4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This chapter provides an evaluation of the potential effects or impacts of each of the alternatives on the resources described in the issue statements presented in Chapter 1, Purpose and Need for Action. Appendix F provides a summary of potential ecosystem effects of invasive plants found in Alaska NPS units. Appendix G provides a summary table of potential environmental fate and effects of proposed herbicides for use in Alaska NPS units.

4.2 Impact Criteria and Assessment

For each issue selected for detailed analysis (see section 1.3) and for which the subject resources are described in chapter 3, the direct, indirect, and cumulative effects are analyzed. The effects to the subject resources are analyzed on the basis of the duration, context, and intensity of the impacts. Summary impact levels (characterized as negligible, minor, moderate, or major) are given for each issue topic in the analyses. Definitions of impact terms are provided below. Table 4-1 presents a summary of impact level thresholds.

<u>Duration:</u>
Temporary: Impacts would last no more than a season, or for the duration of the discreet activity, such as maintenance of a road or trail segment.
Long-Term: Impacts would extend for several years up to the life of the project.
Permanent: Impacts are a permanent change to the resource that would last beyond the life of the project even if the actions causing the impacts were to cease.

<u>Context:</u>
Common: The affected resource is widespread, and is not identified in enabling legislation as important to the park, nor is it rare within or outside the park. The portion of the affected resource impacted by the action does not fill a unique role within the park or its region of the park.
Important: The affected resource is identified by enabling legislation, or is rare either within or outside the park. The portion of the affected resource does not fill a unique role within the park or its region of the park.
Unique: The affected resource is identified by enabling legislation, and the portion of the affected resource uniquely fills a role within the park and its region of the park.

<u>Intensity</u>
Low: A change in resource condition is perceptible, but does not measurably alter the resource function in the park ecosystem, cultural context, or visitor opportunity.
Medium: A change in a resource condition is measurable or observable, and an alteration is detectable to the resource function in the park ecosystem, cultural context, or visitor opportunity.
High: A change in a resource condition is measurable or observable, and an alteration to the resource function in the park ecosystem, cultural context, or visitor opportunity is clearly and consistently observable.

Table 4-1 – Summary Impact of Level Thresholds

Negligible	Minor	Moderate	Major
Effects would tend to be low intensity, temporary, and would not affect unique resources.	Effects would tend to be low intensity and short duration, but common resources may sustain medium intensity and long-term effects.	Effects on common resources would tend to be medium to high intensity and long-term, while important and unique resources would tend to be affected by medium to low intensity and short-term to temporary impacts, respectively.	Effects would tend to be medium to high intensity, long-term to permanent, and affect important to unique resources.
Impairment occurs when a resource no longer fulfills the specific purposes in the enabling legislation or its role in maintaining the park's natural integrity			

4.2.1 Assumptions for the Cumulative Effects Analysis

Past human impacts to park areas, ongoing activities other than invasive plant control efforts, and future planned developments and activities need to be considered in the cumulative analyses. A simple way to view cumulative impacts is with an equation a + b = c, where "a" is the effects of past, present, and future impacts of human activities not addressed by the alternative, "b" is the effects of the alternative to control invasive plants, and "c" is the total combined effects to the resource of all these activities. Examples of prominent human activities that could impact invasive plant infestations are noted below.

- Cumulative Impacts of Mining: The NPS completed three environmental impacts statements in 1990 to address the cumulative effects of mining in Denali National Park and Preserve (USDI-NPS 1990a), Wrangell-Saint Elias National Park and Preserve (USDI-NPS 1990b), and Yukon-Charley Rivers National Preserve (USDI-NPS 1990c). These documents addressed the acres of mining effects on park resources like: aquatic resources, wetlands, wildlife resources, subsistence, recreation and visitor use, visual quality, wilderness resources, cultural resources and local economies.

- Denali National Park and Preserve Entrance Area and Road Corridor Plan EIS: This 1997 plan outlines future developments from the entrance area to Kantishna in the park (USDI-NPS 1997). Many of these projected developments have been completed.

- Denali National Park and Preserve Backcountry Management Plan EIS: This 2005 plan addresses desired levels of uses and methods of access into Denali National Park and Preserve other than along primary road corridors and entrance areas (USDI-NPS 2005).

- Katmai National Park and Preserve Brooks Camp Development Concept Plan EIS: This 1996 plan addressed the goal to move the existing Brooks Camp facilities with problems associated with fuel leaks and sewage treatment limitations in an archeological district and high use bear habitat to an upland area with fewer of these issues (USDI-NPS 1996). This project has not been implemented due to lack of funding and political reasons, however, the park is planning to move maintenance and fueling functions from the margin of Brooks Lake to the road Y leading to the Valley of Ten Thousand Smokes

- Gates of the Arctic National Park and Preserve All-Terrain Vehicle for Subsistence Use LEIS: This legislative EIS called for the exchange of NPS lands for Native Corporation lands to accommodate dispersed all-terrain vehicle (ATV) access to subsistence hunting grounds and private properties and allotments near Anaktuvuk Pass and to reduce adverse impacts on park lands and wilderness (USDI-NPS 1992). Congress got involved with this EIS because de-authorizing and designating Wilderness was involved, which takes Congressional action. BLM is in the process of making land conveyances to the two parties. In summary, the NPS allows ATV access rights on 126,632 acres of park lands and conveys 30,642 acres of park lands in fee to Native Corporations. The non-federal offering provides public access across 148,484 acres of Native Corporation lands, forgoes development rights on 116,949 acres of Native corporation lands, and conveys 38,840 acres to the NPS. About 74,000 acres of Wilderness was de-authorized in GAAR and 57,000 acres were designated in GAAR and another 17,000 acres were added to Noatak National Preserve.

- Commercial Lodges and Concession Contracts: There are 6 commercial lodges and commercial joint ventures on Alaska National Park lands, which provide lodging, meals, and visitor services that cover about 20 acres in 3 parks (DENA, KATM, and GLBA). Many other lodges on inholdings surrounded by park lands or on adjacent area lands provide visitor services within parks. In 2006 the NPS issued 106 concession contracts to various providers for recreational guiding, sport hunting and outfitting, recreational equipment rentals, air taxi and air charters, cruise ships, vessel charters, dog sledding, food and lodging, and convenience sales. Many of these visitor services and activities could introduce exotic plants into parks.

- Roads: There are 12 roads or road clusters traversing over 275 miles in Alaska National parks. Road side areas are disturbed surfaces and vehicles are major vectors for exotic plant translocations. The miles of roads surveyed by the NPS Exotic Plant Management Team (EPMT) in Alaska Region National Parks is provided below:

- There are documented and undocumented off-highway vehicle (OHV) trails traversing about 470 miles in Alaska National parks. GLBA is considering designating up to 63 miles of OHV trails in the Dry Bay area and closing about 21 miles of OHV trail (NPS 2007). WRST is addressing OHV trails with a new EIS, but the future outcome of this process is not known. A summary of the OHV trails by park is provided below in Table 4-3:

"Documented" means centerline mapped and condition assessment in hand. Most are not being actively managed as OHV trails (such as BELA's documented) and some (like CAKR) are largely on state tide lands (below MHW). The ones to be "inspected" in 2007 are those we hope to look at this summer so those numbers will change.

Table 4-2. Roads & OHV Trails surveyed by the EPMT Program within Park Boundaries

Park	*Name*	*Length_km*	*Length_mi*
DENA	Park Road to Kantishna	148	92
DENA	Parks Highway	11	7
WRST	McCarthy Road to Kennecott	95	59
WRST	Nabesna Road	62	38.5
KLGO	Dyea Roads	4	2.5
GLBA	Gustavus Road	7	4
KATM	Valley of 10,000 Smokes Road	35	22
KATM	Lake Camp Road	6	4
CAKR	DMTS (Red Dog Mine) Road	37	23
KEFJ	Exit Glacier Road	2	1
LACL	Port Alsworth Roads	3	2
GLBA	Dry Bay Roads	30	19
	TOTAL	**440**	**274**

Table 4-3. Miles of OHV Trail Distances by NPS Unit in Alaska

ALAG	Unknown but unlikely
ANIA	none
BELA	5.4 documented; 25+/- inspected summer 2007
CAKR	49.1 documented; 25+/- or so additional along beach between Red Dog and Kivalina.
DENA	19.1 documented; 46+/- inspected summer 2007
GAAR	22 documented; 8.5 mapped summer 2007
GLBA	72 documented
KATM	0 documented; 19+/- inspected in summer 2007
KLGO	0 documented; 6+/- inspected in summer 2007
KOVA	none
LACL	17 documented
NOAT	0 documented; 45+/- inspected summer 2007
WRST	199.6 documented; 10+/- inspected summer 2007
YUCH	30.7 documented
TOTAL	**414.8: 55 to be determined: grand total = 469.8**

- Airstrips: Nine maintained airstrips and 3 helicopter landing areas exist in or are surrounded by Alaska NPS units. Airstrips provide another avenue for exotic invasive plants to arrive into remote locations in parks. A list of park and FAA identified airstrips is provided below. Many additional seasonal and unofficial landing strips and seaplane landing areas exist throughout the parks in Alaska, which are used by air taxi operators and NPS personnel.

Table 4-4 FAA and NPS Documented Airstrips in Alaska National Parks

PARK	LOCATION/NAME	RUNWAY 1- NPS-Owned 2- Private	HELICOPTER ONLY
DENA	McKinley Park Strip	1	
DENA	Kantishna Airstrip	1	
DENA	Stampede Airstrip	1	
GAAR	Anaktuvuk Pass	2	
GLBA	Dry Bay Airstrip/Alsek River	1	
GLBA	East Alsek River	1	
GLBA	Cape Spencer	1/USCG	X
KLGO	Chilkoot Trail/Sheep Creek Ranger Station	1	X
KLGO	Chilkoot Trail Canyon City Trail Crew Cabin	1	X
LACL	Port Alsworth	2	
LACL	Wilder/Natwick Airstrip @ Port Alsworth	2	
WRST	Chisana	1	
WRST	May Creek	1	
WRST	Jakes Bar		
WRST	Young Creek		
WRST	Swift Creek		
WRST	Unnamed (5 mi W. Swift Ck)		
WRST	McCarthy	1	
WRST	Glacier Creek		
WRST	Devil’s Mountain Lodge		
WRST	Sportsman’s Paradise		
WRST	Unnamed 10 mi. W. of Slana		
WRST	Horsefeld		
WRST	Unnamed @ Ptarmigan Lake		
YUCH	Coal Creek	1	

4.3 Effects to Aquatic Resources and Fish

Below are brief descriptions of the effects that invasive riparian plant species could have on aquatic resources in Alaskan park units. The information on the effects of invasive riparian plants is derived largely from *Invasive Plants of Alaska* (AKEPIC 2005) and from the USDA Forest Service Fire Effects Information System invasive plant database: http://www.fs.fed.us/database/feis/plants/weed/weedpage.html . Other sources are cited as necessary.

A number of riparian invasive plants have been found in Alaskan National Parks, though not all are riparian obligates. These include white sweet clover, smooth brome grass, yellow toadflax, reed canarygrass, common sheep sorrel, common tansy and Japanese knotweed. Of these, several are known or are likely to have detrimental and long-lasting effects on aquatic ecosystems. White sweetclover (*Melilotus alba*) establishes extensively along early successional river bars throughout Alaska and has already been found in dense mono-specific patches along a number of Alaskan rivers. Extensive infestations exist along the Stikine, Matanuska and Nenana Rivers. White sweetclover is a nitrogen fixer with the capacity to alter nutrient cycling rates in and near riparian areas; this in turn can alter community metabolic processes in the stream itself. It also has the capacity to alter sedimentation rates in river ecosystems. Finally it appears to out-compete native riparian flora. White sweetclover has been detected in DENA, KLGO, and WRST and near GAAR, GLBA, SITK, and YUCH. However, the species is pervasive in Fairbanks and has been found along the Dalton Highway, so it is probably only a matter of time before it appears in GAAR and YUCH. Although there are not currently extensive infestations in Alaskan National Parks, white sweet clover is difficult to eradicate mechanically and requires several treatments per year. Hence, continued efforts to control white sweet clover using purely mechanical means are likely to fail in the long run. The result could be substantial alterations of affected aquatic ecosystems.

Yellow toadflax (*Linaria vulgaris*) is an aggressive invasive that is common in disturbed sites. It colonizes river gravel bars and riparian pastures and has been shown to compete with cottonwood seedlings for establishment sites on gravel bars. Yellow toadflax is very difficult to control mechanically. Although to date mechanical control has apparently been successful at retarding establishment of yellow toadflax, it is not likely to do so over the long term, with potentially deleterious effects on aquatic ecosystems.

Smooth brome grass (*Bromus inermis*) is commonly found in riparian zones, and is often used for stream bank and stream bottom stabilization. It is an aggressive colonizer and competitor in the lower 48, though it is more widespread in upland areas. While the direct effects of smooth brome grass infestation on aquatic ecosystems are unclear, based on its effects in upland areas it may out-compete native riparian species and alter fire regimes. Either of these could have potentially negative impacts on adjacent aquatic ecosystems. Smooth brome grass is difficult to control mechanically.

Although to date it has only been documented in GLBA, reed canarygrass (*Phalaris arundinacea*) is likely to become a serious problem in some Alaskan park units. It is highly invasive and forms dense persistent monotypic stands along stream banks, in riparian wetlands and in spring margins that exclude and displace native plant species. It can also interfere with the natural hydrology of adjacent streams, eliminating the scouring action needed to maintain spawning gravels and promoting the deposition of fine sediments.

Japanese knotweed (*Polygonum cuspidatum*) is a very successful invader of riparian habitats throughout North America. It is a very aggressive species and often forms monotypic stands that shade out native vegetation. A combination of unique life-history features makes it well-adapted to dynamic riparian and floodplain habitats, particularly gravel bars and the lower parts of stream banks. It is adapted to disturbed, low-nutrient habitats, and can tolerate poor soils and prolonged submersion. Its rapid early season growth to heights of 2-6 meters allows it to shade out native riparian vegetation. It can impede stream flow, exacerbate the effects of flooding, lower fish habitat quality and reduce the food supply for juvenile salmonids. Information regarding Japanese knotweed was obtained from Soll *et al.* (2006) in addition to the sources cited above.

Common sheep sorrel (*Rumex acetosella*) is a common invader in floodplain and riparian habitats. It is well adapted to disturbed sites and reaches peak abundance at low soil nitrogen. Although its potential effects on aquatic ecosystems are not well documented, it may out-compete native riparian species and alter nutrient flow. Common tansy (*Tanacetum vulgare*) is another invasive that grows along streams and has been shown to restrict water flow, altering hydrology and potentially promoting deposition of fine sediment.

4.3.1 Impacts from Alternative 1 – No Action

4.3.1.1 Direct and Indirect Effects on Aquatic Resources and Fish:

The analysis below shows that so long as periodic physical removal proves sufficient over the long term to keep invasive plant infestations from becoming established, the effects of Alternative 1 on aquatic resources, including fish and water quality, would probably be minor. However, it is not clear whether species like white sweetclover, which is relatively difficult to eradicate mechanically and requires several treatments per year, can be kept in check over the long term under Alternative 1.

Under Alternative 1, the no-action alternative, the NPS would continue to monitor and physically remove invasive plant infestations. This approach has been effective for all detected infestations in and near riparian areas except for perennial sow thistle on estuarine shores of Strawberry Island in Glacier Bay proper and oxeye daisy adjacent to the Dry Bay fish plant and airstrip and near a riverine slough of the Alsek River in Glacier Bay National Preserve. NPS crews attempted to remove perennial sow thistle on Strawberry Island, but only a small portion of the 2.5 acre infestation could be dug up, and this effort failed to remove all roots and seeds in the treated area. The NPS has attempted to remove oxeye daisy infestations in Glacier Bay National Preserve, but the acre-size patch at the Dry Bay fish plant persists. The NPS continues to detect and remove biomass of reed canarygrass near Gustavus, but the species continues to return, especially where ground disturbance occurs.

NPS crews would continue to remove white sweetclover from roadsides and river bars near Slana in WRST and in the front country area of DENA, which prevents its escape onto this portion of the Nenana River. Japanese knotweed has been pulled from 2 locations not immediately adjacent to water for the last 5 years in SITK, where it continues to return.

Under the no-action alternative aquatic resources and water quality are not likely to be adversely affected in Alaska NPS units, provided that Exotic Plant Management Teams (EPMTs) continue to diligently locate and remove new infestations. If some of the invasive plants described above become established at population levels that exceed established thresholds for successful manual control, then the no-action alternative would be ineffective in protecting aquatic resources. Given increasing levels of visitation, a warming climate, limited staff and tens of millions of acres to patrol, the most likely scenario is that Alternative 1 will not be able to effectively control the establishment of invasive riparian plant species indefinitely, leading eventually to substantial and potentially irreversible ecological harm to the affected aquatic ecosystems.

4.3.1.2 Cumulative Effects:

Substantial effects from past mining activity continue to impact streams in Alaskan NPS units, especially DENA, WRST and YUCH. The majority of mining in DENA occurred in the Kantishna Hills, where substantial impacts to streams persist. These impacts include altered channel morphology, increased turbidity and suspended sediment loads and heavy metals contamination. The stream morphology of at least 12 drainages in the Kantishna Hills was substantially altered; in some cases up to 90% of the stream was disturbed. The total affected acreage is estimated to be in excess of 1,300 acres, most of which is within active stream channels or riparian areas (NPS 2005b). The major impacts in YUCH occurred along Coal Creek and Woodchopper Creek where dredging and mining impacted about 900 acres. There are more than 400 abandoned mine sites in WRST. Although many of these were upland hard-rock mines, mining activity in WRST has had substantial impacts to stream ecosystems, including altered channel morphology, increased sedimentation, elevated metal concentrations and low pH. The areas with the most mining-related impacts to streams are Nabesna, Chisana, Nizina and Kennicott (Weeks 2003).

There are over 275 miles of roads in Alaska NPS units, with the majority located in WRST and DENA. Most of these roads are unpaved, and consequently can lead to increased turbidity and sedimentation in streams that cross or parallel the roadbed. These effects are generally more severe when the road crosses the stream bed itself, rather than being located on a culvert or bridge. An example is the Upper Moose Creek Road in DENA (now restricted to ATV use), which in one section crosses Spruce Creek 36 times in 15 miles. While these effects can sometimes be observed for substantial distances downstream, in general the impacts tend to be relatively localized. During heavy precipitation events, the increase in turbidity and sedimentation may be substantial and propagate for considerable distances downstream. Alaska NPS units also contain many hundreds of miles of ATV trails, including over 600 miles of trails in WRST. These trails are vectors for the spread of invasive plants in addition to creating direct impacts to aquatic resources, primarily through the effects of stream crossings and travel in riparian areas. Studies are planned to attempt to quantify the effects of ATV trails on stream ecosystems along the Nabesna Road corridor in WRST.

Numerous airstrips and helicopter landing pads exist in Alaska NPS units, and some of these are located on riverine gravel bars or near riparian areas (*e.g.*, on floodplain terraces). Most airstrips have been located on well-drained dry land because landing wheel planes on soft wet ground is unsafe. Therefore no estimate of additional impacts to wetlands is provided for airstrips. The effects of airstrips on floodplains are negligible because flood events would simply run over or around the gravel airstrips.

Although, with the exception of the DENA park road corridor and cruise ships in GLBA and KLGO, visitation to Alaskan NPS units remains fairly low. Localized impacts due to recreational activities do occur. These impacts can include disturbances in riparian zones (*e.g*., trampling of vegetation and stream banks, increased sedimentation due to runoff from trail erosion) and alterations of water quality (e.g., *E. coli* or Giardia contamination). In WRST, Copper, Tanada, and Ptarmigan Lakes have seasonally high recreational use. Trail erosion is substantial at Sanctuary River in DENA, for example.

The cumulative effects of past, present, and expected future human activities are substantial and significant. The incremental increase from the no-action alternative to manage invasive plants would result in a minor additional impact on aquatic resources and water quality in Alaska NPS units.

4.3.1.3 Conclusion:

The impacts to aquatic resources and water quality from the no-action/status quo alternative to control invasive plants would be minor and on balance beneficial. The no-action/status quo alternative would not likely remain effective, however, in controlling the establishment of invasive plants along aquatic habitats over the long term. No impairment to Alaska NPS unit streams and lakes would result from the implementation of this alternative.

