nitrogen-fixing algae. 2,4-D is highly toxic to many non-target plants. Effects of 2,4-D amine salts are nearly non-toxic to fish, but ester formulations are highly toxic to fish and aquatic invertebrates. Effects to terrestrial organisms range from practically non-toxic to birds from butyl ester, ester formulations are least toxic to insects, and mammals are moderately sensitive to 2,4-D exposures.
Aminopyralid (Milestone, Milestone VM)	Half-life in soil varies from 5.5 to 343 days, depending on soil type with average soil half-life of 32 days	May remain active if not washed out of soil.	Does not evaporate easily. No information on potential by-products from burning.	Highly soluble in water.	Easily washed through various soil types to depths of 60 inches.	Because aminopyralid is soluble, surface waters may hold the herbicide for long periods.	No plausible toxic effect is likely at recommended application rates to mammals, birds, bees, earthworms, soil micro-organisms, fish, amphibians, and aquatic invertebrates, though few studies on amphibian species. Persistent adverse effects on broad-leaved plants likely (not grasses), which could affect some wildlife browse.
Chlorsulfuron (Glean XP, Telar)	Half-life is one month for slightly acidic soil (pH 5.6 to 6.7) to 3 months for alkaline spoils (>pH 7.3)	Active in soil and usually absorbed from soil by plants.	Does not evaporate easily. No information on potential by-products from burning.	Telar may be suspended in water with constant agitation and dispensed.	Telar has high potential for leaching in permeable soils, but less in soils with pH below 6.0. Potential ground water contamination is low due to low use rates and dispersion of residues with leaching.	No information is available.	No effect on soil microorganisms. Contact with non-target plants may kill or injure plants. Nearly non-toxic to most fish and aquatic invertebrates. Practically non-toxic to birds and mammals, and relatively non-toxic to bees.
Clopyralid (Transline, Lontrel)	Half-life is 15-287 days. May be present in anaerobic soil or soils with low micro-organisms.	Active in soil and usually absorbed from soil by plants. Soil microorgan-isms break down Clopyralid.	Does not evaporate easily. No information on potential by-products from burning.	Highly soluble in water.	May leach into ground water because clopyralid is highly soluble in water, does not absorb to soil particles and is not readily decomposed in soil. Clopyralid may contaminate ground water where applied to areas with very permeable soils and shallow water tables.	Because clopyralid is soluble, surface waters may be contaminated if directly applied to water bodies or wetlands.	No information on effects to soil microorganisms. Non-target plants may be injured or killed Low toxicity to fish and aquatic invertebrates. Clopyralid does not bio-accumulate in fat tissues. Low toxicity to birds and mammals, and not toxic to bees.
Glyphosate (Roundup Pro, Roundup Ultra, Rodeo, GlyPro, Accord, AquaPro, Aquamaster, Touchdown)	Half-life ranges from 3 to 174 days, and soil microorganisms break it down. Surfactant in Roundup has half-life of less than 1 week.	Generally not active in soil, and plants usually do not absorb glyphosate from soil.	Does not evaporate easily. Major products from burning treated vegetation include phosphorus pentoxide, acetonitrile, carbon dioxide, and water. None of these compounds is known to be a health threat at levels from a vegetation fire.	Dissolves easily in water.	Potential for leaching is low, and glyphosate and surfactant in Roundup are strongly absorbed by soil particles. Half life for glyphosate in water ranges from 35 to 65 days. Surfactant half life ranges from 3 to 4 weeks.	Very low concentrations of glyphosate have been observed in surface water following heavy rains up to 3 weeks after application.	No known effect on soil microorganisms from Glyphosate or associated surfactants. Non-target plants may be injured or killed. Does not bioaccumulates in fish. Accord and Rodeo formulations are practically non-toxic to freshwater fish and aquatic invertebrates, but Roundup is slightly to moderately toxic to fish and invertebrates. Practically non-toxic to birds, mammals, and bees.
Imazapyr (Arsenal, Habitat)	Aerobic half-life varies from 210 days to 5.9 years. Exposure to sunlight and soil micro-organisms contributes to breakdown.	Can remain active in soil for 6 months to 2 years.	Does not evaporate easily.	Soluble in water.	Imazapyr has low potential for leaching into ground water.	May move from treated areas to streams, but mostly found in runoff from storms. Streamside management zones can significantly reduce water contamination. Half life in water is about 4 days.	Little effect on soil microorganisms. Non-toxic to conifers, but toxic to many other non-target plants. Low toxicity to invertebrates and practically non-toxic to fish. Does not build up in aquatic animals. Imazapyr is practically non-toxic to birds and mammals, has low toxicity to bees, and is rapidly excreted by animals.
Metsulfuron methyl (Escort)	Half-life ranges from 120 to 180 days (in silt loam). Soil organisms break down.	Generally active in soil, and usually absorbed from the soil by plants.	Does not evaporate easily. Insufficient information is available on potential by-products form burning.	Dissolves easily in water.	Metsulfuron methyl has the potential to contaminate ground water at very low concentrations and leaches through silt loam and sandy soils.	Surface waters may be contaminated if applied directly to water or wetlands. When exposed to artificial sunlight, half life is 1-8 days.	Insufficient information on effects to soil microorganisms. Non-target plants may be injured or killed with contact. Practically non-toxic to fish and aquatic invertebrates, and does not bioaccumulates in fish. Practically non-toxic to birds, mammals, and bees.
Triclopyr (Garlon products)	Average half-life in soil is 46 days (range 10 – 100 days). Microorganisms degrade triclopyr rapidly.	Triclopyr is active in soil and absorbed by plants roots.	Potential for volatilization is very low, but no information is available on potential by-products from burning treated vegetation.	Moderate to low solubility.	Potential for leaching depends on soil type, acidity, and rainfall conditions. Because triclopyr binds to clay and organic matter, leaching should not be a concern, except if heavy rainfall and light soils.	Sunlight rapidly breaks down triclopyr in water. Half life in water is less than 24 hours. Irrigation ditches or waters used for domestic uses should not be polluted by triclopyr.	Slightly to practically non-toxic to soil microorganisms. It is toxic to many plants, and small amounts may injure some plants. Low toxicity to fish, except the ester form in Garlon 4, which rapidly breaks down. Does not bioaccumulates in fish. Slightly toxic to mammals, low toxicity to birds, and non-toxic to bees.

