THE STATUS AND MANAGEMENT OF INVASIVE SPECIES IN NATIONAL WILDLIFE REFUGE WILDERNESS AREAS

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ABSTRACT

We conducted a survey by mail of all federally designated U.S. Fish and Wildlife Service (FWS) wilderness areas to assess the current status and management of invasive plants and exotic animals and pathogens in these areas. Managers for 68 of the 70 wilderness areas responded to the survey. Wilderness areas can serve as important ecological benchmarks for natural systems. Despite their relatively natural condition and special management status, refuge wilderness areas contained large numbers of non-native species. Exotic animals were deemed a major problem (1 of the top 10 management priorities) in 22 wilderness areas throughout the country. Invasive plants were a major problem in 12 wilderness areas in the lower 48 states, but not in any of Alaska's 21 wilderness areas. Exotic pathogens were considered to be a major problem in only 1 wilderness area. Wilderness areas in 3 FWS Regions appeared to be particularly susceptible to non-native species introductions: Region 2 (Southwest), Region 4 (Southeast), and Region 6 (Mountain-Prairie). Control programs were being conducted in 19 wilderness areas for invasive plants, in 14 for exotic animals, and in 2 for exotic pathogens. Although many managers reported that invasive and exotic species were monitored, systematic sampling efforts were uncommon (19% for plants, 18% for animals, and 10% for pathogens). Managers commonly cited a lack of staff, funding, or both as being a barrier to implementation of monitoring and management programs. Our survey form was used in the development of an upcoming survey for invasive species on all National Wildlife Refuge lands, as part of a new effort to develop a system-wide monitoring protocol. We recommend that this protocol be designed to easily allow the comparison of invasive species distributions within and outside wilderness areas.

Key words: invasive species, exotic species, U.S. Fish and Wildlife Service, National Wildlife Refuges, wilderness areas, control programs, monitoring.

INTRODUCTION

Within the past two centuries, the dispersal of biological species into new regions of the world has greatly increased in scale and magnitude due to human activity. Moreover, this process is expected to intensify in upcoming years due to the increasing globalization of travel and commerce (Baskin 2002). Although many introduced species fail to establish self-sustaining populations in the wild, some become naturalized in their new locations and expand their ranges, thus becoming invasive species (Richardson et al. 2000). Among these invasive species, some eventually become dominant members of their biological communities, and ultimately have dramatic effects on ecosystems, economies, and human health.

It is now believed that invasive exotic species (plants, animals, and pathogens) are the second biggest threat to the conservation of biodiversity, behind only habitat destruction. For example, invasive species are the main or contributing cause for the listing of 36% of terrestrial vertebrates, 57% of fishes, and 22% of plants as threatened or endangered in the United States (OTA 1993). Invasives may compete with, prey upon, or cause disease in native species, as well as alter large-scale ecological processes to the detriment of native species (see Cox 1999).

Additionally, invasive species often pose a serious threat to human health (e.g., AIDS, influenza) and native wildlife populations (e.g., West Nile virus, chronic wasting disease). The invasive species is normally the disease agent, but it can also be a vector for the spread of disease (e.g., the Asian tiger mosquito [*Aedes albopictus*]).

Invasive species are estimated to cost the U.S. economy nearly $137 billion per year in damages and control costs (Pimentel et al. 2000). Pimentel et al. further note that the annual cost would have been several times greater had they been able to assign monetary values to items such as species extinctions, ecosystem services, and aesthetics.

In response to a growing concern about invasive species, the U.S. Fish and Wildlife Service (FWS) made the monitoring and management of invasive species a high priority (U.S. Fish and Wildlife Service 1999). As part of these efforts, the FWS is developing a national system for surveying its lands for invasive species and for storing and disseminating information about invasive species. As an initial step, the FWS requested the Aldo Leopold Wilderness Research Institute (Leopold Institute) to conduct a survey of invasive and exotic species within all designated wilderness areas on FWS lands. This report summarizes the results of the survey, which was conducted by mail and phone in the summer of 2001.

Wilderness areas were chosen for the initial survey because they have been established in areas that were relatively undisturbed by human activity. Furthermore, under the directives of the Wilderness Act of 1964, these areas have been managed to maintain their natural conditions. Thus, wilderness areas serve as an ecological benchmark for identifying environmental change, a "base datum of normality … [that] assumes unexpected importance as a laboratory for the study of land-health" (Leopold 1949).

The Leopold Institute conducted a mail survey in 1997-98 of exotic plants in wilderness areas on all federal lands (Marler 2000). Only 22 of the 70 wilderness areas managed by the FWS responded to the earlier survey. However, a more recent survey, described in this report, achieved a 97% (68 of 70) response rate. In contrast to the earlier survey, this recent survey focused on invasive plants rather than exotic plants to assist responding managers in presenting reliable data. In addition, this survey included exotic animal and pathogen species and collected more detailed information on the distribution, monitoring, and management of invasive and exotic species in each wilderness area.

The results are located in an online database (ALWRI 2002). This database may be used as a tool to assess the current status of invasive species, monitor changes over time, and identify other wilderness areas that are experiencing similar invasive species problems. Examples of questions that can be used to query the database are:

- Which wilderness areas have saltcedar present?
- Which wilderness areas are using biological control agents on purple loosestrife?
- What is the contact information for managers who are dealing with feral hogs in wilderness areas?

For managers and other interested persons wishing to familiarize themselves with the scientific literature on invasive plant species in wilderness, the Leopold Institute has developed an annotated reading list on the subject (Osborn et al. 2002). This document is the fourth volume in the Leopold Institute's *Linking Wilderness Research and Management* series. It highlights journal articles, publications, and web sites pertaining to invasive plant ecology and their management in wilderness and other natural areas.

TERMINOLOGY

We use the definitions provided in Executive Order 13112 on invasive species (1999) for the same terms appearing in this report. Additionally, we consider an "exotic species" to be identical to an "alien species" as defined in the Order. Definitions of key terms that appear in this report include:

(a) Ecosystem—the complex of a community of organisms and its environment.
(b) Species—a group of organisms all of which have a high degree of physical and genetic similarity, generally interbreed only among themselves, and show persistent differences from members of allied groups of organisms.
(c) Introduction—the intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity.
(d) Native species—with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.
(e) Alien species—with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.
(f) Invasive species—an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.
(g) Control—as appropriate, eradicating, suppressing, reducing, or managing invasive species populations, preventing spread of invasive species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of invasive species and to prevent further invasions.

It must be noted that these definitions were not provided to the survey respondents when the survey forms were completed. Thus, individual respondents may have had differing interpretations for terms such as "exotic" and "invasive." In addition, respondents commented on several occasions that they were uncertain if a species was native to the area. This determination is made difficult by the dynamic nature of species distributions and the relatively short period of time in which distributions have been carefully documented (Schwartz 1997).

SURVEY METHODS

In 2001, the Leopold Institute developed a survey form asking for detailed information on the current presence, distribution, spread, monitoring, and management of invasive plants and exotic animals and pathogens in FWS wilderness areas (see Appendix A). Packets containing a

memorandum from the Chief of the National Wildlife Refuge System, a survey form, and a list of noxious weeds found in the appropriate state were sent to the Regional Chiefs, who then distributed them to the Refuge Managers at all refuges containing wilderness areas. The noxious weed list for each state was generated from the U.S. Department of Agriculture's Invaders Database System, accessed at http://invader.dbs.umt.edu/Noxious_Weeds/state_query.asp. For the 22 wilderness areas that participated in the 1997-98 survey on exotic plants, a copy of the completed form for that survey was mailed separately to the appropriate refuge. The noxious weed list and previously completed survey form were intended to facilitate the completion of the current survey. Refuge Managers were asked to route the survey materials to the appropriate refuge staff for completion. In most cases, Wildlife Biologists, Refuge Managers, or Assistant Refuge Managers completed the survey, but occasionally Project Leaders, Ecologists, or Wilderness Coordinators did so as well. Completed surveys were received in July and August of 2001. When necessary, follow-up phone calls were made to clarify or obtain information missing from a completed survey. A list of the participating wilderness areas is provided in Appendix B.

Survey results are organized into four separate tables: 1) general results (including all of the contact information for each wilderness area); 2) plant results; 3) animal results; and 4) pathogen results. The general results table contains information such as contact numbers and addresses for survey respondents, how many invasive and exotic species are present in each wilderness area, and qualitative assessments of the status and management of these species. The tables for specific taxa contain more detailed information, including which species are of greatest concern and what methods are being used to eradicate, control, or prevent invasions. These tables and a database composed of these tables can be accessed over the Internet (ALWRI 2002).

SURVEY RESULTS

General Results

This survey had a 97% response rate (68 of 70 wilderness areas). The survey was distributed from the top down within the Division of Refuges, which imparted a sense of importance to completing the survey. In addition, each wilderness area that did not complete the survey by the initial due date was contacted directly and asked to commit to completing the survey.

Region 7 (Alaska) contained the greatest number of responding refuge wilderness areas with 21. Region 4 (Southeast) was next with 16, half of which were located in Florida. The remaining wilderness areas were evenly distributed among the other Regions (see Figure 1). Because of the high response rate, this closely reflects the actual distribution of FWS wilderness areas.

At the time of this survey, Alaska contained over 90% of the total FWS wilderness acreage, 18.7 million of the 20.7 million total acres (see Figure 2). A single wilderness area, the Mollie Beattie Wilderness in the Arctic NWR, contained 8 million acres. Region 2 (Southwest) contained the large majority of the remaining wilderness acreage, primarily due to 2 large wilderness areas in Arizona's Sonoran Desert, the Cabeza Prieta Wilderness and the Kofa Wilderness.

Figure 1: Percent of wilderness areas surveyed by Region

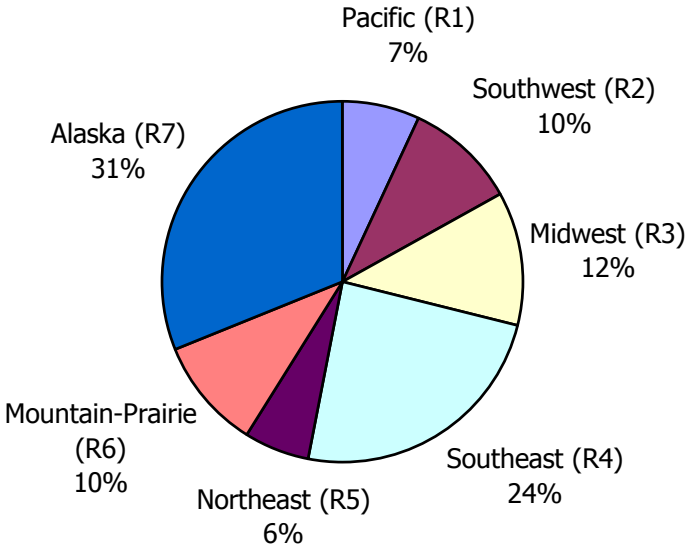
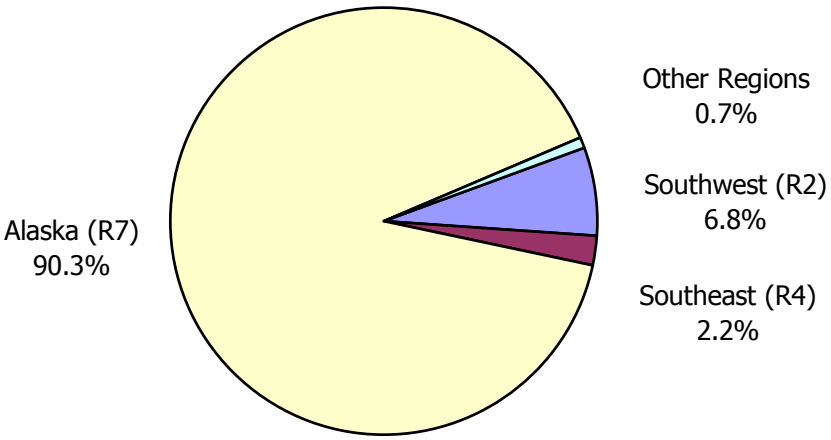


Figure 2: Percent of wilderness acres by Region



Analysis of the survey data showed substantial differences in the results for FWS wilderness areas in Alaska and those in the lower 48 states. For example, invasive plants were perceived as an insignificant problem in Alaskan wilderness areas, but they were a much more serious concern in the lower 48 wildernesses. On the other hand, exotic animals were deemed a serious concern in half of the Alaskan wilderness areas and a less serious concern in most of the lower 48 wildernesses.

