Invasive Plants in Alaska: assessment of research priorities

Jeff Conn
Research Agronomist, USDA Agricultural Research Service, University of Alaska Fairbanks
Ruth Gronquist
Wildlife Biologist, USDI Bureau of Land Management, Fairbanks
Marta Mueller
Program Assistant, Cooperative Extension Service, University of Alaska Fairbanks

Research needs and priorities on the threat of invasive plants differ for various state and federal agencies in Alaska—so how can they be assessed and ranked? The authors describe the problem posed by invasive plants, and present the approach to this question and some of the findings of the Committee for Noxious and Invasive Plant Management. The committee ranked research in three main areas of infestation management (prevention, eradication or control, and restoration).

The annual economic loss caused by invasive plants in the United States is estimated to be over 34 billion dollars (Pimentel et al. 2000). Forty-two percent of the species listed as threatened or endangered are primarily at risk due to competition or predation caused by non-native species (Wilcove et al., 1998). The rapidly increasing problem of invading plants into range and wild lands was a primary reason behind President Clinton's issue of executive order 13112, which required all federal land management agencies to develop action plans for preventing and controlling invasive species. Federal research agencies have expanded research on invasive species to aid in management of this problem.

Japanese knotweed is an agressive invader in Southeast Alaska.
—Photo by Nanna Borchert, Sitka Conservation Society

Though the severity of the invasive plant problem in Alaska is not as great as in other states, where invasives such as purple loosestrife, yellow star thistle, and European cheatgrass are rapidly degrading wetlands and grasslands, recent surveys for invasive plant species in Alaska have revealed that non-natives are increasing in number and could cause problems for Alaska agriculture and forestry and have negative effects on Alaska ecosystems. In southeast Alaska, garlic mustard has been found in Juneau. This species has been found to outcompete spring-flowering understory species in the eastern United States. White sweetclover has invaded the floodplains of the Stikine and Matanuska rivers. The recent discovery of extensive white sweetclover stands on the Nenana River suggest that the entire Yukon River drainage may be susceptible to invasion by this species. If white sweetclover is competing with other floodplain species such as willows, it may affect moose winter food availability and plant succession. Other non-native plants that appear to be increasing in Alaska include: Japanese knotweed, bird vetch, orange hawksbeard, narrow-leaf hawksbeard, Canada thistle, and perennial sowthistle.

Development of a ranking system for research needs

In June 2000 a group of concerned citizens and land managers met in Fairbanks at the invitation of the UAF Cooperative Extension Service to discuss how non-native plant invasions could be prevented and controlled in Alaska. The group decided that a statewide effort was needed, and formed the Committee for Noxious and Invasive Plant Man-

agement (CNIPM). The CNIPM strategic plan recognized that research was needed to determine the best methods for preventing and controlling invasive plants in Alaska (Hebert 2001). During the Third Alaska Noxious and Invasive Plant Management Workshop in November 2002, attendees were asked to list ideas for research needed to improve prevention and control of invasive plant infestations in Alaska. Over the course of the meeting, forty-two ideas were submitted. Meeting attendees voted on the importance of the various research ideas. A breakout session at the end of the meeting was devoted to consolidating similar research ideas and was used to recruit members to serve on a CNIPM research needs subcommittee. The role of the subcommittee was to prioritize the research ideas and propose how the research might be accomplished. Subcommittee members are state experts on prevention and control of invasive weeds in Alaska and come from a wide cross-section of Alaska resource management and research agencies. Several people were members of the public who had been active in combating invasive weeds.

The committee, which included the authors, met every two weeks from February 2003 to June 2003, and looked at five main considerations. These were: whether some of the research ideas were similar enough to be combined; if research ideas should be rated by how they relate to management objectives or particular aspects of competing weed invasions; how the ideas should be ranked; how priorities should be peer reviewed; and how best to explain the process and results to potential funding sources.

The original forty-two research ideas were reduced to twenty-four, because of duplication. Since invasive weeds are managed at three levels (prevention, eradication/control, restoration) the remaining research needs were classified into these functional groups.