APPENDIX H

Herbicide Use Best Management Practices (BMP)

The following measures would be taken for any herbicide application:

- Herbicides would be selected and BMPs would be implemented to maximize the effectiveness of the treatment on the target plant species and to minimize the potential effects on non-target plants.
- Herbicides would be applied according to application rates specified on the product label. Concentrations used would minimize the amount of herbicide while providing effective control of the target species. Lower application rates are often more effective than higher application rates because translocation is enhanced prior to loss of physiologic function. Higher rates may burn off leaves and reduce translocation.
- Herbicides would be applied only during periods of suitable meteorological conditions. Loss of spray from a treated area increases during high winds or low humidity. Herbicides should also not be applied during periods of dead calm (this could indicate an inversion) or when wind velocity and direction pose a risk of spray drift. Conditions at the treatment site would allow for complete and even coverage and would prevent drifting of spray onto non-target sensitive resources or areas used by humans. All label recommendations will be followed regarding suitable conditions for application.
- Herbicides would be applied using coarse sprays to minimize the potential for drift. Avoid combinations of pressure and nozzle type that would result in fine particles (mist). Add thickeners if the product label permits.
- Herbicides would be applied at the appropriate time based on the herbicide's mode of action. Poor timing of application can reduce the effectiveness of herbicides and can increase the impact on non-target plants.
- In areas where there is the potential to affect surface water or ground water resources, herbicide pH and soil pH would be considered to select the herbicide with the lowest leaching potential.
- Highly water-soluble herbicides would not be used in areas where there is potential to affect surface water or ground water resources.
- Herbicides with high volatility would not be used to treat areas located adjacent to sensitive areas because of the potential for unwanted movement of herbicides to these areas.
- Herbicides with high soil retention would be used in areas where there is potential to affect surface water or ground water resources.
- Herbicides with longer persistence would be applied at lower concentrations within the labeled range and with less frequency to limit the potential for accumulation of herbicides in soils.
- As needed to protect the efficacy of the herbicide, water would be buffered, depending on hardness, pH, and other factors.
- Safety protocols would be followed at all times for storing, mixing, transporting, handling spills, and disposing of unused herbicides and containers and would be consistent with EPA and ADEC regulations. These protocol and plans for emergency spills are available from the Alaska EPMT Manager.

APPENDIX H

- All federal and state regulations regarding herbicide use would be followed at all times.
- All product labels would be read and followed by herbicide applicators. It is a violation of federal law to use an herbicide in a manner that is inconsistent with its label.
- Herbicide applicators would obtain an Alaska Pesticide Applicator Certification from the Department of Environmental Conservation or would possess a Federal Pesticide Applicator License.
- Where conditions permit, herbicide applicators will where disposable slippers over foot wear to prevent herbicide residues from being tracked off-site.
- Equipment would be maintained and calibrated prior to each application of herbicides. During all applications, droplet size would be controlled to decrease the risk of herbicide drift to non-target species outside the immediate treatment area. Droplet size is controlled by nozzle settings.
- All concessioners would comply with the IPMP/EA and NPS policy when applying herbicides. Concessioners would comply with guidance document, *Understanding the National Park Service's Integrated Pest Management Program* (NPS 2003i).