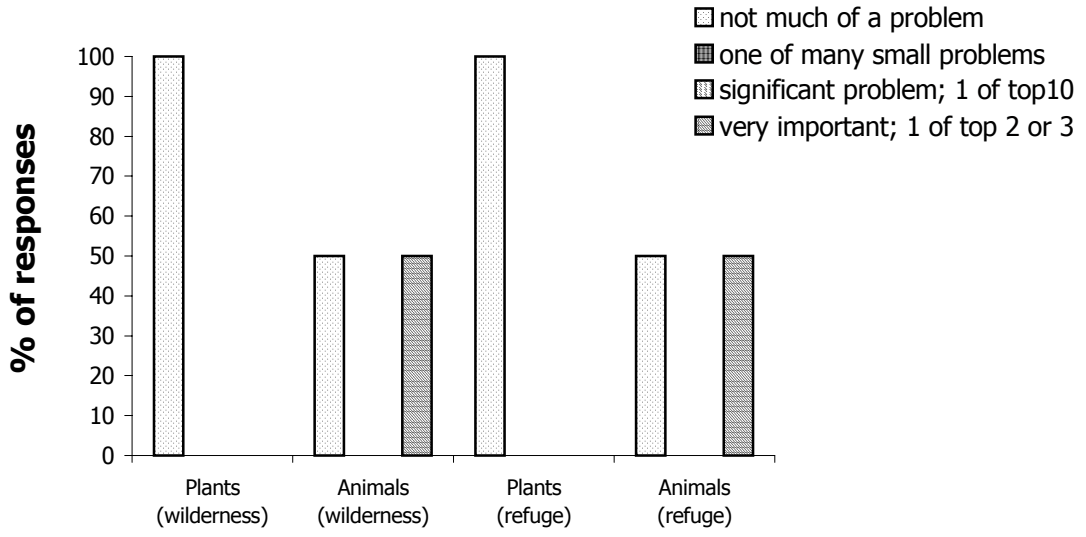
These results may have been due to characteristic differences between wilderness areas in the 2 regions. For example, Alaskan wilderness areas are remote, more isolated from intensive human development, and have more severe climates, which may make them less susceptible to plant invasions. On the other hand, many of the Alaskan wilderness areas are islands that lack most or all of the carnivore and herbivore species found on the mainland, which may make them more susceptible to exotic animal introductions. Thus, we present survey results separately for Alaska and the lower 48 states.

The general survey questions are grouped into 2 categories: 1) severity of the invasive and exotic species problem; and 2) monitoring and management of these species. The detailed survey results are presented in Appendices C, D, and E.

Severity of the problem

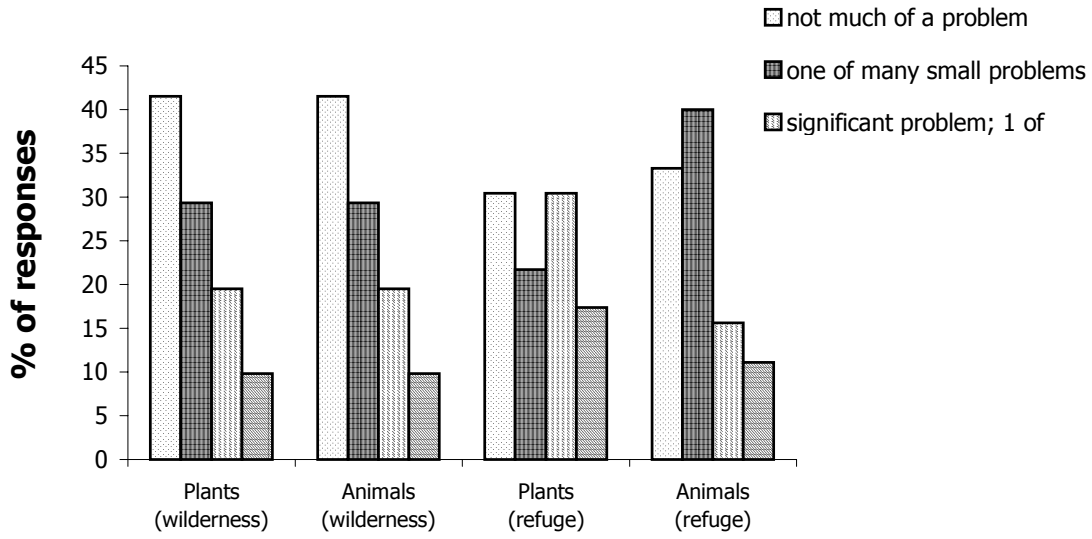
Alaska respondents indicated that exotic animals posed a greater threat than invasive plants (see Figure 3). In every case, plants were considered to be "not much of a problem," both within the wilderness area and the refuge as a whole. Furthermore, the perceived threat of invasive plant establishment in wilderness within the next 5 years was thought to remain "not much of a problem" in 95% of the responses (see Appendix C). On the other hand, exotic animals were thought to be "1 of the top 2 or 3" management problems in 50% of the responses, both within the wilderness area and the whole refuge. The perceived threat of exotic animal establishment in wilderness within the next 5 years was expected to still be "1 of the top 10" management problems in 50% of the cases. The slight decrease in expected problem severity was mainly due to the successful and ongoing eradication of introduced foxes from 36 islands (Ebbert 2000).

Figure 3: In Alaska, the presence and distribution of invasives/exotics are:



In the lower 48 states, 29% of the managers thought that both invasive plants and exotic animals were either a "significant" (1 of the top 10) or "very important" (1 of the top 2 or 3) management problem within wilderness areas (see Figure 4). Within refuges as a whole, invasive plants were considered a greater threat than exotic animals. Forty-eight percent of the managers indicated that invasive plants were a "significant" or "very important" problem, while most thought exotic animals were not a significant problem. The perceived threat of invasive plant and exotic animal establishment in wilderness within the next 5 years was expected to be similar to the current threat (see Appendix C). Thirty percent felt that invasive plants would be at least 1 of the top 10 problems, and 21% thought that exotic animals would be at least 1 of the top 10 problems.

Figure 4: In the lower 48 states, the presence and distribution of invasives/exotics are:



Exotic pathogens were not considered to be a serious problem in either Alaska or the lower 48 states. About 90% of the managers overall indicated that pathogens were "not much of a problem" in either the wilderness areas or the entire refuges (see Appendix C). The establishment of exotic pathogens within wilderness during the next 5 years was not generally perceived to be a great threat. Overall, 86% of the managers thought that pathogens would remain "not much of a problem." It should be noted, however, that 10% of the managers in the lower 48 anticipated that pathogens would become 1 of the top 10 management problems.

Monitoring and management

Monitoring—In Alaska, monitoring efforts were more common for exotic animals than for invasive plants and exotic pathogens. Invasive plants were monitored in only 10% of the wilderness areas, and exotic pathogens were monitored in only 5% (see Appendix D). In areas where monitoring did not occur, 90% of the managers felt that plants and pathogens were "not a significant problem." Conversely, exotic animals were monitored in 62% of the wilderness areas.

When monitoring of exotic animals did not occur, 50% of the managers cited a lack of staff and funding.

In the lower 48 wildernesses, invasive plants and exotic animals were monitored at similar rates (49% for plants, 46% for animals). Exotic pathogens were monitored only 14% of the time. For all 3 taxa, a large number of managers did not monitor these species because of a lack of staff and funding (54% for plants, 50% for animals, and 36% for pathogens). However, monitoring efforts in wildernesses usually did not involve systematic sampling surveys. Surveys were only conducted in 19% of the wildernesses for invasive plants, 18% for exotic animals, and 10% for exotic pathogens, reducing the reliability of the information provided.

Quality of the information—In Alaskan FWS wilderness areas, survey respondents had much more confidence in their knowledge of exotic animals than invasive plants. Sixty-seven percent of the respondents rated the accuracy of their plant information as a 1 (least accurate on a scale of 1-5; see Figure 5). Conversely, 83% rated the accuracy of their animal information as a 4 or 5. This difference in perceived accuracy occurred despite the similarity of the information sources for invasive plants and exotic animals (see Figure 6). Managers relied mainly on their best guesses followed by casual or opportunistic observations.

In the lower 48 wilderness areas, survey respondents had a similar degree of confidence in their knowledge of invasive plants and exotic animals (see Figure 5), in this instance reflecting the similarity of the information sources for the 2 groups (see Figure 6). Managers relied heavily on casual or opportunistic observations for their information, and there was less reliance on best guesses than with Alaskan managers, who often have difficulty in accessing wilderness.

Figure 5: What is the nature of the species list provided?

