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:	*Halogeton glomeratus*
Common name:	Saltlover
Assessor:	Shauna-Lee Chai
Reviewer:	Joseph Ditomaso
Date:	November 29, 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	0.777	0.777
Parkland	No	0.801	0.828
Foothills	No	0.823	0.813
Grassland	No	0.856	0.874
Rocky Mountains	No	0.776	0.761
Shield	No	0.828	0.739

B. Invasiveness Ranking

	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40(40)	20
2. Biological characteristic and dispersal ability	25(25)	10
3. Ecological amplitude and distribution	25(25)	15
4. Feasibility of control	10(10)	7
Outcome score	100(100)[b]	[a]52
Relative maximum score[2]	52	*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 -Yes

-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: Causes increases in pH, exchangeable sodium, potassium, magnesium, electrical conductivity, and decreases in water percolation. High salts inhibit micro-organisms aiding nitrification, which depresses plant growth (Cronin et al 1965). Changes not completely irreversible (Ditomaso, pers.comm.).

Identify ecosystem processes impacted:

Rational:

Sources of information:

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 influences 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: as above

Identify type of impact or alteration:

Rational:

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: as above. Not an extremely competitive plant (Whitson et al. 2000)

Identify type of impact or alteration:

Rational:

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: Halogeton is high in oxalates and is a serious health threat to grazing animals, especially sheep (Cronin et al. 1965). Palatability is extremely low, and halogeton is seldom eaten by livestock. It is readily grazed at times causing thousands of livestock poisoning (Whitson et al. 2000). The palatability of halogeton is listed as poor for ungulates. in Montana, Utah, and Wyoming. In Utah and Wyoming, halogeton palatability is fair for small mammals, good for game and nongame birds, and poor for waterfowl (Cronin et al. 1965).

Identify type of impact or alteration:

Rational:

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: Halogeton can produce 75 seeds per inch (35 seeds per cm) of stem, which is 200 to 400 pounds of seeds per acre (222-449 kg/ha) Cronin et al. 1965

Describe key reproductive characteristics (including seeds per plant):

Rational:

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: Animals are capable of spreading large amounts of seed great distances; seeds pass with the feces. Wind and road works are other means

Identify dispersal mechanisms:
Rational:
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: 3

Documentation: spread in open or disturbed ground such as dry lakebeds, railways, gravel pits, overgrazed ranges and rodent workings

Identify dispersal mechanisms:
Rational:
Sources of information:

2.4 Allelopathic

a. no 0
b. yes 2
u. unknown

Score:0

Documentation:

Describe effect on adjacent plants:
Rational:
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:Poor competitor because it does not establish large shoots or roots early in the growing season (Eckert 1954). It can however survive extended drought due to 10 yr dormancy of seeds (Cronin et al. 1965)

Evidence of competitive ability:

Rational:

Sources of information:

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:

Describe growth form:

Rational:

Sources of information:

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: Halogeton readily invades and dominates rangeland depleted by persistent and continuous overgrazing (Cronin et al 1965)

Describe germination requirements:

Rational:

Sources of information:

2.8 Other species in the genus invasive in Alberta or elsewhere

a. No 0
b. Yes 3
u. Unknown

Score:0

Documentation:

Species:

Sources of information:

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:
Rational:
Sources of information:

Total Possible:25
Total:10

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: agricultural pest, low palatability to livestock as noted above
Identify reason for selection, or evidence of weedy history:
Rational:
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:3

Documentation: occurs in degraded areas
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: open or disturbed ground such as dry lakebeds, railways, gravel pits, overgrazed ranges and rodent workings

Identify type of disturbance:
Rationale:
Sources of information:

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: Occurs in North America, Australia, Asia

Describe distribution:
Rational:
Sources of information:

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: Noxious in Arizona, California, Colorado, Hawaii, New Mexico and Oregon (USDA PLANTS)

Identify provinces invaded:
Rational:
Sources of information:

Total possible:25
Total:15

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: 2 types of seeds produced: black seds viable for 1 yr and brown seeds that can survive for 10 yrs (Cronin et al. 1965)
Identify longevity of seed bank
Rational:
Sources of information:

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:0

Documentation: DiTomaso et al. 2013
Describe vegetative response:
Rational:
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:4

Documentation: The best defense against halogeton is a vigorous stand of perennial range plants and variations in grazing patterns (Pemberton 1986)
Identify types of control methods and time-term required: chemicals, cultural, biocontrol (Cronin et al. 1965).
Rational:
Sources of information:

Total Possible: 10
Total: 7
Total for 4 sections Possible: 100

Total for 4 sections:55

References:

Cronin, Eugene H.; Williams, M. Coburn. 1965. Principles for managing ranges infested with halogeton. Journal of Range Management. 19: 226-227.