To minimize the potential impact of herbicides on surface water and ground water resources, the following best management practices would be implemented:

- Only herbicides that are registered for use in or near water would be used in those areas.
- Only those herbicides that have a low potential toxicity, such as glyphosate (Aquamaster and Rodeo), would be used within areas near surface waters or in areas with a high leaching potential. Glyphosate is strongly adsorbed into soil, with little potential for leaching to ground water. Microbes in the soil readily and completely degrade it even in low temperatures. It tends to adhere to sediments when released to water and does not accumulate in aquatic life (Forest Service 2004).
- Each park would monitor potable drinking water quality. This monitoring would continue to confirm that potable water meets drinking water standards as outlined by the Safe Drinking Water Act (SDWA).
- Parks would implement surface water and ground water monitoring programs as appropriate to protect natural resources. Rigorous testing of herbicides is required prior to release as a registered product.
- The RAVE system would be used by parks, as necessary and appropriate, to evaluate potential risks to ground water from chemical treatments.

Herbicide Use Regulations and Record-Keeping

Federal regulation requires that all product labels would be read and followed by herbicide applicators. It is a violation of federal law to use an herbicide in a manner that is inconsistent with its label. Under certain conditions, Alaska regulation requires that herbicide applicators obtain an Alaska Pesticide Applicator Certification from the Alaska Department of Environmental Conservation (DEC). Under the preferred alternative, all applicators would

require this certification. A permit from the DEC would be needed for an herbicide application within a state right-of-way. Alaska regulation (18 Alaska Administrative Code 90) also requires specific measures for product selection, handling, use, disposal, and record-keeping.

Detailed and accurate record-keeping and monitoring are fundamental components of the preferred alternative. Record-keeping would be used to provide a historical record of activities and also to provide information that can be used to justify future invasive plant management activities. Monitoring would be used to determine whether exotic plant management activities are effective in meeting management objectives.

Pesticide uses would be recorded using the Pesticide Use Proposal Form. Information recorded on pesticide use forms would include the following:

- Date and time of application
- Name, location, and estimated area of treatment site
- Brand name of the material or materials used, including formulation
- USEPA registration number of materials used
- The mix rate of material used
- The amount of material used
- Name and license number of pesticide applicator
- General weather conditions, including wind speed

Annual pesticide use reports would be submitted electronically using the intranet-based system. Pesticide use reports must be entered into this system by March 15 of each year.

Herbicide Use Notification

By April 30 of each year, park personnel will identify locations in parks where herbicide application is warranted. Herbicide treatment will not be done outside of the identified locations. Public use areas will be identified that are located within or adjacent to the planned treatment areas. This information will be made available to the public via the Alaska Region website, park newsletters, local newspapers, and park Visitor Centers.

The following individuals and entities will be notified in writing of proposed herbicide applications:

- The park Superintendent, by whom information will be disseminated to appropriate park Divisions.
- All park inholders or adjacent landowners located within ¼ mile of the proposed treatment sites.
- All individuals that would like to be informed about proposed herbicide use in Alaska parks, including individuals with Multiple Chemical Sensitivity.

APPENDIX H

All sites proposed for herbicide use will be posted with signs available from ADEC that comply with 18 AAC 90 and contain the following information:

- Treatment Date
- Targeted invasive plant species
- Name of the herbicide to be applied
- Restricted entry period
- Contact name and telephone number

These signs will be posted at access points to the treated area two weeks before application and will remain in place for a month following application.

Relative Aquifer Vulnerability Evaluation

Under the preferred alternative, resource managers may use the Relative Aquifer Vulnerability Evaluation (RAVE) system to assess the potential risk for ground water contamination resulting from the use of herbicides. Use of the RAVE model would be required for areas where leaching to ground water is possible. RAVE is a numeric scoring system that is relatively simple to use and allows resource managers to quantitatively evaluate the potential for an herbicide to contaminate ground water. The RAVE system includes a model that addresses irrigation systems developed by Montana State University (MSU 1999) and one that addresses natural precipitation systems developed by the Forest Service (Forest Service 1992). An adaptation of the system developed for this plan is included as in Appendix C, which also includes a supplemental table to be used with the RAVE system for herbicides not originally evaluated in the system developed by Gerald McCrea (Regional Integrated Pest Management [IPM] Coordinator for the Intermountain Region).

To determine the potential for ground water contamination, the RAVE system considers several factors: depth to ground water, distance to surface water, percent organic matter, herbicide application frequency, herbicide application method, herbicide leachability, and topographic position. Values are assigned to each of these factors and then totaled. The total value is then compared to a "scorecard interpretation scale" to determine the potential for ground water contamination by an individual herbicide. Higher scores indicate a higher vulnerability of ground water to herbicide application. If an herbicide is determined to have a high potential for ground water contamination, an alternative herbicide or alternative application method is selected and results are compared. The alternative that has the lowest potential for ground water contamination and that has an acceptable score is then selected. Approval by the Regional IPM Coordinator is also required. In some cases, herbicide soil mobility data are available which has enabled the establishment of herbicide-specific buffer zones. In such cases, these data could be used instead of the RAVE model, as it is based on research data rather than modeling.