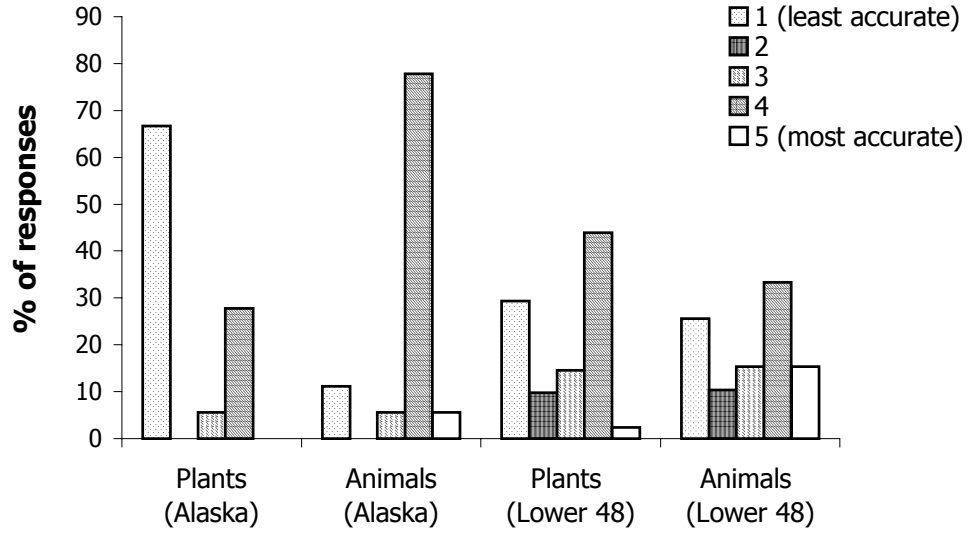
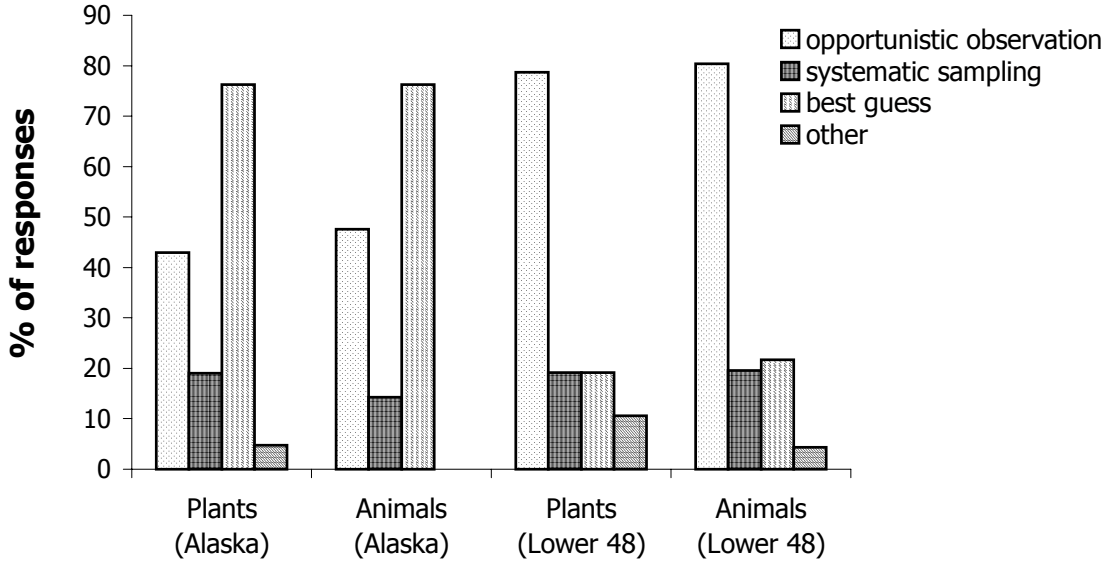


Figure 6: What is the source of information provided?



Neither group of respondents had much information on exotic pathogens in wilderness areas (see Appendix E). Overall, 74% rated the accuracy of their information for pathogens as a 1 (least accurate). Futhermore, 31% indicated that they had no information on pathogens (the "other" category for question #9) and could not even make an informed guess on the presence and distribution of exotic pathogens.

Management Plans—In Alaska, written management plans for invasive and exotic species in wilderness areas existed only for exotic animals (48% of the time; see Appendix D); there were no management plans for invasive plants or exotic pathogens. When plans had not been written for animals and plants, 48% of the respondents cited a lack of staff and funding. For pathogens, they were not considered to be a significant problem.

In the lower 48 states, management plans for invasive and exotic species in wilderness were not common for any of the taxa (17% for plants, 15% for animals, and 4% for pathogens). As with monitoring efforts, managers were frequently unable to write plans because of a lack of staff, funding, or both. This frequency was 41% for plants, 44% for animals, and 32% for pathogens.

NEPA—The National Environmental Policy Act (NEPA) requires that all proposals for "major Federal actions significantly affecting the quality of the human environment" must be accompanied by an environmental analysis that considers alternative courses of action and any adverse environmental impacts associated with each course of action. All Alaskan wilderness areas that were actively controlling exotic animals had completed environmental analyses. Control measures consisted of lethal removal of introduced rats and foxes from islands.

Thirty-three percent of the wilderness areas in the lower 48 states that were actively controlling invasive and exotic species had completed environmental analyses. Two general types of control activities were accompanied by a NEPA process in the lower 48 states: 1) lethal

and non-lethal removal of mammal species (burro, gemsbok, hog, nutria); and 2) integrated control programs for invasive plants that incorporated both biological and chemical methods.

Minimum Tool—According to Asher and Harmon (1995):

> Using the "minimum tool" ... means that when planning necessary actions within wilderness, managers must use the minimum necessary tools, equipments, or structures to accomplish wilderness management objectives.

Asher and Harmon note that in some cases, chemical control may be the only method capable of meeting management objectives in wilderness areas. Minimum tool analyses were completed for only 3 control efforts in all FWS wilderness areas despite the fact that several control programs involved the use of chemicals or the release of exotic biological control agents, both of which have the potential for unintended, adverse effects.

Regional Results

All species reported in each Region are listed in Appendix F. Respondents provided detailed information on each invasive and exotic species known to occur within their wilderness area, such as the number of acres invaded, the severity of threat to wilderness area goals, and what control methods, if any, were being used against it. Respondents further indicated which species, if any, were of greatest concern and provided additional information on the vectors and patterns of these species' establishment and spread (see survey form in Appendix A, page 24).

Survey results were summarized for each FWS Region. General information on each wilderness area (vegetation types, geographic features, management restrictions, etc.) was obtained by searching the National Wilderness Preservation System database (NWPS 2002). Most of the wilderness areas within a given Region were similar in terms of their vegetation and accessibility to the general public, and as a result, generally faced similar invasive species problems.

Region 1 (Pacific)

The 5 wilderness areas within the Pacific Region consist of rocky islands near the Pacific coast that are important breeding areas for marine birds and mammals and are off-limits to the public. Public access is not allowed to 4 of the areas, and refuge personnel seldom visit any of the areas because of their inaccessibility and the wildlife's sensitivity to disturbance.

Invasive and exotic species were not deemed a "significant problem" within any of the 5 wildernesses. Only 4 species of concern were listed, and 2 of these were introduced by early settlers. English ivy (*Hedera helix*) was restricted to the site of an old homestead in Washington's San Juan Wilderness. The house mouse (*Mus musculus*) was probably transported to California's Farallon Wilderness on the boats of early inhabitants. As a result, only 2 control efforts were being conducted. Hand pulling of English ivy was decreasing its abundance in the San Juan Wilderness, and an eradication project was being planned for the house mouse in the Farallon Wilderness.

Region 2 (Southwest)

Six of the 7 wilderness areas in the arid and semi-arid Southwest Region contain similar vegetation communities, such as desert scrub, desert grassland, and desert riparian zones. The Wichita Mountains Wilderness in Oklahoma contains mixed-grass prairie with some forest.

Invasive plants were considered to be a "significant problem" in 5 of the 7 wilderness areas. The most widespread invasive plant was saltcedar (*Tamarix spp.*), which was present in all 6 areas within Arizona and New Mexico and was a species of concern in 4 of these. Other problem species included Russian thistle (*Salsola kali*), Asian mustard (*Brassica tournefortii*), red brome (*Bromus rubens*), buffelgrass (*Pennisetum ciliare*), crimson fountaingrass (*P. setaceum*), eastern red cedar (*Juniperus virginiana*), and mesquite (*Prosopis spp.*). Each of these species was reported in only 1 or 2 wilderness areas, although some were considered a moderate or severe threat to wilderness area goals.

Despite the concern over invasive plants, control efforts were being conducted in only 2 cases. Managers at the Bosque del Apache Wilderness in New Mexico were attempting to control saltcedar by cutting and then spraying the stumps with an herbicide. At the Wichita Mountains Wilderness, prescribed fire and limited chemical treatment were being used to control eastern red cedar and mesquite. Roads were the most commonly mentioned vector of spread, being cited in 4 instances.

Four exotic animal species were listed as species of concern, and three of these were large ungulates (burro, *Equus asinus*; gemsbok, *Oryx gazella*; and hog, *Sus scrofa*). Wherever these ungulate species occurred, they were considered to be moderate or severe threats to wilderness area goals and active control efforts (lethal and non-lethal trapping, shooting) were being conducted. One respondent stated that efforts to control burros were hindered by federal legislation (Wild Free-Roaming Horses and Burros Act) that protected them. Gemsbok and hogs had been intentionally released for sport hunting on adjacent lands and will likely remain an ongoing management problem.

Region 3 (Midwest)

The 8 wilderness areas in the Midwest Region represent a more diverse mix in terms of location and vegetation. Three areas are islands located in the Great Lakes that are important breeding areas for birds (Michigan Islands, West Sister Island, and Wisconsin Islands), and 3 are a mixture of northern forest and wetlands (Agassiz, Seney, and Tamarac).

Invasive plant and exotic animal species were not considered to be a "significant problem" in any of these areas. However, on the non-wilderness portion of Ohio's West Sister Island NWR, invasive plants were considered to be a "very important" problem. Only 4 plants were listed as a species of concern, and each was listed in a single wilderness area. Of these, purple loosestrife (*Lythrum salicaria*) and spotted knapweed (*Centaurea maculosa*) have become major problems in other areas of the country. Only 1 control program was underway for invasive plants; a biological control agent for purple loosestrife had been released in the Michigan Islands Wilderness.

Three animal species of concern were noted, and no control efforts were being undertaken. In Missouri's Mingo Wilderness, nutria (*Myocastor coypus*) and nine-banded armadillos (*Dasypus novemcinctus*) had recently expanded their range northward into the area. These species were not problems yet, but the respondent stated that they were being monitored. The zebra mussel (*Dreissena polymorpha*) and gypsy moth (*Lymantria dispar*) were each known to occur in a single wilderness area, but they were not listed as a species of concern.

Region 4 (Southeast)

The 16 wilderness areas in the Southeast Region contain a variety of wetland ecosystems, including freshwater marshes, saltwater marshes, and estuaries, as well as some oak and pine woodlands in drier areas. Eight of the wilderness areas are located in Florida, which has probably

been more impacted by invasive species than any state other than Hawaii (see Simberloff et al. 1997).

Nineteen plant species were listed as a species of concern. Alligatorweed (*Alteranthera philoxeroides*), water hyacinth (*Eichhornia spp.*), water thyme or hydrilla (*Hydrilla verticillata*), Chinese tallow (*Sapium sebiferum*), and Brazilian pepper (*Schinus terebinthifolius*) were all listed as a species of concern in at least 2 wilderness areas. Yet, only 5 respondents thought that either invasive plants or exotic animals were "a significant problem." Because of the aggressive management actions being taken in this Region, these species may have been perceived as being under control. Sixteen control programs were in operation, and a chemical spraying program for several species in Florida's Lake Woodruff Wilderness was likely to be implemented in the near future. Most of the control programs consisted of either burning or cutting followed by chemical spraying, although a few programs relied solely on chemicals. The most common vector of spread reported for these species (14 instances) was dispersal by animals, mainly seed dispersal by birds. Transport by boats was an important vector in 7 cases.

Five wilderness areas were concerned about feral hogs, and 4 of these areas considered them to be moderate or severe threats to wilderness area goals. These 4 areas controlled hog populations by either trapping or shooting. Nutria was a species of concern in 2 wilderness areas, and both populations were trapped and shot to control their numbers.

Four areas also reported the known presence of pathogens, more than in any other FWS Region. In Louisiana's Lacassine Wilderness, managers attempted to prevent the occurrence of avian botulism (*Clostridium botulinum*) and duck virus enteritis (Family Herpesviridae) outbreaks by managing water levels to force waterfowl to occasionally relocate.