DiTomaso, J.M., G.B. Kyser et al. 2013. Weed Control in Natural Areas in the Western United States. Weed Research and Information Center, University of California. 544 pp.

Eckert, Richard E., Jr. 1954. A study of competition between whitesage and halogeton in Nevada. Journal of Range Management. 7: 223-225

Reynolds, Timothy D.; Trost, Charles H. 1981. Grazing, crested wheatgrass, and bird populations in southeastern Idaho. Northwest Science. 55(3): 225-234.

USDA PLANTS database

Pavek, Diane S. 1992. Halogeton glomeratus. 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/ [2013, November 29].

Pemberton, Robert W. 1986. The distribution of halogeton in North America. Journal of Range Management. 39(3): 281-282

Whitson, T. D., Burrill, L. C., Dewey, S. A., Cudney, D. W., Nelson, B. E., Lee, R. D., and Parker, R. 2000. Weeds of the West. Jackson, WY: Western Society of Weed Science. 628 pp.

Notes

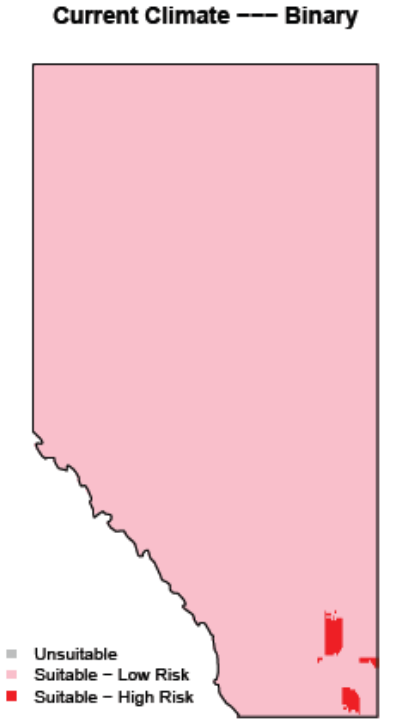
Halogeton is an exotic succulent **annual** forb. The taproot can penetrate as deep as 20 inches. Halogeton is adapted to alkaline soils and semiarid environments. It has rapidly invaded millions of acres in the western states.

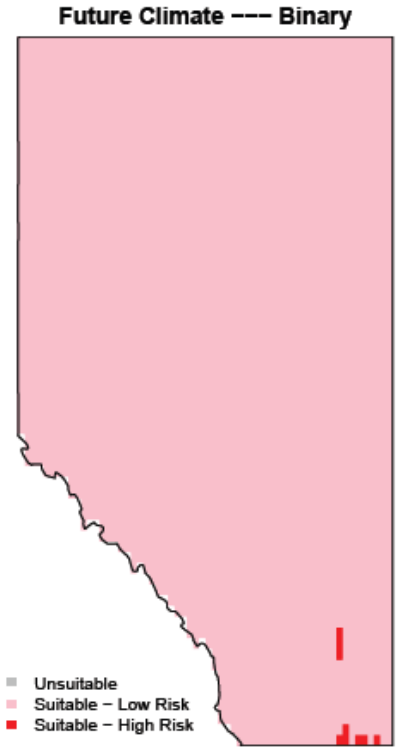
Score Interpretation

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.

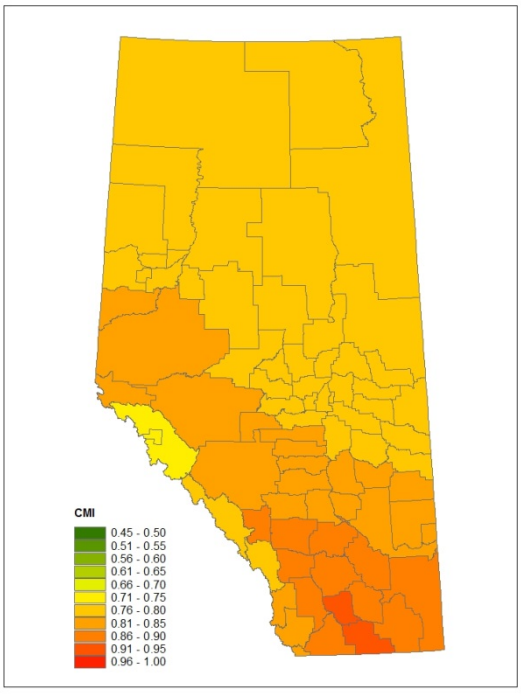
Species Distribution Model (1975=current, 2050=future climate)





CLIMEX climate match by county

1975



2050