WEED RISK ASSESSMENT FORM

Botanical and common name: *Carduus nutans* L. musk thistle, *C. acanthoides* L. plumeless thistle, *C. pycnocephalus* L. Italian thistle, *C. tenuiflorus* W. Curtis slender-flowered thistle

Assessors:

Irina Lapina
Botanist, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501
tel: (907) 257-2710; fax (907) 257-2789

Matthew L. Carlson, Ph.D.
Assistant Professor, Alaska Natural Heritage Program, University of Alaska Anchorage, 707 A Street, Anchorage, Alaska 99501
tel: (907) 257-2790; fax (907) 257-2789

Reviewers:

Michael Shephard
Vegetation Ecologist Forest Health Protection State & Private Forestry 3301 C Street, Suite 202, Anchorage, AK 99503 (907) 743-9454; fax 907 743-9479

Jeff Conn, Ph.D.
Weed Scientist, USDA Agricultural Research Service
PO Box 757200 Fairbanks, Alaska 99775
tel: (907) 474-7652; fax (907) 474-6184

Roseann Densmore, Ph.D.
Research Ecologist, US Geological Survey, Alaska Biological Science Center, 1101 East Tudor Road Anchorage, AK 99503
tel: (907) 786-3916, fax (907) 786-3636

Julie Riley
Horticulture Agent, UAF Cooperative Extension Service
2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143
tel: (907) 786-6306

Jamie M. Snyder
UAF Cooperative Extension Service
2221 E. Northern Lights Blvd. #118 Anchorage, AK 99508-4143
tel: (907) 786-6310 alt.tel: (907) 743-9448

Jeff Heys
Exotic Plant Management Program Coordinator, National Park Service, Alaska Region - Biological Resources Team, 240 W. 5th Ave, #114, Anchorage, AK 99501 tel: (907)644-3451, fax: 644-3809

Outcome score:

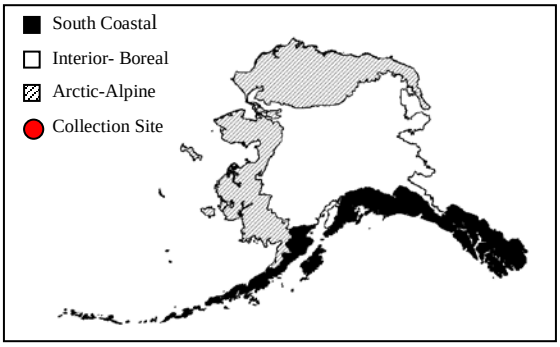
A.	**Climatic Comparison**		
	This species is present or may potentially establish in the following eco-geographic regions:		
1	South Coastal	Yes	
2	Interior-Boreal	Yes	
3	Arctic-Alpine	Yes	

B.	**Invasiveness Ranking**	Total (Total Answered*) Possible	Total
1	Ecological impact	40 (40)	22
2	Biological characteristic and dispersal ability	25 (25)	17
3	Ecological amplitude and distribution	25 (25)	14
4	Feasibility of control	10 (10)	8
	Outcome score	100 (100)[b]	61 [a]
	Relative maximum score†		0.61

* For questions answered "unknown" do not include point value for the question in parentheses for "Total Answered Points Possible."
† Calculated as [a]/[b].

A. CLIMATIC COMPARISON:

	1.1. Has this species ever been collected or documented in Alaska?
	Yes – continue to 1.2
No	No – continue to 2.1
	1.2. Which eco-geographic region has it been collected or documented (see inset map)? *Proceed to Section B. Invasiveness Ranking.*
	South Coastal
	Interior-Boreal
	Arctic-Alpine



Documentation: No *Carduus* species have been recorded in Alaska (AK Weeds Database 2004, Hultén 1968, UAM 2004).
Sources of information:
AK Weeds Database. 2004. Database of exotic vegetation collected in Alaska. University of Alaska, Alaska Natural Heritage Program – US Forest Service – National Park Service Database. Available: http://akweeds.uaa.alaska.edu/
Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA. 1008 p.
University of Alaska Museum. University of Alaska Fairbanks. 2004. http://hispida.museum.uaf.edu:8080/home.cfm