Region 5 (Northeast)

All 4 wilderness areas in the Northeast Region are located along the Eastern seaboard, and many contain large areas of wetlands (freshwater marshes, salt marshes, bogs). Respondents were concerned with a number of species that had the potential to become serious problems in wilderness, but felt that overall, invasive species were not currently a "significant problem." For example, air pollution was considered a more serious threat in Maine's Moosehorn Wilderness. Another respondent noted that invasive plants were a serious problem on New Jersey's Edwin B. Forsythe NWR, but that the harsh saline environment within the Refuge's Brigantine Wilderness made it less of a concern there. One exception was New Jersey's Great Swamp Wilderness, where invasive plants were thought to be a "very important" problem. Managers there had previously released biological control insects for purple loosestrife and were in the process of drafting a management plan for invasive plants.

Unlike the other Regions, there were no animal species of concern within the wilderness areas, and no control efforts were underway. However, 2 pathogens were present or suspected of being present that have the potential to seriously affect wilderness ecosystems: white pine blister rust (*Cromartium ribicola*) and West Nile virus (Family Flaviviridae).

Region 6 (Mountain-Prairie)

Six of the 7 wilderness areas in the Mountain-Prairie Region contain northern Great Plains prairie as well as freshwater lakes and ponds. The FWS-managed portion of Colorado's Mount Massive Wilderness contains conifer forest and grassland. Human visitation of these wilderness areas is generally restricted, as 5 areas do not allow camping.

In 4 of the wilderness areas, invasive plants were a "very important" problem. Leafy spurge (*Euphorbia esula*) and Canada thistle (*Cirsium arvense*) were the most widespread invasives, each being a species of greatest concern in 3 different areas. Seventeen control efforts were in

place for invasive species throughout the Region. Most of these were integrated management programs, using a combination of mechanical (burning, mowing), biological (insects, grazing), and chemical control methods. On North Dakota's Lostwood NWR, restoration efforts were also being undertaken. Native grass species were being reseeded, and these efforts were expected to extend into the Lostwood Wilderness within the next 3 years.

In 4 instances, trout species that had been historically stocked for fishing were listed as species of concern. Montana's Red Rocks Lakes Wilderness had utilized gillnetting, electroshocking, and angling pressure to reduce populations of brook trout (*Salvelinus fontenalis*), rainbow trout (*Onchorhynchus mykiss*), and Yellowstone cutthroat trout (*O. clarki bouvieri*). In the Leadville NFH portion of the Mount Massive Wilderness, brook trout were also being controlled with electroshocking and angling pressure.

The only case in the entire survey in which a pathogen was considered to be a "very important" problem occurred in the UL Bend Wilderness of Montana. Bubonic plague (*Yersinia pestis*) had been detected in prairie dog towns in proximity to the wilderness area and in blood samples taken from coyotes (*Canis latrans*) and badgers (*Taxidea taxus*) within the wilderness. Concern about the potential impacts of bubonic plague on black-tailed prairie dog (*Cynomys ludovicianus*) and black-footed ferret (*Mustela nigripes*) populations prompted managers to initiate a chemical spraying program that included the wilderness area.

Region 7 (Alaska)

The 21 wilderness areas in Alaska contain tundra, boreal forest, and rocky offshore islands. All of these areas are remote, subject to a harsh climate, and receive relatively few visitors. Thus, despite covering an area of nearly 19 million acres, many of these areas reported little concern for invasive species. All 21 areas thought that invasive plants and pathogens were "not much of a problem", and 10 areas thought that exotic animals were "not much of a problem."

However, managers of the 10 wilderness areas within the Alaska Maritime NWR were greatly concerned with exotic animals. All of these areas are oceanic islands located throughout an immense geographic area, ranging from the southeastern Alaska panhandle to the middle of the Bering Sea. Although the presence of exotic animals was documented for only 3 of the wilderness areas, the respondents felt that preventing the introduction of new exotics was a top management priority for all of the areas. The exotics were all introduced mammal species, and the Aleutian Islands Wilderness, containing dozens of islands spread out over hundreds of miles, was particularly affected. A management plan and control program had been developed there for eliminating and preventing the spread of Arctic foxes (*Alopex lagopus*) and Norway rats (*Rattus norvegicus*).

Comparison of Plant Results for 1997-98 and 2001 Surveys

In 1997-98, the Leopold Institute conducted an exotic plants survey of all federal wilderness areas. Although this survey asked respondents to list all exotic plants, the results from the 22 FWS wilderness areas that participated in the survey indicated that nearly all listed species were invasive. Seven of the 22 individuals who completed the initial survey for a FWS wilderness area also completed the 2001 survey, and 2001 survey respondents were also sent the completed 1997-98 survey form as a reference. Therefore, a comparison of the results between the surveys should still be meaningful. Managers of the following 22 wilderness areas completed invasive plant surveys in both 1997-98 and 2001:

Region	Wilderness Area
Pacific	Farallon, Oregon Islands
Southwest	Cabeza Prieta
Midwest	none
Southeast	Breton, Chassahowitzka, Florida Keys, J.N. "Ding" Darling, Lacassine, St. Marks
Northeast	none
Mountain-Prairie	Chase Lake, Medicine Lake, UL Bend
Alaska	Aleutian Islands, Andreafsky, Becharof, Izembek, Kenai, Nunivak, Saint Lazaria, Selawik, Togiak

The 1997-98 exotic plants survey contained questions about the quality of the information provided, current management efforts, identity of species present, and identity of species of greatest concern (see the 1997-98 survey form in Appendix G). These questions were similar to the 2001 survey questions.

Overall, the 2001 survey results documented an increased threat to these FWS wilderness areas from invasive plants (Table 1). These totals were calculated by summing up the number of species reported in each wilderness area. Even though the initial survey supposedly included all exotic plant species, the 2001 survey, which was limited to invasive plants, listed more total species and species of concern. Additionally, the number of wilderness areas where invasive plants were considered to be at least a "significant problem" increased from 9% to 23%.

TABLE 1: A Comparison of the General Results Between the 1997-98 and 2001 Invasive Plant Surveys for 22 FWS Wilderness Areas

Severity of Threat	1997-98	2001
Total # of Invasive Plant Species	49*	56
Total # of Species of Concern	8	20
# of Wilderness Areas Where Invasive Plants Were a "Significant" or "Very Important" Problem	2	5
Management Efforts	**1997-98**	**2001**
# of Wilderness Areas With an Invasive Plants Management Plan (Completed or In Progress)	2	4
# of Wilderness Areas Where Invasive Plants Are Monitored	13	14

# of Wilderness Areas Where Systematic Sampling for Invasive Plants Occurs	4	6

* —the Oregon Islands Wilderness survey respondent had originally indicated that 7 exotic plant species were present in the 1997-98 survey, compared to 17 in the 2001 survey. However, the 2001 survey indicated that the exotic species list was obtained from a botanical survey conducted in 1984. After consulting the respondent, it was determined that a total of 17 species should also have been listed in the 1997-98 survey.

Furthermore, there was an increase in management effort during the time between the surveys (see Table 1). The number of management plans, completed or in progress, for invasive plants in wilderness areas increased from 2 to 4. There was also a slight increase in the monitoring and sampling effort for invasive plants in wilderness areas.

Most of the reported increase in invasive plant species of concern occurred within 3 wilderness areas. The Cabeza Prieta Wilderness in Arizona reported 4 new species of concern in the 2001 survey: buffelgrass, crimson fountaingrass, Lehmann lovegrass (*Eragrostis lehmanniana*), and saltcedar. The Bosque del Apache Wilderness in New Mexico reported 2 new species of concern, Russian knapweed and saltcedar. None of these species were even listed as being present in the initial survey, although the 2001 survey respondents indicated in follow-up communication that all 6 species had probably been present in 1997-98 but were undetected. Neither of these wilderness areas is monitored for invasive plants; invasive plants are detected solely by opportunistic, casual observations. Thus, the detection of these species, all of which have been highly invasive in other areas, was probably delayed by the lack of systematic monitoring programs. Additionally, the Chase Lake Wilderness in North Dakota upgraded 3 species that were present on the initial survey to "concern" status on the 2001 survey. Their control efforts for leafy spurge that had been reported on the first survey (biological and chemical control) were still in place, and the distribution of all 3 species of concern were reported to be stable.

Two wilderness areas in Florida had eradicated some invasive plant species during the time between the 2 surveys. Australian pine (*Casuarina equisetifolia*) and white leadtree (*Leucaena leucocephala*) were eradicated from the Florida Keys Wilderness, and Australian pine was removed from the J.N. "Ding" Darling Wilderness. Although these species are still present outside of the wilderness areas, both refuges have aggressive refuge-wide control programs in place.

MANAGEMENT IMPLICATIONS

Severity of the Problem

Managers' concerns over invasive plants varied greatly by Region. For example, largely due to the remote nature and harsh climates of wilderness areas in Region 7 (Alaska), all 21 areas in Alaska reported that plants were not a significant problem. However, plants were a significant concern in Region 2 (Southwest), Region 4 (Southeast), and Region 6 (Mountain-Prairie). Wilderness areas in these Regions are coping with several species that are capable of greatly altering ecosystem structure and function. In the Southwest and Mountain-Prairie Regions, invasive grasses, such as cheatgrass and Lehmann lovegrass, can dominate vast areas of grassland

and shrub steppe, resulting in an accelerated fire regime that reinforces their dominance over native plants (Brooks and Pyke 2001, Grace et al. 2001). Saltcedar invades desert riparian areas, leading to changes in fire regimes, hydrology, and stream morphology (DiTomaso 1998). In Florida, woody species, such as Brazilian pepper, Chinese tallow, and Australian pine, can convert sawgrass marshes and coastal prairies into dense woodlands (Simberloff et al. 1997).

Concern over exotic animals varied greatly by Region also. In Alaska, nearly half of the wilderness areas consisted of islands that are important breeding grounds for seabirds and waterfowl and are threatened by exotic animals. Breeding bird populations have been nearly eliminated from many islands due to historical, intentional releases of Arctic foxes and red foxes (*Vulpes vulpes*) for fur farming (Bailey 1993). The unintentional introduction of rats to some of these islands has also threatened these breeding colonies (Bailey 1993). As a result, the Alaska Maritime NWR has an aggressive control program that has successfully eliminated these predators from many of the wilderness islands. As with invasive plants, Region 2 (Southwest), Region 4 (Southeast), and Region 6 (Mountain-Prairie) have major problems with several exotic animal species. In the Southwest, feral burros can seriously damage vegetation and soil, and their management is complicated by the protection afforded to them by the Wild Free-Roaming Horses and Burros Act (Pogacnik 1995). In the Southwest and Southeast, feral hogs disturb the vegetation, compete with native herbivores for forage, and prey on ground-nesting birds and reptiles (see Cox 1999). In the Mountain-Prairie Region, exotic fish species, such as brook trout and rainbow trout, are a concern at 2 refuges and are being actively controlled by managers.

In contrast to plants and animals, exotic pathogens were not considered to be a current problem in FWS wilderness areas. However, 10% of the managers in the lower 48 states anticipated that pathogens would become a significant problem within the next 5 years. Some pathogens, such as West Nile virus in birds and chronic wasting disease in ungulates, have recently been found in new regions of the country and may become serious problems in some areas (Enserink 2002, Williams et al. 2002).

