Predicting invasive plant response to climate change: Prioritization and mapping of new potential threats to Alberta's biodiversity
(Chai et al. 2014)

Supplemental Information: Alberta non-native plant invasiveness ranking form
(Adapted from Carlson et al. 2008)

Full report available at http://www.biodiversityandclimate.abmi.ca

Scientific name:	*Onopordum acanthium*
Common name:	Scotch thistle
Assessor:	Shauna-Lee Chai
Reviewer:	Paul Cavers
Date:	August 20, 2013

Outcome score:

A. Climatic Comparison

This species is present or may potentially establish in the following natural regions:

	Collected in Alberta regions	CLIMEX similarity in 1975	CLIMEX similarity in 2050
Boreal	No	0.744	0.797
Parkland	No	0.813	0.856
Foothills	No	0.833	0.858
Grassland	No	0.852	0.882
Rocky Mountains	No	0.780	0.800
Shield	No	0.664	0.725

B. Invasiveness Ranking

	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40(40)	20
2. Biological characteristic and dispersal ability	25(23)	13
3. Ecological amplitude and distribution	25(25)	13
4. Feasibility of control	10(10)	7
Outcome score	100(98)[b]	[a]53
Relative maximum score[2]	54	*'Modestly Invasive'*

[1]For questions answered "unknown" do not include point value for the question in parentheses for "Total answered points possible."

[2]Calculated as a/b x 100.

A. Climatic Comparison:

1.1 Has this species ever been collected or documented in Alberta?

__Yes – continue to 1.2

x No – continue to 2.1

Which natural region has it been collected or documented (see inset map)? Proceed to section B. Invasiveness Ranking.

__Boreal

__Rockies

__Grassland

__Foothills

__Parkland

__Shield

Documentation:

Sources of information: ANPC Rogues gallery, ACIMS, PLANTS database, GBIF

2.1 Is there a 70 percent or higher similarity (based on CLIMEX climate matching) between climates anywhere the species currently occurs and

a. Boreal - Yes

b. Rockies - Yes

c. Grassland - Yes

d. Foothills - Yes

e. Parkland - Yes

f. Shield - Not in 1975, but in 2050

-If "no" is answered for all regions, reject species from consideration

Documentation:

Sources of information:

B. Invasiveness Ranking

1. Ecological Impact

1.1 Impact on Natural Ecosystem Processes

a. No perceivable impact on ecosystem processes 0

b. Has the potential to influence ecosystem processes to a minor degree (e.g., has a perceivable but mild influence on soil nutrient availability) 3

c. Has the potential to cause significant alteration of ecosystem processes (e.g., increases sedimentation rates along streams or coastlines, reduces open water that are important to waterfowl) 7

d. May cause 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: 7

Documentation: Dead plants remain standing and spreads fire in this manner. Affects grazing and competes with desirable forage species.

Identify ecosystem processes impacted: helps spread fire, alters community composition

Rationale:

Sources of information: ISSG, Cavers et al 2011

1.2 Impact on Natural Community Structure

a. No perceived impact; establishes in an existing layer without influencing its structure 0
b. Has the potential to influence structure in one layer (e.g., changes the density of one layer) 3
c. Has the potential to cause significant impact in at least one layer (e.g., creation of a new layer or elimination of an existing layer) 7
d. Likely to cause major alteration of structure (e.g., covers canopy, eradicating most or all layers below) 10
u. Unknown

Score: 3

Documentation: up to 3 m tall, large leaves smother other plants. Minor impact on floral strata (ISSG)

Identify type of impact or alteration:

Rationale:

Sources of information:

1.3 Impact on Natural Community Composition

a. No perceived impact; causes no apparent change in native populations 0
b. Has the potential to influence community composition (e.g., reduces the number of individuals in one or more native species in the community) 3
c. Has the potential to 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. Likely to cause 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: 3

Documentation: competes with desirable forage species. One reason for the lack of persistence of Scotch thistle populations in Southern Ontario is that overwintering plants are often destroyed by populations of small rodents under the snow cover. We do not know which species of rodents are involved but in each case the growing point of the thistle plant is destroyed. This leaves a plant with large leaves in the early spring but one that cannot flower. In most thistle populations that we examined all or virtually all plants are destroyed. The occasional plants that escape destruction are usually the smallest plants and ones that occupy the least favourable sites for thistle growth and reproduction. In general, the larger and more

vigorous populations of Scotch thistle are the most likely to be destroyed by this "winter grazing"- (Cavers pers. comm.)