4.3.2 Impacts from Alternative 2 – NPS Proposed IPMP

4.3.2.1 Direct and Indirect Effects of Alternative 1 on Aquatic Resources and Fish:

Provided that herbicide applications near streams and lakes are limited and carefully conducted, the analysis below shows impacts of Alternative 2 to aquatic resources (including fish and water quality) in Alaskan NPS units would be minor. Overall, the impact of Alternative 2, which includes a decision tree that prioritizes manual removal, should be beneficial to aquatic resources by preventing the establishment of invasive riparian plant species with known harmful effects. Effects on water quality should be minimal given the limited area and duration of the herbicide applications and the generally short half-lives of these herbicides in natural waters.

The NPS proposed action alternative to include a decision tree for the possible use of herbicides where warranted would result in the removal and nearly complete control of invasive plant infestations. Manual removal has been effective for all detected infestations in floodplain and wetland areas except for perennial sow thistle on or near estuarine shores (E2EM1/USN) of Strawberry Island in Glacier Bay and oxeye daisy near the Dry Bay fish plant and airstrip located mostly on uplands but near a riverine slough (R1US/UB) of Alsek River (see section 3.8 for wetlands descriptions). The proposed use of Milestone VM herbicide (aminopyralid) to remove these infestations would reduce human impacts that would otherwise occur from trampling and digging in these areas. Due to its low toxic nature, other than to plants, aminopyralid does not need to be evaluated for impacts to groundwater contamination. The adjacent small palustrine and estuarine beach wetlands on Strawberry Island would be returned to natural and healthy plant populations. Oxeye daisy would be removed from the airstrip entry way location at Dry Bay, thereby reducing the potential for plant seed transport and the migration of this species into adjacent area riverine shores.

The proposed uses of Roundup Pro to remove 2.1 acres of reed canarygrass near Bartlett Cove in GLBA and Habitat to remove 0.1 acre of Japanese knotweed near Indian River in SITK would protect palustrine and riverine wetlands near those areas as habitat for aquatic resources. As noted in appendix G, Round-up Pro with surfactants has a half life of less than one week, which may be slightly to moderately toxic to fish and invertebrates. The glyphosate and surfactant in Roundup are strongly absorbed by soil particles, but glyphosate may wash off into surface waters after heavy rains. These chemicals do not bioaccumulates in fish. So long as application occurs when there is a good weather window and no impending rain storms and placed as distant from surface waters as practicable, the impacts to fish and other aquatic organisms can be minimized. See the discussion below on the impacts of glyphosate (Roundup) to aquatic taxa. Habitat with active ingredient imazapyr is known to have low toxicity to invertebrates and is practically non-toxic to fish. It does not build up in aquatic animals.

NPS crews would continue to remove white sweet clover from roadsides and river bars near Slana in WRST and in the front country area of DENA, which prevents its escape onto this portion of the Nenana River. Reed canary grass has been successfully removed from small wetlands near Bartlett Cove in GLBA. Yellow toadflax has been reduced along Exit Glacier Road where some small wetlands areas occur nearby. Japanese knotweed has been pulled from 2 locations not immediately adjacent to water for the last 5 years in SITK, where it continues to return.

Floodplain functions are not likely to be adversely affected in Alaska NPS units so long as EPMTs diligently locate and manually remove new infestations. If some of the invasive plants described in section 4.3 above exceed thresholds for regular manual control methods, then the proposed action alternative would allow for rapid effective control methods to remove or reduce invasive plant infestations that could harm floodplains and aquatic resources over a wider distribution.

Several of the proposed herbicides in Alternative 2 have acute toxic effects on aquatic taxa, therefore their use in or near aquatic ecosystems could have harmful, though probably temporary, effects. Relatively little is known regarding the potential effects of chronic low-level exposure of most of these herbicides on aquatic taxa, so we cannot predict with any confidence what the effects of such exposure may be on aquatic resources. Information on the relative toxicity of the proposed herbicides to aquatic taxa is derived from U.S. Forest Service risk assessments or other relevant literature as cited and provided in appendix C. See appendix C for the Relative Aquifer Vulnerability Evaluation (RAVE) and appendix G for herbicide fate and effects summaries. The following analyses are also presented for potential effects of the proposed herbicide in aquatic settings.

2,4-D

2,4-D is an effective herbicide with a long history of use. Consequently, its effects have been relatively well studied. There are a number of different formulations of 2,4-D with widely varying toxicities to aquatic taxa. The most important distinction is between formulations using the DMA salt and those composed of one of a variety of ester compounds of 2,4-D. These esters are generally much more toxic than the acid/salt formulations, and this is particularly the case for aquatic taxa.

Little is known about bioaccumulation of 2,4-D in freshwater food chains, although it has been demonstrated in some fish species, or about the effects of long-term low-level exposure on aquatic organisms or ecosystems. Relatively low concentrations have been shown to kill fathead minnow eggs. Adsorption of 2,4-D to soils (normally low for salts, higher for esters) is increased with decreasing pH, increased organic content. Decreasing pH also inhibits hydrolysis of 2,4-D esters. Degradation of 2,4-D esters is slower in colder soils and in the presence of excessive soil moisture.

Although it is specifically designed for use in aquatic systems, Aqua-Kleen is a butoxyethyl ester formulation of 2,4,-D. Each of the other 2,4-D formulations proposed for use under Alternative 2 is also an ester and hence would be acutely toxic to aquatic taxa. Direct application of 2,4-D esters for control of aquatic invasives would be expected to cause mortality, perhaps substantial, among sensitive fish species (whose identities among Alaskan species are unknown, although rainbow trout [*Oncorhynchus mykiss*] appear to be relatively tolerant). However, because 2,4-D esters are not persistent, long-term exposure is unlikely. Because of the relatively small amounts involved, spot application of 2,4-D on terrestrial plants is unlikely to lead to problematic concentrations of 2,4-D in aquatic ecosystems, particularly for streams, rivers and large lakes. Repeated application near small ponds or wetlands should be approached with caution, as should application on riparian vegetation. Direct application to aquatic macrophytes should be avoided due to the likelihood of acute toxic effects on aquatic organisms, including fish and amphibians. Spills and immediate runoff are also potentially problematic. At the upper range of Forest Service application rates, spills or runoff of 2,4-D salts could lead to toxic effects on aquatic macrophytes. On the other hand, spills or immediate runoff could lead to acute toxicity effects on aquatic plants and animals at all application rates for 2,4-D esters. In its Risk Assessment of 2,4-D, the USDA Forest Service recommended "consideration … [of] … alternate herbicides" near aquatic ecosystems and that "… the use of 2,4-D should be limited to situations where other herbicides are ineffective or to situations in which the risks posed by 2,4-D can be mitigated". In general, application of 2,4-D esters should be avoided altogether in the vicinity of aquatic ecosystems, due to the extreme sensitivity of many aquatic taxa to this formulation. Information from USDA Forest Service (2006).

Glyphosate
Glyphosate, the active ingredient in Roundup and a number of other commercial herbicides, is itself relatively nontoxic to fish, but surfactants included in some formulations appear to be highly toxic (POEA, the surfactant used in some Roundup formulations is particularly toxic), and may also increase the toxicity of glyphosate. Most studies of glyphosate toxicity have not considered the effects of surfactants (most use technical grade glyphosate), so the toxicity results that are available are difficult to interpret. Nevertheless, some salmonid species have been shown to be highly sensitive to technical grade glyphosate irrespective of the surfactant. Furthermore, as the Forest Service Risk Assessment makes clear, the difficulty in determining which formulations (which surfactants) were tested for toxicity during the initial EPA approval process makes it difficult to associate particular formulations with particular risk levels. However, it appears that Roundup Pro and Roundup Ultra contain the most toxic surfactants. In addition, Trumbo (2002) found 30% mortality in fathead minnows exposed to water collected near a Rodeo/R-11 application to control purple loosestrife and determined that the toxicity was related to the presence of R-11. In a related study, R-11 was also found to be moderately toxic to larval amphibians (Trumbo 2005). Little information is available regarding the toxicity of the other formulations listed under Alternative 2. Although not yet documented, deleterious effects on aquatic microorganisms can be expected because these microorganisms share the target metabolic pathway with higher plants. Some glyphosate/surfactant combinations have also been shown to be highly toxic to larval amphibians. Although glyphosate apparently has relatively low toxicity to aquatic invertebrates, the effects of surfactants have not been well studied. Based on the data that are available, enough is known to postulate that some surfactants may be much more toxic to invertebrates than others.

At typical application rates, less-toxic formulations are probably a low risk to aquatic taxa, but more toxic formulations should not be used near surface waters. Importantly, there have been no studies of the potential for chronic effects among the most acutely toxic formulations. The Forest Service risk assessment of glyphosate states "this risk characterization strongly suggests that the use of more toxic formulations near surface water is not prudent." Furthermore, they state "the use of [less toxic formulations of] glyphosate near bodies of water where sensitive species of fish may be found (e.g., salmonids) should be conducted with substantial care to avoid contamination of surface water." It is not clear what glyphosate/surfactant combination is proposed for use under Alternative 2. Information is from USDA Forest Service (2003a).

Chlorsulfon
According to the Forest Service risk analysis, detectable damage to aquatic macrophytes is plausible at typical application rates of chlorsulfon. There is a large range of sensitivities to chlorsulfon among algae, but changes in phytoplankton communities have been observed at concentrations as low as 1 ug/L. The limited data on toxicity to aquatic animals suggests it to be much lower in general. Information is from USDA Forest Service (2004a).

Triclopyr
Although data on the toxicity of triclopyr to aquatic taxa are limited, they suggest that formulations with Triclopyr BEE (*e.g*., Garlon 4) are substantially more toxic to aquatic taxa than Triclopyr TEA formulations (*e.g*., Garlon 3A). Information is from USDA Forest Service (2003b).

Of the remaining 4 herbicides proposed for use under Alternative 2, three are classified by the USDA Forest Service or the Environmental Protection Agency as low risk or practically non-toxic to aquatic taxa at normal application rates. These are imazapyr, metsulfuron methyl, and aminopyralid. Aminopyralid is slightly toxic to aquatic algae and macrophytes and has been shown to reduce early life-stage survival and growth of some fish species. Imazapyr appears to be relatively non-toxic to fish and aquatic invertebrates at normal application rates, but some species of aquatic macrophytes are sensitive and no data are available on toxicity to amphibians. Information is from USDA Forest Service (2004b, 2004c, 2004d)

Data regarding the toxicity to aquatic taxa of Clopyralid, the last herbicide proposed for use, are very limited. The few data that do exist suggest that clopyralid has relatively low acute toxicity to fish. However, there are no data on the effects of chronic exposure to fish. There are limited data on invertebrates, and these suggest that both acute and chronic toxicities are low. There are no data regarding either acute or chronic effects of clopyralid on amphibians. According to the EPA analysis (USEPA 2005), based on these limited data no adverse effects of clopyralid on aquatic taxa would be expected at normal application rates.

4.3.2.2 Cumulative Effects:

Substantial effects from past and ongoing mining activity, roads, visitor and administrative buildings, ORV trails, airstrips, and increasing human activities continue to impact streams and other aquatic resources in Alaskan NPS units, especially DENA, WRST and YUCH as described in section 4.3.1.1. The cumulative effects of past, present, and expected future human activities on aquatic resources and water quality are substantial and potentially moderate. The incremental increase from the implementation of Alternative 2 to manage invasive plants would result in a minor additional impact on aquatic resources and water quality in Alaska NPS units.

4.3.2.3 Conclusion

The impacts to aquatic resources and water quality from Alternative 2 to control invasive plants would be minor and on balance beneficial, provided that appropriate measures are taken when herbicides are applied near streams and lakes. However, it would be necessary to carefully consider the potential toxic effects of each of the herbicides when application near aquatic ecosystems is warranted. No impairment to Alaska NPS unit aquatic resources would result from the careful implementation of this alternative.

4.4 Effects to Cultural Resources

Cultural resources occur in all of Alaska parks and include archaeological resources, ethnographic resources, cultural landscapes, and historic structures. While there may be potential for impacts to these resources from invasive plant eradication actions, until specific sites and proposed removal methods are identified, it is difficult to determine impacts to cultural resources. The consideration of cultural resources and exotic plant management in Alaska's NPS units involves two issues: 1) whether invasive species themselves are cultural resources, and therefore warrant preservation; and 2) whether the management of invasive species could adversely affect cultural resources. As noted in EA section 1.2.5 NPS Management Policies, exotic plants would not be allowed in NPS units unless the identified exotic species itself has a high level of historic significance and is a contributing feature of a landscape, district, or site listed on or eligible for listing on the National Register of Historic Places, and the exotic species in non-invasive.

<u>4.4.1 Impacts from Alternative 1 – No Action</u>

4.4.1.1 Direct and Indirect Impacts of Alternative 1:

Potential Impacts to Archeological Resources
The method of treating invasive species could adversely affect archeological resources. Archeological sites are an obvious example where invasive species removal by hand, mechanical or biochemical means could potentially harm or destroy the integrity of an archeological site. For instance, mechanical removal could alter the distribution of surface artifacts or disturb shallow archeological deposits. Furthermore, although Alaska Natives did not cultivate plants prehistorically; in historic archeological sites culturally significant exotic plant taxa may be present that could be impacted in the course of the invasive species action.

Potential Impacts to Cultural Landscapes
It is possible that NPS management practices outlined in this document, as articulated for alternative 1, could potentially compromise the integrity of the characteristics contributing to a cultural landscape. Historic roads and trails are examples where many infestations of invasive species occur along these corridors. The proposed treatment should take into consideration potential affects to the structural integrity of roads and trails. When vegetation is removed, by hand or mechanical means, erosion often becomes an issue. Therefore erosion control must be an integral part of any invasive species

management regime along these historic corridors. And finally, any decision to maintain an exotic or invasive species which is part of a defined cultural landscape needs to be carefully weighed against it potential for ecological harm beyond the identified historic boundaries.

Potential Impacts to Ethnographic Resources
Invasive plants may threaten ethnographic resources by supplanting traditionally-used plants, or by impeding access to harvesting areas. Alternatively, possibly after several generations, exotic plants may eventually come to be used in traditional ways. A further consideration is that efforts to eradicate invasive plants may have greater impacts than the invasive plants themselves, since treatments might also damage native plants and animals.

Potential Impacts to Historic Structures/Buildings
It is unlikely that historic buildings and structures could be impacted negatively from physical removals of invasive plants unless foundations are undermined in some manner.

Because physical plant removal activities at all National Register listed and eligible sites are subject to NHPA Section 106 reviews and compliance, the potential for any adverse effects to the subject cultural resources noted above would not likely exceed any more than an accidental minor level. If adverse effects are determined to be likely from the proposed plant removal activities, ways would be sought to avoid, minimize, or mitigate the adverse effects.

4.4.1.2 Cumulative Effects:

Past impacts to cultural resources in areas near invasive plant control efforts have been scattered but widespread. Most of these impacts have occurred near roads, airstrips, ORV trails, foot paths, mining areas, building sites, campsites, and day-use areas, which is where most invasive plants would likely occur. Vandalism and looting are some of the most egregious past and ongoing adverse impacts to cultural resources, but these effects are diminishing with better NPS law enforcement and education programs. Application of NHPA Section 106 compliance has resulted in greatly diminished adverse effects from NPS actions. Due to the magnitude of the past and proposed new infrastructure in Alaska NPS units and the associated public access and potential for vandalism and looting, the overall effects to cultural resources is judged to be moderate. The minor additive effects from the past and ongoing NPS physical control activities on invasive plants would not change the overall cumulative effects on cultural resources in the Alaska Region.

4.4.1.3 Conclusion:

Because of the relatively small treatment areas in Alaska National Parklands and the use of NHPA Section 106 reviews to protect archeological and historical resources, the potential impacts to cultural resources from the no-action (status quo) alternative to physically control and remove invasive plants are judged to be minor. No impairment to cultural resources in Alaska NPS units would result from this alternative.

4.4.2 Impacts from Alternative 2 – NPS Proposed IPMP

4.4.2.1 Direct and Indirect Impacts of Alternative 2:

Potential Impacts to Archeological Resources
As in alternative 1, physical methods of treating invasive species could adversely affect archeological resources. Similarly, certain chemical treatments might change the soil chemistry and effect the preservation of bone and other archeological remains. The potential of chemical treatments to affect the accuracy of radiocarbon age determinations is unknown. Furthermore, although Alaska Natives did not cultivate plants prehistorically; in historic archeological sites culturally significant exotic plant taxa may be present that could be impacted in the course of the invasive species action.

Potential Impacts to Cultural Landscapes
It is possible that NPS management practices outlined in this document for alternative 2 could potentially compromise the integrity of the characteristics contributing to a cultural landscape. For example, buildings and structures, which are often components of cultural landscapes could also be impacted negatively from physical effects of herbicides and other toxic substances used in the eradication of invasive species. These chemicals may adversely affect physical materials of historic buildings and structures.

Historic roads and trails are another example, given that many infestations of invasive species occur along these corridors. The proposed treatment should take into consideration potential affects to the structural integrity of roads and trails. When vegetation is removed, by hand, mechanical, or biochemical means, erosion often becomes an issue. Therefore erosion control must be an integral part of any invasive species management regime along these historic corridors. And finally, any decision to maintain an exotic or invasive species which is part of a defined cultural landscape needs to be carefully weighed against it potential for ecological harm beyond the identified historic boundaries. Furthermore, control of invasive plants with herbicides could result in the damage or death of the culturally significant plants near treatment sites.

Potential Impacts to Ethnographic Resources
Invasive plants may threaten ethnographic resources by supplanting traditionally-used plants, or by impeding access to harvesting areas. Alternatively, possibly after several generations, exotic plants may eventually come to be used in traditional ways. A further consideration is that efforts to eradicate invasive plants may have greater impacts than the invasive plants themselves, since chemical and other treatments might also damage native plants and animals. As noted for several listed herbicides in table 2.4, the potential to damage or kill native plants near treatment sites is likely, but adverse impacts on birds, mammals, and fish is low or less likely.

Potential Impacts to Historic Structures/Buildings
It is possible that historic buildings and structures could be impacted negatively, in that it is generally unknown what physical effects herbicides and other toxic substances used in

the eradication of invasive species may have on the physical materials of historic buildings and structures.

4.4.2.2 Cumulative Effects:

Past impacts to cultural resources in areas near past and proposed invasive plant control efforts have been scattered but widespread. Most of these impacts have occurred near roads, airstrips, ORV trails, foot paths, mining areas, building sites, campsites, and day-use areas, which is where most invasive plants would likely occur. Vandalism and looting are some of the most egregious past and ongoing adverse impacts to cultural resources, but these effects are diminishing with better NPS law enforcement and education programs. Application of NHPA Section 106 compliance has resulted in greatly diminished adverse effects from NPS actions. Due to the magnitude of the past and proposed new infrastructure in Alaska NPS units and the associated public access and potential for vandalism and looting, the overall effects to cultural resources is judged to be moderate. The minor additive effects from the past and ongoing NPS physical control methods and potential future chemical control activities of invasive plants would not change the overall moderate cumulative adverse effects on cultural resources in the Alaska Region.

4.4.2.3 Conclusion:

Because of the relatively small treatment areas in Alaska National Parklands and the use of NHPA Section 106 reviews to protect archeological and historical resources, the potential impacts to cultural resources from the proposed action alternative (integrated invasive plant management with limited herbicide use to physically and chemically control and remove invasive plants) are judged to be minor. No impairment to cultural resources in Alaska NPS units would result from this alternative.

4.5 Effects to Human Health and Safety

<u>4.5.1 Impacts from Alternative 1 – No Action</u>

Defining Risk Levels
To determine the “risk level” associated with these activities the probability of an injury occurring and what the severity of the injury might be is determined by defining the terms.
(1) “Probability” is defined as: The chance that a given event will occur.
The probability rating is:
Low - If the factors considered indicate it would be unlikely that an accident could occur;
Medium - If the factors considered indicate it would be likely that an accident could occur; or
High - If the factors considered indicate it would be very likely that an accident could occur.
(2) “Severity” is defined as: the degree of injury or illness which is reasonably predictable.

The severity rating is: Low, First Aid Case; Medium, Serious injury or illness; High, Fatality.

4.5.1.1 Direct and Indirect Impacts of Alternative 1:

The analysis below shows the anticipated effects of Alternative 1 on human safety and health. These assessments are based on two conditions:

1. Job Hazard Analysis - (JHAs) are developed and followed for each of the jobs to be completed. Employees are expected to follow the JHAs recommendations (personal protective equipment use, equipment, work practices, etc.) when performing that job.

2. Training - Employees must receive all required training when completing jobs. See mitigating measures in EA section 2.4 regarding employee training and licensing and public notifications for invasive plant control activities. The potential impacts to the health and safety of the visiting public is expected to be less than to EPMT employees because they are not performing the tasks or are distant from them; however, some exposure to fire and falling or flying debris from cutting or mowing is possible.