2.1. Is there a 40% or higher similarity (based on CLIMEX climate matching) between climates any where the species currently occurs and

a. Juneau (South Coastal Region)?
Yes – *record locations and similarity; proceed to Section B. Invasiveness Ranking*
No

b. Fairbanks (Interior-Boreal)?
Yes – *record locations and similarity; proceed to Section B. Invasiveness Ranking*
No

c. Nome (Arctic-Alpine)?
Yes – *record locations and similarity; proceed to Section B. Invasiveness Ranking*
No
– *If "No" i answered for all regions, reject species from consideration*

Documentation: CLIMEX matching program shows that climatic similarity between Juneau and areas where the species are documented is high. Native range of the species includes Bogolovsk and Sverdlovsk, Russia (Gubanov et al. 1995), which have a 71% and 66% climatic match with Fairbanks, and 67% and 66% climatic match with Nome, respectively. Musk thistle is naturalized along the coastal region of Norway, including the area around Bergen and Kristiansand (Lid and Lid 1994), which have a 73% and 60% similarity with Juneau, respectively. This suggests that if introduced, establishment of species from the genus *Carduus* in South Coastal, Interior-Boreal and Arctic-Alpine ecogeographic regions may be possible.
Sources of information: CLIMEX for Windows, Version 1.1a. 1999. CISRO Publishing, Australia.
Gubanov IA, Kiseleva KV, Novikov VS, Tihomirov VN. An Illustrated identification book of the plants of Middle Russia, Vol. 3: Angiosperms (dicots: archichlamydeans). Moscow: Institute of Technological Researches; 2004. 520 p.
Lid, J. and D. T. Lid. 1994. Flora of Norway. The Norske Samlaget, Oslo. Pp. 1014.

B. INVASIVENESS RANKING

1. ECOLOGICAL IMPACT

1.1. Impact on Natural Ecosystem Processes

A.	No perceivable impact on ecosystem processes	0
B.	Influences ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability)	3
C.	Significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl)	7
D.	Major, possibly irreversible, alteration or disruption of ecosystem processes (e.g., the species alters geomorphology; hydrology; or affects fire frequency, altering community composition; species fixes substantial levels of nitrogen in the soil making soil unlikely to support certain native plants or more likely to favor non-native species)	10
U.	Unknown	

Score 5

Documentation:

Identify ecosystem processes impacted:
Overwintering rosettes can severely inhibit the establishment of other plants. This may retard natural processes of secondary succession (Pitcher and Russo 1988, Rutledge and McLendon 1996). Dead stands can trap snow in winter, increasing soil moisture in the spring (Desrochers et al. 1988).
Rational:

Sources of information:
Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.
Pitcher, D. and M.J. Russo. 1988. Element stewardship abstract for *Carduus pycnocephalus* Italian thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/cardpycn.html [2005, May 2].
Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

1.2. Impact on Natural Community Structure

A.	No perceived impact; establishes in an existing layer without influencing its structure	0
B.	Influences structure in one layer (e.g., changes the density of one layer)	3
C.	Significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer)	7
D.	Major alteration of structure (e.g., covers canopy, eradicating most or all layers below)	10
U.	Unknown	

Score 5

Documentation:
Identify type of impact or alteration:
Carduus species are capable of forming a dense tall herbaceous layer of vegetation (Royer and Dickinson 1999, Whitson et al. 2000).
Rational:

Sources of information:
Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.
Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

1.3. Impact on Natural Community Composition

A.	No perceived impact; causes no apparent change in native populations	0
B.	Influences community composition (e.g., reduces the number of individuals in one or more native species in the community)	3
C.	Significantly alters community composition (e.g., produces a significant reduction in the population size of one or more native species in the community)	7
D.	Causes major alteration in community composition (e.g., results in the extirpation of one or several native species, reducing biodiversity or change the community composition towards species exotic to the natural community)	10
U.	Unknown	

Score 5

Documentation:
Identify type of impact or alteration:
Thistle stands can outcompete and reduce the number of individuals and may displace native herbaceous plants (Pitcher and Russo 1988, Royer and Dickinson 1999, Whitson et al. 2000)

Rational:

Sources of information:

Pitcher, D. and M.J. Russo. 1988. Element stewardship abstract for *Carduus pycnocephalus* Italian thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/cardpycn.html [2005, May 2]

Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

1.4. Impact on higher trophic levels (cumulative impact of this species on the animals, fungi, microbes, and other organisms in the community it invades)

A.	Negligible perceived impact	0
B.	Minor alteration	3
C.	Moderate alteration (minor reduction in nesting/foraging sites, reduction in habitat connectivity, interference with native pollinators, injurious components such as spines, toxins)	7
D.	Severe alteration of higher trophic populations (extirpation or endangerment of an existing native species/population, or significant reduction in nesting or foraging sites)	10
U.	Unknown	

Score 7

Documentation:

Identify type of impact or alteration:

Infestations in meadows and rangelands reduce foraging sites and hinder the movement of grazing animals (Hull and Evans 1973, Royer and Dickinson 1999, Whitson et al. 2000). Thistle flowers are usually very attractive to insect pollinators and can alter the behavior of native pollinators (Desrochers et al. 1988, Gubanov et al. 2004). Hybridization between musk thistle and plumeless thistle has been reported (Warwick et al. 1989).

Rational:

Sources of information:

Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.

Gubanov IA, Kiseleva KV, Novikov VS, Tihomirov VN. An Illustrated identification book of the plants of Middle Russia, Vol. 3: Angiosperms (dicots: archichlamydeans). Moscow: Institute of Technological Researches; 2004. 520 p.

Hull, A.C.Jr and J.O. Evans. 1973. Musk thistle (*Carduus nutans*): An undesirable range plant. Journal of Range Management 26(5): 383-385.

Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Warwick, S.I., J.F. Bain, R. Wheatcroft, B.K. Thompson. 1989. Hybridization and introgression in *Carduus nutans* and *C. acanthoides* reexamined. Systematic Botany 14(4): 476-494.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

Total Possible 40

Total 22

2. BIOLOGICAL CHARACTERISTICS AND DISPERSAL ABILITY

2.1. Mode of reproduction

A.	Not aggressive reproduction (few [0-10] seeds per plant and no vegetative reproduction)	0
B.	Somewhat aggressive (reproduces only by seeds (11-1,000/m^2)	1
C.	Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed, <1,000/m^2)	2
D.	Highly aggressive reproduction (extensive vegetative spread and/or many seeded, >1,000/m^2)	3
U.	Unknown	

Score 3

Documentation:

Describe key reproductive characteristics (including seeds per plant):

Carduus species reproduce by seed only. Seed production can be as great as 11,000 seeds per plant (Desrochers et al. 1988).

Rational:

Sources of information:

Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.

2.2. Innate potential for long-distance dispersal (bird dispersal, sticks to animal hair, buoyant fruits, wind-dispersal)

A.	Does not occur (no long-distance dispersal mechanisms)	0
B.	Infrequent or inefficient long-distance dispersal (occurs occasionally despite lack of adaptations)	2
C.	Numerous opportunities for long-distance dispersal (species has adaptations such as pappus, hooked fruit-coats, etc.)	3
U.	Unknown	

Score 3

Documentation:

Identify dispersal mechanisms:

The majority of the seeds fall near the parent plant. Experimental studies in Virginia suggest that seeds do not travel far from the parent plant, with over 80% of seeds deposited within 40 m of the parent plant (Smith and Kok 1984). However seeds can also be dispersed by wind, small mammals, birds, and water (Beck 2004, Butterfield et al. 1996, Rutledge and McLendon 1996).

Rational:

Sources of information:

Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].

Butterfield, C., J. Stubbendieck, and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).

Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

Smith, L.M. and L.T. Kok. 1984. Dispersal of musk thistle (*Carduus nutans*) seeds. Weed science 32: 120-125.

2.3. Potential to be spread by human activities (both directly and indirectly – possible mechanisms include: commercial sales, use as forage/revegetation, spread along highways, transport on boats, contamination, etc.)

A. Does not occur 0
B. Low (human dispersal is infrequent or inefficient) 1
C. Moderate (human dispersal occurs) 2
D. High (there are numerous opportunities for dispersal to new areas) 3
U. Unknown

Score 3

Documentation:
Identify dispersal mechanisms:
Seeds may attach to animals, farm machinery, and vehicles. They may contaminate crops and hay (Rutledge and McLendon 1996, Zouhar 2002).
Rational:

Sources of information:
Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).
Zouhar, K. 2002. *Carduus nutans*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2005, May 4].