Thus, the survey results indicate that invasive and exotic species are a widespread problem in FWS wilderness areas, with some Regions being particularly susceptible. Despite their relatively natural condition and special management status, wilderness areas have not been immune to the increasing spread of non-native species. Because wilderness areas within individual FWS Regions have similar invasive species and management issues, further dialogue among managers within Regions should aid prevention and control efforts.

Monitoring and Management

Few refuges monitored invasive or exotic species within wilderness areas using systematic sampling surveys. Although many refuges stated that invasive and exotic species were monitored, they relied heavily on opportunistic or casual observations to do so. Early detection and action is critical in preventing the spread of invasive species because once populations have become well established, eradication can be extremely difficult (Randall 1991). Furthermore, monitoring of both invasive and native species is needed to assess the effectiveness of current control efforts and to determine if these efforts have restored native species' populations and ecosystem processes. Establishing a Refuge System-wide monitoring protocol is greatly needed and has been identified as a management goal within the System (U.S. Fish and Wildlife Service 1999).

Many FWS wilderness areas are small and relatively isolated, making the control and eradication of invasive species a feasible objective if they are detected at an early stage. In some cases, this requires cooperation between the FWS and local, state, and other federal agencies, as well as surrounding private landowners. For example, the J. N. "Ding" Darling NWR, located on Sanibel Island in Florida, was cooperating with the city of Sanibel and a local non-profit

organization to control invasive plants on the island. As a result, melaleuca (*Melaleuca quinquenervis*) was eradicated from the island, and Australian pine was removed from the J. N. "Ding" Darling Wilderness. In another example, Australian pine and white leadtree were removed from the Florida Keys Wilderness through the volunteer work of a Refuge wildlife biologist and local citizens, who donated several weekends to the effort. Cooperative efforts were also needed to prevent the introduction of non-native species to refuges and refuge wilderness areas. One example was a rodent prevention program in the Pribilof Islands involving the Alaska Maritime NWR and local governments, industry, the State of Alaska, and other federal agencies that seeks to keep rats and mice from being introduced to the islands. Some of these islands are critical breeding grounds for seabirds and waterfowl.

A wide variety of control efforts were underway on many refuges, particularly in 3 Regions that have proven especially vulnerable to invasive species (Southeast, Southwest, and Mountain-Prairie), and respondents thought that these efforts were making a difference. When control efforts were being conducted, species of concern were thought to be decreasing in distribution 33% of the time. When control efforts were not in place, species of concern were thought to be decreasing in only 4% of the cases. Fifty-one percent of the refuges that were conducting current control efforts in wilderness had completed NEPA analyses, but only 8% had completed a minimum tool analysis. Managers could easily incorporate a minimum tool analysis into future NEPA documents. A "Minimum Requirement Decision Guide" is available for use by managers in determining the minimum action and tool required to achieve wilderness management objectives (Arthur Carhart National Wilderness Training Center 2002).

Many survey respondents cited a lack of funding and staff for their inability to adequately survey, monitor, and control invasive and exotic species, similar to wilderness managers within other agencies (Marler 2000). Given these limitations, strategies could be developed to incorporate the early detection of invasive species into regular work duties. For example, all refuge personnel (including non-biologists) could be trained to identify potential problem species and could note the location of these species when working on the refuge. This could be particularly effective in wilderness areas that are infrequently visited by refuge personnel. Ultimately, however, efforts to "address inadequate and inconsistent biological staffing" will be needed. Such efforts have been previously identified as a management priority (U.S. Fish and Wildlife Service 1999).

FUTURE DIRECTIONS

The information collected in this survey indicates the value of the FWS continuing to move forward with a Refuge System-wide effort to survey, monitor, and control invasive and exotic species. Although the majority of refuges did not have systematic sampling efforts in place, non-native species were known to be present in every wilderness area that was surveyed and were serious problems in many.

The agency has initiated a project to develop a System-wide inventory program for identifying and prioritizing invasive species on all refuge lands, not just wilderness areas (NIISS 2002). As a first step in this initiative, personnel at each FWS refuge will complete an electronic survey on invasive plants, animals, and pathogens. The Leopold Institute survey was consulted and expanded upon during the development of the electronic survey. Some improvements in the electronic survey were the inclusion of more detailed questions (e.g., the availability of vegetation and soils maps, which habitat types have been invaded the most, which survey methods have been used), a definition of invasive species, and background information for each section of the survey. The results of this survey will help to identify gaps in the current knowledge of invasive species and to guide the next phase of the project, in which field surveys will be conducted on

each refuge. Ultimately, this program will result in a standard protocol to adequately survey all FWS refuges for invasive species.

It will be important to continue monitoring the status of invasive species in FWS wilderness areas both to provide an ecological benchmark for the rest of the Refuge System and to ensure that diversions from the wilderness mandate to maintain natural conditions are noted. The planned surveying protocol should be designed to easily allow a comparison of wilderness and non-wilderness portions of the Refuge System.

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APPENDIX A: 2001 Invasive Species Survey Form

WILDERNESS AREA INVASIVE SPECIES SURVEY 2001

U.S. FISH AND WILDLIFE SERVICE & THE ALDO LEOPOLD WILDERNESS RESEARCH INSTITUTE

This survey documents the occurrence and quantifies the scope of the problem of invasive / exotic species on National Wildlife Refuge Wilderness Areas. For plants, we are most interested in those species that are seen as problem invasives (species either listed on your state's noxious weed list and other non-native species of concern). However, we are interested in all exotic (non-native) animals and pathogens. If no invasives are present in your Wilderness area, please just fill out questions 3 - 9. Thank you very much for your assistance.

Please return this survey by 7-25-01 to Amy Cilimburg, Leopold Institute, P.O. Box 8089, Missoula, MT 59807. If you have questions contact Amy at 406-542-3244 or acilimburg@fs.fed.us. This form is available through our web site (www.wilderness.net/leopold/ - go to "staff" – "Cilimburg").

Name_____ Your Position _____ Phone _____ Email _____
Address_____ Date _____
Name of Refuge _____ Name of Wilderness_____

SPECIES LISTS – include species found in the Wilderness area only (not adjacent lands). Attach additional pages if necessary. For **control priority ranking**, place 0 (not used), 1 (highest), 2, 3, or 4 (lowest) next to the M (mechanical), B (biological), Ch (chemical) and Cu (cultural) to prioritize control methods used.

INVASIVE PLANTS **Latin name**	**Common name**	**Coverage** Approx. # of acres	**Threat to Wilderness area goals** 1- negligible 2- moderate 3- severe 4- unknown	**Control priority ranking** M, B, Ch, Cu (see note above)	**Mechanical controls** Type, frequency and approx. acres covered (e.g., mowing, burning, pulling)	**Biological controls** Name or description of the agent used (insects, grazing animals, disease).	**Chemical controls** Brand name (e.g. Tordon, RoundUp) approx. acres treated, and application method	**Cultural controls** Restrictions (humans, domestic animal), timing of activities, re-vegetation, etc.
e.g. *Centaurea maculosa*	spotted knapweed	300 acres	3	M 2, B 0, Ch 1, Cu 0	Hand pulling once/yr – 2 acres	none	Tordon – 30 acres, vehicle spray	none
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				
				M__, B__, Ch__ , Cu__				

Exotic and Invasive Animals – include all non-native amphibians, birds, fish, invertebrates (insects, mollusks, etc.), mammals (feral and domestic), and reptiles.

EXOTIC ANIMALS **General taxon** (see above)	**Latin name**	**Common name**	**Is species invasive?** 1 – yes 2 – no 3 – unkn.	**Percent of available habitat occupied** approximate	**Threat to Wilderness goals** 1 - negligible 3 - severe 2 - moderate 4 - unkn	**Control efforts type and frequency** e.g. trapping, shooting, restricting entry, pesticides, chemical, none
e.g. birds	*Malothrus ater*	Brown-headed Cowbird	1	20 %	3	Trap adults once/year

EXOTIC PATHOGENS **Latin name**	**Common name**	**Intensity of impact** (if relevant) approx. % host affected	**Is species invasive?** 1 – yes 2 – no 3 – unkn.	**Threat to Wilderness goals** 1 - negligible 3 - severe 2 - moderate 4 - unkn.	**Control efforts / comments**
e.g. *Cronartium ribicola*	White pine blister rust	10%	1	2	none

1. Circle the number that best describes the nature of the species lists on pages 1 and 2. 1 - the list is rough ….. 5 - the list is highly accurate

Invasive plants:					**Exotic animals :**					**Exotic pathogens:**				
1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

2. For this *Wilderness area*, the presence and distribution of invasive / exotic species is: (fill in blanks)

A) not much of a problem.
B) one of many small problems
C) a significant problem; 1 of the top 10 management concerns
D) very important; one of 2 or 3 top priorities / management concerns

Invasive plants ____ **Exotic animals ____** **Exotic pathogens _____**

3. For this *Wildlife Refuge as a whole*, the presence and distribution of invasive / exotic species is: (fill in blanks)

A) not much of a problem.
B) one of many small problems
C) a significant problem; 1 of the top 10 management concerns
D) very important; one of 2 or 3 top priorities / management concerns

Invasive plants ____ **Exotic animals ____** **Exotic pathogens _____**

4. For this *Wilderness area*, the perceived threat in 5 years of invasive/ exotic species establishment is likely to be: (fill in blanks)

A) not much of a problem.
B) one of many small problems
C) a significant problem; 1 of the top 10 management concerns
D) very important; one of 2 or 3 top priorities / management concerns

Invasive plants ____ **Exotic animals ____** **Exotic pathogens _____**

5. Is there a written invasive /exotic species management plan for this Wilderness area?

Invasive plants: Y N If yes, does it prioritize species for control? Y N Is it a refuge-wide plan or specific to Wilderness?_____
When was it completed? _____ When was it last updated? _____
Exotic animals: Y N If yes, does it prioritize species for control? Y N Is it a refuge-wide plan or specific to Wilderness?_____
When was it completed? _____ When was it last updated? _____
Exotic pathogens: Y N If yes, does it prioritize species for control? Y N Is it a refuge-wide plan or specific to Wilderness?_____
When was it completed? _____ When was it last updated? _____

If there is not a plan, why not? (fill in blanks)

A) weeds/ exotics are not a significant problem
B) it has been started but not completed
C) cost prohibitive / lack of funding
D) labor prohibitive / lack of staff
E) C and D
F) other (explain)

Invasive plants _____ **Exotic animals** _____ **Exotic pathogens** _____

6. Are invasives / exotics monitored in this Wilderness area?

Invasive plants: Y N If yes, how frequently?_____
Exotic animals: Y N If yes, how frequently?_____
Exotic pathogens: Y N If yes, how frequently?_____

If no, why not? (fill in blanks)

A) weeds / exotics are not a significant problem
B) cost prohibitive / lack of funding
C) labor prohibitive / lack of staff
D) B and C
E) other (explain)

Invasive plants _____ **Exotic animals** _____ **Exotic pathogens** _____

7. Was a NEPA process completed for any current invasive / exotics control efforts in the Wilderness area? Y N
If yes, for which species?_____

8. Was a Minimum Tool Analysis completed for any current invasive / exotics control efforts in the Wilderness area? Y N
If yes, for which species?_____

9. In general, what is the source of the information you are providing? (fill in blanks)

A) casual or opportunistic observation
B) systematic sampling (along transects, in long term plots, etc.)
C) best guess, based on knowledge of similar, surrounding areas outside the Wilderness
D) other (explain below)

Invasive plants _____ **Exotic animals** _____ **Exotic pathogens** _____

SPECIES OF GREATEST CONCERN

We would appreciate more detailed information on invasive / exotic species that are of greatest concern in your Wilderness area. Please attach additional pages if necessary. Examples of disturbance vectors are livestock, vehicles, horsepackers, hikers, timber harvest, escape from cultivation, unknown, etc.