Description of Activities
Field employees manually or mechanically remove plants. Activities involve removing plants by hand, cutting or pulling with minor digging as the prevailing control method. In a few cases brush trimmers have been used for larger areas

Manual activities involving hand cutting, pulling and digging.
Potential Injuries are ergonomic injuries to the back, hand, knees and arms; or sprains, strains, cuts. The probability of injury occurring is low to medium, and the severity of injuries is usually low.

Motorized activities involving brush trimmers.
Potential injuries are from impacts from flying particles or moving parts, cuts by moving parts, burns, bruising, and excessive vibration. The probability of injuries occurring is low. The severity of injuries is low to medium.

Thermal treatments include soil solarization and burning.
These activities include, covering the soil with plastic, control burning and spot burning with a propane torch. An employee health and safety analysis on control burning activities can not be completed until more site specifics details are provided. Any "control burning" treatments would be planned and implemented under the guidance of wild land fire program. While covering the soil with plastic material, potential injuries include back injuries, sprains, and strains. The probability of injuries occurring is low. The expected severity of injuries is also low.

4.5.1.2 Cumulative Effects to Human Health and Safety in Project Areas:

The overall effects to human safety and health for this alternative would be low for the probability of an injury occurring and low for the severity of the injuries. If one were to compare this to other injuries that might be expected to occur from motor vehicle operations, ATV operations, or other slips, trips or falls that occur in normal park settings, the injury numbers and rates would be much lower from invasive plant control activities. No increases in human injuries would be expected to occur from this alternative.

4.5.1.3 Health and Safety Conclusion:

Removing exotic plants by the use of manual and motorized activities, soil solarization and weed burning have easily recognized hazards that can be predicted and easily controlled. The overall risk of human injury would be low and the impacts to human health and safety are judged to be minor overall.

<u>4.5.2 Impacts from Alternative 2 – NPS Proposed IPMP</u>

4.5.2.1 Direct and Indirect Impacts of Alternative 2:

This analysis below shows the effects of Alternative 2, "Decision Tree" on human safety and health. The potential effects to the visiting public would be less than to employees because they are not performing the tasks and signs would be posted warning people of activities. This alternative follows a decision tree that determines the method to be used. The two recommended options are physical control and herbicide use. The use of herbicides would only be considered after all the other alternatives have been ruled out. The risks associated with physical control (manual, motorized, and solarization) have been described in more detail above in alternative 1. The additive risk of using herbicides is reviewed in this alternative. This assessment is based on three conditions:

1. Job Hazard Analysis - (JHAs) are developed and followed for each of the jobs to be completed. Employees are expected to follow the JHAs recommendations (personal protective equipment use, well-maintained equipment and herbicide supplies, good work practices, etc.) when completing that job.
2. Training/certification - Employees would receive all required training/certification when applying herbicides.
3. Recommendations on the labels and material safety data sheets (MSDSs) for each herbicide would be strictly followed. If these 3 conditions are not met, then the severity and probability of employee or public injuries would increase. See also mitigating measures in EA section 2.5 and best management practices in appendix X.

Hazard Rating of Selected Herbicides
The herbicides recommended for use and two hazard ratings for each herbicide are shown below in Table 4.5.

Oregon State University and Intertox Inc. prepared a series of fact sheets to assist interested parties in understanding the risk associated with herbicides use by the Washington State Department of Transportation integrated Vegetation Management program. A fact sheet has been prepared for all of the herbicides listed for use. The complete fact sheets can be found at:
http://www.wsdot.wa.gov/maintenance/vegetation/herbicide_use.htm

The Human Health and Risk Assessment associated with the identified herbicides according to these fact sheets is listed below in Table 4.6.

Table 4.5 Herbicide Hazard Ratings

Name of Herbicide	NFPA 704 Hazard rating	EPA Toxicity Category
Milestone VM (Aminopyralid)	H - 1, F - 0, R - 0	Toxicity class IV (Very Low) Signal word: CAUTION
Transline (Clopyralid)	H - 2, F - 2, R - 1	Toxicity class III, (Low) Signal word: CAUTION
Rodeo (Glyphosate)	H - 1, F - 1, R - 1	Toxicity class III (Low) Signal word: CAUTION
Habitat (Imazapyr)	H - 1, F - 1, R - 1	Toxicity class III, (low) Signal word CAUTION
Arsenal (Imazapyr)	H - 1, F - 1, R - 1	Toxicity class III (low) Signal word Caution
Oust XP (sulfometuron-methyl)	H - 1, F - 1, R - 0	Toxicity class III (low) Signal word: CAUTION
Escort XP (Metsulfuron-methyl)	H - 1, F - 1, R - 1	Toxicity class III (low) Signal Word CAUTION
Telar XP (Chlorsulfuron)	H - 1, F - 1, R - 0	Toxicity class III (low) Signal word CAUTION

H = Health
F = Flammability
R = Reactivity

Description of Activities
Employees would be mixing chemicals and water, cleaning equipment, storing and applying the designated herbicides. The herbicides would be applied using minimum volume techniques, backpack or hand held spray mechanism, injection, or wicks, brushes or sponges for direct contact with target plants. Spray mechanism would be equipped with low regulators that control application rates, maximize effectiveness, and minimize drift. Under this alternative, the use of herbicides would be considered only after manual, mechanical, thermal, or cut rural treatment methods have been ruled out using the decision tree.

Table 4.6 Herbicide Health Risks		
Name of Herbicide	*Cancer risk*	*Non–cancer risk*
Milestone VM (Aminopyralid)	Negligible	Negligible
Transline (Clopyralid)	Negligible	Negligible
Rodeo (Glyphosate)	Negligible	Negligible
Habitat (Imazapyr)	Negligible	Negligible
Arsenal (Imazapyr)	Negligible	Negligible
Oust XP (sulfometuron-methyl)	Negligible	Negligible
Escort XP (Metsulfuron-methyl)	Negligible	Negligible
Telar XP (Chlorsulfuron)	Negligible	Negligible

Application of Transline
NFPA 704 rating: Health 2, Flammability 2, Reactivity 0
EPA toxicity Class III (low)
Potential injuries: Temporary eye irritation, skin irritation, nose and throat irritation, thermal burns, lower back strains and sprains,
Probability of injury occurring: Low
Severity of the injuries: Low

Application of: Milestone VM, Rodeo, Habitate, Arsenal, Oust XP, Escort XP, Telar XP
NFPA 704 rating: Health 1, Flammability 1, Reactivity 0
EPA toxicity Class III or IV (low or very low)
Potential injuries: Temporary eye irritation, skin irritation, lower back strains and sprains,
Probability of injury occurring: Low
Severity of the injuries: Low

An example of human health risk assessment is provided below for 2,4-D, which is at the more toxic end of the scale for proposed herbicides in alternative 2. This data is summarized from the Forest Service risk assessment web page for sensitive public members:

> "Upper bound hazard quotients for direct spray of a whole naked child with 2,4-D acid or salts are greater than 1 (the level of concern) for all application rates, ranging from a value of 3 for 0.5 lb a.e./acre, to a value of 28 for 4 lb a.e./acre. While this scenario is highly unlikely, it is a standard extreme scenario that is used in all Forest Service risk assessments as an indicator of the most serious exposures which could result from accidental spraying of members of the general public. All pesticide applications are conducted in a manner to avoid accidental spraying of members of the general public;

> however, this scenario suggests that such caution is particularly warranted with the use of 2,4-D.
>
> Based on central and upper-bound hazard quotients, adverse health outcomes are plausible following an accidental spill of 2,4-D into a small body of water. Upper bound hazard quotients for a young child consuming contaminated water following an accidental spill are 82, 41, and 328 for the typical, lowest, and highest anticipated application rates, respectively. Estimates of exposure via consumption of contaminated fish following an accidental spill result in hazard quotients of concern (i.e., greater than 1) for both subsistence and typical fish consumption scenarios.
>
> As with exposures to almost any chemical, there is particular concern for children, women who are pregnant or may become pregnant, the elderly, or individuals with any number of diseases. As discussed previously, reproductive-age females are sensitive to 2,4-D exposure. Developing fetuses are also sensitive to 2,4-D exposure at doses that are toxic to the mother. These issues were taken into account in the derivation of the acute and chronic RfD values for 2,4-D. Sunscreens increase the dermal permeability of 2,4-D. Consequently, individuals using sunscreens may absorb a greater dose of the compound, making them more likely than others to have adverse effects associated with dermal to 2,4-D. Studies with animals and humans suggest that 2,4-D is capable of causing adverse effects to the immune system. Accordingly, individuals who are immuno-compromised (e.g. the very young, the elderly, individuals with chronic illness) may be unusually sensitive to 2,4-D. The mechanism of action of 2,4-D involves disruption of the cell at the level of the membrane and basic metabolic functions. Individuals who have diseases involving the integrity of the cell membrane (e.g. sickle cell anemia) may be more sensitive than others to 2,4-D exposure. As with many chemicals, there is some evidence that individuals, particularly children, who are malnourished may be at increased risk when exposed to 2,4-D (e.g., Ferri et al. 2003)."

In general, because proposed and potential herbicide applications would be relatively small (2.5 acres or smaller), widely separated in space and time, and located and timed to avoid general public uses or with area closures, the potential adverse impacts to human health and safety would be minor.

4.5.2.2 Cumulative Effects to Human Health and Safety in Project Areas:

The overall effects to human safety and health from other injuries that might be expected to occur from motor vehicle operations, ORV operations, or other slips, trips, or falls that occur in normal park operations and visitation would be much greater than for potential injury numbers and rates from activities association with this alternative. No increase in employee OSHA recordable injuries would be expected to occur from this alternative and injuries to the public would be avoided with proper warning signs, emergency closures, and timing of control activities.

4.5.2.3 Conclusion:

As noted for alternative 1, removing exotic plants by the use of manual and motorized activities and soil solarization have easily recognized hazards that would result in low risk of injuries to employees or the general public. Removing exotic plants by the use of the identified herbicides with approved application methods and proposed public notification and areal closures would result in low overall risk of injuries to employees or the public and the impacts to human health and safety are judged to be minor overall.

4.6 Effects to Soils

4.6.1 Impacts from Alternative 1 – No Action

4.6.1.1 Direct and Indirect Impacts of Alternative 1:

Alternative 1 includes the currently used pulling, cutting, and mechanical removal of invasive plant species. Also included under this alternative are thermal methods for weed control including soil solarization and burning. Because soils are a complex system, any change in physical or biological properties caused by measures to control them may result in changes to soils.

Cutting of invasive plant species is the least damaging option to soil, but can still have impacts. Personnel doing the work can compact the soil decreasing organic matter thickness and altering thermal regime, microbial populations, frost penetration, and water penetration. Cutting invasive plants can also increase light reaching the soil surface and thermal regime. Cut plant materials left on the soil surface can change soil thermal and moisture properties, effect carbon to nitrogen levels, and change microbial and other populations.

Mechanical methods also disturb soils. The trampling caused by weed control personnel trying to find and remove weeds is probably greater than when cutting methods are used. In addition, holes are left where roots are removed which greatly modifies soil thermal and moisture properties and have cascading effects on frost penetration and biological communities. Mechanical weeding methods may also move weed seed to the soil surface where they may germinate.

Thermal methods include solarization and flaming. Solarization (using plastics to increase soil temperatures) has been effective in reducing weed seed populations in high-light locations such as Israel and Mississippi, but has been less effective at northern latitudes due to lower light intensities. Clear and infrared-transmitting plastics produce higher soil temperatures than black plastic. Black plastic or other mulches could be used to control weeds by eliminating light. Solarization would effect the soil by increasing soil temperatures, effecting permafrost (when present), microbial populations and nutrient cycling. Because the plastics are impenetrable to rain, soil moisture would decrease over time, further effecting microbial populations, nutrient cycling, mycorrhizae, and roots of non-target species.

Flaming is used to kill aboveground portions of weeds. Soil organic matter could be ignited during this process which would affect soil thermal and moisture characteristics. Prescribed burns may convert dead plant accumulations to ash and charcoal, which can have beneficial effects on soil productivity for one to several growing seasons.

The effectiveness of non-chemical weed control and its effects on soil depends on a number of factors including: 1) The biology of the invasive plant, if the species is annual or perennial, and whether it would resprout after cutting and pulling; 2) the size of the infestation; 3) the density of plants in the infestation; 4) the type of weed control method used and its effectiveness; 6) the number of people used; 5) whether a seedbank or propagule bank exists; 6) the susceptibility of the soil to compaction and disturbance.

Non-chemical control methods are most effective and cause less damage to soil when the invasive species are annuals in a small area that can be easily pulled and do not resprout. If such an infestation is found and weeded before seed are produced, a small number of people can eradicate the infestation and can cause very little damage to soil from compaction from workers feet or holes made by pulling. If the infestation has already produced a seed or propagule bank, control teams will need to perform weedings over many years which will greatly increase soil compaction and other damage. Physical control methods could result in impacts to over 1,000 acres of soil by 2018 (see Table 2.1). Non-chemical means of control for very dense infestations may result in so much compaction due to the number of people required and soil disturbance from pulling that the damage resulting from trying to control the invasive plant could be greater than the damage done by these plants to the soil and other portions of the ecosystem.

There are a few high-density infestations or infestations of species that are resistant to control by non-chemical means where attempted mechanical weed control would be ineffective and cause major impacts to soils through trampling (compaction) and profile disruption. Five of these infestations are in GLBA. An infestation of perennial sowthistle on Strawberry Island is 2.4 acres in size, two infestations of oxe-eye daisy at Dry Bay are 0.9 and 0.4 acres in size, and two infestation areas of reed canarygrass near Bartlett Cove cover 2.1 acres. Japanese knotweed in SITK affects 0.1 acre near Indian River. Under Alternative 1 these infestations would not be completely controlled and impacts to soil by these species (severity unknown) would continue. Attempted control using mechanical methods would result in major impacts to soils due to trampling and profile disturbance. This activity is not likely, however, especially for sow thistle. Some invasive plant species would not be effectively removed by manual methods. They may irrevocably change soils through the addition of nitrogen or allelo-chemicals, changes in microbial and mycorrhizal populations, and changes to nutrient cycling and fire frequency. These areas could be adversely affected for long periods of time.

4.6.1.2 Cumulative Effects:

Surveys performed by NPS personnel show that 1,567 acres of park land have been infested with medium to high risk invasive weeds. These weeds may be causing impacts (severity not known) to soil on all of this area by altering light, thermal regime, nutrients, and biological interactions. Non-chemical weed control methods have been used to control invasive weeds on 44 acres, 2 % of the acres affected by invasive weeds. These weed control efforts have caused minor impacts to soils through compaction and profile disturbance caused by pulling.

Other effects to soils form other human activities in the parks from mining, road construction and use, airstrip construction and use and the construction of railroads and maintenance of their beds, have had major impacts to soils in those locations.

Several thousand acres of soil have been adversely affected or destroyed throughout the Alaska region NPS units from past and ongoing mining, construction of roads, airstrips, ORV trails, public and administrative buildings, campsites, day-use areas, and other infrastructure and uses. Rough calculations indicate about 4,000 acres of surface area have been severely altered by mining, about 1,000 acres from roads, 340 acres from ORV trails, 60 acres from landing strips, and another few hundred acres from buildings, campgrounds, trails, and other infrastructures. All totaled about 6,000 acres of pristine soil acreage has been lost to human activities throughout Alaska National Parklands. Compared to the millions of acres of pristine lands and soils unaltered by human activities this is a small percentage; however, the effects are long-term, severe, and generally located in high productivity areas, and therefore moderate. Adverse impacts to up to 2,000 acres from invasive plants and EPMT physical control actions, including access to invaded sites, would be minor to soils because effects would be localized and relatively short-term. The additive effects of alternative 1 to other past, ongoing, and future impacts to soils would still result in no more than moderate overall impacts to soils.

4.6.1.3 Conclusion:

The no action alternative would result in small, localized adverse effects on NPS unit soils where EPMTs compact soil surfaces or dig up plant infestations, but these treatment areas could result in over 1,000 acres of soil disturbance by the year 2018. At large, high-density sites with difficult to control invasive plants, such as the 5.8 acres in GLBA, attempted physical control could result in long-term impacts to soil due to compaction and disturbance to organic layers and the soil profiles. The overall impacts to park soils and function would be minor over the next decade. This alternative would not result in impairment of soil resources in Alaska NPS areas.

<u>4.6.2 Impacts from Alternative 2 – NPS Proposed IPMP</u>

4.6.2.1 Direct and Indirect Impacts of Alternative 2:

Alternative 2 involves use of a decision tree to determine the most effective weed control method to eradicate or control invasive plant species while minimizing environmental impacts. It is expected that non-chemical means would be employed on small infestations of annual species where this method can be effective. For larger infestations or for invasive plants where mechanical control is ineffective, herbicides that are relatively environmentally benign may be used. The effects on soils from mechanical and thermal control methods that may be employed in this alternative are discussed above under alternative 1; however, large or difficult to control infestations would not receive physical control treatments under this alternative. The analysis below focuses on impacts to soils from herbicide uses.

An advantage to soils of herbicides for weed control is drastic reduction in soil trampling, damage to the organic layer, compaction and associated thermal and moisture effects of mechanical and thermal methods. Similar to mechanical methods, use of herbicides would result in increased light penetration to the soil surface as invasive species are killed. The dead weeds on the soil surface would reduce light penetration, perhaps insulate the soil, and result in higher soil C:N ratios as the organic matter was mineralized.

Herbicides may reach the soil directly during spray operations, can be translocated downward into roots (only herbicides that are translocated) or may reach the soil surface when leached from plant parts or when killed plant parts fall to the soil surface. Once an herbicide contacts the soil, its fate and effects depend on herbicide chemistry, soil properties, and environmental conditions. Thus it is difficult to generalize regarding the effects of herbicides on soils. The effects would be different for each herbicide and each soil/environment.

Appendix G. describes the fate and effects of herbicides that could be used in Alternative 2. Solubility in water has an effect on how much of the soil the herbicide comes into contact with and how likely it would leach. More than one aspect of an herbicide's chemistry and interaction with soils is needed to understand the herbicide effects to the soils. Various models have been developed to evaluate herbicide chemistry simultaneously with site specific soil and environmental data to determine the amount of leaching that should occur. Appendix C shows one such model, the Relative Aquifer Vulnerability Evaluation (RAVE). For example, glyphosate is highly soluble in water, but when it reaches the soil it is tightly bound to soil particles and is not available to microorganisms and will not leach. Other herbicides, such as 2,4-D, do not have high affinity for soil clay or organic matter and are highly leachable. However, 2,4-D is readily biodegraded by soil bacteria and does not persist long in soil, thus lowering its leaching potential.

Environmental conditions also affect herbicide fate and effects on soil. Cold soil temperatures can slow volatilization and microbial decomposition of herbicides. Leaching may be increased with higher rainfall.

Many herbicides are degraded by microorganisms. Temporary increases in the populations of specific micro-organisms that degrade the particular herbicide can be expected. These microorganisms could compete with limiting nutrients with other soil organisms.

Four infestations in GLBA have been identified for potential herbicide treatment: perennial sowthistle on Strawberry Island, oxeye daisy in Dry Bay, and two infestations of reed canarygrass near Bartlett Cove. A new persistent infestation of Japanese knotweed in SITK is also proposed for herbicide treatment. Manual removal is not practical due to the large size of the infestations and vegetative reproduction. Continued spread of these species could be very detrimental to the soil chemistry and surrounding ecosystems.

Glacial till soils are present at the perennial sowthistle infestation on Strawberry Island with abundant pebbles and thin organic layers. This area has a mean annual rainfall of 70 inches and an annual mean temperature of 41.5 degrees F. Aminopyralid (Milestone VM) has been proposed as the herbicide for control. This herbicide has extremely low toxicity to birds, mammals, aquatic invertebrates, bees, and fish and is very effective at controlling perennial sowthistle. It is applied at low rates (3 fl oz/acre) and is weakly adsorbed by soil. EPA gives a 104 day half life for aminopyralid in soil. The projected effect of this herbicide treatment on soils at Strawberry Island is: a temporary increase in microorganisms that degrade aminopyralid; temporary changes in soil thermal regime as perennial sowthistle and other susceptible plants are killed; an increase in soil C:N ratio as dead vegetation reaches the soil surface. The likelihood that some aminopyralid would leach to groundwater is high because of the high rainfall, low soil sorption, relatively great persistence and shallow groundwater. However, low application rates and extremely low toxicity of this herbicide mitigate any adverse consequences to organisms besides susceptible plants.

