

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:	Tribulus terrestris
Common name:	Puncturevine
Assessor:	Shauna-Lee Chai
Reviewers:	Lisa Scott
Date:	December 2, 2013

Outcome score:

A. Climatic Comparison

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

	Collected in Alberta	CLIMEX similarity in	CLIMEX similarity
	regions	1975	in 2050
Boreal	No	0.798	0.845
Parkland	No	0.828	0.798
Foothills	No	0.836	0.822
Grassland	No	0.874	0.845
Rocky Mountains	No	0.778	0.776
Shield	No	0.833	0.869

В.	Invasiveness Ranking	Total (Total answer	ed ¹ points po	ossible)	Total score	

1. Ecological impact	40(40)	16
2. Biological characteristic and dispersal ability	25(25)	17
3. Ecological amplitude and distribution	25(25)	16
4. Feasibility of control	10(10)	5
Outcome score	$100(100)^{b}$	^a 54
Relative maximum score ²	54	Modestly Invasive

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

²Calculated as $a/b \ge 100$.

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

1.2 Which natural region has it been collected or documented? 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

Sources of information:

В.	3. 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	e	
			likely to favor non-native species)	10	

Score: 3 Documentation: capable of massive population increase over a short time (Squires 1979) Identify ecosystem processes impacted: Rationale: Sources of information: 1.2 Impact on Natural Community Structure a. No perceived impact; establishes in an existing layer without influencing its 0 structure b. Has the potential to influence structure in one layer (e.g., changes the density 3 of one layer) c. Has the potential to cause significant impact in at least one layer (e.g., creation 7 of a new layer or elimination of an existing layer) d. Likely to cause major alteration of structure (e.g., covers canopy, eradicating most or all layers below) 10 u. Unknown

Documentation:

Identify type of impact or alteration: Rationale:

u. Unknown

Sources of information:

1.3 Impact on Natural Community Composition

- a. No perceived impact; causes no apparent change in native populations
- b. Has the potential to influence community composition (e.g., reduces the number of individuals in one or more native species in the community)
- 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)
- 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)
- u. Unknown

Documentation:

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
 - a. Negligible perceived impact0b. Has the potential to cause minor alteration3

Score:3

0

3

Score: 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)
- 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)
- u. Unknown

Score: 7

7

Documentation: unpalatable to grazers (Randall 2001). Spines injure wildlife (Holm et al. 1977) Identify type of impact or alteration:

Rationale:

Sources of information:

Total Possible:40 Total:16

2. Biological Characteristics and Dispersal Ability

e		
2.1 Mc	ode 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
с.	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. 1	Unknown	
		Score:
Documenta	ation: no vegetative reproduction (Squires 1979)	
	key reproductive characteristics (including seeds per plant): 400 fruits/pl	ant, each
	seeds. Thousands of seed may be produced by 1 plant (Squires 1979)	
Rationale		
Sources o	f information:	
2.2 Inr	nate potential for long-distance dispersal (bird dispersal, sticks to animal	hair, buoyant
fru	its, 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
с.	Numerous opportunities for long-distance dispersal (species has	
	adaptations such as pappus, hooked fruit-coats, etc.)	3
u.	Unknown	
		Score:

Documentation: water and birds (Randall 2001). Fruit is dispersed by adhering to the feet of animals and humans or vehicle and bicycle tyres. Fruit also sticks to sheep wool and is often found in hay, straw and manure (Smith 2002).

Identify dispersal mechanisms:

Rationale:

Sources of information:

2.3 Potential to be spread by human activities (both directly and in mechanisms include: commercial sales, use as forage/revegeta 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 ne	w areas)	3
u. Unknown		5
		Score: 3
Documentation:vehicles, machinery, animals		50010. 5
Identify dispersal mechanisms:		
Rationale:		
Sources of information:		
sources of information.		
2.4 Allelopathic		
a. no	0	
b. yes	2	
u. unknown	2	
		Score:2
Documentation:Verdu et al. 1999		50010.2
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: Can tolerate dry soil. The deep taproot that the plant forms provides the mechanism for acquiring more water. Due to its ability to extract soil moisture, water losses due to T. terrestris are of economic concern for the agriculture, because of the plant's ability to extract soil moisture from great depths and to compete well with crops (Holm et al 1991). It is a poor competitor where perennials exist however (Squires 1968)

Evidence of competitive ability:

Rationale:

2.5

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: <u>annual</u> (Nikolova and Vassilev 2011). But not dense (Randall 2001). Other reports list 'dense' mats formed. Puncturevine forms extremely dense mats when there is limited competitive vegetation and other conditions (soil, climate) are ideal. Has also been observed on rare occasion to climb on other plants (native and non-native) and appear more hedge like (Scott pers. comm).
Describe growth form: Rationale:

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:2

Documentation: shade intolerant (Nikolova and Vassilev 2011). This plant reproduces mainly through seed. Germination percentage of T. terrestris is very low under natural and laboratory conditions. Seeds germination and seedlings establishment in this species are vulnerable to environmental stress and produce very a limited number of plants. The growth of T. terrestris plants is very slow and they produce scanty biomass. The main problem of the reproduction of this species is the low and irregular germination of the seeds (Nikolova & Vassilev 2011).