Species name_____

What disturbance vector may be responsible for its establishment/spread?_____

Pattern of infestation – circle one

A) one or more large populations B) few or several small populations C) one or more large and few to several small populations

Infestations are mainly along roads, rivers, trails: Y N

Spread – this species is:

A) increasing despite control efforts C) decreasing through control efforts E) stable through control efforts G) unknown
B) increasing; there are no control efforts D) decreasing without control efforts F) stable without control efforts

Species name_____

What disturbance vector may be responsible for its establishment/spread?_____

Pattern of infestation – circle one

A) one or more large populations B) few or several small populations C) one or more large and few to several small populations

Infestations are mainly along roads, rivers, trials: Y N

Spread – this species is:

A) increasing despite control efforts C) decreasing through control efforts E) stable through control efforts G) unknown
B) increasing; there are no control efforts D) decreasing without control efforts F) stable without control efforts

Species name_____

What disturbance vector may be responsible for its establishment/spread?_____

Pattern of infestation – circle one

A) one or more large populations B) few or several small populations C) one or more large and few to several small populations

Infestations are mainly along roads, rivers, trials: Y N

Spread – this species is:

A) increasing despite control efforts C) decreasing through control efforts E) stable through control efforts G) unknown
B) increasing; there are no control efforts D) decreasing without control efforts F) stable without control efforts

Species name___________________________________
What disturbance vector may be responsible for its establishment/spread?____
Pattern of infestation – circle one
A) one or more large populations   B) few or several small populations   C) one or more large and few to several small populations
Infestations are mainly along roads, rivers, trials: Y   N
Spread – this species is:
A) increasing despite control efforts   C) decreasing through control efforts   E) stable through control efforts   G) unknown
B) increasing; there are no control efforts   D) decreasing without control efforts   F) stable without control efforts

Species name___________________________________
What disturbance vector may be responsible for its establishment/spread?____
Pattern of infestation – circle one
A) one or more large populations   B) few or several small populations   C) one or more large and few to several small populations
Infestations are mainly along roads, rivers, trials: Y   N
Spread – this species is:
A) increasing despite control efforts   C) decreasing through control efforts   E) stable through control efforts   G) unknown
B) increasing; there are no control efforts   D) decreasing without control efforts   F) stable without control efforts

Species name___________________________________
What disturbance vector may be responsible for its establishment/spread?____
Pattern of infestation – circle one
A) one or more large populations   B) few or several small populations   C) one or more large and few to several small populations
Infestations are mainly along roads, rivers, trials: Y   N
Spread – this species is:
A) increasing despite control efforts   C) decreasing through control efforts   E) stable through control efforts   G) unknown
B) increasing; there are no control efforts   D) decreasing without control efforts   F) stable without control efforts

We are also interested in your general impressions of the status of invasive / exotic species in this Wilderness area and any relevant background information (grazing history, elevation tolerance of species, etc.) to which you may have access. If possible, include a map indicating the location of your problem invasives.

Feel free to expand on any of your responses on the back of this page.

THANK YOU VERY MUCH FOR YOUR TIME AND EXPERTISE.

APPENDIX B: List of Participating Wilderness Areas

The wilderness and refuge names and wilderness sizes were obtained from pages 34-35 in "National Wilderness Preservation System Database: Key Attributes and Trends, 1964 Through 1999" by Peter Landres and Shannon Meyer, U.S.D.A. Forest Service, General Technical Report RMRS-GTR-18, July 2000. Some wilderness areas contained multiple units, which were combined to determine the administrative refuge(s) and size of the wilderness area. This information can be accessed online (NWPS 2002).

The 2 non-participating FWS wilderness areas were the Pelican Island Wilderness in Florida and the Huron Islands Wilderness in Michigan.

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* — completed invasive plants survey in both 1997-98 and 2001.

+ — by law, there is both a Moosehorn (Baring Unit) Wilderness and a Moosehorn Wilderness. These units were considered to be a single wilderness area for the purposes of this survey.

REGION	STATE	WILDERNESS NAME	REFUGE NAME	SIZE (acres)
1	CA	*Farallon	Farallon NWR	141
1	OR	*Oregon Islands	Oregon Islands NWR	575
1	OR	Three Arch Rocks	Three Arch Rocks NWR	15
1	WA	San Juan	San Juan Islands NWR	353
1	WA	Washington Islands	Copalis NWR Flattery Rocks NWR Quillayute Needles NWR	485
2	AZ	*Cabeza Prieta	Cabeza Prieta NWR	803,418
2	AZ, CA	Havasu	Havasu NWR	17,801
2	AZ, CA	Imperial Refuge	Imperial NWR	15,056
2	AZ	Kofa	Kofa NWR	516,200
2	NM	*Bosque del Apache	Bosque del Apache NWR	30,287
2	NM	Salt Creek	Bitter Lake NWR	9,621
2	OK	Wichita Mountains	Wichita Mountains NWR	8,570
3	IL	Crab Orchard	Crab Orchard NWR	4,050
3	MI	Michigan Islands	Michigan Islands NWR	12
3	MI	Seney	Seney NWR	25,150
3	MN	Agassiz	Agassiz NWR	4,000
3	MN	Tamarac	Tamarac NWR	2,180
3	MO	Mingo	Mingo NWR	7,730
3	OH	West Sister Island	West Sister Island NWR	77

3	WI	Wisconsin Islands	Gravel Island NWR Green Bay NWR	29
4	AR	Big Lake	Big Lake NWR	2,143
4	FL	Cedar Keys	Cedar Keys NWR	379
4	FL	*Chassahowitzka	Chassahowitzka NWR	23,578
4	FL	*Florida Keys	Great White Heron NWR Key West NWR National Key Deer Refuge	6,197
4	FL	Island Bay	Island Bay NWR	20
4	FL	*J.N. “Ding” Darling	J.N. “Ding” Darling NWR	2,619
4	FL	Lake Woodruff	Lake Woodruff NWR	1,146
4	FL	Passage Key	Passage Key NWR	36
4	FL	*St. Marks	St. Marks NWR	17,350
4	GA	Blackbeard Island	Blackbeard Island NWR	3,000
4	GA	Okefenokee	Okefenokee NWR	353,981
4	GA	Wolf Island	Wolf Island NWR	5,126
4	LA	*Breton	Breton NWR	5,000
4	LA	*Lacassine	Lacassine NWR	3,345
4	NC	Swanquarter	Swanquarter NWR	8,785
4	SC	Cape Romain	Cape Romain NWR	29,000
5	MA	Monomoy	Monomoy NWR	2,420
5	ME	+Moosehorn	Moosehorn NWR	7,392
5	NJ	Brigantine	Edwin B. Forsythe NWR	6,681
5	NJ	Great Swamp National Wildlife Refuge	Great Swamp NWR	3,660
6	CO	Mount Massive	Leadville NFH	2,560
6	MT	*Medicine Lake	Medicine Lake NWR	11,366
6	MT	Red Rock Lakes	Red Rock Lakes NWR	32,350
6	MT	*UL Bend	UL Bend NWR	20,819
6	ND	*Chase Lake	Chase Lake NWR	4,155
6	ND	Lostwood	Lostwood NWR	5,577
6	NE	Fort Niobrara	Fort Niobrara NWR	4,635
7	AK	*Aleutian Islands	Alaska Maritime NWR	1,300,000
7	AK	*Andreafsky	Yukon Delta NWR	1,300,000
7	AK	*Becharof	Becharof NWR	400,000

7	AK	Bering Sea	Alaska Maritime NWR	81,340
7	AK	Bogoslof	Alaska Maritime NWR	175
7	AK	Chamisso	Alaska Maritime NWR	455
7	AK	Forrester Island	Alaska Maritime NWR	2,832
7	AK	Hazy Islands	Alaska Maritime NWR	32
7	AK	Innoko	Innoko NWR	1,240,000
7	AK	*Izembek	Izembek NWR	300,000
7	AK	*Kenai	Kenai NWR	1,350,592
7	AK	Koyukuk	Koyukuk NWR	400,000
7	AK	Mollie Beattie	Arctic NWR	8,000,000
7	AK	*Nunivak	Yukon Delta NWR	600,000
7	AK	*Saint Lazaria	Alaska Maritime NWR	65
7	AK	*Selawik	Selawik NWR	240,000
7	AK	Semidi	Alaska Maritime NWR	250,000
7	AK	Simeonof	Alaska Maritime NWR	25,855
7	AK	*Togiak	Togiak NWR	2,270,000
7	AK	Tuxedni	Alaska Maritime NWR	5,566
7	AK	Unimak	Alaska Maritime NWR	910,000

APPENDIX C: Results—Severity of the Problem

2. Within the wilderness area, the presence and distribution of invasives / exotics are:	Alaska	Lower 48	Combined
Plants:			
A—not much of a problem	100.0	41.5	60.7
B—one of many small problems	0.0	29.3	19.7
C—a significant problem (1 of top 10)	0.0	19.5	13.1
D—very important (1 of the top 2 or 3)	0.0	9.8	6.6
Animals:			
A—not much of a problem	50.0	41.5	44.3
B—one of many small problems	0.0	29.3	19.7
C—a significant problem (1 of top 10)	0.0	19.5	13.1
D—very important (1 of the top 2 or 3)	50.0	9.8	23.0
Pathogens:			
A—not much of a problem	100.0	83.3	89.3
B—one of many small problems	0.0	13.9	8.9
C—a significant problem (1 of top 10)	0.0	0.0	0.0
D—very important (1 of the top 2 or 3)	0.0	2.8	1.8
3. Within the entire wildlife refuge, the presence and distribution of invasives / exotics are:	**Alaska**	**Lower 48**	**Combined**
Plants:			
A—not much of a problem	100.0	30.4	51.5
B—one of many small problems	0.0	21.7	15.2
C—a significant problem (1 of top 10)	0.0	30.4	21.2
D—very important (1 of the top 2 or 3)	0.0	17.4	12.1
Animals:			
A—not much of a problem	50.0	33.3	38.5
B—one of many small problems	0.0	40.0	27.7
C—a significant problem (1 of top 10)	0.0	15.6	10.8
D—very important (1 of the top 2 or 3)	50.0	11.1	23.1
Pathogens			
A—not much of a problem	100.0	84.6	89.8
B—one of many small problems	0.0	12.8	8.5
C—a significant problem (1 of top 10)	0.0	2.6	1.7
D—very important (1 of the top 2 or 3)	0.0	0.0	0.0
4. Within the wilderness area, the perceived threat of invasive / exotic species establishment in the next 5 years is likely to be:	**Alaska**	**Lower 48**	**Combined**
Plants:			
A—not much of a problem	95.0	33.3	51.5
B—one of many small problems	5.0	35.4	26.5
C—a significant problem (1 of top 10)	0.0	20.8	14.7
D—very important (1 of the top 2 or 3)	0.0	10.4	7.4
Animals:			
A—not much of a problem	45.0	36.4	39.1
B—one of many small problems	5.0	43.2	31.3
C—a significant problem (1 of top 10)	50.0	9.1	21.9
D—very important (1 of the top 2 or 3)	0.0	11.4	7.8
Pathogens:			
A—not much of a problem	95.0	81.1	86.0
B—one of many small problems	5.0	8.1	7.0
C—a significant problem (1 of top 10)	0.0	10.8	7.0
D—very important (1 of the top 2 or 3)	0.0	0.0	0.0