Aminopyralid at an application rate of 4 fl oz/acre is also proposed for control of two large infestations of oxeye daisy at Dry Bay. Soils there appear to be sandy with abundant pebbles and cobbles. Rainfall is very high (160 in at Yakatat). The effects of aminopyralid to soils at this site would be similar to those at Strawberry Island. The likelihood for leaching would be greater due to sandy soils and lack of organic matter which decrease adsorption, higher rainfall, and a cooler climate (average temperature 39.5 degrees F at Yakatat). Again, the effect of leaching on non-target organisms should be minimal due to low application rates and extremely low toxicity.

Application of Roundup Pro (glyphosate) to 2.1 acres of with reed canarygrass near Bartlett Cove in GLBA would be bound tightly by soil particles and not readily leached into underground or adjacent waters. Roundup is generally not active in soil and not available to plants from soil particles, but soil microorganisms break it down where it has a half-life of 3 to 130 days. The half life of the associated surfactants is less than one week. Because no known effect on soil microorganisms is known from glyphosate and its associated surfactants, the impacts to soil properties and productivity would be minimal.

Imazapyr (Habitat) to be used on 0.1 acre of Japanese knotweed in SITK can persist in soil from 6 months to 2 years, but exposure to sunlight and soil microorganisms contribute to breakdown rates. Imazapyr is soluble in water, but it has a low potential to leach into ground water. It has little effect on soil microorganisms and is nontoxic to conifers, so it is thought imazapyr does not affect soil productivity.

Overall under Alternative 2 approximately 6 acres would be treated by herbicides the first year and it is estimated that a few additional acres would be treated with herbicides in each subsequent year. The number of acres treated and associated impacts to soils by manual methods under Alternative 2 would be much less than under Alternative 1 over the next 10 years. Soil compaction, alteration in soil moisture and thermal regimes would result from trampling. There would be minor, short-lived changes in soil microorganisms caused by herbicides. The effects of trampling on the 6-acres of herbicide-treated soil would be much less than if manual weed control methods were used, and these weeds would be effectively controlled, eliminating the effects of non-native plants on these soils.

4.6.2.2 Cumulative Effects:

Several thousand acres of soil have been adversely affected or destroyed throughout the Alaska region NPS units from past and ongoing mining, construction of roads, airstrips, ORV trails, public and administrative buildings, campsites, day-use areas, and other infrastructure and uses. Rough calculations indicate about 4,000 acres of surface area have been severely altered by mining, about 1,000 acres from roads, 340 acres from ORV trails, 60 acres from landing strips, and another few hundred acres from buildings, campgrounds, trails, and other infrastructures. All totaled about 6,000 acres of pristine soil acreage has been lost to human activities throughout Alaska National Parklands. Compared to the millions of acres of pristine lands and soils unaltered by human activities this is a small percentage; however, the effects are long-term, severe, and generally located in high productivity areas, and therefore moderate. Adverse impacts to up to 1,000 acres of invasive plant infestations and about 600 acres of EPMT physical and chemical control actions up until 2018, including access to invaded sites, would be minor to soils because effects would be localized and relatively short-term. The additive effects of alternative 2 to other past, ongoing, and future impacts to soils would still result in no more than moderate overall impacts to soils.

4.6.2.3 Conclusion:

The effects on soil from physical control methods can be considerable due to trampling and thermal changes and depend on the area and intensity of disturbance and soil susceptibility. These effects would be reduced in area and intensity under alternative 2, totaling about 600 acres until year 2018. The effects of herbicides on soils would be minor and short-lived due to the small number of acres involved with the proposed herbicides. The overall impacts to park soils and function would be minor over the next decade. This alternative would not result in the impairment of soil resources in Alaska NPS areas.

4.7 Effects to Subsistence

For a summary evaluation and findings to subsistence resources and uses in the Alaska Region National Park System from the alternatives considered for invasive plant management, see the ANILCA Section 810(a) review in appendix A. The analyses of impacts to subsistence resources and uses draws heavily upon the analyses of effects to aquatic resources (4.3), human health and safety (4.5), vegetation (4.8), and wildlife (4.11). The analyses of effects focus on park areas where subsistence activities are authorized and where invasive plant management activities are expected to take place. It must be kept in mind, however, that invasive plant control methods in one location could have an indirect effect to subsistence uses and resources in an adjacent or distant location. For example, a migratory fish or animal resource could be adversely affected (population reduction) from habitat loss due to invasive plant infestations or similar resources could be adversely impacted from chemical contamination.

4.7.1 Impacts from Alternative 1 – No Action

4.7.1.1 Direct and Indirect Impacts of Alternative 1 on Subsistence

The analysis below shows the effects of alternative 1 on subsistence resources and uses would probably be minor so long as manual removal of invasive plants is adequate to avert major infestations of invasive plants. Fortunately, many of the most troubling invasive plant infestations occur in park units not allowing subsistence uses.

As described in section 4.3.1.1, NPS crews have so far successfully contained aquatic and riparian species that could eventually overwhelm manual control methods, except for the 2.5-acre perennial sow thistle infestation on the estuarine shores of Strawberry Island in GLBA, the 1-acre oxeye daisy infestation near the Dry Bay fish plant and airport adjacent to a slough of the Alsek River, and small patches of reed canarygrass near Bartlett Cove in GLBA and Japanese knotweed near Indian River in SITK. Subsistence is allowed in the Glacier Bay National Preserve in the Dry Bay area, but Strawberry Island and other locations within Glacier Bay National Park of SITK are not open to subsistence uses, so the impacts of invasive plants and manual control methods there would have no adverse impacts on subsistence. White sweet clover (*Melilotus alba*) has formed major infestations and monocultures along river bars of the Stikine, Nenana, and Matanuska Rivers of Alaska, but to date NPS crews have manually removed small infestations along portions of the Nenana River in DENA and Copper River in WRST. Subsistence uses do not occur in the entrance area and Parks Highway corridor of DENA, so control of white sweet clover has no direct effect on subsistence here. Subsistence uses do occur along the Copper River, and eventually white sweet clover could become widely established there and adversely affect habitat for moose, fish, and various bird species, leading to an indirect adverse effect on subsistence resources. White sweet clover contains coumarin, a substance toxic to animals (AKEPIC 2005). Also, sweet clover has been used for bee farming, and native pollinators could be distracted from native plant species, thereby reducing berry crops and reproduction of native species important for wildlife habitat. White sweet clover has been observed in fire-disturbed areas in Interior Alaska, possibly introduced from fire response crews (Jeff Heys, pers. comm.). Thus this species could become widespread in YUCH, GAAR, DENA, and WRST and exceed the NPS EPMT crew capacities to control manually.

Other aquatic and riparian invasive plants species in Alaska park system units such as yellow toad flax, reed canarygrass, Japanese Knotweed, sheep sorrel, and smooth brome grass occur primarily in park units where subsistence uses are not permitted, except smooth brome grass which is near Coal Creek in YUCH and in WRST along the McCarthy Road, but not in a riparian zone.

There would be no adverse impact to subsistence user health and safety from alternative 1, unless infestations become large enough to reduce primary subsistence food resources and then indirectly the health and well-being of subsistence populations. This outcome is not anticipated at this time because infestations are relatively small in area, scattered, and many do not occur in areas subject to subsistence uses.

As discussed in sections 4.6.1.1 and 4.8.1.1, the direct and indirect effects of physical control methods for invasive plants would result in short-term, small areal impacts to soil surfaces and non-native vegetation. These activities would have virtually no adverse effect on subsistence resources and uses, especially since most control efforts would occur in early summer and subsistence hunting or gathering periods are mostly in late summer and early fall.

Table 3.1 displays the various invasive plants found in and near Alaska NPS units and appendix F summarizes the known effects of these plants on wildlife and its habitat. Fourteen known invasive plant species occur in NPS units where subsistence is allowed. The common dandelion occurs in six such park units, but its threat level is considered relatively low. Black bears have been observed foraging this species in GLBA, and it is commonly eaten by moose, grouse, and gophers, and birds eat the seeds. Narrowleaf hawksbeard occurs in three park units allowing subsistence, and its environmental and wildlife threats effect are similarly low. Oxeye daisy occurs in two parks, but the most extensive infestations are in Dry Bay. The entire plant has a disagreeable odor, grazing animals avoid it, and it contains chemicals toxic to most insect herbivores. This species produces 1,300 to 4,000 fruits annually that can persist for years before germinating and can reproduce vegetatively (AKEPIC 2005). White sweetclover can dominate large tracts of open areas, especially river bars and recent burns, which may alter habitat for wildlife and attract pollinators away from native plants. It occurs in DENA and near other parks with subsistence (GAAR, WRST, and YUCH). Presently oxeye daisy, common dandelion, hawksbeard, and white sweetclover pose a low threat to subsistence resources and uses, however, if unchecked, oxeye daisy could displace native vegetation and wildlife habitat, thereby reducing the overall populations of subsistence food sources. As noted above, the physical control methods in alternative 1 would have at most minor effects on subsistence wildlife resources and uses.

4.7.1.2 Cumulative Effects:

Subsistence resources (vegetation, berries, wildlife habitat, and wildlife distributions) have been adversely affected by over 275 miles of road, over 470 miles of ORV trails, past and ongoing mining, 6 commercial lodges and associated activities, several airstrips and helipads, NPS administrative activities and developments, and competing recreational activities such as general hunting. Many of the access facilities are used by subsistence and recreational users of NPS areas.

The McCarthy and Nabesna Roads and attached ORV trails in WRST are used extensively by local rural residents for access to subsistence resources. The Denali Park

Road is used for access to the Kantishna area by local rural residents to gather berries and to hunt moose and other wildlife in the fall, but this road is used primarily by recreational visitors during the busy summer season.

The GAAR ATV Subsistence Use Legislative EIS authorized a land exchange between the NPS and Anaktuvuk Pass to allow ATV access to hunting grounds while unaffected lands would be provided to the NPS, including an equal exchange of lands for wilderness designation. This agreement affected over 300,000 acres of land near Anaktuvuk Pass and removed about 30 miles of ATV trails from NPS management. The Dry Bay ORV EA (NPS 2007a) has resulted in a decision to close about 20 of 80 miles of ORV trails, including reclamation of widened areas along ORV trails to remain in use. The Cantwell Subsistence ORV EA (NPS 2007b) has resulted in a decision to allow continued uses of ORVs for subsistence hunting and gathering in the traditional use area on the south side of the Alaska Range, but trails are to be closed or hardened where they traverse wetlands or other sensitive areas. Short segments of ORV trails or primitive roads are used for access to subsistence resources in YUCH at Coal and Woodchopper creeks.

Commercial lodges occur in or near subsistence use areas of Alaska NPS units at GLBA in Dry Bay (3), DENA Kantishna area (3), Alagnak WSR (7), KATM Preserve at Nonvianuk Lake (2), WRST along Nabesna and McCarthy roads and Chisana and other remote locations (12), LACL Port Alsworth area, GAAR at Walker and Takahula lakes. Guided hunts from these facilities could compete with local rural residents for subsistence resources in these ANILCA conservation system units.

In preserves where general hunting, guided hunts, and outfitter-guided trips occur, competition for subsistence resources may occur. This is a sensitive issue in the Western Arctic National Parklands, however, invasive plants are not yet documented in these park areas.

The impacts to subsistence resources from various past and ongoing uses and developments has been widespread, extensive, displaces vegetation and wildlife habitat, and fractures wildlife distributions, and may result in reduction of and competition for resources with subsistence users. Because ANILCA Title VIII recognizes a preference for subsistence uses of these resources, the larger impacts should be reduced by closures to general uses. These impacts to subsistence resources and uses could be construed as moderate overall. The impacts of the no action (status quo) alternative involving physical control methods of invasive plants would contribute a minor additional impact to subsistence resources and uses, resulting in no more than the overall moderate cumulative effect on subsistence resources and uses.

4.7.1.3 Conclusion:

The continuation of the no-action (status quo) alternative to control invasive plants in Alaska NPS units with physical control methods would result in minor impacts to subsistence resources and uses. Should these methods fail to contain infestations resulting in greater habitat losses of important subsistence resources, then the area of impact could increase. The no-action alternative would not result in the impairment of subsistence resources and uses identified in the enabling legislation for the affected conservation system units.

4.7.2 Impacts from Alternative 2 – NPS Proposed IPMP

4.7.2.1 Direct and Indirect Impacts of Alternative 2 on Subsistence

The effects of physical control methods of invasive plants on subsistence resources and uses would be similar to those described in Alternative 1. Where feasible, those control methods would be the preferred methods. Only where the decision tree shows these methods are not effective, herbicides would be considered to control the invasive plant infestation. This alternative would result in less human disturbance to subsistence resources and use areas from repeated large manual control teams. The primary difference of effects on subsistence resources and uses is the difference between the impacts of allowing infestations to increase from ineffective manual control methods to rapidly treating these infestations with minimum-volume spot treatments with herbicides.

As noted in sections 4.5 and 4.11, none of the proposed herbicides pose a serious risk to humans or wildlife inadvertently exposed to these chemicals. For risks to human and ecological health see: http://www.fs.fed.us/foresthealth/pesticide/risk.shtml and the summary table 4.5.2. None of the proposed herbicides pose more than and negligible cancer or non-cancer risk to humans from accidental intake. Herbicide applicators are trained in safe application procedures of herbicides, including proper use of personal protective equipment (PPE). Treated areas would be posted and the public would be notified in local offices and newsletters to avoid treated areas for a safe period of time. Timing and locations of applications would be selected to maximize effectiveness to remove invasive plants while avoiding public and subsistence use periods. In general, herbicide applications are most effective in early summer when invasive plants are rapidly growing. Most subsistence activities in parks take place in late summer (berry-picking) and fall (hunting), but fishing, egging, and vegetable gathering occur during mid summer. Because herbicide applications would be spot-sprayed on target invasive plant species and the native species would be avoided, and all of the sprayed species would be degraded or dead, it is unlikely subsistence gatherers would pick and eat treated plants. Also, because the current proposed treatment areas are relatively small and limited (1 acre in Dry Bay GLBA and 2.5 acres on Strawberry Island in GLBA where subsistence does not occur) and future potential treatment areas would likely be as small or smaller, the extent and period of potential exposure of subsistence resources and subsistence users to herbicides is small in area and limited in duration.

As noted in section 4.3.2.1 several of the proposed potential herbicides could have acute toxic effects on aquatic organisms; however, the NPS would not likely apply these chemicals in or near aquatic systems pursuant to recommended uses and the decision tree for invasive plant control. Often the herbicide chemical is less toxic than the esters or surfactants combined with the herbicide. Mixtures with 2,4-D, glyphosate (Roundup), chlorsulfon, and triclopyr (Garlon) are known to be toxic to aquatic taxa. Mixtures with imazapyr, metsulfuron methyl, and aminopyralid are relatively non-toxic to fish and slightly toxic to aquatic algae and macrophytes. Data on toxic effects of Clopyralid on aquatic taxa is limited, but suggests low acute toxicity to fish, but no adverse effects are expected from normal application rates. Again, because of the limited extent and duration of potential herbicide applications in or near aquatic resources in NPS units in Alaska, likely adverse effects to subsistence resources and users are very low.

As a specific example, the risk assessment for aminopyralid (Milestone, a relatively new and low toxicity herbicide) from the web page noted above provides a worst case scenario supporting the low likelihood of an adverse impact to the general public or subsistence users:

> Take a combined scenario where an individual is sprayed on the lower legs, stays in contact with contaminated vegetation, eats contaminated fruit, drinks contaminated ambient water, and consumes contaminated fish at rates characteristic of subsistence populations. In such a case, the combined hazard quotient would be 0.0935 (0.006 + 0.0005 + 0.02 + 0.007 + 0.06), below the level of concern by a factor of about 10.6. Similarly, for all of the chronic exposure scenarios, the addition of all possible pathways at the maximum application rate leads to a combined hazard quotient of about 0.0884 which is below the level of concern by a factor of about 11.

The same risk assessment reported effects to sensitive subgroups exposed to dosages higher than recommended field application rates. Impacts to eye movements in mice and muscular coordination in rabbits resulted in gavage (force-feeding) experiments. These results were not always reproducible, and the impacts could have been caused by something other than the chemical. Furthermore, wildlife and humans are not likely to be exposed to aminopyralid in the same manner and at the higher doses administered to these test animals.

Considerably more risk assessment data is available for 2,4-D, which is at the more toxic end of the scale for proposed herbicides in alternative 2. The U.S. Forest Service risk assessment web page reports the following for sensitive public members, including subsistence populations (see also section 4.5.2):

> "Estimates of exposure via consumption of contaminated fish following an accidental spill (into water) result in hazard quotients of concern (i.e., greater than 1) for both subsistence and typical fish consumption scenarios. For subsistence populations (i.e., those who may eat wild caught fish as a necessity rather than a sport), upper bound hazard quotients for fish consumption range from a low value of 4 for the lowest anticipated application rate to a high of 32 for the greatest anticipated application rate. Comparable hazard quotients for consumption by the general population range from 0.8 at the lowest application rate to 7 at the highest application rate.
>
> On the basis of hazard quotients presented in worksheets, the only longer term exposures which could plausibly result in adverse health effects are those associated with consumption of fruit and vegetation. The upper bound hazard quotients for ingestion of contaminated vegetation are higher than those for ingestion of fruits, with values of 38, 19, and 152, for application rates of 1, 0.5, and 4 lb a.e./acre, respectively. These results suggest that adverse health effects are plausible should such exposures occur. These

> adverse effects could target the developing fetus as well as the blood, kidney, liver, thyroid, eyes, reproductive system, immune system, and nervous systems of adults."

In general, because proposed and potential herbicide applications would be relatively small (2.5 acres or smaller), widely separated in space and time, and located and timed to avoid general public and subsistence resources and use areas, the potential adverse impacts to subsistence uses and users would be minor. On the other hand the protection of native, wild subsistence resources and habitat over the long run would be a major beneficial effect.

4.7.2.2 Cumulative Effects:

Cumulative effects to subsistence resources and uses under alternative 2 would be similar to those described in alternative 1 section 4.7.1.2. These impacts to subsistence resources and uses could be construed as moderate overall. The impacts of alternative 2 involving physical and chemical (herbicide) control methods of invasive plants would contribute minor short-term adverse additional effects on subsistence resources and uses, resulting still in a moderate cumulative effect on subsistence resources and uses.

4.7.2.3 Conclusion:

Alternative 2 (IPMP with herbicide option) uses a decision tree to decide the best method to control invasive plant infestations in Alaska NPS units, including physical and chemical (herbicide) control methods where appropriate, would result in minor impacts to subsistence resources and uses. Long term beneficial effects could accrue from the prevention of rapidly spreading invasive plants and the resultant loss of subsistence resources and use areas. The preferred action alternative would not result in the impairment of subsistence resources and uses identified in the enabling legislation for the affected conservation system units.

4.8 Effects to Terrestrial Vegetation

4.8.1 Impacts from Alternative 1 – No Action

4.8.1.1 Direct and Indirect Impacts of Alternative 1:

This analysis consists of two sections that consider separately the impacts of manual and mechanical control methods and the impacts of uncontrolled invasive plant populations on terrestrial vegetation.

Impacts of Manual and Mechanical Control Efforts

Personnel conducting invasive plant management would cause short-term, direct impacts to vegetation from foot and ORV traffic en route to invasive plant populations and during control efforts, particularly with work crews. Individual plants would be trampled resulting in no effect, reduced vigor, or death depending on the stature and structure of the plant and the amount and duration of pressure applied. Infrequent impacts to individual plants generally do not affect plant populations, plant communities, or ecological processes. The impacts of intrusion into parks on vegetation resources would therefore be directly adverse, site-specific, short-term, and minor.

Cutting is effective for some species but not others and for native plants in the same area can result in no effect, reduced vigor, or death depending on the stature and structure of the plant and the selectivity, height, and frequency of the cutting. Infrequent impacts to individual plants generally do not affect plant populations, plant communities, or ecological processes. The impacts of intrusion into parks on vegetation resources would therefore be directly adverse, site-specific, short-term, and minor.

Digging and pulling are ground disturbing activities that may cause minor mechanical disturbance to individual native plants. A small percentage of human-disturbed ground in Alaska parks have been treated and would be treated under this alternative using these methods. However, infrequent impacts to individual plants generally have negligible to minor impacts to plant populations, plant communities, or ecological processes.