While deciding how best to rank the research needs, we decided that various resource management agencies would probably rank them differently. For example, State of Alaska Department of Transportation and Public Facilities (ADOT&PF) would be interested in knowing which plant species could be used for revegetation without becoming invasive, while farmers may not. Thus, research ideas were ranked according to land use objective. The land use objectives were: agriculture, natural areas, transportation, and urban. Agriculture refers to crop production and grazing lands. Natural areas are relatively wild lands managed by federal, state, or local government, private interests, or Native Alaskan interests. These lands may be managed for timber and other commercial uses, recreation, or conservation values. Transportation refers to roads, trails, railroads and airports. Urban areas are disturbed lands associated with cities and villages.

We developed a matrix with land use objectives as columns and research needs grouped by management objectives as rows. The committee then gave the research needs a value of 0 (no need) to 5 (highest need) for each land use objective. A research need that was ranked of low priority for a particular land use objective does not necessarily mean that the research is not important, but that other research needs rank higher for that land use objective.

The scores for each research need were averaged across objectives to produce an average score for each research need. Research needs that had a high average score can be perceived as being important topics of research for all or most land use areas. This is not to say that research needs with a low average score are unimportant. It may be that answers to certain research topics are urgently needed, but for only one or a few resource management agencies.

The entire research needs subcommittee and then the entire CNIPM membership, through e-mail solicitation, reviewed the results of the ranking process.

Infestation management priorities

Prevention

The most cost-effective strategy for combating noxious and invasive plants is to prevent the establishment of plant populations in the first place (National Invasive Species Council 2001). We ranked fifteen prevention research needs.

• Invasiveness Index by region

The Invasiveness Index is a ranking system that takes into consideration aspects of an invasive species' biology and history in other locations to estimate its potential to spread and create economic and ecological damage. Not all exotic species will be invasive, and use of the Invasiveness Index will allow scientists and managers to focus personnel and funds on addressing prevention and eradication or control of the most invasive species (Hiebert 1997). Due to the diverse climatic regimes in Alaska, which can influence species biology, we recognized that the invasiveness indexes would need to be performed separately for each Alaska ecoregion. Committee members thought that invasiveness indexing was very important (5) for all management objectives.

• Method and rate of spread

To design an effective prevention strategy, one needs to know how seeds or vegetative propagules of various species are brought into Alaska and disseminated, and how fast the infestation could be expected to spread. For example, if seed were found to spread from soil adhering to construction equipment, one strategy for preventing new infestations would be to wash equipment before it leaves an area where invasive species are found. If exotics are found to spread down rivers, efforts should be made to prevent the spread of these species along roads where they would intersect rivers. The relative importance of various routes of plant introduction is largely unknown. How frequently is plant seed introduced from vehicles driving through Canada versus through contaminated crop, horticulture, or revegetation seed? The answer to this question could be helpful in deciding whether stronger seed laws are required, or whether a vehicle washing station should be built at the Alaska-Canada border. This research need was also ranked high under most land use objectives (5). An exception was Agriculture (3), where agencies

Table 1. Invasive plant research needs ranked according to land use and infestation management objectives, with averages over land use objectives. Needs are ranked from no need, 0, to highest need, 5.

Research Need	Agricultural Areas	Natural Areas	Transportation	Urban Areas	Average
Prevention					
Invasiveness Index by region	5	5	5	5	5.0
Methods and rates of spread	3	5	5	5	4.5
Potential for new invasion from outside Alaska	3	4	4	5	4.0
Species biology of exotics (for use in ranking systems)	3	4	4	4	3.8
How exotics affect ecosystems (diversity, wildlife)	2	4	4	4	3.5
Costs of prevention versus control later	2	2	4	4	3.0
Invasions from horticulture (wildflowers, nursery containers, introductions)	1	3	1	4	2.3
Nitrogen-fixing legumes that are not invasive	4	0	2	2	2.0
History of introductions and distribution in Alaska	1	1	3	3	2.0
Use of remote sensing and GIS to map and predict invasions	1	2	2	1	1.5
Effects of fire on movement of exotics	0	3	0	0	0.8
Effects of nitrogen-fixing plants on facilitating exotics	0	1	2	0	0.8
Hybridization of native species with non-natives	0	1	0	1	0.5
Effects of global change on invasions	0	2	0	0	0.5
Most effective inventory methods	0	0	1	0	0.3
Eradication and Control					
Longevity of seed in soil	5	5	5	5	5.0
IPM approaches and best management practices	5	5	5	5	5.0
Effectiveness and cost of using herbicides	5	3	4	4	4.0
Persistence and fate of herbicides in soil and injury to later crops	4	4	4	4	4.0
Cost and effectiveness comparison for control methods	4	3	4	3	3.5
Non-chemical control methods (heat, mowing, tillage, digging, pulling)	4	2	4	1	2.8
Biological control methods	3	2	3	2	2.5
Restoration					
Methods for producing propagules of native plants for revegetation	5	5	5	4	4.8
Which plants can be used for revegetation without being invasive?	2	3	5	3	3.3

have a better idea of the methods and rates that agronomic weeds spread than do other resource management areas.