Identify type of impact or alteration:

Rationale:

Sources of information:

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. Has the potential to cause minor alteration 3

c. Has the potential to cause moderate alteration (minor reduction in nesting/foraging sites, reduction in habitat connectivity, interference with native pollinators, injurious components such as spines, toxins) 7

d. Likely to cause 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: spines make it unpalatable, excludes cattle in California (Fuller 1977). But, can be grazed by goats, sheep in the western United States (Cavers et al. 2011)

Identify type of impact or alteration:

Rationale:

Sources of information:

Total Possible:40

Total:20

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/m2) 1

c. Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed, <1,000/m2) 2

d. Highly aggressive reproduction (extensive vegetative spread and/or many seeded, >1,000/m2) 3

u. Unknown

Score: 3

Documentation: >7500 fruits m^{-2} (1 seed/fruit) (Pettit et al. 1996)

Describe key reproductive characteristics (including seeds per plant):20±19 capitula per plant and each capitulum contains many seeds (cypselas). An average of 173 seeds per capitulum is present,

which means there are 3460 seeds per plant (Steel and Threadgill, unpublished data in Cavers et al. (2011)

Rationale:

Sources of information:

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: (Cavers et al 2011)

Identify dispersal mechanisms: dispersed by humans, wind, water, animals-livestock, wildlife, including long distance dispersal

Rationale:

Sources of information:

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: 2

Documentation:

Identify dispersal mechanisms:

Rationale:

Sources of information: ISSG, Cavers et al. (2011)

2.4 Allelopathic

a. no 0
b. yes 2
u. unknown

Score:unknown

Documentation: anecdotal evidence exists that the distribution of Scotch thistle plants in a number of communities may be suggestive of allelopathic effects from these plants but this is unconfirmed (Cavers pers. comm.). No evidence of allelopathy given in Cavers et al. (2011).

Describe effect on adjacent plants:

Rationale:
Sources of information:

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: competes with desirable forages
Rationale:
Sources of information: Cavers et al 2011

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:0

Documentation: Does not form dense thickets in Canada (Cavers pers. comm.)
Describe growth form: up to 3 m tall, broad leaves
Rationale:
Sources of information: Cavers et al 2011

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: open areas, strong dormancy of Scotch thistle seeds 5-15 years in Ontario (Cavers pers. comm.)
Rationale:
Sources of information: Cavers et al 2011

2.8 Other species in the genus invasive in Alberta or elsewhere

a. No	0
b. Yes	3
u. Unknown	

Score:3

Documentation: Onopordum illyricum L. is very similar to Scotch thistle and it has been invasive in Australia for many years (Auld and Medd 1987; Parsons and Cuthbertson 1992). Small populations of this species have become established in California and it has been grown in gardens in several places in Canada (Cavers et al. 2011). Onopordum acaulon L. (stemless thistle) is a widely distributed alien weed in Australia. O. tauricum Willd., native to southeastern Europe and southwest Asia is invasive in California and Colorado and is a noxious weed in both states

Species:

Sources of information: Cavers et al 2011

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: 1

Documentation: There is general agreement in North America that Scotch thistle does not grow in wetlands. However, it does occur in riparian communities. It has been recorded from gravel bars in and beside the Thames River; sites that become very dry during summer droughts (Cavers pers. comm.). Elsewhere it is present in rivers canals waterways (ISSG)

Describe type of habitat:

Rationale:

Sources of information:

Total Possible:23

Total:13

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: 4

Documentation: weed in southern Ontario (Moore and Frankton 1974)

Identify reason for selection, or evidence of weedy history:

Rationale:

Sources of information:

3.2 Known level of ecological 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 Alberta	1
c. Known to cause low impact in natural areas in similar habitats and climate	

zones to those present in Alberta 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: minor invader of protected natural areas in Southern Ontario. Likely source is from gravel used for riverside stabilization (Cavers pers. comm.)