Interagency Fire Plans have been approved for BELA, CAKR, DENA, GAAR, KOVA, LACL, NOAT, YUCH, and WRST that would permit the use of prescribed fire or spot-burning. For other parks, a Prescribed Fire Plan would have to be prepared prior to the use of these methods. Parks with approved plans would benefit from the direct effects of removing stagnant, dead plant accumulations while converting that mass to ash and charcoal. Fires tend to increase species diversity and reduce woody species relative to grass and forbs species. The impacts of prescribed fire on vegetation resources would therefore be directly beneficial, site-specific, short-term, and moderate.

The effect of fire on plants is species-specific. Fire may either increase or reduce germination and vigor of plants. Prescribed fire may have adverse impacts on some individual plants, but would affect a relatively small portion of the overall population. Overall, prescribed fire would have infrequent adverse, short-term, minor impacts on individual plants. Infrequent impacts to individual plants generally do not impact plant populations, plant communities, or ecological processes. Prescribed fire could encourage the establishment of exotic plants following fires. However, follow-up treatments would be used to control exotic plants after fires, as needed. The impacts of fire on vegetation resources are therefore directly beneficial and adverse, site-specific, short-term to long-term, and minor.

Impacts of Uncontrolled Infestations

Manual and mechanical methods are not effective for control of particular invasive plant species under certain circumstances (Art 1996, Radosevich et al. 1997, Sheley et al. 1999, Monaco et al. 2002, Czarapata 2005). Pulling and cutting can stimulate resprouting among certain invasive plant species, which are generally those that reproduce vegetatively and have substantial root reserves. Results include infestations with increased density and size, are more difficult to control in the future, or require regular treatment for continued suppression. Manual and mechanical methods can also be unfeasible due to large population sizes and individual plant morphology. Soil disturbance resulting from pulling and digging plants can increase invasive plant seedbank germination rates.

Where physical control invasive plant infestations fail, individual parks would need to conduct additional compliance measures to obtain clearance to use herbicides where necessary for invasive plant control. This could result in delays in taking action, which could result in moderate impacts from expansion of existing infestations or establishment of new infestations. This alternative would therefore increase the amount of future effort required to rehabilitate native plant populations. For example, the populations of perennial sowthistle and oxeye daisy proposed for initial herbicide application under Alternative 2 are beyond the feasibility of manual or mechanical control. Under Alternative 1, these infestations would continue to grow in size and density, displacing native plants in their vicinity and increasing the probability of dispersal into new areas.

The highest-risk invasive plants in Alaska are likely to spread substantially if ineffectively controlled by physical methods under Alternative 1. The resulting impacts to terrestrial vegetation would be many and varied. At the most basic level, invasive plants displace native plant communities by forming dense monocultures and out-competing native plants for moisture, light, and nutrients. In addition, they can alter plant community composition and diversity. In certain cases, invasive plants cause genetic modification of closely related native plant species through hybridization. Uncontrolled infestations of invasive plant infestations could result in moderate adverse impacts to native vegetation.

Invasive plants can also impact terrestrial vegetation indirectly through changes to the biotic or abiotic environment. For example, pollinators can be attracted to invasive rather than native plants, reducing reproduction rates in the native species. Invasive plants can also carry diseases that can be transmitted to native species, reducing their vigor or survival. Some invasive plant species alter soil nutrient composition, particularly among nitrogen-fixing legumes, and moisture availability, thereby altering native plant community composition. Finally, invasive plants can affect disturbance regimes and the rate and composition of plant succession following disturbances. For more thorough accounts of the impacts of individual species on terrestrial vegetation, refer to *Invasive Plants of Alaska* (AKEPIC 2005).

4.8.1.2 Cumulative Effects:

The primary anthropogenic impacts to terrestrial plants in Alaska parks are the clearing of native vegetation for facilities and transportation corridors and the maintenance of pioneer plant communities where trees and shrubs would inhibit an area's administrative use. Additional impacts include irregular disturbance by visitors and park staff through trampling and camping-associated activities.

Approximately 275 miles of road exist in Alaska parks; an average disturbance width of 10 m would indicate overall vegetation impact of 1,094 acres. More than 470 miles of OHV trails traverse Alaska parks; an average disturbance width of 3 m would indicate overall vegetation impact of 561 acres. Nine FAA-recognized airstrips and 3 helicopter landing areas exist in or are surrounded by Alaska NPS units, and probably more than 100 landing areas are used on a regular basis. While there is no standard size for these areas, a rough estimate of 10 acres per area would indicate over 1,000 acres of vegetation impact. There are 6 commercial lodges and commercial joint ventures on Alaska National Park lands, which provide lodging, meals, and visitor services, that cover about 20 acres in 3 parks (DENA, KATM, and GLBA). There are approximately 1,550 acres of land in the Kantishna area of DENA that have been impacted by mining, of which 517 acres are currently being revegetated (DENA Reclamation of Mined Lands Program 2001). The NPS completed three environmental impacts statements (DENA, WRST, and YUCH) to address the cumulative effects of mining (NPS 1990 a, b, & c). Finally, park buildings, campgrounds, and other facilities have disturbed vegetation in most park units in the vicinity of existing infestations.

The impacts of physical control methods under Alternative 1 to terrestrial vegetation would be minor relative to the scale of other impacts of human actions.

The impacts of uncontrolled invasive plant infestations due to ineffectiveness, on the other hand, would be multiplicative according to the amount of cleared vegetation in the vicinity of the infestations. For example, if an infestation is bounded on one side by pavement and on all others by a wetland, the cumulative impacts of ineffective control would be no greater than the direct impact of the control method. If an infestation is surrounded by an area that has been cleared of native vegetation, ineffective control will result in greater impacts due to the ability of the infestation to expand. In general, cleared vegetation in Alaska parks would provide the opportunity for invasive plants to rapidly spread, such as along roads or trails or in cleared areas, while intact plant communities would limit their expansion.

4.8.1.3 Conclusion:

The overall success of invasive plant management under Alternative 1 would vary from park to park. Where physical control methods are successful in managing invasive plant infestations, the impacts on native vegetation resources would be minor and beneficial. Where physical control methods are not successful in managing invasive plant infestations, the impacts on native vegetation resources could be adverse and moderate in the next 10 years. This alternative would not result in impairment to vegetation resources in the short-term but could do so over the long-term.

4.8.2 Impacts from Alternative 2 – NPS Proposed IPMP

4.8.2.1 Direct and Indirect Impacts of Alternative 2 to Terrestrial Vegetation

Impacts of manual and mechanical control methods to terrestrial vegetation are discussed in 4.8.1.1. These impacts would be the same under Alternative 2 with the exception of areas where herbicides are used.

Where herbicides are used, non-target plants subjected to drift or interspersed with the target invasive plant could experience no effect, reduced vigor, or death depending on the sensitivity of the plant species to the specific herbicide and the dose to which the plant was subjected. Infrequent impacts to individual plants generally have negligible to minor impacts on plant populations, plant communities, or ecological processes. The impacts of pesticide use on vegetation resources would therefore be directly adverse, site-specific, short-term, and negligible to minor.

Personnel conducting invasive plant management would cause short-term, direct impacts to vegetation from foot and ORV traffic en route to invasive plant populations and during control efforts, as in Alternative 1. The number of personnel, their duration at treatment sites, and the extent of surface pressure, however, would be significantly less for herbicide application relative to manual and mechanical treatments. Infrequent impacts to individual plants generally do not affect plant populations, plant communities, or ecological processes. The impacts of intrusion into parks on vegetation resources would therefore be directly adverse, site-specific, short-term, and negligible to minor.

Active ingredients considered for use under Alternative 2 vary in their selectivity (the degree to which they target certain plant families and have little to no impact on others). Glyphosate is non-selective, most grasses are resistant to aminopyralid, chlorsulfuron, clopyralid, triclopyr, and 2,4-D, and most conifers are resistant to imazapyr and metsulfuron. Impacts to native broadleaf plants will vary by herbicide and species. The preferential use of herbicides that have the least impact on the native plant species within and adjacent to an invasive plant infestation would minimize damage to and promote the re-establishment of healthy native vegetation capable of resisting invasion.

For the two sites in GLBA where herbicides would initially be used, the target invasive plant species – perennial sowthistle and oxeye daisy – have achieved sufficient density to crowd out native plant species. Herbicide use could harm the native vegetation in the midst of the infestations, but implementation of the best management practices for herbicide use listed in the Alternative 2 description would minimize such impacts. The long-term result of herbicide use at these sites would be the recovery of the native plant communities within a few years.

4.8.2.2 Cumulative Effects:

See Cumulative Effects of Alternative 1 for a description of human impacts to terrestrial vegetation other than invasive plant control in Alaska parks. The impacts of herbicide use under Alternative 2 to terrestrial vegetation would be negligible due to the small size of applications being considered relative to the scale of other impacts of human actions.

4.8.2.3 Conclusion:

Alternative 2 would result in effective control of invasive plant infestations and benefit native plant vegetation and ecosystem integrity. The minor short-term adverse impacts would be outweighed by the long-term benefits to native vegetation. This alternative would not result in impairment to vegetation resources.

4.9 Effects to Wetlands and Floodplains

4.9.1 Impacts from Alternative 1 – No Action

4.9.1.1 Direct and Indirect Impacts of Alternative 1:

The analysis below shows impacts to floodplains and wetlands in Alaska NPS units would be minor because periodic manual removal of invasive plant species would keep these infestations in check and because most invasive plant infestations in Alaska NPS units primarily inhabit upland habitats.

Under the no-action alternative the NPS would continue to monitor and physically remove invasive plant infestations. Reed canary grass has been successfully removed from small wetlands near Bartlett Cove in GLBA. Yellow toadflax has been reduced along Exit Glacier Road where some small wetlands areas occur nearby. This approach has been effective for all detected infestations in floodplain and wetland areas except for perennial sow thistle on estuarine shores (E2EM1/USN) of Strawberry Island in Glacier Bay proper and oxeye daisy near the Dry Bay fish plant and airstrip located mostly on uplands but near a riverine slough (R1US/UB) of Alsek River. NPS crews attempted to remove perennial sow thistle on Strawberry Island, but only a small portion of the 2.5 acre infestation could be dug up, and this effort failed to remove all roots and seeds in the treated area. Eventually perennial sow thistle could overwhelm the adjacent small palustrine wetland and take over the estuarine beach areas on the south side of this island. The NPS has not yet attempted to remove the nearly acre-size infestation at the Dry Bay fish plant.

NPS crews have successfully removed white sweet clover from roadsides and river bars near Slana in WRST and in the front country area of DENA, which prevents its escape onto this portion of the Nenana River. Reed canary grass has been successfully removed from small wetlands near Bartlett Cove in GLBA. Yellow toadflax has been reduced along Exit Glacier Road where some small wetlands areas occur nearby. Japanese knotweed has been pulled from 2 locations not immediately adjacent to water for the last 5 years in SITK, where it continues to return.

The no-action alternative could result in the persistent infestation of perennial sow thistle in up to 2 acres of coastal estuarine and palustrine wetlands in GLBA, which in the grand scheme of things would result in a minor localized impact to wetland resources. Floodplain functions are not likely to be adversely affected in Alaska NPS units so long as EPMTs diligently locate and remove new infestations. If some of the invasive plants described above exceed thresholds for regular manual control methods, then the current no-action alternative would be ineffective in protecting floodplains and wetlands over a wider distribution.

4.9.1.2 Cumulative Impacts Analysis:

NPS estimates of past wetland impacts from mining in DENA, WRST and YUCH total over 3,000 acres (NPS 1990 a, b. c). For DENA alone estimates totaled about 1,300 acres (NPS 1990a). This is because placer mining for gold occurred in stream riparian habitat and adjacent wetland areas. The major impacts in YUCH occurred along Coal Creek and Woodchopper creek where dredging and mining impacted about 900 acres (NPS 1990c). In WRST, though more areas were mined, the estimates are lower because not all mining was placer mining in riparian wetlands areas. Much mining in WRST was hard rock in upland areas.

Over 275 miles of roads exist in Alaska NPS units (Heys, pers.com.), and an estimated 20% of this distance traverses wetlands. Roads and highways vary greatly in width, but with an estimated average width of 25 feet, the estimated past impacts to wetlands would have been about 160 acres.

A similar approach at estimating wetlands impacts from 275 miles of ORV trails (Meyer, pers. com.) averaging 8 feet in width results in past impacts of about 53 acres. A proposed action to close unneeded and repair widened segments of ORV trails in the Dry Bay area of GLBA could result in the recovery of about 16 acres of wetlands (NPS 2007). The net effect would be about 36 acres of past and projected cumulative impacts to wetlands from ORV trails.

Numerous airstrips and helicopter landing pads exist in Alaska NPS units (Ken Barnes pers. com.), and some of these occur on gravel floodplains or formerly riparian wetlands. Most airstrips have been located on well-drained dry land because landing wheel planes on soft wet ground is unsafe. Therefore no estimate of additional impacts to wetlands is provided for airstrips. The effects of airstrips on floodplains are negligible because flood events would simply run over or around the gravel airstrips.

The total past and projected impacts to wetlands from various developments of employee offices, residences, parking, gravel extraction, visitor service structures, and concession lodges totals a few acres (see NPS DENA DCP 1996, NPS DENA GAP 2003). Most of these developments avoid wetlands, but an estimated 15 acres of wetlands have been disturbed statewide. New construction sites must address NPS policies to restore at least one acre of wetland for every acre of wetlands impacted. Some temporary impacts to floodplains occur where gravel extraction occurs in the Toklat River of DENA, however, natural replenishment rapidly replaces removed gravel.

The grand total of past and projected future impacts to wetlands in Alaska NPS units, including riparian and floodplain areas, is estimated at about 3,250 acres.

The projected future persistent impacts to wetlands and floodplains from the no-action/status quo alternative to control invasive plants would add less than 2 more acres to this total.

The cumulative effects to wetlands from past, present, and future human activities would moderate overall. The incremental increase from the no-action alternative to manage invasive plants would result in a minor additional impact on wetlands and floodplain function in Alaska NPS units.

4.9.1.3 Conclusion

The impacts to wetlands and floodplains from the no-action/status quo alternative to control invasive plants would be minor. No impairment to regional park wetlands and floodplains would result from this alternative.

<u>4.9.2 Impacts from Alternative 2 – NPS Proposed IPMP</u>

4.9.2.1 Direct and Indirect Impacts of Alternative 2

The analysis below shows impacts to floodplains and wetlands in Alaska NPS units would be minor because periodic manual removal of invasive plant species and limited application of herbicides after careful review via a decision tree would keep these infestations in check where they occur in wetlands and floodplains. See section 3.8 for brief descriptions of the effects invasive plant species in Alaska NPS units could have on floodplains or wetlands.

Alternative 2 would include a decision tree for the possible use of herbicides where warranted would result in the removal and nearly complete control of invasive plant infestations. Manual removal has been effective for all detected infestations in floodplain and wetland areas except for perennial sow thistle on or near estuarine shores (E2EM1/USN) of Strawberry Island in Glacier Bay and oxeye daisy near the Dry Bay fish plant and airstrip located mostly on uplands but near a riverine slough (R1US/UB) of Alsek River. The proposed use of Milestone VM herbicide (aminopyralid) to remove these infestations would reduce human impacts that would otherwise occur from trampling and digging in these areas. Due to its low toxic nature, other than to plants, aminopyralid does not need to be evaluated for impacts to groundwater contamination. The adjacent small palustrine and estuarine beach wetlands on Strawberry Island would be returned to natural and healthy plant populations. Oxeye daisy would be removed from the airstrip entry way location at Dry Bay, thereby reducing the potential for plant seed transport and the migration of this species into adjacent area riverine shores.

NPS crews have successfully and would continue to remove white sweet clover from roadsides and river bars near Slana in WRST and in the front country area of DENA, which prevents its escape onto this portion of the Nenana River. Reed canary grass was successfully removed from small wetlands near Bartlett Cove in GLBA, but recently these infestations have grown to over 2 acres so that application of Roundup Pro is advised. Yellow toadflax has been reduced along Exit Glacier Road where some small wetlands areas occur nearby. Japanese knotweed has been pulled from 2 locations not immediately adjacent to water for the last 5 years in SITK, where it continues to return and the application of imazapyr (Habitat) is advised.

The NPS proposed action alternative would result in the removal of the persistent infestation of perennial sow thistle in about 4 acres of coastal estuarine and palustrine wetlands in GLBA, which in the grand scheme of things would result in a minor localized beneficial impact to wetland resources. Floodplain functions are not likely to be adversely affected in Alaska NPS units so long as EPMTs diligently locate and manually remove new infestations. If some of the other invasive plant infestations described in section 4.9.1 above exceed thresholds for regular manual control methods, then the proposed action alternative would allow for rapid effective control methods to remove or reduce invasive plant infestations that could harm floodplains and wetlands over a wider distribution. We estimate up to 10 acres of wetlands would be treated to control such infestations.

4.9.2.2 Cumulative Impacts Analysis:

The cumulative effects to floodplains and wetlands across all NPS units in Alaska from other activities such as mining, construction, roads, ORV trails, airstrips, and other human activities would be similar as described for alternative 1 in section 4.9.1.2. The grand total of past and projected future impacts to wetlands in Alaska NPS units, including riparian and floodplain areas, is about 3,250 acres. The projected future persistent impacts to wetlands and floodplains from alternative 2 to control invasive plants would return about 2 acres to natural vegetation and function in wetlands and floodplains in Alaska NPS units. The cumulative effects to wetlands from past, present, and future human activities would be moderate overall. The incremental increase from the proposed action alternative to manage invasive plants would result in a minor beneficial impact on wetlands and floodplain function in Alaska NPS units.

4.9.2.3 Conclusion:

The impacts to wetlands and floodplains from the NPS proposed action alternative to control invasive plants in about 4 acres of wetlands in GLBA and SITK in the short term and up to 10 acres of various wetlands and floodplains over the next 10 years would be minor and beneficial. No impairment to regional park wetlands and floodplains would result from this alternative.

4.10 Effects on Wilderness and Scenic Quality

<u>4.10.1 Impacts from Alternative 1 – No Action</u>

4.10.1.1 Direct and Indirect Impacts to Wilderness and Scenery from Alternative 1:

The effects of Alternative 1 on wilderness resources, (including undeveloped, untrammeled, naturalness, and opportunity for solitude or unconfined recreation) from the presence and spread of invasive plant species would be minor provided the manual or mechanical control efforts were mostly successful in controlling invasive plant species and preventing their spread into wilderness. However, it is not clear how successful these efforts would be with all species, and if an invasive species were to escape this control, then the effect on the naturalness quality of wilderness may be greater than a minor level. The effects from the monitoring and control efforts themselves, including the use of helicopters and the use of mechanical means of control such as brush whips, mowers and chainsaws, in wilderness would have a minor effect on the opportunity for solitude or unconfined recreation and on the untrammeled quality of the wilderness.

The presence of non-native species in wilderness areas as a result of human activities constitutes a change in the natural ecosystem and poses a potential threat to the naturalness of wilderness by changing the way in which native plants and animals develop and respond to their environment. It is also a direct sign of human influence in the wilderness. Control activities outside of the wilderness are critical to addressing this threat, but may not always be successful. Where necessary, control activities in wilderness may need to occur to stop the spread of an invasive plant species in order to restore and protect the naturalness of the wilderness resource. By effectively treating the infestations, the naturalness of wilderness would be protected. This does, however, result in an effect on the untrammeled quality of wilderness. Even though the original introduction of invasive plants to the wilderness is the result of human influences, it can be argued that this is part of the natural process and that wilderness should be left "untrammeled" to evolve under these new influences. The choice is whether to protect the naturalness of wilderness at the expense of the untrammeled or not. For small area control measures such as proposed in this action this is rarely a topic of concern and eradication of the non-native species is preferred to protect the overall wilderness resource and a wide variety of other values.

The value of wilderness includes the opportunity for solitude or unconfined recreation, and a wilderness experience is also partly dependent on the wilderness setting representing a natural and native ecosystem. Where non native species are present and/or are changing the plant and animal communities, this could negatively affect visitor interactions with wilderness because they are expecting an ecosystem that is largely uninfluenced by modern human activities. The use of helicopters for access to monitor visitor portals, including airstrips, cabins, camps and other locations for the presence of invasive plants or for control activities in the wilderness would have a temporary and site specific effect on the opportunity for solitude. The use of mechanical tools such as brush cutters, mowers and chainsaws would also have a temporary and localized effect on the opportunity for solitude. Where control efforts leave visible signs of human activity and where treatment is required at recurring intervals or over multiple years, these areas would not appear natural until the native vegetation restores itself to those areas. This would result in a short term impact but in a localized area of up to several acres.