• **Potential for new species from outside Alaska**

Knowing which plants have the potential to be serious invaders would lead to improved regulation. Outbreaks may be prevented by banning seed of these species in revegetation mixes and from livestock feed shipped in from outside the state. This research need was ranked highly (4-5) under most resource management objectives.

• **Species biology of exotics (for ranking)**

Invasiveness indexing requires knowledge of plant species biology, including number of seeds produced, competitiveness, and growth potential (Hiebert 1997). This information is lacking for many species and the information that is known may be from other locations that are warmer than Alaska. Thus, for some species, species-specific information is needed to determine their invasiveness potential under Alaska conditions. This research need was ranked highly (3-4) as a need for all management objectives.

• **How do exotics affect ecosystems (diversity, wildlife)?**

In some cases invasive weeds have been shown to displace other plant species and decrease overall ecosystem diversity (Wilcove et al. 1998). If the displaced species are essential to wildlife, this can have a detrimental effect on other ecosystem components, as well as on subsistence and sporting activities. Subcommittee members ranked this as important research for natural areas, Urban, and Transportation (4), and less important for Agriculture (2) than other research needs.

• **Costs of prevention versus control later**

Prevention measures are usually inexpensive compared to the costs of an ongoing control effort or to the economic and ecological damage that may occur if an invasive weed becomes established (National Invasive Species Council 2001). Results of studies to examine the relative costs of prevention versus control could be used to help spur managers, regulators, and landowners to take preventative measures. Committee representatives ranked this important research for Transportation and Urban (4) and less important for Agriculture and Natural Areas (2). Agriculture representatives felt that this information is largely already known and appreciated. For Natural Areas, other research is currently more pressing.

• **Invasions from horticulture (wildflowers, nursery containers, introductions)**

Weeds can be imported in nursery containers and can be components of wildflower seed mixes. Also, gardeners have sought out exotic species from outside Alaska to add to their gardens. These species can occasionally become invasive. At this point we do not know how important these avenues are for importation of invasive species into Alaska, and what should be done to decrease this risk. It is suspected that the garlic mustard *(Allaria petiolata)* invasion that has recently occurred in Juneau was from seed brought in with a nursery container or from wildflower seed. Committee representatives ranked this as important research for Urban and Natural Areas (3-4) and not important, or that other needs were more pressing, for Transportation and Agriculture (1).

• **Nitrogen-fixing legumes that are not invasive**

Agronomists have experimented with nitrogen-fixing legumes to determine which are adapted to Alaska. These legumes could be used by farmers and in revegetation to enhance soil nitrogen levels without using expensive inorganic nitrogen fertilizers. Unfortunately, several legumes, such as sweet clover (Melilotus spp.) and bird vetch (Vicia cracca) have been found to be invasive in Alaska. Sweetclover has taken over the floodplain of the lower Stikine River and is spreading along the Matanuska and Nenana rivers and along the Dalton Highway north of the Yukon River bridge, while bird vetch has spread along roadsides and is colonizing urban areas. There is a need to determine which legumes that are adapted to Alaska can be grown for nitrogen enrichment without becoming invasive. Subcommittee members ranked this as important research for Agriculture (4), of moderate importance for Transportation and Urban (2), and not very important for Natural Areas (0).

• **History of introductions and distribution in Alaska**

Study of the historic methods of introduction and rate of spread of plant invaders already in Alaska could give important lessons learned that may help in designing strategies to prevent future invasions. Committee representatives determined that this research need was a moderate priority (3) for Transportation and Urban Areas and a low priority (1) for Agriculture and Natural Areas.

• **Use of remote sensing/GIS to map and predict invasions**

Locations of exotic species could be plotted and the rate of spread determined using GIS. Habitat information from remote sensing and climatic data could be used to make GIS layers to model potential sites for invasion and to estimate the potential for infestation. This research need was ranked fairly low by committee representatives (1-2). It was perceived that this was a very good tool that should be applied to Alaska, but that much of the research had already been done and could be transferred readily to Alaska as agencies complete inventories of invasive plants.