Only those herbicides that have been registered by the USEPA would be used under the preferred alternative. When considering the use of a chemical treatment, the resource management specialist would confirm that its use is necessary and that all other treatment options are either not acceptable or not feasible. The resource manager should also confirm that use of the selected herbicide is appropriate for the site and that it has the potential to be effective

on the target species. Taking these extra steps would help to ensure that the most appropriate and cost-effective herbicide is selected. Herbicides are classified according to their mode of action, which is determined by the active ingredients.

An adjuvant is a substance added to an herbicide to aid its action, but has no herbicide action by itself. Some herbicides require the addition of an adjuvant to work effectively. Surfactants are adjuvants used in conjunction with herbicides to increase absorption. A surfactant is a surface active ingredient that lowers surface tension of the solvent in which it is dissolved or the tension between two immiscible liquids. Safety procedures and MSDSs must be kept on site for all adjuvants used under the preferred alternative. Each herbicide varies in terms of its chemical and biological behavior in the environment. Factors that affect herbicide behavior in the environment include herbicide properties, soil characteristics, and climatic conditions. Factors that influence the behavior of herbicides in the environment are summarized below. This summary is based on information provided by Miller and Westra (1998) in *Colorado State University Fact Sheet Herbicide Behavior in Soils*.

- Acid or base strength - refers to whether an herbicide has basic, acidic, or non-ionic properties. This factor determines the ability of an herbicide to exist in soil water or be retained onto soil solids. In general, herbicides whose pH is close to the pH of soil are strongly retained and are not subject to runoff, erosion, and/or leaching. In contrast, herbicides whose pH is not close to that of the soil are less strongly retained and are subject to runoff, erosion, and/or leaching. These herbicides are also more available for plant uptake than those herbicides that are strongly retained onto soil solids.
- Water solubility - refers to how readily an herbicide dissolves in water and determines the extent to which an herbicide is in the solution (water) phase or the solid phase. An herbicide that is water soluble generally is not retained by soil.
- Volatility - refers to the tendency of an herbicide molecule to become a vapor. Herbicides with high vapor pressures are likely to escape from the soil and volatilize in the atmosphere.
- Soil retention - is an index of the binding capacity of the herbicide molecule to soil organic matter and clay. In general, herbicides with high soil retention are strongly bound to soil and are not subject to leaching. Those not exhibiting high soil retention are not strongly bound and are subject to leaching.
- Soil persistence - refers the longevity of an herbicide molecule, typically expressed in terms of a half-life, as determined under normal conditions in the region where the herbicide would be used.

These factors influence the environmental fate and effects of an herbicide, including its residual soil activity, persistence, volatilization, water solubility, and potential for leaching into ground water.

APPENDIX H

Summary of federal and state compliance measures:

- Purchase, distribute and use EPA and State registered pesticides.
- Ensure that personnel conducting or supervising pesticide applications are trained, certified, and licensed to address proper labeling, storage, use, and disposal of herbicides.
- Follow all pesticide label requirements and be in compliance with the Alaska Pesticide Control Regulations in 18 AAC 90, and the Federal Insecticide Fungicide Rodenticide Act (FIFRA), at all times. (FIFRA also addresses herbicides.)
- Maintain ADEC and NPS required records of pesticide purchases and applications and make these available to ADEC on request.
- Monitor sensitive areas, endangered and threatened species, and water quality.
- Because the National Parks are considered "*public places*," as defined in State Pesticide Control Regulations 18 AAC 90.630, public notification and posting requirements must be met, included the use of a specific notification sign that is available from ADEC.
- A permit from ADEC may be necessary under certain circumstances, such as a pesticide application to water or state "rights-of-way." Please contact the Pesticides Program at 1-800-478-2577 to determine the permitting requirements for a particular treatment.
- Since the State of Alaska does not have an approved list of adjuvants, NPS will use only adjuvants approved in Washington State. See link: http://www.ecy.wa.gov/programs/wq/pesticides/regpesticides.html
- All herbicide applications will address both leaching into ground water and run-off and erosion to surface water. Using aminopyralid, Milestone VM as an example, according to the label "[t]*his chemical has characteristics associated with chemicals detected in groundwater. The use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in groundwater contamination*." Given the unknown effects of this herbicide to groundwater, use of this herbicide would be limited to situations where groundwater contamination is unlikely.
- Special requirements may exist if vegetation is burned or composted after an herbicide application. Additionally, the NPS must follow manufacturer's recommendations and consult with ADEC Air Quality Division prior to burning a pesticide container.