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

Sources of information:

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:0

Documentation: in waste places and roadsides

Identify type of disturbance:

Rationale:

Sources of information: Cavers et al 2011

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: in all continents except Antarctica

Describe distribution: Native to southern Europe and southwestern Asia, it has been introduced to almost 50 countries in all continents except Antarctica. Does not appear to tolerate subarctic or arctic conditions.

Rationale:

Sources of information: cavers et al 2011

3.5 Extent of the species Canada range and/or occurrence of formal state or provincial listing

a. 0-5 percent of the states/provinces 0

b. 6-20 percent of the states/provinces 2

c. 21-50 percent, and/or state/province listed as a problem weed (e.g., “Noxious,” or “Invasive”) in 1 state or Canadian province 4

d. Greater than 50 percent, and/or identified as "Noxious" in 2 or more states or Canadian provinces 5

u. Unknown

Score:5

Documentation: regulated in 6 nearby states/provinces. Regulated in Arizona, California, Colorado, Connecticut, Idaho, Missouri, Nevada, new Mexico, Oklahoma, Oregon, Utah, Washington, Wyoming

Identify provinces invaded:BC, Ont, Quebec, Montana, Wyoming

Rationale:

Sources of information:

Total possible:25

Total:13

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:>15% germination after 39 years, persistent seed bank in S-W Ontario

Identify longevity of seed bank

Rationale:

Sources of information: Cavers et al. (2011)

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:1

Documentation: resprouting after cultivation which splits large rosettes (Cavers et al 2011). Parsons and Cuthbertson (1992): "Isolated plants should be grubbed, taking care to remove as much of the taproot as possible, otherwise regrowth occurs from any substantial pieces of the root left intact." In contrast, Cavers found that regrowth only occurs from fragments that include growing points from the vegetative stem tissue and has not recorded more than 3 individuals after fragmentation of a single non-flowering plant. Possibly, there is more vegetative regeneration from fragmented plants of the hybrid (in Australia) than from plants of Onopordum acanthium in North America. Hybrids from other weed species do have a greater capacity for vegetative regeneration than plants from a single species (e.g. Rumex, Cavers, unpublished).

Describe vegetative response:

Rationale:

Sources of information:

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: digging, mowing, herbicide. Multiyear control efforts have been recorded in Australia, initiated in 1968, and by 1987 the area infested was reduced from 1449 ha to250 ha.

Rationale:

Sources of information: Briese et al. 1990

Total Possible: 10

Total: 7

Total for 4 sections Possible: 98

Total for 4 sections: 53

Score Interpretation (Carlson et al. 2008):

While different users will have different concepts of what constitutes various levels of invasiveness (e.g., what is "highly invasive" vs. "moderately invasive" may differ among management agencies), we divided the ranks into six blocks in Appendix A. We consider species with scores ≥80 as "Extremely Invasive" and species with scores 70–79 as "Highly Invasive;" both of these groups are composed of species estimated to be very threatening to Alberta. Species with scores of 60–69 as "Moderately Invasive" and scores of 50–59 represent "Modestly Invasive" species; both of these groups still pose significant risks to ecosystems. Species with scores of 40–49 are "Weakly Invasive", and <40 are considered "Very Weakly Invasive." These last two groups generally have not been shown to significantly alter ecosystem processes and communities elsewhere and probably do not require as much attention as the other species

Notes:

Onopordum acanthium could be a hybrid between Onopordum acanthium and Onopordum illyricum L. (Illyrian thistle) (Cavers pers. comm.).

References:

Briese, D. T., Lane, D., Hyde-Wyatt, B. H., Crocker, J. and Diver, R. G. 1990. Distribution of thistles of the genus Onopordum in Australia. Plant Prot. Q. 5:23-27.

Carlson, M. 2008. Invasiveness Ranking System for Non-Native Plants of Alaska. USDA. Available at: http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_037575.pdf

Cavers, P.B. M. Qaderi, P. Threadgill & M. Steel. 2011. The Biology of Canadian Weeds. 147. *Onopordum acanthium* L. Can. J. Plant Sci. 91, 739-758.