2.4. Allelopathic

A. No 0
B. Yes 2
U. Unknown

Score 2

Documentation:
Describe effect on adjacent plants:
Aqueous extracts and dead plant material from musk thistle have an inhibitory effect on germination and growth rate of several grass species (Wardle et al 1993).
Rational:

Sources of information:
Wardle, D.A., K.S. Nicholson, and A. Rahman. 1993. Influence of plant age on the allelopathic potential of nodding thistle (*Carduus nutans* L.) against pasture grasses and legumes. Weed Research 33: 69-78.

2.5. Competitive ability

A. Poor competitor for limiting factors 0
B. Moderately competitive for limiting factors 1
C. Highly competitive for limiting factors and/or nitrogen fixing ability 3
U. Unknown

Score 1

Documentation:
Evidence of competitive ability:
Thistles are highly competitive plants; however, establishment may be negatively affected by grasses (Butterfield et al. 1996, Rutledge and McLendon 1996, Wardle et al. 1996). *Carduus* species are usually more productive in communities where levels of competition are low (Austin et al. 1985).
Rational:

Sources of information:
Austin, M.P., R.H. Groves, L.M. Fresco, P.E. Kaye. 1985. Relative growth of six thistle species along a nutrient gradient with multispecies competition. Journal of Ecology 73(2): 667-684.
Butterfield, C., J. Stubbendieck, J. Stumpf. 1996. Species abstract of highly disruptive

exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).
Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).
Wardle, D.A., K.S. Nicholson, and A. Rahman. 1996. Use of a comparative approach to identify allalopathic potential and relationship between allelopathy bioassays and "competition" experiments for ten grasslands and plant species. Journal of Chemical Ecology 22(5): 933-948.

2.6. Forms dense thickets, climbing or smothering growth habit, or otherwise taller than the surrounding vegetation

A.	No	0
B.	Forms dense thickets	1
C.	Has climbing or smothering growth habit, or otherwise taller than the surrounding vegetation	2
U.	Unknown	

Score 2

Documentation:

Describe grow form:

Members of the genus *Carduus* are capable of forming dense stands, especially at highly disturbed sites where competition is low. Plants can be as tall as 6 feet (Desrochers et al. 1988).

Rational:

Sources of information:

Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.

2.7. Germination requirements

A.	Requires open soil and disturbance to germinate	0
B.	Can germinate in vegetated areas but in a narrow range or in special conditions	2
C.	Can germinate in existing vegetation in a wide range of conditions	3
U.	Unknown	

Score 0

Documentation:

Describe germination requirements:

Sufficient light is required for germination (Rutledge and McLendon 1996), therefore more seeds germinate and establish on bare soils in open pastures and poorly vegetated sites (Beck 2004, Hamrick and Lee 1987).

Rational:

In greenhouse experiments, optimum levels of germination and establishment occurred in habitats with a light covering of litter that reduced evapotranspiration. Thick litter layers reduced germination and establishment by preventing seeds from reaching the soil surface (Hamrick and Lee 1987).

Sources of information:

Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].
Hamrick, J.L. and J.M. Lee. 1987. Effect of soil surface topography and litter cover on the germination, survival, and grow of musk thistle (*Carduus nutans*). American Journal of Botany 74(3): 451-457.
Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem

Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

2.8. Other species in the genus invasive in Alaska or elsewhere

A.	No	0
B.	Yes	3
U.	Unknown	

Score 3

Documentation:

Species:

The *Carduus* genus is comprised of a number of noxious pasture and range weeds (Royer and Dickinson 1999, USDA 2002, Whitson et al. 2000).

Sources of information:

Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

2.9. Aquatic, wetland, or riparian species

A.	Not invasive in wetland communities	0
B.	Invasive in riparian communities	1
C.	Invasive in wetland communities	3
U.	Unknown	

Score 0

Documentation:

Describe type of habitat:

Carduus species can be found in waste ground, old fields, pastures, and along roads and railroads. They can invade open natural areas such as meadows, prairies, and grasslands (Beck 2004, Butterfield et al. 1996).

Rational:

Sources of information:

Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].

Butterfield, C., J. Stubbendieck and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).