The treatments that have occurred or are occurring at the present time in designated wilderness are in GLBA at Strawberry Island (perennial sowthistle) and in GAAR at Walker Lake (common dandelions). Other identified infestations in designated wilderness occur in Reid Inlet at GLBA (common dandelion and oxeye daisy) and at Twin Lakes in LACL (common dandelion).

There is the potential for invasive plant species to affect eligible or designated wilderness in the parks in the future. Current infestations along the park road and the Parks Highway in Denali National Park are located within a short distance (about 100 feet) of designated wilderness. The road to McCarthy and the road to Nabesna in Wrangell-St. Elias National Park and Preserve also have invasive species present on the road sides. Those species that spread by natural vectors such as wind, water and wildlife, are of particular concern in this situation. For example, common dandelions are easily spread by wind. White sweetclover can be spread by water, and European mountain-ash can be spread by birds.

The other most likely places in eligible or designated wilderness for invasive plants to appear are at access portals, OHV use areas, cabins or along lake and ocean beaches. Seeds may be transported on aircraft wheels and be deposited on airstrips, gravel bars or tundra landing areas. Where OHVs are used, tires or parts of the frames could be transport mechanisms for plant parts or seeds. When aircraft or water taxis are pulled up onto beaches there is also an opportunity for seeds or plant parts to be deposited. Education of park and commercial services personnel and park visitors would help to make them observers for the monitoring efforts in parks. Checking aircraft wheels and floats, boat lines and anchors, and boot treads so that foreign plant material is not carried into the wilderness and active observation and monitoring so that invasive plants can be detected at the earliest possible time when control efforts are most effective would reduce the threat of invasive plants in the wilderness. If infestations were to become established in remote locations in wilderness, control options outlined in Alternative 1 would not likely be sufficient to prevent moderate impacts to the natural and scenic values of wilderness over the long term (decades).

4.10.1.2 Cumulative Effects:

The cumulative effects from the use of helicopters for access to eligible and designated wilderness for research (conducted by NPS or conducted by permittees), the NPS Inventory and Monitoring program, mineral evaluations (under ANILCA 1010), fire monitoring, and other park management activities has a moderate effect on wilderness resources throughout the national park units in Alaska. The use of helicopters affects the opportunity for solitude and the untrammeled character of the wilderness. There were 1,267 rotor wing flight hours flown in FY05 by the Alaska region of the NPS (Ken

Barnes, pers. comm.); these hours do not include those hours flown by permittees. These hours are flown primarily during the field season months of June through September. This number is expected to stay about the same or increase slightly during the foreseeable future. The cost of fuel and rental costs for helicopters will likely continue to increase and may affect the ability of park units to be able to afford as many flight hours as they would like to have. The addition of the flight hours flown by helicopters in wilderness from implementing this alternative would have a minor effect. The total effect of this alternative and other ongoing and future effects from helicopter access would be a moderate effect on wilderness resources.

The use of mechanical tools, including chainsaws, brush cutters and mowers in wilderness is rare at the present time. There is some use of these tools in parks for trail maintenance or clearing, or for maintenance on airstrips or at public use cabins. Chainsaws may be permitted for use by subsistence users or by commercial services providers, but these uses are uncommon and are not expected to increase in the foreseeable future. Although there may be some localized minor effects, the overall regional effect of these uses on the opportunity for solitude and for untrammeled wilderness character at the present time is negligible. The additional effect from implementing this alternative is also negligible. The total cumulative effect is negligible at the regional scale.

The current acreage affected by restoration activities in wilderness is very small. There are a few limited campsites in Gates of the Arctic, Denali and Glacier Bay that are being monitored and/or treated for overuse from recreational activity. Under this alternative a small number of acres in wilderness would be treated for invasive plants, and then restored through natural revegetation and monitoring. The effect of restoration activities is negligible and will remain so if this alternative is implemented.

The cumulative effect of management use of helicopters, mechanical tools, and treatment areas to wilderness resources is moderate. The incremental increase from this alternative to manage invasive plants would result in a minor additional impact on wilderness and scenic resources and would not change the overall moderate cumulative effect.

4.10.1.3 Conclusion:

The impacts to wilderness from Alternative 1 would be minor and would overall be beneficial to wilderness and scenic resources. No impairment to wilderness or scenery would result from the implementation of alternative 1.

<u>4.10.2 Impacts from Alternative 2 – NPS Proposed IPMP</u>

4.10.2.1 Direct and Indirect Impacts to Wilderness and Scenery from Alternative 2:

Alternative 2 with a decision tree would help managers decide the most effective means of controlling an invasive plant in specific situations and would add herbicides as a possible means of treatment. The analysis below shows impacts to wilderness resources (including undeveloped, untrammeled, naturalness, and opportunity for solitude or unconfined recreation) in Alaska NPS units would be minor because the combination of manual, mechanical and herbicide treatment options would be likely to maintain the naturalness of wilderness. If an invasive species were to escape this control, then the effect on the naturalness quality of wilderness may be greater than a minor level, but that likelihood is reduced in this alternative as the decision tree would be a more effective management tool. The effects from the monitoring and control efforts themselves, including the access by helicopter and the use of mechanical means of control such as brush whips, mowers and chainsaws, in wilderness would have a minor effect on the opportunity for solitude or unconfined recreation and on the untrammeled quality of the wilderness because the control efforts would be localized and of short duration.

The effects of non-native species on the naturalness of wilderness and the scenic quality of park areas to visitors would be the same as in Alternative 1. The addition of herbicides to the toolkit for park managers does not change the discussion about untrammeled and natural wilderness and scenic quality of park areas from the analysis in Alternative 1. However, having herbicides as an option for treatment of invasive plants would likely make the initial treatments more effective and may limit the need for multiple follow-up treatments with mechanical tools. This could make the effects of the control efforts themselves less intrusive on the opportunity for solitude in this alternative.

The use of helicopters for access to monitor for the presence of invasive plants or for control activities and the use of mechanical tools such as brush cutters, mowers and chainsaws in the wilderness would have the same effect on the opportunity for solitude as in Alternative 1. Where control efforts leave visible signs of human activity and where treatment is required at recurring intervals or over multiple years, the short term impact in a localized area of up to several acres would also be the same.

The summary provided in Alternative 1 about where treatments have occurred in designated wilderness and how invasive plants have been or would be introduced to eligible or designated wilderness is also applicable in Alterative 2. If infestations were to become established in remote locations in wilderness, having the decision tree and the additional option of limited herbicide use in this alternative would have a greater likelihood of preventing the spread of the invasive plants to larger areas and more sites in wilderness. This alternative would therefore help limit the potential larger impacts to the natural and scenic values of wilderness and other park areas.

4.10.2.2 Cumulative Effects:

The cumulative effects from the use of helicopters for access to eligible and designated wilderness for research (conducted by NPS or conducted by permittees), the NPS Inventory and Monitoring program, mineral evaluations (under ANILCA 1010), fire monitoring, and other park management activities has a moderate effect on wilderness resources throughout the national park units in Alaska. The use of helicopters affects the opportunity for solitude and the untrammeled character of the wilderness. There were 1267 rotor-wing flight hours flown in FY05 by the Alaska region of the NPS (Ken

Barnes, pers. comm.); these hours do not include those hours flown by permittees. These hours are flown primarily during the field season months of June through September. This number is expected to stay about the same or increase slightly during the foreseeable future. The cost of fuel and rental costs for helicopters will likely continue to increase and may affect the ability of park units to be able to afford as many flight hours as they would like to have. The addition of the flight hours flown by helicopters in wilderness from implementing this alternative would have a minor effect. The total effect of this alternative and other ongoing and future effects from helicopter access would be a moderate effect on wilderness resources.

The use of mechanical tools, including chainsaws, brush cutters and mowers in wilderness is rare at the present time. There is some use of these tools in parks for trail maintenance or clearing, or for maintenance on airstrips or at public use cabins. Chainsaws may be permitted for use by subsistence users or by commercial services providers, but these uses are uncommon and are not expected to increase in the foreseeable future. Although there may be some localized minor effects, the overall regional effect of these uses on the opportunity for solitude and for untrammeled wilderness character at the present time is negligible. The additional effect from implementing this alternative is also negligible. The total cumulative effect is negligible at the regional scale.

The current acreage affected by restoration activities in wilderness is very small. There are a few limited campsites in Gates of the Arctic, Denali and Glacier Bay that are being monitored and/or treated for overuse from recreational activity. Under this alternative a small number of acres in wilderness would be treated for invasive plants, and then restored through natural revegetation and monitoring. The effect of restoration activities is negligible and will remain so if this alternative is implemented.

The cumulative effect of management use of helicopters, mechanical tools, and treatment areas to wilderness resources is moderate. The incremental increase from this alternative to manage invasive plants would result in a minor additional impact on wilderness resources and would not change the overall moderate cumulative effect.

4.10.2.3 Conclusion:

The impacts to wilderness from Alternative 2 would be minor and would overall be beneficial to the wilderness and scenic resources. No impairment to wilderness and park scenery would result from the implementation of this alternative.

4.11 Effects to Wildlife and Habitat

Without concerted efforts to control their colonization, establishment and spread, available scientific studies haves shown that invasive plants would outcompete native species in many areas, alter biotic communities and radically change the habitats and survival capabilities of wildlife species, particularly rare species. Some invasive plants may provide wildlife benefits but many are known to directly harm wildlife and to cause indirect effects to wildlife by lowering their competitive advantages and altering and degrading their habitat. The following summary is excerpted from the Forest Service Pacific Northwest Region EIS on Invasive Plant Management (FSR6, 2005), which we incorporate by reference here according to CEQ regulations at 40 CFR 1502.21.

Invasive plants are known or suspected of causing the following effects to wildlife:

- Embedded seeds in animal body parts (e.g. foxtails), or entrapment (e.g. common burdock) leading to injury or death.
- Scratches leading to infection.
- Alteration of habitat structure leading to premature predation (which alters population, demography, and social breeding system).
- Change to effective population through nutritional deficiencies or direct physical mortality.
- Ingestion of plants or plant parts leading to poisoning.
- Altered food web, perhaps due to altered nutrient cycling.
- Source-sink population demography, with more demographic sinks than sources.
- Lack of proper forage quantity or nutritional value at critical life periods.
- Cascading effect of direct or indirect mortality on other species.

The 23 invasive plant species currently found in recent surveys in and near Alaska Parks are listed in Table 3.1. The characteristics of these species that make them a threat to Alaska wildlife and habitats are summarized in Appendix F. A review of available studies indicates that there are none that detail the direct impacts of the 23 invasive plants in Alaska Parks at the wildlife population level. Some studies do show several of the plants to be toxic if ingested, particularly in livestock. There are no studies on the 23 Alaska invasive plant species that directly link habitat changes with quantified reductions in animal populations. Therefore, the analyses and conclusions below are based on the best available data on the plant characteristics that have shown to be generally related to wildlife habitat declines for other invasive plants.

Based on the invasive plant characteristics provided in Appendix F, the predominant adverse effect of the 23 invasive plants on wildlife and habitats in Alaska Parks is expected to be encroachment on and replacement of native habitats with monotypic invasive plant stands that do not have the structural characteristics needed for wildlife survival. For nesting birds and small mammals this would mean loss of quality nesting and escape cover. For herbivores and omnivores, most of the invasive plants would not provide palatable, nutritious foods that would otherwise be available in native habitats. Dandelions and red clover would provide food for some animal species but would degrade habitat for other species. For predators, their prey base would be directly reduced by these habitat changes. At the wildlife population level, the number and distribution of quality breeding territories and foraging home ranges would diminish as more and more native habitat is outcompeted by invasives for space.

Impacts would occur if some animals are directly affected by plant poisons, from invasive plants such as foxglove, yellow toadflax, and white sweetclover, or by viral diseases, such as are carried by smooth brome and white sweetclover. These effects are likely to be limited to a small number of individual animals at infested sites. The invasive plant management measures proposed under Alternatives 1 and 2 and evaluated in the following sections would reduce or eliminate these types of wildlife and habitat impacts at Alaska Parks.

4.11.1 Impacts from Alternative 1 – No Action

4.11.1.1 Direct and Indirect Impacts on Wildlife and Habitat

The direct effects on wildlife and habitat of the invasive plant management activities proposed under Alternative 1 would be impacts that occur during, or as an immediate consequence of, invasive plant removal activities at current or future infestation locations in any of the Alaska Parks. Indirect effects would be the impacts that occur downstream, down-gradient, or on the treated site after a period of time.

Alternative 1 includes removal of invasive plant infestations by pulling, cutting, and mechanical removal. Also included are thermal weed control methods— soil solarization and spot and prescribed burning—to be used on certain infestations that are not feasible to control with manual or mechanical treatments.

The most beneficial direct effects of Alternative 1 would be removal of the infestations in:

1. areas not currently supporting native plants and wildlife habitat, therefore of little or no value to sustaining wildlife on the Parks
2. areas serving as source sites for seeds or other propagules that would cause further habitat degradation through continued invasive plant spread

A direct adverse impact would be temporary loss of protective plant cover and the potential for soil erosion and longer term site deterioration. These impacts are discussed in the soils section. Such sites would need to be replanted or otherwise revegetated with native plants to ensure the soils would not be subject to rain and wind erosion, resurgence of the original invasive plant, or colonization by other invasive plants. Reseeding with stored native plant stock should mitigate this potential.

The importance to wildlife of rapidly restoring an infested site to natural habitat depends on the extent to which the site recently supported native vegetation. In general, invasive plants in Alaska NPS units occur on disturbed sites, along roadsides, and in other developed or previously developed areas that do not provide natural habitat conditions. These disturbance factors are likely to continue to prevail in the future. Some previously disturbed sites have since recovered from that disturbance and now provide natural habitats for wildlife. Sites where invasive plant treatment is coupled with elimination or reduction in human disturbance could be restored to natural habitat conditions.

Regardless of the level of continuing disturbance, removing invasive plants would at a minimum prevent seed dispersal or other dispersion mechanisms from allowing the invasives to expand the size of the localized infestation to encroach on native habitats or to colonize and proliferate on other sites.

There may be instances where an invasive plant is providing a wildlife value, for example dandelions that grow along roadsides provide a favored food source for black bears at GLBA. In these instances the park managers would need to determine whether the value to bears warrants allowing the plants to continue to grow in the park and preserve.

Exceptions to the general characterization of invasive plants occurring in disturbed areas are species such as white sweet clover that invade river floodplains where the disturbance or lack of native plant cover that allows rapid colonization are the result of natural processes. White sweet clover is known to be proliferating along the Matanuska, Stikine, and Nenana rivers (USFS 2006). Removal of the infestation and management of the site would allow planting, eventual colonization by native plants, or a return to a more natural unvegetated condition.

The two species for which manual and mechanical control methods are unlikely to be effective in the near future are perennial sowthistle and oxeye daisy. Perennial sowthistle varies in terms of providing forage for some wild grazers but is not of high value when compared to native forage. These are areas are known to have substantial bear and moose activity, but no grazing has been observed in sowthistle infested areas.

Oxeye daisy's greatest impact is on forage production in infested meadows. Wildlife species avoid grazing and walking in infested areas because the plant irritates their nose, mouth, and legs. Most animals avoid eating oxeye daisy because they prefer to eat more desirable and palatable species first. This reduces competition for oxeye daisy allowing it to crowd out other plants and decrease the land's carrying capacity (UNCE, 2006).

Animals with large home ranges, such as moose and bear, would not depend on small infested sites for food and even less for cover, so they would not likely be adversely affected by the presence of an invasive plant infestation for forage and survival. Invasive plants would not likely constitute a portion of their diets, so to the extent native plants may have been displaced by the invasives, they would adjust their feeding locations accordingly. An exception noted above is that dandelions are preferred by black bears. Otherwise, herbivores and omnivores tend to feed on palatable native species and may avoid feeding at all on some invasives, such as yellow toadflax. This behavior encourages the survival and expansion of the invasive plant infestation. In general, larger animals in Alaska NPS units would not be affected in terms of loss of food or cover by removal of invasive plants, because most infestations are still at a small scale. An exception would be that black bears in GLBA would likely be affected by removal of dandelions. In the short term, individual animals in the vicinity of a treated site might be disturbed and leave the area while crews are conducting the treatments and for some time afterward.

Small mammals, songbirds, and other ground-nesting birds may be using an area for cover, nesting, or foraging where invasive plants constitute a more substantial portion of their home range. Some 204 bird species found at Alaska NPS units are known to nest on the ground and would therefore be more susceptible to the effects of invasive plant management activities (see Appendix D.) Amphibians such as the western toad, one of only four amphibian species known to inhabit Alaska's NPS units, may also be found at these sites, particularly in the vicinity of surface water. In the short term, removal of the plants might directly, adversely affect individual small mammals or birds by disturbing and displacing them, destroying their nests, or removing escape cover and making them more susceptible to predators. Nest predators and other mammalian and avian predators could benefit with increased predation success for a short period due to removal of some portion of the small mammal and bird cover. These effects would likely be short-term, negligible impacts because the sites would likely be marginal habitat. Also, removal of individual plants, as called for in the Alternative 1 methods of invasive plant removal, would cause a low level of disturbance, if any, to the native plant portions of their habitat.

Park wide populations of mammals, birds or amphibians would not likely be affected because the infestations are few and have been confined to sites of less than an acre to a few acres. In the long term, removal of the plants and revegetation of the sites with native plant species would constitute a minor, locally beneficial impact because the survival and reproductive success of animals using the treated sites in the future might be improved. The much greater, longer-term benefit would be in preventing encroachment of major portions of wildlife habitat by invasives that would ultimately significantly degrade wildlife sustainability within the Parks' ecosystems.

An indirect effect of invasive plant removal would be sedimentation and turbidity in local watersheds down-gradient of the treated site. These impacts are discussed in the aquatic resources section. There would be negligible impacts to local fisheries because the sites and control operations are at a small scale. Therefore, there would be no indirect adverse impacts to any fish-eating mammals or birds.

Soil solarization over an infestation area would remove any marginal habitat value of the site for the short term, but would provide long term benefits to the extent that the site is revegetated with native plants. Spot burning would have the same impacts as manual removal in most instances, except that soil disturbance would be reduced or eliminated. Neither method is likely to result in killing of individual birds or mammals. Prescribed burning would present a slightly higher risk of direct mortality to individual animals if the burn is extensive.

4.11.1.2 Cumulative Impacts on Wildlife and Habitat

There are over 275 miles of roads in Alaska NPS units, with the majority located in WRST and DENA. Alaska NPS units also contain many hundreds of miles of ATV trails, including over 600 miles of trails in WRST. These roads and trails have fragmented wildlife habitat, and have led to disturbance of wildlife and to occasional wildlife-human interactions. They also facilitate the spread of invasive plants. Numerous airstrips and helicopter landing pads exist in Alaska NPS units. As is the case with roads and trails, these human encroachments have reduced native habitats, are the locus of wildlife disturbance, and also facilitate the spread of invasive plants. There are 6 commercial lodges and commercial joint ventures on Alaska National Park lands, which provide lodging, meals, and visitor services, covering about 20 acres in 3 parks (DENA, KATM, and GLBA). There are approximately 1,550 acres of land in the Kantishna area of DENA that have been impacted by mining, of which 517 acres are currently being revegetated (DENA Reclamation of Mined Lands Program 2001). The NPS completed three environmental impacts statements to address the cumulative effects of mining in DENA, WRST, and YUCH (USDI NPS 1990). Finally, park buildings, campgrounds, and other facilities have disturbed vegetation in most park units and served as the focus of exotic plant infestations.

The cumulative effects of these past, present, and expected future human activities on the wildlife and habitat of Alaska's Parks are judged moderate in a setting with the millions of acres of undisturbed wildlife habitat and healthy wildlife populations. The incremental increase in impacts from the no-action alternative to manage invasive plants would result in a negligible additional impact on wildlife in terms of short-term disturbance from crews conducting invasive plant removal. Countering this would be the longer-term incremental decrease in adverse cumulative impacts due to the reduction in invasive plants in Alaska NPS units.

4.11.1.3 Conclusion:

The success of invasive plant management and beneficial effects to native plant communities under Alternative 1 would vary from park to park. The impacts of invasive plant management activities on wildlife habitat and populations would be minor overall. In parks where early detection and immediate control of invasive plants are feasible and achievable, the manual and thermal methods available under Alternative 1 would be sufficient to prevent their establishment and spread and to preserve native wildlife habitat. Where invasive plants become established to a greater extent, herbicides may be the only effective means of controlling an infestation and individual NEPA analyses would have to be conducted for each use. Continuing to manage invasive plants under Alternative 1 would help parks only partially achieve the desired condition of maintaining natural park ecosystems. This alternative would not result in impairment to wildlife and habitat in Alaska NPS units in the short-term; however, Alternative 1 methods alone would ultimately fail to contain current or future invasive plant infestations to effectively protect natural wildlife habitat and their populations.