• **Effects of fire on movement of exotics**

In the Lower 48 States, populations of invasive plants have been found to increase dramatically in native ecosystems after fires. The newly burned areas provide areas to colonize without competition from established species. The burns also provide corridors for invasive species to spread through previously continuous or late-succession ecosystems. Invasive species can also cause an ecosystem to be more fire-prone (Vitousek et al. 1996). Committee members thought this research need was of moderately high priority (3) for Natural Areas but not important (0) for other management areas. At this point we have not seen that invasive species have been increasing in burned areas in Alaska.

• **Effects of nitrogen-fixing plants on facilitating exotics**

Invasion by nonindigenous plant species can be greater when soil nitrogen levels are elevated (Mountford et al. 1996). It is common to plant legumes for revegetation pur-

poses to increase soil nitrogen, which may enhance growth and spread of invasive plants. Subcommittee members gave this research need moderate priority for Transportation (2) and a no-need (0) or a very low priority (1) for other management objectives.

• Hybridization of natives with non-native species

It is possible for closely related native species to hybridize with invading plant species, which could lower the fitness of native plants. Subcommittee members gave this research need a low score (0-1) for all management objectives.

• Effects of global change on invasions

The subcommittee members recognized that global change would likely affect the number of plant invasions and range extensions in Alaska, yet there is little that agencies can do. Committee members gave this a moderate need rating (2) for Natural Areas and no-need (0) for other management objectives.

• Most effective inventory methods

The committee members felt that effective inventory methods had already been established and were being used in Alaska.

Eradication and Control

If prevention measures have failed, the next step in invasive plant management is to try to eradicate new populations. If eradication is not feasible, then invasive species should be controlled to limit spread to new areas.

• Longevity of seed in soil

Since a species will continue to germinate and grow in an area as long as seed or other propagules remain viable in the soil, it is important to determine how long the seeds or propagules will remain viable. This period will define the length of time that control measures must be in place to totally prevent production of new seeds or propagules. Subcommittee members thought this was a high research priority (5) for all land use objectives.

• Integrated Pest Management approaches and best management practices

Integrated Pest Management (IPM) relies on a multidisciplinary approach using several control options to tackle pest management problems. Best management practices enable management agencies to more efficiently target invasive plant problems or manage projects so that the infestations do not spread. For example, best management practices involving control of soil movement by and on equipment could aid ADOT&PF to prevent spread of invasive plants that may occur at a road construction site with an existing infestation. This research need was also given the highest priority (5) for all areas.

• Effectiveness and cost of using herbicides

Herbicides can be very effective tools for controlling invasive plants. Research conducted to determine which herbicides and what rates are effective for killing specific invasive plants under Alaska conditions is needed. This research need was ranked highly (3-4) by committee members for all areas.

• Persistence and fate of herbicides in soil and injury to following crops

Herbicides can pose environmental problems by killing or injuring untargeted organisms. Herbicides can be slow to break down in cold Alaska soils and can injure crops that are planted in subsequent years (Conn et al. 1996). The possible detrimental effects of herbicides should be evaluated before using them as a control option. This was ranked as an important research need (4) for all land use objectives.

• Cost and effectiveness comparison for control methods

Managers need information on the effectiveness and costs of control alternatives to make good decisions about what methods to employ. Often there may be a short window in which eradication is possible. It may be more effective to pick the most effective control measure rather than the cheapest one. This was ranked as medium to high priority (3-4) for all areas.

• Nonchemical control methods (heat, mowing, grazing, tillage, digging, pulling)

Herbicides can negatively affect untargeted species. Also, it is often difficult to get permit approval for use of herbicides on public lands. Thus, there is a need for nonchemical methods to control invasive weeds. Subcommittee members thought this was an important

Japanese knotweed rhizomes can be transferred to new sites with soil removed in ditch cleaning operations.
—Photo by Michael Shephard, U.S. Forest Service, Anchorage

research need (4) for Transportation and Agriculture but gave it a low ranking (1-2) for Urban and Natural Areas.