Total Possible 25

Total 17

---

3. DISTRIBUTION

3.1. Is the species highly domesticated or a weed of agriculture

A.	No	0
B.	Is occasionally an agricultural pest	2
C.	Has been grown deliberately, bred, or is known as a significant agricultural pest	4
U.	Unknown	

Score 2

Documentation:

Identify reason for selection, or evidence of weedy history:

Carduus species are not major agricultural pests; instead they are mostly weeds of pastures and ranges (Beck 2004, Royer and Dickinson 1999, Whitson et al. 2000).

Rational:

Sources of information:

Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].

Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

3.2. Known level of impact in natural areas

A.	Not known to cause impact in any other natural area	0
B.	Known to cause impacts in natural areas, but in dissimilar habitats and climate zones than exist in regions of Alaska	1
C.	Known to cause low impact in natural areas in similar habitats and climate zones to those present in Alaska	3
D.	Known to cause moderate impact in natural areas in similar habitat and climate zones	4
E.	Known to cause high impact in natural areas in similar habitat and climate zones	6
U.	Unknown	

Score 1

Documentation:

Identify type of habitat and states or provinces where it occurs:

Musk thistle invades natural communities in the Midwest, especially in Nebraska and Kansas. Infestations of musk thistle have been observed in areas of tallgrass prairie (Heidel 1987). This species is common in open grassy meadows and spreads into sagebrush, pinyon juniper, and mountain brush communities in Rocky Mountain National Park, Colorado (Rutledge and McLendon 1996). Musk thistle invades mid-successional sites that were disturbed in the last 11 to 50 years in Pipestone National Monument, Minnesota (Butterfield et al. 1996). It has been observed in fir-spruce habitats in Wyoming (Hull and Evans 1973). Musk thistle infests thousands of hectares of pastures in New Zealand (Jessep 1990). Italian thistle invades chaparral and oak savanna in California (Bossard and Lichti 2000).

Sources of information:

Bossard, C. and R. Lichti. *Carduus pycnocephalus*. In: Bossard C.C., J.M. Randsll, and M.C. Hoshovsky, editors. Invasive plants of California wildlands. Berkeley, Los Angeles, London: University of California Press; 2000. p 86-90.

Butterfield, C., J. Stubbendieck and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).

Heidel, B. 1987. Element stewardship abstract for *Carduus nutans* Musk thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/allipeti.html [2005, May 2].

Hull, A.C.Jr and J.O. Evans. 1973. Musk thistle (*Carduus nutans*): An undesirable range plant. Journal of Range Management 26(5): 383-385.

Jessep, C.T. 1990. Aspects of the biology of nodding thistle (*Carduus nutans* L.) in Canterbury, New Zealand. New Zealand Journal of Agricultural Research 33: 173-183.

Rutledge, C.R. and T. McLendon. 1996. An Assessment of Exotic Plant Species of

Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

3.3. Role of anthropogenic and natural disturbance in establishment

A.	Requires anthropogenic disturbances to establish	0
B.	May occasionally establish in undisturbed areas but can readily establish in areas with natural disturbances	3
C.	Can establish independent of any known natural or anthropogenic disturbances	5
U.	Unknown	

Score 3

Documentation:

Identify type of disturbance:

Thistles colonize anthropogenically disturbed areas, but can colonize areas subject to natural disturbances such as landslides or frequent flooding (Remaley 2004). Fire or heavy grazing are favorable to thistle establishment and development (Zouhar 2002).

Rational:

In Minnesota, prairie thistle populations decreased rapidly after grazing was removed and natural succession began to take place (Heidel 1987).

Sources of information:

Heidel, B. 1987. Element stewardship abstract for *Carduus nutans* Musk thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/allipeti.html [2005, May 2].

Remaley,T. 2004. Musk thistle *Carduus nutans* L. Aster family (Asteraceae). The Plant Conservation Alliance's Alien Plant Working Group. Available: http://www.nps.gov/plants/alien/fact/canu1.htm [2005, May 2].

Zouhar, K. 2002. *Carduus nutans*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2005, May 4].

3.4. Current global distribution

A.	Occurs in one or two continents or regions (e.g., Mediterranean region)	0
B.	Extends over three or more continents	3
C.	Extends over three or more continents, including successful introductions in arctic or subarctic regions	5
U.	Unknown	

Score 3

Documentation:

Describe distribution:

Members of the genus *Carduus* are native to Europe, western Siberia, Asia Minor, and North Africa (Desrochers et al. 1988). They have been introduced to North and South America, Australia, and New Zealand.