<u>4.11.2 Impacts from Alternative 2 – NPS Proposed IPMP</u>

4.11.2.1 Direct and Indirect Impacts of Alternative 2 on Wildlife and Habitat:

The impacts of the manual and thermal methods would be the same as those described under Alternative 1. Those would be the methods of preference wherever feasible and so would be used in all of the same locations and situations where they are feasible under both Alternatives 1 and 2. Only where those methods are judged to be ineffective, would herbicides be used to manage invasive plants. So the difference in the impacts of the alternatives to wildlife and habitat is the difference between the impacts from allowing infestations that are not amenable to manual, mechanical or thermal treatments to persist (unless costly and time-consuming individual NEPA reviews are conducted for each herbicide application) as compared to the impacts from minimum-volume spot treating those infestations with herbicides.

The potential for adverse impacts from herbicides depends on the following factors:
- potential for direct toxic effects in exposed mammals and birds
- potential for toxic effects to terrestrial invertebrates that are part of the wildlife food chain
- potential for bioconcentration of the herbicides in certain organisms leading to toxic effects to wildlife at higher trophic levels feeding on those organisms
- potential for the proposed herbicide to damage nearby native plants comprising native wildlife habitat

Based on an evaluation of the information in U.S. Forest Service risk assessments, none of the herbicides proposed for use to control or eradicate invasive species would pose a serious risk to wildlife species or their habitat at any of the Alaska Parks. That evaluation indicated that effects on wildlife populations from herbicide use would be negligible to minor, short-term and localized for several reasons.

First, it is highly unlikely that any individual animals would be exposed to enough herbicide to cause any ill effects. Because of the small size of the treatment sites, it is virtually certain that no major population of any vertebrate species would be directly exposed. It is unlikely that any individual animal located in a treatment site would be directly exposed to an herbicide while it is being applied because of the proposed methods of herbicide application. These are restricted to minimum volume techniques, including backpack or handheld spray mechanisms, injection, or wicks, brushes, or sponges for direct contact with target plants or cut stumps. Any animals at these sites would almost certainly move out of the site away from applicators while the herbicides are being applied simply because of the human disturbance.

Animals would more likely be exposed to smaller residual amounts of herbicides when they reenter or move through a sprayed site some time after the applicators have left. Herbivores might ingest herbicide if they consume sprayed plants, although the herbicides are likely to render the plants unpalatable. Other animals might receive an oral dose in grooming their feathers or fur after coming in contact with sprayed plants. A predator might consume an animal that has received such a dose and thereby receive a secondary dose.

All of these potential routes of exposure have been evaluated in the Forest Service risk assessments for the herbicides proposed for NPS use. None of the herbicides has been shown likely to lead to a lethal or injurious dose by any set of exposure pathways because the herbicides in question are of low toxicity to animals.

***Effects in Birds/Mammals*: ** All seven herbicide active ingredients were found to be of low toxicity in acute and chronic exposure studies of birds or mammals, even at relatively high doses. No bird or mammal in the wild is likely to get as high a dose as the doses that were found to be of low toxicity in the controlled exposure studies.

***Effects on Terrestrial Invertebrates*:** Insects and other terrestrial invertebrates are important in wildlife food chains for species such as shrews and songbirds. Testing on invertebrates is very limited for most of the herbicides. However, data that do exist indicate that none of the seven herbicide active ingredients is likely to be an important mortality factor for any terrestrial invertebrate.

***Food Web Effects*:** No food web effects would result even if wildlife receive doses from multiple exposure pathways including feeding on insects or other invertebrates at treated sites. The total estimated doses that were evaluated in the Forest Service risk assessments included all potential pathways including consumption of herbicide contaminated dietary items.

***Effects from Bioconcentration*:** Bioconcentration studies for the seven herbicides have been conducted almost exclusively in fish, where bioassays indicate the relative concentration in fish tissue compared to the concentration in the water over a period of time. These bioassays have shown that none of the seven herbicides poses a risk of a high level of bioconcentration and resulting high dose in fish-eating birds or mammals.

***Wildlife Habitat*:** Because all of the herbicides are designed to kill the target plants, they are likely to also damage or kill non-target plants at the treatment sites that could comprise wildlife habitat. The minimum volume techniques proposed for use and standard application precautions would confine any such effects to the immediate vicinity of the treated plants such that resulting off-site plant damage would be minimized.

4.11.2.2 Cumulative Impacts Analysis

The same past, present and reasonably foreseeable future actions at Alaska NPS units and their effects on wildlife and habitat discussed above are relevant to Alternative 2. The cumulative effects of past, present, and expected future human activities on the wildlife and thousands of acres of habitat of Alaska's NPS units are moderate in a setting with the millions of acres of undisturbed wildlife habitat and healthy wildlife populations. The incremental increase in impacts from activities on up to 600 acres until 2018 to manage invasive plants under Alternative 2 would result in a negligible additional impact on wildlife in terms of short-term disturbance from crews conducting invasive plant removal with physical methods or using spot herbicide treatments to eliminate the plants. Countering this would be the longer-term incremental decrease in adverse cumulative impacts due to the reduction in invasive plants that these other human activities and encroachments have facilitated in Alaska NPS units. This decrease is more likely to be realized because of the more effective management approach of Alternative 2.

4.11.2.3 Conclusion

The benefits of Alternative 2 to wildlife and habitat in Alaskan NPS units would be minor and localized in the near term but would prevent moderate to major and more widespread impacts in the longer term. The direct adverse impacts of Alternative 2 to wildlife and habitat in Alaskan NPS units would be no more than minor. The indirect effect of Alternative 2 should be beneficial to wildlife and habitat by more effectively curtailing the long term establishment of invasive plant species. The success of invasive plant management and beneficial effects to native plant communities under Alternative 2 would vary from park to park. In parks where early detection and immediate control are feasible and achievable, the manual and thermal methods available under Alternative 2 would be sufficient to prevent establishment and spread. Because spot treatment with herbicides is included under this Alternative, impacts to wildlife and habitats could be readily reduced or eliminated for most sites even when control is not feasible by manual and thermal methods. Managing invasive plants under Alternative 2 would help parks better achieve the desired condition of maintaining all wildlife habitats as part of the natural park ecosystems. This alternative would result in a minor beneficial effect to wildlife and habitat over the next decade because Alternative 2 methods would contain the majority of current or future invasive plant infestations. Actions under alternative 2 would not result in the impairment of wildlife habitat or populations that are key to the purposes and values for which Alaska NPS units were established.

This page intentionally left blank

CHAPTER 5: CONSULTATION AND COORDINATION

5.1 Public Involvement

The NPS mailed a scoping newsletter for the plan to about 250 stakeholders in spring 2006. The public scoping meetings occurred during fall 2006 in three Alaska regional towns (Anchorage, Fairbanks, and Juneau) and in the NPS Alaska Regional Office with the Alaska Lands Act Coordinating Committee (ALACC).

The public scoping results were sent out to participating parties in October 2006 and January 2007. The issues and analyses identified in the EA are largely a result of the public and agency scoping. The title was changed from "Exotic Plant Management Plan" to "Invasive Plant Management Plan" to more accurately reflect the focus of the effort.

Central scoping issues involved the level of NEPA required for the invasive plant control plan and the potential use of chemical herbicides. If broadcast applications of herbicides or aerial spraying were contemplated, commenters thought an EIS would be required to enable greater public involvement and review of the contemplated actions. Commenters also asked for examples of successful herbicide control of invasive plants in other locations, how many applications were needed, and whether soil, water, plant, and animal conditions were monitored after applications. The ALACC group asked the NPS to clarify the feedback loops in the decision tree where a high risk invasive species persists after three years of unsuccessful physical control methods but the chemical control could cause harm to resources or humans as well.

The NPS presented two basic alternatives: 1) a continuation of the ongoing surveys, physical control efforts, and monitoring of effectiveness with retreatment where needed; and 2) continue the ongoing monitoring and physical control methods where effective but also consider the use of herbicides where these methods fail after 3 or more years of physical controls. Commenters suggested a third alternative emphasizing partnership and leadership with adjacent landowners, concession and business operators in park areas, and volunteer groups. The NPS decided to merge the concepts of alternative 2 with this suggestion.

Public meetings on the EA are planned during a 60-day public review period.

5.2 Intra-agency and Inter-agency Involvement

Since May of 2006, the NPS has involved Alaska NPS unit Superintendents and Chiefs of Resources Management through the Natural Resources Advisory Council. All affected Alaska National Park System units have had an opportunity to provide resources information and review and comment on draft parts of the EA.

The NPS did not have the expertise to address the potential impacts of herbicides on soils and wildlife and habitat, so eventually the agency contracted with Phil Sczerzinie of Mangi, Incorporated to complete the wildlife and habitat effects sections of the EA and arranged for Jeff Conn of the USDA Agriculture Research Service to complete soils analyses.

5.3 List of Preparers and Consultants

Table 5-1 and Table 5-2 list personnel who prepared parts and consulted on the development of this environmental assessment, respectively.

Table 5-1 List of EA Preparers (Interdisciplinary Team)

Name	Organization	Position
Bud Rice	NPS, Alaska Region, Environmental Planning and Compliance	NEPA Project Coordinator, Wetlands and Subsistence Effects Analyses
Jeff Heys	NPS, Alaska Region, Exotic Plant Management Team Leader	Project Manager, Alternatives and Vegetation Descriptions and Effects Analyses
Pat Owen	NPS, Denali National Park and Preserve	IPM Coordinator
Trey Simmons	NPS Central Alaska Network I&M Team	Aquatic Resources Biologist
Janet Clemens	NPS, Alaska Region, Cultural Resources	Cultural Resources Compliance Officer
Jay Cable	NPS, Alaska Region, Visitor Education, Safety, and Protection	Regional Safety Officer, Human Health and Safety
Jeff Conn	Agricultural Research Service, USDA, Fairbanks, AK	Research Agronomist, Description of soils and effects analyses.
Clarence Summers	NPS, Alaska Region, Subsistence Specialist	ANILCA 810 Evaluation
Phil Sczerzinie	Mangi, Inc.	Contract Wildlife Biologist, Wildlife and Habitat Effects Analyses
Judy Alderson	NPS, Alaska Region, Natural Resources	Regional Wilderness Coordinator
Staci Deming	NPS, Alaska Region, Geographic Resources	GIS Specialist

Table 5-2 List of EA Consultants

Name	Organization	Position
Joan Darnell	NPS, Alaska Region, Environmental Planning and Compliance	Team Manager
Glen Yankus	NPS, Alaska Region, Environmental Planning and Compliance	Alaska Region NEPA Coordinator
Russ Kucinski	NPS, Alaska Region, Natural Resources	Team Manager
Park Contacts	Alaska National Park Offices	Chiefs of Resources Management
Kevin Meyer	NPS, Alaska Region, Natural Resources	Environmental Specialist/Regional Soils & Trails Specialist
Tom Meier	Denali National Park and Preserve	Wildlife Biologist
Carol McIntyre	Denali National Park and Preserve	Avian Wildlife Biologist
Mason Reid	Wrangell Saint-Elias National Park and Preserve	Wildlife Biologist
Lewis Sharman	Glacier Bay National Park and Preserve	Ecologist
John Quinley	NPS, Alaska Regional Office	Public Information Officer
Tim Hudson	NPS, Alaska Regional Office	Associate Director for Resources and Planning
Brenda Coleman	NPS, Alaska Regional Office	Concessions Analyst
Becky Brock	LACL/KATM	Concessions Analyst
Lisa Fox	NPS, Alaska Region, Environmental Planning and Compliance	Environmental Protection Specialist – Wildlife

This page intentionally left blank

CHAPTER 6 – REFERENCES CITED

ADFG. 1978. The Black Bear in Alaska, by Loyal Johnson. Wildlife Notebook Series, Habitat Division.

ADFG. 1989. Final Development Concept Plan, Environmental Impact Statement, South Side Denali, Denali State Park Master Plan, Division of Parks and Outdoor Recreation.

ADFG. 1992a. Final Development Concept Plan, Environmental Impact Statement, South Side Denali Moose Annual Report of Survey-Inventory Activities.

ADFG. 1992b. Final Development Concept Plan, Environmental Impact Statement, South Side Denali Lower Susitna Valley Moose Population and Identification and Movement Study, by R. D. Modaferri.

ADFG. 1995. Final Development Concept Plan, Environmental Impact Statement, South Side Denali, Personal communication with Herman Griese, Area Wildlife Biologist, Palmer, Alaska, September 11, 1995.

ADFG. 1996a. Species of Special Concern. State of Alaska, Department of Fish and Game, Juneau, Alaska.

ADFG. 1996b. Personal communication with Herman Griese, Area Wildlife Biologist, Palmer, Alaska, January 29, 1996.

ADNR. 1985. Vegetation map for the Copper River Resource Mapping Area.

ADNR. 1991. Final Development Concept Plan, Environmental Impact Statement, South Side Denali, Susitna Basin Recreation Rivers Management Plan – Resource Assessment. Division of Land, Land and Resources Section, prepared with Alaska Department of Fish and Game, the Matanuska-Susitna Borough, and the U.S. Department of Interior.

ADNR. 1995. Comparative Analysis of View Potential: North and South. Unpublished data compiled by Rick McIntyre and Dave Johnston, Denali National Park and Preserve Ranger and Denali State Park Ranger, respectively. On file at Alaska Department of Natural Resources, Anchorage, Alaska.

AKEPIC. 2005. Invasive Plants of Alaska. Alaska Association of Conservation Districts Publication. Anchorage, AK.

AKNHP. (Alaska Natural Heritage Program). 2000a. Non-native Plant Species of Alaska, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501 Profiles of: bird vetch, Canada thistle, common timothy, creeping buttercup, European mountain ash, Japanese knotweed, lambs-quarters, narrow-leaf hawk's-beard, orange hawkweed, oxeye daisy, perennial sowthistle, purple foxglove, red clover, reed canarygrass, sheep sorrel, Siberian peashrub, smooth brome (grass), white sweetclover, yellow toadflax

Andres, Brad A. and B. T. Browne. 1998. Spring migration of shorebirds on the Yakutat Forelands, Alaska. Wilson Bulletin, Vol. 110. No. 3 pp 326-331.

Art, H.W. To spray or not to spray. In: Invasive Plants: Weeds of the Global Garden. Eds: Randall, J.M. and J. Marinelli. Handbook #149. Brooklyn Botanic Garden, Inc. Brooklyn, NY.

Babbitt, Bruce. 1998. U.S. Department of the Interior, Statement by Secretary of the Interior Bruce Babbitt on Invasive Alien Species "Science in Wildland Weed Management" Symposium, Denver, CO, April 8, 1998

Barnes, Ken. Personal Communication. NPS Alaska Region Aviation Manager.

Benson, A.M. 1999. Denali Institute Migration Station 1999 annual report. Alaska Bird Observatory, Box 80505, Fairbanks, AK, 99708

Bryant, Jane. Denali National Park and Preserve. Personal Communication, August 2000.

Capra, Jim. Personal Communication. GLBA Dry Bay Ranger.

Clark, Mark and Mike Duffy. 2004. Soil Survey of the Denali National Park and Preserve Area. Natural Resources Conservation Service, Palmer, Alaska. 954 pages.

Cook, J. A. and S. O. MacDonald. 2003. Mammal inventory of Alaska's national parks and preserves: Wrangell-St. Elias National Park and Preserve. Annual report 2001-2003. Idaho State University, Pocatello.

Cole, D.N. 1996. Ecological manipulation in wilderness: An emerging management dilemma. International Journal of Wilderness 2(1): 15-19.

Cole, D.N. 2000. Paradox of the primeval: Ecological restoration in wilderness. Ecological Restoration 18:77-86.

Cowardin, Lewis M., Virginia Carter, Francis C. Golet, and Edward T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Washington, DC: Office of Biological Services, Fish and Wildlife Service, U.S. Department of the Interior. Document FWS/OBS-79-31. 131 pp.

Czarapata, E.J. 2005. Invasive Plants of the Upper Midwest: an illustrated guide to their identification and control. The University of Wisconsin Press. Madison, WI.

Danby, R. K. 2003. Birds and mammals of the St. Elias mountain parks: checklist evidence for a bio-geographic convergence zone. Can. Field Nat. 117(1): 1-18.

Dalle-Molle, J., and J. Van Horn. 1991. Observations of vehicle traffic interfering with migration of Dall sheep, Ovis dalli dalli, in Denali National Park, Alaska. Canadian Field-Naturalist 105: 409-411.

Eichenlaub, Bill. Personal Communication. GLBA GIS Specialist

Ely, C.R. and A. X. Dzubin. 1994. Breeding distribution of Tule Greater White-Fronted Geese. *The Birds of North America* No. 131.

Ferri, A., Duffard, R., Sturtz, N., and A.M. Evangelista de Duffard. 2003. Iron, zinc and copper levels in brain, serum and liver of neonates exposed to 2,4-dichlorophenoxyacetic acid. Neurotoxicology and Teratology 25(5):607-613.

French, B. 2003. Assessing and managing the impact of humans along national park coastlines of Southcentral Alaska: bears as an indicator in Kenai Fjords National Park, Kenai Peninsula, Alaska. Prepared for Kenai Fjords National Park by Hart Crowser, Inc., Anchorage, AK

Gabrielson, Ira and F. Lincoln. 1959. The Birds of Alaska. The Stackpole Co., Harrisburg, PA, and the Wildlife Management Institute, Washington, DC.

Gibeau, Michael L., A. P. Clevenger, S. Herrero, and J. Wierzchowski. 2002. Grizzly bear response to human development and activities in the Bow River watershed, Alberta, Canada. Biological Conservation, Vol. 103. No. 2 Pp 227-236.

Heys, Jeff and Whitney Rapp. 2008. NPS Alaska Exotic Plant Management Team (AK-EPMT) Protocol 2008. NPS Alaska Regional Office, 240 West 5th Avenue, Anchorage, AK 99501.

Kertell, K. 1986. Reproductive biology of northern hawk-owls in Denali National Park, Alaska. Raptor Research 20: 91-101.

Landres, Peter, Mark W. Brunson and Linda Merigliano. 2000. Naturalness and Wildness: the Dilemma and Irony of Ecological Restoration in Wilderness. Wild Earth: Winter 2000/2001: 77-82.

Larsen, C.F., R.J. Motyka, J.T. Freymueller, K.A. Echelmeyer, E.R. Ivins. 2004. Rapid uplift of southern Alaska caused by recent ice loss. Geophys. J. Int. 158:1118-1133.

Larsen, C.F, R.J. Motyka, J.T. Freymueller, K.A. Echelmeyer and E.R. Ivins. 2005. Rapid viscoelastic uplift in southeast Alaska caused by post-Little Ice Age glacial retreat. Earth and Planetary Science Letters 237:548-560.

Loso, Mike. 2006. Narrative descriptions and working database for vegetation field assessment conducted summer 2006. Documents on file in the Resource Management Division, botanist's office, Wrangell-St. Elias National Park and Preserve, Alaska. 26 pp.

McIntyre, Carol. Personal Communication. Avian Wildlife Biologist DENA.

McIntyre, C.L. 2002. Birds, bird studies, and bird conservation in Denali National Park and Preserve, Alaska. Arctic Research of the United States, Volume 16: 22-30.

McIntyre, C.L. and L.G. Adams. 1999. Reproductive characteristics of migratory golden eagles in Denali National Park, Alaska. Condor 101:115-123.

McIntyre, Carol and Carl Roland. 2002. I don't know what this refers to. Perhaps it should be Roland and McIntyre (2006)? If so, the citation would be:

Roland, C. and C. McIntyre. 2006. Integrated monitoring of physical environment, plant and bird communities in Denali. Alaska Park Science 5 (1): 46-48.

Mech, L.D., L.G. Adams, T.J. Meier, J.W. Burch, and B.W. Dale. 1998. The Wolves of Denali. University of Minnesota Press, Minneapolis, MN. 225 pp.

Meier, T.J., J.W. Burch, L.D. Mech, and L.G. Adams. 1995. Pack structure and genetic relatedness among wolf packs in a naturally regulated population. Pages 293-302 in L.N. Carbyn, S.H. Fritts, and D.R. Seip, eds. Ecology and Conservation of Wolves in a Changing World. Canadian Circumpolar Institute, Edmonton, Alberta.

Monaco, T.J., Weller, S.C. and F.M. Ashton. 2002. Weed Science: principles and practices. Fourth Edition. John Wiley and Sons, Inc. NewYork, NY.