APPENDIX D: Results—Monitoring and Management

6. Within the wilderness area, are invasives / exotics monitored?	Alaska	Lower 48	Combined
Plants:			
Yes	9.5	48.9	36.8
No	90.5	51.1	63.2
Animals:			
Yes	61.9	45.5	50.8
No	38.1	54.5	49.2
Pathogens:			
Yes	4.8	13.6	10.8
No	95.2	86.4	89.2
If no, why not?	**Alaska**	**Lower 48**	**Combined**
Plants:			
A—not a significant problem	89.5	36.0	59.1
B—cost prohibitive / lack of funding	0.0	0.0	0.0
C—labor prohibitive / lack of staff	0.0	24.0	13.6
D—both B and C	0.0	40.0	22.7
E—other	10.5	0.0	4.5
Animals:			
A—not a significant problem	38.9	46.4	43.5
B—cost prohibitive / lack of funding	0.0	0.0	0.0
C—labor prohibitive / lack of staff	0.0	17.9	10.9
D—both B and C	55.6	32.1	41.3
E—other	5.6	3.6	4.3
Pathogens:			
A—not a significant problem	90.0	56.4	67.8
B—cost prohibitive / lack of funding	0.0	0.0	0.0
C—labor prohibitive / lack of staff	5.0	10.3	8.5
D—both B and C	0.0	25.6	16.9
E—other	5.0	7.7	6.8
5. Is there a written invasive / exotic species management plan for this wilderness area?	**Alaska**	**Lower 48**	**Combined**
Plants:			
Yes	0.0	17.0	11.8
No	100.0	83.0	88.2
Animals:			
Yes	47.6	14.9	25.0
No	52.4	85.1	75.0
Pathogens:			
Yes	0.0	4.3	3.0
No	100.0	95.7	97.0

If no, why not?	Alaska	Lower 48	Combined
Plants:			
A—not a significant problem	52.4	40.9	44.6
B—has been started but not completed	0.0	9.1	6.2
C—cost prohibitive / lack of funding	0.0	4.5	3.1
D—labor prohibitive / lack of staff	0.0	6.8	4.6
E—both C and D	47.6	29.5	35.4
F—other	0.0	9.1	6.2
Animals:			
A—not a significant problem	52.4	48.8	50.0
B—has been started but not completed	0.0	0.0	0.0
C—cost prohibitive / lack of funding	0.0	2.4	1.6
D—labor prohibitive / lack of staff	0.0	7.3	4.8
E—both C and D	47.6	34.1	38.7
F—other	0.0	7.3	4.8
Pathogens:			
A—not a significant problem	100.0	56.8	70.3
B—has been started but not completed	0.0	0.0	0.0
C—cost prohibitive / lack of funding	0.0	0.0	0.0
D—labor prohibitive / lack of staff	0.0	4.5	3.1
E—both C and D	0.0	27.3	18.8
F—other	0.0	11.4	7.8

7. Was a NEPA process completed for any current invasive / exotic control efforts in the wilderness area?	Alaska	Lower 48	Combined
Yes	100.0	33.3	51.4
No	0.0	66.7	48.6

8. Was a Minimum Tool Analysis completed for any current invasive / exotic control efforts in the wilderness area?	Alaska	Lower 48	Combined
Yes	0.0	10.3	7.7
No	100.0	89.7	92.3

APPENDIX E: Results—Quality of the Information

Note: All results shown are the % of survey responses for each question. Question numbers correspond to the survey form in Appendix A. Multiple responses were often given for question #9.

1. What is the nature of the species lists provided?	Alaska	Lower 48	Combined
Plants:			
1—the list is rough	66.7	29.3	40.7
2— :	0.0	9.8	6.8
3— :	5.6	14.6	11.9
4— :	27.8	43.9	39.0
5—the list is highly accurate	0.0	2.4	1.7
Animals:			
1—the list is rough	11.1	25.6	21.1
2— :	0.0	10.3	7.0
3— :	5.6	15.4	12.3
4— :	77.8	33.3	47.4
5—the list is highly accurate	5.6	15.4	12.3
Pathogens:			
1—the list is rough	70.6	74.3	73.1
2— :	0.0	2.9	1.9
3— :	0.0	20.0	13.5
4— :	29.4	2.9	11.5
5—the list is highly accurate	0.0	0.0	0.0
9. What is the source of the information provided?	**Alaska**	**Lower 48**	**Combined**
Plants:			
A—casual or opportunistic observation	42.9	78.7	67.6
B—systematic sampling	19.0	19.1	19.1
C—best guess, based on knowledge of area	76.2	19.1	36.8
D—other	4.8	10.6	8.8
Animals:			
A—casual or opportunistic observation	47.6	80.4	70.1
B—systematic sampling	14.3	19.6	17.9
C—best guess, based on knowledge of area	76.2	21.7	38.8
D—other	0.0	4.3	3.0
Pathogens:			
A—casual or opportunistic observation	40.0	50.0	46.8
B—systematic sampling	20.0	4.8	9.7
C—best guess, based on knowledge of area	30.0	38.1	35.5
D—other	50.0	21.4	30.6

APPENDIX F: List of All Species Reported

All plant names (scientific and common) were standardized to conform to the U.S. Department of Agriculture's PLANTS database (U.S. Department of Agriculture 2002).

Virus family names were obtained from the online database, The Big Picture Book of Viruses (www.virology.net 2002).

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* — listed as a species of greatest concern by at least one wilderness area in a particular Region.

+ — all non-native species in the Oregon Islands wilderness were considered to be invasive by the survey respondent because the wilderness was considered to be a botanical reserve.

Region 1 (Pacific)

Taxa	Latin Name	Common Name	Wilderness
Plant	+ *Achillea millefolium*	yarrow	Oregon Islands
	+ *Bromus mollis*	soft brome	Oregon Islands
	+ *Coronopis didymus*	wartcress	Oregon Islands
	+ *Festuca bromoides*	brome fescue	Oregon Islands
	+ *Geranium molle*	dovefoot geranium	Oregon Islands
	* *Hedera helix*	English ivy	San Juan
	+ *Holcus lanatus*	common velvetgrass	Oregon Islands
	+ *Hypochaeris radicata*	hairy catsear	Oregon Islands
	+ *Lolium multiflorum*	Italian ryegrass	Oregon Islands
	+ *Mesembryanthemum chilense*	sea fig	Oregon Islands
	+ *Plantago lanceolata*	narrowleaf plantain	Oregon Islands
	+ *Poa annua*	annual bluegrass	Oregon Islands
	+ *Raphanus raphanistrum*	wild radish	Oregon Islands
	* *Rubus procerus*	Himalayan blackberry	San Juan
	+ *Rumex acetosella*	common sheep sorrel	Oregon Islands
	+ *Rumex crispus*	curly dock	Oregon Islands, Three Arch Rocks
	+ *Senecio jacobaea*	stinking willie	Oregon Islands
	+ *Senecio vulgaris*	old-man-in-the-spring	Oregon Islands
	+ *Silybum marianum*	blessed milkthistle	Oregon Islands
	+ *Sonchus oleraceus*	common sowthistle	Oregon Islands
	+ *Spergularia rubra*	red sandspurry	Oregon Islands
	+ *Stellaria media*	common chickweed	Oregon Islands
Animal	* *Branta canadensis moffitti*	western Canada goose	Oregon Islands
	* *Mus musculus*	house mouse	Farallon
	Sturnus vulgaris	European starling	Oregon Islands, Three Arch Rocks

Region 2 (Southwest)

Taxa	Latin Name	Common Name	Wilderness
Plant	*Arundo donax*	giant reed	Havasu
	* *Brassica tournefortii*	Asian mustard	Cabeza Prieta, Kofa
	Bromus rubens	red brome	Kofa
	* *Centaurea repens*	Russian knapweed	Bosque del Apache
	Cuscuta spp.	dodder	Kofa
	* *Eragrostis lehmanniana*	Lehmann lovegrass	Cabeza Prieta
	Erodium confertiflora	filaree	Kofa
	Erodium texanum	Texas stork's bill	Kofa
	* *Juniperus virginiana*	eastern red cedar	Wichita Mountains
	Kochia scoparia	Mexican fireweed	Salt Creek
	* *Pennisetum ciliare*	buffelgrass	Cabeza Prieta, Kofa
	* *Pennisetum setaceum*	crimson fountaingrass	Cabeza Prieta, Kofa
	Phragmites australis	common reed	Havasu
	* *Prosopis spp.*	mesquite	Wichita Mountains
	Salsola kali	Russian thistle	Imperial Refuge, Kofa, Salt Creek
	Schismus arabicus	Arabian schismus	Kofa
	Schismus barbatus	common Mediterranean grass	Kofa
	Tamarix aphylla	saltcedar	Imperial Refuge
	Tamarix chinensis	saltcedar	Kofa
	Tamarix pentandra	saltcedar	Imperial Refuge
	* *Tamarix ramosissima*	saltcedar	Bosque del Apache, Cabeza Prieta, Havasu
	* *Tamarix spp.*	saltcedar	Salt Creek
Animal	* *Apis melifera acutellata*	Africanized honeybee	Cabeza Prieta
	* *Equus asinus*	burro	Havasu, Imperial Refuge, Kofa
	Equus caballus	horse	Kofa
	Molothrus ater	brown-headed cowbird	Kofa
	* *Oryx gazella*	gemsbok (oryx)	Bosque del Apache
	Sturnus vulgaris	European starling	Imperial Refuge, Kofa
	* *Sus scrofa*	hog	Havasu, Salt Creek, Wichita Mountains
Pathogen	Family Reoviridae	epizootic hemorrhagic disease virus (EHD)	Kofa

Region 3 (Midwest)

Taxa	Latin Name	Common Name	Wilderness
Plant	* *Centaurea maculosa*	spotted knapweed	Seney
	* *Elaeagnus umbellata*	autumn olive	Crab Orchard
	Lespedeza cuneata	Chinese lespedeza	Crab Orchard
	Lonicera japonica	Japanese honeysuckle	Crab Orchard
	* *Lythrum salicaria*	purple loosestrife	Michigan Islands
	Pinus spp.	non-native pines	Crab Orchard

		Rosa multiflora	multiflora rose	Crab Orchard
	*	*Zizaniopsis miliacea*	giant cutgrass	Mingo
Animal	*	*Cygnus olor*	mute swan	Wisconsin Islands
		Cyprinus carpio	common carp	Wisconsin Islands
	*	*Dasypus novemcinctus*	nine-banded armadillo	Mingo
		Dreissena polymorpha	zebra mussel	Wisconsin Islands
		Lymantria dispar	gypsy moth	Seney
		Molothrus ater	brown-headed cowbird	Crab Orchard, Seney
		Morone americana	white perch	Wisconsin Islands
	*	*Myocastor coypus*	nutria	Mingo
		Sturnus vulgaris	European starling	Seney