• **Biological control methods**

There have been some spectacular success stories in keeping populations of invasive weeds under control through use of natural enemies such as insects and fungi. This research topic was ranked as having medium priority (2-3) for all management objectives. It was thought that most of the invasive plants in Alaska were cosmopolitan in distribution and did not lack their natural predators. Many of the success stories for biological control have involved introduction of a predator that is lacking in the new range of the invasive plant.

Restoration

Once an invasive plant species has been eradicated or mostly controlled, newly opened bare areas need to be replanted to prevent soil erosion and to discourage colonization by other undesirable species. The CNIPM annual workshop attendees recognized two research needs that could help improve restoration efforts.

• **Methods for producing propagules and planting native plants for revegetation**

It is desirable to use native species for revegetation whenever possible. Seed of invasive species can be introduced when non-native species or seed sources from outside Alaska are used for revegetation. Alaska's annual production of seed lots of native species is too low to meet the demands of restoration projects. Research is needed to determine the best agronomic practices for planting, growing, harvesting, and cleaning native species for seed production or for obtaining vegetative propagules. All of the subcommittee members ranked this research topic very highly (4-5) for all areas.

• **Which plants can be used for revegetation without being invasive?**

One requirement for plant species under consideration for use in the initial phases of a restoration program is that the species germinate and cover ground surfaces rapidly. This reduces the potential for soil erosion and eliminates empty space for undesirable plant species to invade. Rapid growth and colonization ability are also characteristics of invading species. It is possible that non-native plants used in the initial phases of revegetation could become invasive themselves, as was the case for kudzu (Pueraria montana) in the southeastern United States. Sweet clover (Melilotus spp.) and other legumes that have been used in revegetation mixes are showing that they can be invasive, as has been seen on the Stikine, Nenana, and Matanuska rivers. Subcommittee members gave this research need a moderate priority for Agriculture (2), and Natural Areas and Urban (3). For Transportation, this research topic ranked as a high priority (5) due to the amount of revegetation done and the proximity of roads to rivers and other natural areas that could be subject to invasions.

Since funding for research is always limited, we hope that the research priorities identified by CNIPM will provide administrators and legislators insight on the most important research needs for Alaska. Limited research funds can accomplish the most when agencies can develop common priorities and pool resources and effort. Research on ways to prevent further invasive weed introductions to Alaska will give the greatest benefit in the long run. Similar to oil spill response strategy, prevention is much more cost effective than cleanup.

Literature Cited

Conn, J.S., W.C. Koskinen, N.R. Werdin, and J.S. Graham. 1996. Persistence and leaching of metribuzin and metabolites in two subarctic soils. *J. Envir. Qual.* 25: 1048–1053.

Hebert, M. 2001. Strategic Plan for Noxious and Invasive Plants Management in Alaska. University of Alaska Fairbanks Cooperative Extension Service. Fairbanks, AK.

Hiebert, R.D. 1997. Prioritizing invasive plants and planning for management. Pages 195–212 in J.O. Luken and J.W. Thieret, editors. Assessment and management of plant invasions. Springer-Verlag, New York, New York, USA.

Mountford, J.O., K.H. Lakhani, and R.J. Holland. 1996. Reversion of grassland vegetation following the cessation of fertilizer application. *Journal of Vegetation Science* 7: 219–228.

National Invasive Species Council. 2001. Meeting the Invasive Species Challenge. A National Management Plan. Washington, D.C.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of nonindigenous species in the United States. *Bioscience* 50: 53–65.

Vitousek, P.M., C.M. D'Antonio, L.L. Loope, and R. Westerbrooks. 1996. Biological invasions as global environmental change. *American Scientist* 84: 468–478.

Wilcove, D.S., D. Rothstein, J. Dubow, A. Phillips, and E. Loses. 1998. Quantifying threats to imperiled species in the United States. *Bioscience* 48: 607–615.

Contributors on the development of research needs ranking:

Michele Hebert, Cooperative Extension Service, University of Alaska Fairbanks

Beth Shulz, Pacific Northwest Research Unit, USDA Forest Service

Phil Kaspari, Cooperative Extension Service, University of Alaska Fairbanks

Clint Adler, Research and Technology Transfer, ADOT&PF

Michael Shephard, State and Private Forestry, USDA Forest Service

Kaleen Knodel, Homer Soil and Water Conservation District

Otto Kilcher, Homer Soil and Water Conservation District

Shirley Schollenberg, Homer Soil and Water Conservation District