Rational:

Sources of information:

Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.

3.5. Extent of the species U.S. range and/or occurrence of formal state or provincial listing

A.	0-5% of the states	0
B.	6-20% of the states	2
C.	21-50%, and/or state listed as a problem weed (e.g., "Noxious," or "Invasive") in 1 state or Canadian province	4
D.	Greater than 50%, and/or identified as "Noxious" in 2 or more states or Canadian provinces	5

U. Unknown

Score 5

Documentation:
Identify states invaded:
Occurs in 45 American states and all Canadian provinces. Species of genus *Carduus* are classified as noxious, restricted, or prohibited weeds in 22 American states and 5 Canadian provinces (Royer and Dickinson 1999, USDA 2002).
Rational:

Sources of information:
Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.
USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Total Possible 25
Total 14

---

4. FEASIBILITY OF CONTROL

4.1. Seed banks

A. Seeds remain viable in the soil for less than 3 years 0
B. Seeds remain viable in the soil for between 3 and 5 years 2
C. Seeds remain viable in the soil for 5 years and more 3
U. Unknown

Score 3

Documentation:
Identify longevity of seed bank:
Seeds have been reported to remain viable in the soil for 10 to 15 years (Butterfield et al. 1996, Burnside et al. 1981, Desrochers et al. 1988, Rutledge and McLendon 1996).
Rational:

Sources of information:
Butterfield, C., J. Stubbendieck, and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).
Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.
Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

4.2. Vegetative regeneration

A. No resprouting following removal of aboveground growth 0
B. Resprouting from ground-level meristems 1
C. Resprouting from extensive underground system 2
D. Any plant part is a viable propagule 3
U. Unknown

Score 2

Documentation:
Describe vegetative response:

Plants can regrow from the root buds, then flower and set seed (Butterfield et al. 1996, Heidel 1987).
Rational:

Sources of information:
Butterfield, C., J. Stubbendieck, and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).
Heidel, B. 1987. Element stewardship abstract for *Carduus nutans* Musk thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/allipeti.html [2005, May 2].

4.3. Level of effort required

A.	Management is not required (e.g., species does not persist without repeated anthropogenic disturbance)	0
B.	Management is relatively easy and inexpensive; requires a minor investment in human and financial resources	2
C.	Management requires a major short-term investment of human and financial resources, or a moderate long-term investment	3
D.	Management requires a major, long-term investment of human and financial resources	4
U.	Unknown	

Score 3

Documentation:
Identify types of control methods and time-term required:
Cultural, mechanical, biological, and chemical control methods have all been used on thistles with varying degrees of success. Hand-cutting or mowing can provide control if repeated over a period of years (Beck 2004, Heidel 1987, Remaley 2004).
Rational:

Sources of information:
Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].
Heidel, B. 1987. Element stewardship abstract for *Carduus nutans* Musk thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/allipeti.html [2005, May 2].
Remaley,T. 2004. Musk thistle *Carduus nutans* L. Aster family (Asteraceae). The Plant Conservation Alliance's Alien Plant Working Group. Available: http://www.nps.gov/plants/alien/fact/canu1.htm [2005, May 2].

Total Possible	10
Total	8

Total for 4 sections Possible	100
Total for 4 sections	61

References:

AK Weeds Database. 2004. Database of exotic vegetation collected in Alaska. University of Alaska, Alaska Natural Heritage Program – US Forest Service – National Park Service Database. Available: http://akweeds.uaa.alaska.edu/

Austin, M.P., R.H. Groves, L.M. Fresco, P.E. Kaye. 1985. Relative growth of six thistle species along a nutrient gradient with multispecies competition. Journal of Ecology 73(2): 667-684.

Beck, K.G. 2004. Fact Sheet No. 3.102: Musk thistle. CO: Colorado State University, Cooperative Extension. Available: http://www.ext.colostate.edu/pubs/natres/03102.html [2005, May 2].

Bossard, C. and R. Lichti. *Carduus pycnocephalus*. In: Bossard C.C., J.M. Randsll, and M.C. Hoshovsky, editors. Invasive plants of California wildlands. Berkeley, Los Angeles, London: University of California Press; 2000. p 86-90.