Fuller, T. C. 1958. Scotch thistle (Onopordum acanthium) in California. Calif. State Dep. Agric. Bull. 47: 222-223

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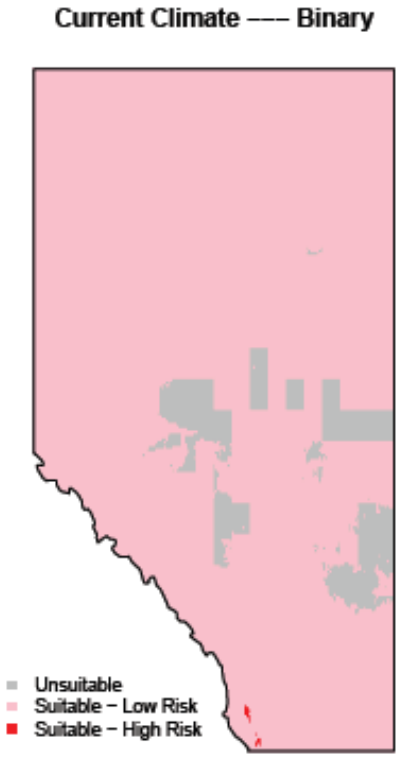
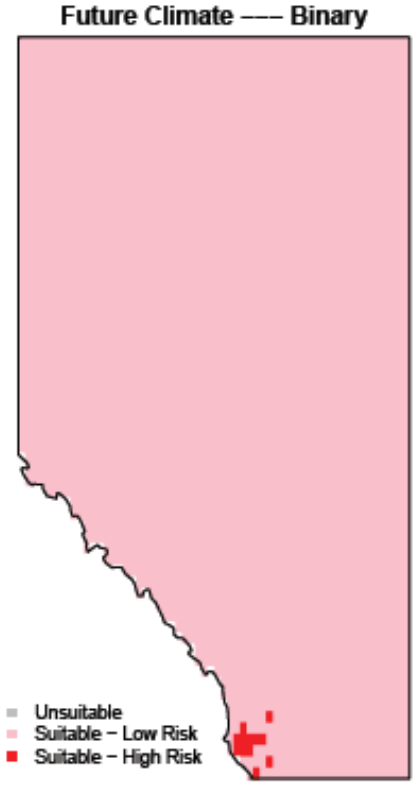
Pettit, W. J., Briese, D. T., Walker, A., Woodburn, T. L. and Corey, S. 1996. Aspects of thistle population dynamics with reference to Onopordum. Plant Prot. Q. 11 (Suppl. 2): 232-235.

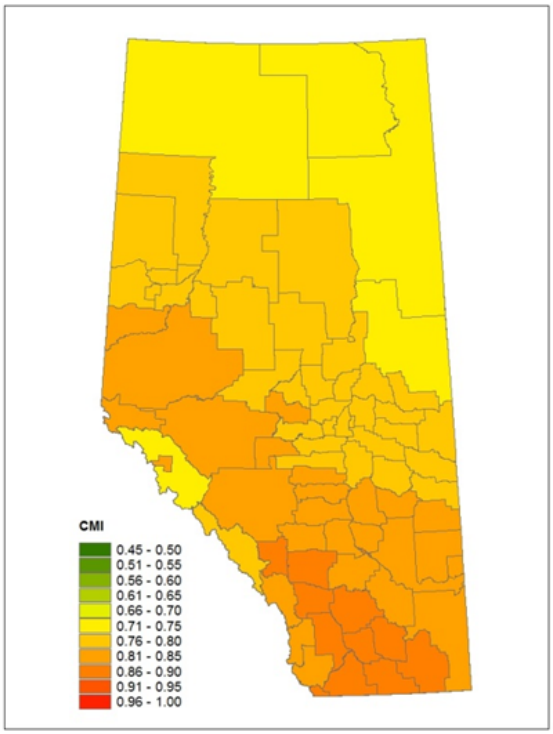




(future climate=2050)

CLIMEX climate match results

1975



2050