Region 4 (Southeast)

Taxa		Latin Name	Common Name	Wilderness
Plant	*	*Alternanthera philoxeroides*	alligatorweed	Lacassine, Lake Woodruff
		Blyxa aubertii	roundfruit blyxa	Lacassine
	*	*Casuarina equisetifolia*	Australian pine	Florida Keys
	*	*Colubrina asiatica*	Asian nakedwood	Florida Keys
	*	*Cuscuta spp.*	dodder	Lake Woodruff
	*	*Eicchornia spp.*	water hyacinth	Lake Woodruff
	*	*Eichhornia crassipes*	common water hyacinth	Lacassine
	*	*Euonymus phellomana*	corktree	Florida Keys
	*	*Hydrilla verticillata*	water thyme (hydrilla)	Lacassine, Lake Woodruff
	*	*Imperata cylindrica*	cogongrass	St. Marks
	*	*Leucaena leucocephala*	white leadtree	Florida Keys
	*	*Lygodium japonicum*	Japanese climbing fern	St. Marks
		Myriophyllum spicatum	Eurasian watermilfoil	Chassahowitska
		Otellia alismoides	thin-leaved water lettuce	Lacassine
	*	*Phragmites spp.*	common reed	Swanquarter
	*	*Phragmites australis*	common reed	Cape Romain
	*	*Pistia stratiotes*	water lettuce	Lake Woodruff
	*	*Salsola kali*	Russian thistle	Cape Romain
	*	*Salvinia spp.*	watermoss	Lake Woodruff
	*	*Sapium sebiferum*	Chinese tallow	Lacassine, St. Marks
	*	*Scaevola taccada*	beach naupaka	Florida Keys
	*	*Schinus terebinthifolius*	Brazilian pepper	Cedar Keys, Chassahowitzka, Florida Keys
Animal	*	*Anolis sagrei*	brown anole	J.N."Ding" Darling
		Bubulcus ibis	cattle egret	Cedar Keys
		Columba livia	rock dove	Chassahowitzka
		Dreissena polymorpha	zebra mussel	Lacassine
		Molothrus ater	brown-headed cowbird	Cedar Keys, Lacassine, Okefenokee
		Molothrus bonariensis	shiny cowbird	Florida Keys

	* *Myocastor coypus*	nutria	Big Lake, Lacassine
	* *Osteopilus septentrionalis*	Cuban tree frog	J.N."Ding" Darling
	Passer domesticus	house sparrow	Chassahowitzka
	Rattus rattus	black rat	Florida Keys
	Solenopsis invicta	fire ant	Chassahowitzka, St. Marks
	Streptopelia decaocto	Eurasian collared dove	Florida Keys, St. Marks
	Sturnus vulgaris	European starling	Chassahowitzka, Lacassine, Okefenokee, St. Marks
	* *Sus scrofa*	hog	Blackbeard Island, Chassahowitzka, Florida Keys, St. Marks, Wolf Island
Pathogen	*Clostridium botulinum*	avian botulism	Lacassine
	Family Flaviviridae	West Nile virus	Blackbeard Island, Wolf Island
	Family Herpesviridae	duck virus enteritus (DVE)	Lacassine

Region 5 (Northeast)

Taxa	Latin Name	Common Name	Wilderness
Plant	* *Alliaria petiolata*	garlic mustard	Great Swamp
	* *Berberis thunbergii*	Japanese barberry	Great Swamp
	* *Cirsium arvense*	Canada thistle	Moosehorn
	* *Lythrum salicaria*	purple loosestrife	Great Swamp
	* *Microstegium vimineum*	Nepalese browntop	Great Swamp
	* *Phragmites australis*	common reed	Brigantine, Monomoy
	* *Polygonum cuspidatum*	Japanese knotweed	Great Swamp
	* *Typha spp.*	cattail	Monomoy
	Verbascum thapsus	common mullein	Moosehorn
Animal	*Rattus norvegicus*	Norway rat	Brigantine
	Sturnus vulgaris	European starling	Great Swamp
Pathogen	* *Cromartium ribicola*	white pine blister rust	Moosehorn
	* Family Flaviviridae	West Nile virus	Brigantine

Region 6 (Mountain-Prairie)

Taxa	Latin Name	Common Name	Wilderness
Plant	* *Agropyron cristatum*	crested wheatgrass	Medicine Lake
	* *Artemisia absinthium*	absinthium	Chase Lake
	* *Bromus inermis*	smooth brome	Fort Niobrara, Lostwood, Medicine Lake
	Bromus tectorum	cheatgrass	Fort Niobrara
	Cardaria draba	whitetop	UL Bend
	* *Centaurea maculosa*	spotted knapweed	Red Rock Lakes
	* *Cirsium arvense*	Canada thistle	Chase Lake, Lostwood, Medicine Lake, Red Rock Lakes, UL Bend

	Cirsium vulgare	bull thistle	Red Rock Lakes
	Cynoglossum officinale	gypsyflower	Red Rock Lakes
	Elaeagnus angustifolia	Russian olive	Medicine Lake
	* *Euphorbia esula*	leafy spurge	Chase Lake, Lostwood, Medicine Lake
	Juniperus virginiana	eastern red cedar	Fort Niobrara
	* *Lythrum salicaria*	purple loosestrife	Fort Niobrara
	* *Melilotus officinalis*	yellow sweetclover	Lostwood, UL Bend
	* *Pao pratensis*	Kentucky bluegrass	Lostwood, Medicine Lake
	* *Tamarix ramosissima*	saltcedar	UL Bend
	* *Tanacetum vulgare*	common tansy	Red Rock Lakes
Animal	*Cyprinus carpio*	common carp	Fort Niobrara, Medicine Lake
	* *Onchorhynchus clarki bouvieri*	Yellowstone cutthroat trout	Red Rock Lakes
	* *Onchorhynchus mykiss*	rainbow trout	Red Rock Lakes
	Perdix perdix	gray partridge	UL Bend
	Phasianus colchicus	ring-necked pheasant	Medicine Lake, UL Bend
	* *Salvelinus fontenalis*	brook trout	Mount Massive, Red Rock Lakes
	Sturnus vulgaris	European starling	UL Bend
Pathogen	* *Yersinia pestis*	bubonic plague	UL Bend

Region 7 (Alaska)

Taxa	Latin Name	Common Name	Wilderness
Plant	*Brassica spp.*	mustard	Simeonof
	Chrysanthemum leucanthemum	oxeye daisy	Simeonof
	Cirsium spp.	thistle	Aleutian Islands
	Holcus lanatus	common velvetgrass	Simeonof
	Picea sitchensis	Sitka spruce	Aleutian Islands, Simeonof
	Plantago major	common plantain	Simeonof
	Rumex acetosella	common sheep sorrel	Simeonof
Animal	* *Alopex lagopus*	Arctic fox	Aleutian Islands
	Felis concolor	mountain lion	Kenai
	Mus musculus	house mouse	Simeonof
	Peromyscus spp.	deer mouse	Aleutian Islands
	* *Rangifer tarandus*	reindeer/caribou	Aleutian Islands
	* *Rattus norvegicus*	Norway rat	Aleutian Islands
	* *Spermophilus undulatus*	Arctic ground squirrel	Aleutian Islands, Semidi, Simeonof
	unknown	cockroach	Aleutian Islands

APPENDIX G: 1997-98 Exotic Plants Survey Form

Wilderness Area Exotic Plant Survey
Aldo Leopold Wilderness Research Institute, 1997-98

This survey is designed to document to occurrence of exotic plants in our federal wilderness areas. While we are focusing on weeds (plants that interfere with management goals, pose a threat to the native flora, and/or are on your state's noxious weed list), please include as many non natives as possible- even if they are not perceived as a threat. Thanks for your participation.

Return this survey to Marilyn Marler, Division of Biological Sciences, University of Montana, Missoula, MT 59812

Name_____

Address_____

Phone, email_____ Name of wilderness area_____

Species list. Please indicate abundance (1= trace, 5= widely established), possible threat to management goals (1= negligible, 3= severe), and what control projects, if any, are underway for the plant. Attach additional pages if needed.

Latin name	abundance 1-5	threat 1-3	Controls/ research projects

1. Please describe as specifically as possible the geographic area to which the list pertains. Enclose a map if possible.

_____

_____

2. Circle the number that you feel best describes the nature of the species list.

1(the list is rough) 2 3 4 5 (the list is highly detailed)

3. For this area, exotic plants are A) not much of a problem. Please explain: _____

_____

B) one of many small problems
C) significant; one of the top 10 management concerns
D) very important; one of 2 or 3 top priorities

4. Is there a written weed management plan for this wilderness area? Y N

If there **is** a plan, does it prioritize weeds for control? Y N

If there **is no plan**, why not? A) weeds aren't a significant problem B) it is cost prohibitive
C) it is labor prohibitive D) other:

5. Are weeds monitored in the wilderness area? Y N **continue on back**

6. In general, what is the source of the data you are providing: a) casual or opportunistic observation
b) systematic sampling (along transects, in long term plots, etc.)
c) best guess, based on knowledge of surrounding, similar areas
d) other:________________________________

We'd appreciate more detailed information on plants that are of greatest concern. Please respond to the following for your most serious weeds. Leave any item blank if information is lacking.

Name ____________________

What disturbance regime may be responsible for establishment or spread of this weed?________________________

Pattern of infestation (circle one)
a) one or more large populations b) few or several small populations
c) one or more large populations and few to several small populations
d) infestations mainly along roads, rivers, trails, etc. e) infestations are just outside wilderness area

The weed is a) increasing despite control efforts b) increasing; there are no control efforts
c) decreasing though control efforts d) decreasing without control efforts e) stable

Name ____________________

What disturbance regime may be responsible for establishment or spread of this weed?________________________

Pattern of infestation (circle one)
a) one or more large populations b) few or several small populations
c) one or more large populations and few to several small populations
d) infestations mainly along roads, rivers, trails, etc. e) infestations are just outside wilderness area

The weed is a) increasing despite control efforts b) increasing; there are no control efforts
c) decreasing though control efforts d) decreasing without control efforts e) stable

Name ____________________

What disturbance regime may be responsible for establishment or spread of this weed?________________________

Pattern of infestation (circle one)
a) one or more large populations b) few or several small populations
c) one or more large populations and few to several small populations
d) infestations mainly along roads, rivers, trails, etc. e) infestations are just outside wilderness area

The weed is a) increasing despite control efforts b) increasing; there are no control efforts
c) decreasing though control efforts d) decreasing without control efforts e) stable

Name ____________________

What disturbance regime may be responsible for establishment or spread of this weed?________________________

Pattern of infestation (circle one)
a) one or more large populations b) few or several small populations
c) one or more large populations and few to several small populations
d) infestations mainly along roads, rivers, trails, etc. e) infestations are just outside wilderness area

The weed is a) increasing despite control efforts b) increasing; there are no control efforts
c) decreasing though control efforts d) decreasing without control efforts e) stable

We'd also like to receive general impressions of the status of exotic plants in this wilderness area, and any relevant background information (grazing history, elevation tolerance of species, etc) that you may have access to. Feel free to expand on any of your responses. Thanks very much for your time.