Butterfield, C., J. Stubbendieck, and J. Stumpf. 1996. Species abstract of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97).

CLIMEX for Windows, Version 1.1a. 1999. CISRO Publishing, Australia.

Desrochers, A.M., J.F. Bain, S.I. Warwick. 1988. The biology of Canadian weeds. 89. *Carduus nutans* L. and *Carduus acanthoides* L. Canadian Journal of Plant Science 68: 1053-1068.

Gubanov IA, Kiseleva KV, Novikov VS, Tihomirov VN. An Illustrated identification book of the plants of Middle Russia, Vol. 3: Angiosperms (dicots: archichlamydeans). Moscow: Institute of Technological Researches; 2004. 520 p.

Hamrick, J.L., and J.M. Lee. 1987. Effect of soil surface topography and litter cover on the germination, survival, and growth of musk thistle (*Carduus nutans*). American Journal of Botany 74(3): 451-457.

Heidel, B. 1987. Element stewardship abstract for *Carduus nutans* Musk thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/allipeti.html [2005, May 2].

Hull, A.C.Jr and J.O. Evans. 1973. Musk thistle (*Carduus nutans*): An undesirable range plant. Journal of Range Management 26(5): 383-385.

Hultén, E. 1968. Flora of Alaska and Neighboring Territories. Stanford University Press, Stanford, CA. 1008 p.

Jessep, C.T. 1990. Aspects of the biology of nodding thistle (*Carduus nutans* L.) in Canterbury, New Zealand. New Zealand Journal of Agricultural Research 33: 173-183.

Lid, J. and D. T. Lid. 1994. Flora of Norway. The Norske Samlaget, Oslo. Pp. 1014.

Pitcher, D. and M.J. Russo. 1988. Element stewardship abstract for *Carduus pycnocephalus* Italian thistle. The Nature Conservancy. Arlington, Virginia. Available: http://tncweeds.ucdavis.edu/esadocs/cardpycn.html [2005, May 2]

Remaley,T. 2004. Musk thistle *Carduus nutans* L. Aster family (Asteraceae). The Plant Conservation Alliance's Alien Plant Working Group. Available: http://www.nps.gov/plants/alien/fact/canu1.htm [2005, May 2].

Royer, F., and R. Dickinson. 1999. Weeds of the Northern U.S. and Canada. The University of Alberta press. 434 pp.

Rutledge, C.R., and T. McLendon. 1996. An Assessment of Exotic Plant Species of Rocky Mountain National Park. Department of Rangeland Ecosystem Science, Colorado State University. 97 pp. Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/Explant/explant.htm (Version 15DEC98).

Smith, L.M. and L.T. Kok. 1984. Dispersal of musk thistle (*Carduus nutans*) seeds. Weed science 32: 120-125.

University of Alaska Museum. University of Alaska Fairbanks. 2003. http://hispida.museum.uaf.edu:8080/home.cfm

USDA (United States Department of Agriculture), NRCS (Natural Resource Conservation Service). 2002. The PLANTS Database, Version 3.5 (http://plants.usda.gov). National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

Wardle, D.A., K.S. Nicholson, and A. Rahman. 1993. Influence of plant age on the allelopathic potential of nodding thistle (*Carduus nutans* L.) against pasture grasses and legumes. Weed Research 33: 69-78.

Wardle, D.A., K.S. Nicholson, and A. Rahman. 1996. Use of a comparative approach to identify allalopathic potential and relationship between allelopathy bioassays and "competition" experiments for ten grasslands and plant species. Journal of Chemical Ecology 22(5): 933-948.

Warwick, S.I., J.F. Bain, R. Wheatcroft, B.K. Thompson. 1989. Hybridization and introgression in *Carduus nutans* and *C. acanthoides* reexamined. Systematic Botany 14(4): 476-494.

Whitson, T. D., L. C. Burrill, S. A. Dewey, D. W. Cudney, B. E. Nelson, R. D. Lee, R. Parker. 2000. Weeds of the West. The Western Society of Weed Science in cooperation with the Western United States Land Grant Universities, Cooperative Extension Services. University of Wyoming. Laramie, Wyoming. 630 pp.

Zouhar, K. 2002. *Carduus nutans*. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2005, May 4].