Murie, A. 1981. The grizzlies of Mount McKinley. U.S. National Park Service Scientific Monograph Series, no. 14. Washington, D.C.

National Park Service. 1990. Record of Decision on the Cumulative Impacts of Mining in Denali.

NatureServe. 2008. Species profiles on: bigleaf lupine; yellow toadflax. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.0. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer.

Noss, R.F. and A.Y. Cooperrider. 1994. Saving Nature's Legacy, Washington, D.C.: Island Press.

Petersen, Margaret R., Jan C. Greilich, and Nancy M. Harrison. 1981. Spring and Fall Migration, and Habitat Use by Water Birds in the Yakutat Forelands, Alaska-1980.

Report. Marine Bird Section, National Fishery Research Center. Anchorage, AK. 30 pp.

Pimentel, D. L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and Economic Costs of Nonindigenous Species in the United States`. BioScience Vol. 50 No. 1

Radosevich, S., Holt, J. and C. Ghersa. 1997. Weed Ecology: implications for management. Second Edition. John Wiley and Sons, Inc. NewYork, NY.

Randall, J.M. and M.C. Hoshovsky. 2000. California's Wildland Invasive Plants. Pp 11-19 (and co-author or sole author of 4 other chapters) In C.C. Bossard, J.M. Randall and M.C. Hoshovsky (eds) Invasive Plants of California's Wildlands. University of California Press, Berkeley.

Rieger, Samuel., Schoephorster, Dale B., and Furbush, Clarance E. 1979, Exploratory Soil Survey of Alaska, United States Department of Agriculture, Soil Conservation Service (Natural Resources Conservation Service).

Rutledge, C R., and T. 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).

Sheley, R.L., Kedzie-Webb, S. and B.D. Maxwell. 1999. Integrated weed management on rangeland. In: Biology and Management of Noxious Rangeland Weeds. Eds: Sheley, R.L. and J.K. Petroff. Oregon State University Press. Corvallis, OR.

Smith, M.E., J.L. Hechel, and E.H. Follman. 1994. Black bear denning ecology in Interior Alaska, International conference on bear research and management, 9:513-522.

Soiseth, Chad. Personal Communication. Fishery Biologist GLBA.

Soll, J., D. Kreuzer, K. Strauss, et al. 2006. *Sandy River Riparian Habitat Protection Project Report 2006*, The Nature Conservancy Oregon Field Office, Portland, OR.

Stelmock, J.J. 1981. Seasonal activities and habitat use patterns of brown bears In Denali National Park – 1980, M.S. Thesis, University of Alaska Fairbanks.

Tetreau, Mike 1989. Personal communication.

Travis, J. 2000. Wood Frog, Rana sylvatica. Denali National Park and Preserve, Resources Division.

Trumbo, J. 2002. *An Assessment of the Non-Target Aquatic Impacts of the Herbicide Rodeo and the Surfactant R-11 when used to Control Purple Loosestrife, Lythrum salicaria.* California Department of Fish and Game Office of Spill Prevention and Response, Administrative Report 02-011.

Trumbo, J. 2005. An assessment of the hazard of a mixture of the herbicide Rodeo and the non-ionic surfactant R-11 to aquatic invertebrates and larval amphibians. California Fish and Game **91**:38-46.

Tu, M., Hurd, C., and J.M. Randall. 2001. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Nature Conservancy. http://tncweeds.ucdavis.edu/handbook.html

UNCE (University of Nevada, Cooperative Extension). 2006. Identification and management of oxeye daisy. Fact Sheet-06-17

USDA Forest Service. 2003a. *Glyphosate – Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service. 2003b. *Triclopyr – Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service. 2004a. *Chlorsulfon - Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service. 2004b. *Clopyralid – Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service. 2004c. *Imazapyr - Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service. 2004d. *Metsulfuron Methyl - Human Health and Ecological Risk Assessment Final Report*, Forest Health Protection, Arlington VA.

USDA Forest Service-R6 (USDA Forest Service Pacific Northwest Region) 2005. EIS on Invasive Plant Management http://www.fs.fed.us/r6/invasiveplant-eis/

USDA Forest Service. 2006. *2,4-D Human Health and Ecological Risk Assessment Final Report*. Forest Health Protection, USDA Forest Service, Arlington, VA.

U.S. Department of Interior, Fish and Wildlife Service. 1999. Fulfilling the Promise.

USDI National Park Service. 1984. GLBA General Management Plan. Glacier Bay National Park and Preserve, Alaska. Gustavus, AK.

USDI National Park Service. 1985. WRST General Management Plan. Wrangell-Saint Elias National Park and Preserve, Alaska. Copper Center, AK.

USDI National Park Service. 1990a. *Final Environmental Impact Statement on Cumulative Impacts of Mining, Denali National Park and Preserve, Alaska*. Denver Service Center, NPS D-121A.

USDI National Park Service. 1990b. *Final Environmental Impact Statement on Cumulative Impacts of Mining, Wrangell-St. Elias National Park and Preserve, Alaska*. Denver Service Center, NPS D-120A.

USDI National Park Service. 1990c. *Final Environmental Impact Statement on Cumulative Impacts of Mining, Yukon-Charley Rivers National Preserve, Alaska*. Denver Service Center, NPS D-14A.

USDI National Park Service. 1990d. Record of Decision on the Cumulative Impacts of Mining in Denali.

USDI National Park Service. 1992. *Final Legislative Environmental Impact Statement, All-Terrain Vehicles for Subsistence Use, Gates of the Arctic National Park and Preserve, Alaska.* NPS Alaska Regional Office, NPS D-22A.

USDI National Park Service. 1996a. *Final Environmental Impact Statement on Entrance Area and Road Corridor Development Concept Plan, Denali National Park and Preserve, Alaska*. Denali National Park and Preserve, P.O. Box 9, Denali National Park, AK 99755. NPS D-244A.

USDI National Park Service. 1996b. *Final Development Concept Plan Environmental Impact Statement, Brooks River Area, Katmai National Park and Preserve, Alaska*. Katmai National Park and Preserve, P.O. Box 7, King Salmon, AK 99613. NPS D-51A.

USDI National Park Service. 2001. Directors Order 12: Conservation Planning and Environmental Impact Analysis, and Decision Making. http://www.nps.gov/policy/DOrders/DOrder12.html

USDI National Park Service. 2003a. *Environmental Assessment for a Gravel Acquisition Plan, Denali National Park and Preserve, Alaska*. Denali National Park and Preserve, P.O. Box 9, Denali National Park, AK 99755.

USDI National Park Service. 2004. *Soil Survey of the Denali National Park and Preserve Area by Mark Clark and Michael Duffy*. Natural Resources Conservation Service, Palmer, AK 954 pages.

USDI National Park Service. 2005a. DENA Backcountry Management Plan/EIS.

USDI National Park Service. 2005b. *Water Resources Information and Issues Overview Report: Denali National Park and Preserve, Alaska*. Technical Report NPS/NRWRD/NRTR-2005/341, National Park Service, Water Resources Division, Ft. Collins, CO.

USDI National Park Service. 2006. *Management Policies 2006.* Mail:Stop IDCC, Washington, DC 20402-0001. ISBN 0-16-076874-8. *http://www.nps.gov/policy*

USDI National Park Service. 2006b. *Water Resources and Water Conditions Assessment, Sitka National Historic Park, Alaska*. Technical Report NPS/NRWRD/NRTR-2006/341, National Park Service, Water Resources Division, Ft. Collins, CO.

USDI National Park Service. 2007a. *Environmental Assessment for the Glacier Bay National Preserve Off-Road Vehicle Use Plan.* Glacier Bay National park and Preserve, P.O. Box 140, Gustavus, AK 99826

USDI National Park Service. 2007a. Cantwell Subsistence ORV Access Management EA, DENA.

U.S.E.P.A. 2005. *Environmental Fate and Ecological Risk Assessment for the Registration of Aminopyralid*, United States Environmental Protection Agency Office of Pesticide Programs, Washington, D.C.

Van Hemert, Caroline, Colleen M. Handel, Melissa N. Cady, and John Terenzi. 2006. Summer Inventory of Landbirds in Kenai Fjords National Park. Unpublished final report for National Park Service. U. S. Geological Survey, Alaska Science Center, Anchorage, Alaska.

Viereck, L.A., C.T. Dyrness, A.R. Batten and K.J. Wenzlick. 1992. The Alaska Vegetation Classification. Portland, Oregon: U.S. Department of Agriculture, Forest service, Pacific Northwest Research Station. General Technical Report PNW-GTR-286. 278 pp.

Weeds BC. 2008. Identification and Management: Weed profile: Annual sow thistle. Website http://www.weedsbc.ca/weed_desc/ann_sow.html Ministry of Agriculture and Lands, British Columbia, Canada

Weeks, D.P. 2003. *Wrangell-St. Elias National Park and Preserve, Alaska Water Resources Scoping Report.* Technical Report NPS/NRWRD/NRTR-2003/315, National Park Service, Water Resources Division, Ft. Collins, CO.

Wilbor, S.L. 1996. Reproductive performance, nesting habitat, and prey of Taiga merlins in Denali National Park and Preserve, Alaska. M.Sc. Thesis, University of Alaska, Fairbanks, Alaska. 175 pp.

Wright, Ami. 2001. Final report: 2001 field season. National Park Service, Kenai Fjords National Park, Seward, AK. Unpublished Report.

http://science.nature.nps.gov/im/apps/npspp/index.cfm

http://wetlandsfws.er.usgs.gov/wtlnds/launch.html

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

http://www.fs.fed.us/database/feis/plants/weed/weedpage.html

http://www.fs.fed.us/foresthealth/pesticide/risk.shtml

http://www.fs.fed.us/r10/spf/fhp/weed_book/
USFS. 2007b. Selected invasive plants of AK. Profiles of: bird vetch, Canada thistle, Japanese knotweed, narrow-leaf hawk's-beard, orange hawkweed, oxeye daisy, perennial sowthistle, reed canarygrass, Siberian peashrub, white sweetclover, yellow toadflax.

http://www.wsdot.wa.gov/maintenance/vegetation/herbicide_use.htm

This page intentionally left blank.

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.

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".

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.

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.

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.

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.

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
Chlorsul-furon	Telar	300 (pH 5) 28,000 (pH7)	40 @ pH7 (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 Easter		900	100 (Estimated)	10	Medium	Small
Glyphosate	Roundup & Rodeo	12,000	24,000	30	Large	Small
Imazapic	Plateau	2,200	10-26	31 - 410	Small	Medium
Metsul-furon methyl	Escort	548 @ pH5 2,790@ pH7 213,000@ pH9	35@ pH 7	120	Medium	Large
Picloram	Tordon	430	Avg. 16	90	Small	Large
Triclopyr	Redeem	430	780	46	Large	Medium
Quinclorac	Paramount	69	13 to 54	18-176	Variable	Medium

Remove imazapic, picloram, and quinclorac – add:
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.

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
seabird	Charadriiformes	Ancient Murrelet	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?
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
shorebird	Charadriiformes	Curlew Sandpiper	No	Yes	No
passerine-omnivore	Passeriformes	Dark-eyed Junco	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?
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
shorebird	Charadriiformes	Least Sandpiper	No	Yes	No
waterfowl	Anseriformes	Lesser Scaup	No	Yes	No
shorebird	Charadriiformes	Lesser Yellowlegs	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?
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
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

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	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
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

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	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 2007. Acreages derived from Exotic Plant Management Team geodatabase. AKNHP rankings from http://akweeds.uaa.alaska.edu/akweeds_ranking_page.htm as of 5/2008.

		Species Detected in or around NPS unit													Total	
Taxon	**Common Name**	**BELA**	**CAKR**	**DENA**	**GAAR**	**GLBA**	**KATM**	**KEFJ**	**KLGO**	**LACL**	**SITK**	**WRST**	**YUCH**	**Units Detected**	**Mapped Acreage**	**AKNHP Ranking**
Aegopodium podagraria	bishop's goutweed					X								1	0.942	
Agrostis gigantea	red top							X						1		
Alopecurus geniculatus	marsh meadow-foxtail									X				1		
Alopecurus pratensis	meadow foxtail					X			X					2	0.002	
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	0.467	
Bromus inermis and similar	smooth brome grass			X		X	X	X		X		X	X	7	209.284	62
Capsella bursa-pastoris	shepherd’s purse			X		X	X		X	X	X	X	X	8	8.648	40
Caragana arborescens	Siberian peashrub											X		1	0.014	66
Centaurea montana	perennial cornflower					X					X			2	0.576	
Cerastium fontanum and similar	mouse-ear chickweed					X	X	X	X		X	X		6	345.06	36
Cerastium tomentosum	snow in summer										X			1	0.11	
Chenopodium album	common lambsquarters			X					X	X	X	X	X	6	20.811	35
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	17.517	54
Dactylis glomerata	orchard grass					X		X						2	0.005	54
Descurainia sophia	flixweed	X	X	X								X		4	0.43	41
Digitalis purpurea	foxglove										X			1	0.504	51
Dodecatheon jeffreyi	Sierra shooting-star									X				1		
Elymus repens	quackgrass			X		X		X	X			X	X	6	195.261	59
Erodium cicutarium	redstem stork's bill									X				1		
Erysimum cheiranthoides	wormseed mustard			X			X		X			X		4	3.246	
Eschscholzia californica	California poppy											X		1		
Euphrasia nemorosa	common eyebright								X					1	0.73	
Fragaria virginiana	common strawberry									X				1		
Galeopsis tetrahit/G. bifida	hempnettle					X		X	X			X		4	0.269	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		4	10.207	63
Hypochaeris radicata	hairy cat's ear					X								1	4.945	
Impatiens glandulifera	ornamental jewelweed								X			X		2		82
Lamium album	white deadnettle					X								1	0.008	
Lappula squarrosa	European stickseed			X								X		2	2.304	44
Leontodon autumnalis	fall dandelion							X						1		

Taxon	Common Name	Species Detected in or around NPS unit BELA	CAKR	DENA	GAAR	GLBA	KATM	KEFJ	KLGO	LACL	SITK	WRST	YUCH	Units Detected	Total Mapped Acreage	AKNHP Ranking
Lepidium densiflorum	common pepperweed			X								X	X	3	2.514	25
Leucanthemum vulgare	oxeye daisy			X		X	X	X	X	X	X	X		8	212.959	61
Linaria vulgaris	yellow toadflax			X		X		X	X		X	X		6	201.551	69
Lolium perenne and similar	perennial ryegrass					X		X		X		X		4	11.885	41
Lupinus polyphyllus	bigleaf lupine			X		X		X						3	353.512	
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	420.834	32
Medicago lupulina	black medic							X				X		2	0.034	48
Medicago sativa ssp. *falcata*	yellow alfalfa							X						1	0.48	64
Melilotus alba	white sweetclover			X		X		X	X			X		5	52.572	80
Melilotus officinalis	yellow sweetclover			X				X				X		3	0.407	65
Mentha sp.	mint					X								1	0.001	
Myosotis scorpioides	forget-me-not					X					X			2	0.348	
Neslia paniculata	ball mustard							X						1		
Papaver nudicale	Icelandic poppy							X						1	0.001	
Papaver rhoes	corn 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	6.66	83
Phleum pratense	common timothy			X		X		X	X	X	X	X		7	50.436	56
Plantago major	common plantain			X		X	X	X	X	X	X	X	X	9	755.33	44
Poa annua	annual bluegrass					X	X	X		X	X			5	1.5	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	199.12	45
Polygonum convolvulus	black bindweed			X							X	X		3	0.466	
Polygonum cuspidatum	Japanese knotweed			X							X			2	0.297	87
Potentilla norvegica	Norwegian cinquefoil							X				X		2		
Prunus avium	sweet cherry										X			1	0.268	
Ranunculus acris	tall buttercup					X		X	X					3	0.73	54
Ranunculus repens	creeping buttercup			X		X			X		X			4	15.214	54
Rheum rhabarbarum	rhubarb					X								1	0.777	
Rosa rugosa	rugosa rose					X					X			2	0.282	
Rosa sp.	rose					X								1	0.001	
Rubus idaeus	red raspberry					X								1	3.574	
Rumex acetosella	common sheep sorrel					X	X	X	X	X	X			6	9.47	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		

Taxon	Common Name	BELA	CAKR	DENA	GAAR	GLBA	KATM	KEFJ	KLGO	LACL	SITK	WRST	YUCH	Units Detected	Total Mapped Acreage	AKNHP Ranking
		Species Detected in or around NPS unit														
Senecio vulgaris	common groundsel								X					1		35
Silene latifolia	bladder campion											X		1	0.001	45
Silene noctiflora	night-blooming cockle			X								X		2	0.537	45
Silene vulgaris	bladder campion								X					1	0.143	45
Sonchus arvensis	perennial sowthistle					X					X			2	2.408	61
Sonchus oleraceus	annual sowthistle			X										1	0.001	
Sorbus aucuparia	European mountain-ash					X					X			2	9.023	59
Spergula arvensis	corn spurry			X				X		X				3	0.466	32
Stellaria media	common chickweed			X		X			X	X		X	X	6	10.316	42/54
Symphytum officinale	common comfrey					X								1	1.987	
Tanacetum vulgare	common tansy					X			X	X				3	0.03	57
Taraxacum officinale ssp. *officinale*	common dandelion	X	X	X	X	X	X	X	X	X	X	X	X	12	1235.189	58
Thlaspi arvense	field pennycress								X			X		2		
Trifolium hybridum	alsike clover			X		X		X		X	X	X		6	211.406	57
Trifolium pratense	red clover			X		X		X	X		X	X		6	16.194	53
Trifolium repens	white clover			X		X	X	X	X	X	X	X		8	375.989	59
Tripleurospermum maritima	false mayweed			X										1	0.001	
Tripleurospermum perforata	scentless false mayweed			X				X				X	X	4	1.453	48
Triticum aestivum	common wheat			X		X		X						3	22.876	
Veronica serpyllifolia and similar	thyme-leaf speedwell									X		X		2		
Vicia cracca	bird vetch			X				X	X			X	X	5	0.08	73
Vicia sativa	common vetch											X		1		
Viola tricolor	Johnny-jump-up violet					X			X					2	0.014	
	Grand Total	3	3	36	1	51	15	38	34	30	31	47	13			

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**
Canada	Canada thistle threatens natural communities by	Canada thistle can increase fire	Forms colonies via an extensive

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**
thistle	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).	frequency and severity due to its abundant and readily ignited litter (Zouhar 2001).	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.	

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**
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 there ranges overlap (Pojar and MacKinnon 1994).	

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**
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 and 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]
Lambs-quarters	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**
Narrow-leaf hawk's-beard	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]

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**
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]

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
(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 form 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 is 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]

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**
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 a 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

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**
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 Non-native Plant Species of Alaska, Alaska Natural Heritage Program, Environment and Natural Resources Institute, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501
[2] 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)

Appendix G: Summary of Potential Environmental Fate and Effects of Proposed Herbicides

Active Ingredient	Persistence in Soil	Residual Soil Activity	Volatility and Burning By-Products	Solubility	Leaching Potential	Surface Waters	Toxixity
2,4-D (Aqua-Kleen, Baarage, Weedone, Esteron brand 99)	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)	Average soil half-life is 32 days		Does not evaporate easily. No information on potential by-products from burning.				
Chlorsulfuron (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 (Curtail, Transline, Reclaim, Lontrel, Redeem)	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, Glyphomax, Touchdown	Half-life ranges from 3 to 130 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)	Exposure to sunlight may break down. Soil microorganisms contribute 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). Sol 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 was 1 to 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.
Troclopyr (Garlon products)	Average half-life in soil is 46 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

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.
- Reduced application rates of herbicides would be used wherever possible. Reduced 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 directly onto target plants with care to avoid application to non-target plants.
- Herbicide application would account for meteorological factors such as wind speed, wind direction, inversions, humidity, and precipitation in relation to the presence of sensitive resources near the treatment area and direction provided on labels.
- Herbicides would only be applied when meteorological conditions at the treatment site allow for complete and even coverage and would prevent drifting of spray onto non-target sensitive resources or areas used by humans.
- 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.
- 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.
- Herbicides would be applied according to application rates specified on the product label.
- 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 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 Jeff Heys.
- 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.
- 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 (Roundup Pro 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.

<u>Herbicide Use Regulations and Record-Keeping</u>

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 of greater than one acre on a state right-of-way within a National Park Service unit. 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 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, and local newspapers.

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 yellow signs that contain the following information:

- Treatment Date
- Targeted invasive plant species
- Name of the herbicide to be applied
- Restricted travel 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.