Describe germination requirements:

Rationale:

Sources of information:

2.8 Other species in the genus invasive in Alberta or elsewhere	

a. No	0
b. Yes	3
u. Unknown	
	Score:3

Documentation: Tribulus cistoides, T. longipetalus Species: Sources of information:

a a		.1 1		• •	-
$\gamma \mathbf{q}$	Adnatic	wetland	or	rinarian	snecies
2.)	rquuito,	wetland,	01	inpuniun	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: Randall 2001 Describe type of habitat: Rationale: Sources of information:

3. Distribution

Total Possible:25 Total:17

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	
Sc	ore:

Documentation: Cultivated for medicinal and food supplement property (Nikolova and Vassilev 2011). Punturevine is a serious competitor of crops, especially in dry conditions. The burrs can be a

nuisance to pickers in orchards and contaminate harvested produce (CAB 2012). Identify reason for selection, or evidence of weedy history:

dentity reason for selection, of evidence of w

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	
	So	core:4

Documentation:

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 disturbanc	es 5
u. Unknown	
Score:0	
Documentation: A weed of cultivated fields, waste places and degraded pasture (Squires Identify type of disturbance: Rationale:	1979)
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	3
Documentation: Europe, Africa, Asia, North America, Australia	
Describe distribution:	
Rationale:	
Sources of information:	
3.5 Extent of the species Canada range and/or occurrence of formal state or provincia	al 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	r
Canadian provinces	5
u. Unknown	-
	Score:5

Documentation: Noxious in Arizona, California, Colorado, Idaho, Iowa, Nevada, North Carolina, Oregon, Washington (USDA PLANTS database)

Identify provinces invaded: Rationale:

Sources of information:

Total possible:25 Total:16

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	
	Scor	e:2
Document	ation:viability to 5 yrs	
•	ngevity of seed bank	
Rationale:		
Sources of	information:	
4 2 Ve	egetative regeneration	
a.		0
	Resprouting from ground-level meristems	1
	Resprouting from extensive underground system	2
d.		3
u.		-
	Scor	e:0
Document	ation: does not resprout (Scott pers. comm.)	
	egetative response:	
Rationale:		
Sources of	information:	
4.3 Le	evel of effort required	
a.	Management is not required (e.g., species does not persist without repeated	b
	anthropogenic disturbance)	0
b.	Management is relatively easy and inexpensive; requires a minor investme	nt in
	human and financial resources	2
C.	Management requires a major short-term investment of human and financi	
	resources, or a moderate long-term investment	3
d.	Management requires a major, long-term investment of human and financi	al
	resources	4
u.	Unknown	~ •
D		Score:3
	ation: mechanical, chemical and biocontrol-weevils	
	pes of control methods and time-term required:	
Rationale:	Sin formation.	
Sources of	information:	
	Total Possible: 10	
	Total:5	

Total:5 Total for 4 sections Possible: 100 Total for 4 sections: 54 References:

AISC 2012. Alberta Invasive Species Council Fact Sheet: Puncturevine

CAB 2012. Tribulus terrestris. Invasive Species Compendium. CAB International. http://www.cabi.org/isc/

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

Holm L.G., Plucknett D.L., Pancho J.V., Herberger J.P. (1991) The World's Worst Weeds, University Press of Hawaii, Honolulu, p. 609.

Holm LG, Pancho JV, Herberger JP, Plucknett DL, 1979. A Geographical Atlas of World Weeds. New York, USA: John Wiley and Sons.

Nikolova, A. & Vassilev, A., 2011. A Study on Tribulus Terrestris L. Anatomy and Ecological Adaptation. Biotechnology & Biotechnological Equipment, 25(2), pp.2369–2372. Available at: http://diagnosisp.com/dp/journals/view_article.php?journal_id=1&archive=0&issue_id=32&article_id=11 50 [Accessed December 2, 2013].

Randall 2001. Pacific Island Ecosystems at Risk (PIER): Tribulus terrestris.

Smith, Nicholas M. 2002. Weeds of the wet/dry tropics of Australia - a field guide. Environment Centre NT, Inc. 112 pp

Squires, V.R. 1979. The Biology of Australian weeds: Tribulus terrestris.

USDA PLANTS database

Verdu, A, M Mas, A Almirall. 1999. Allelopathic effects of Tribulus terrestris. Departamento Hortofruticultura, Botánica i Jardinería, Lérida, Spain. http://www.cabi.org/isc/Default.aspx?site=144&page=2540&LoadModule11=CABISEARCHRESULTS &LoadAction=LoadAbstract&term=au:%22Mas,+M.+T.%22&AbstractSearchTerm=au:%22Mas,+M.+T. %22&query=au:%22Mas,+M.+T.%22&AbstractID=20002302216

Nikolova, A. & Vassilev, A., 2011. a Study on Tribulus Terrestris L. Anatomy and Ecological Adaptation. Biotechnology & Biotechnological Equipment, 25(2), pp.2369–2372. Available at: http://diagnosisp.com/dp/journals/view_article.php?journal_id=1&archive=0&issue_id=32&article_id=11 50 [Accessed December 2, 2013].

Notes

annual

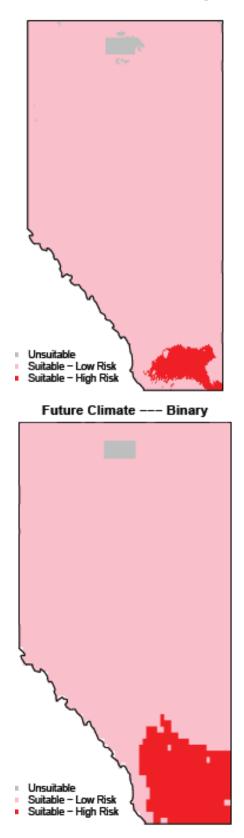
Intolerant of freezing temps, tolerates salt and drought

It is a caltrop-A caltrop is a metal device, used to deter passage by vehicles with pneumatic tires or the hooves of horses; it has four projecting spikes so arranged that when three of the spikes are on the ground, the fourth points upward to poke a tire or hoof.) The seeds of puncturevine are enclosed in a hard caltrop-like case that can injure livestock, people, and pets when stepped on and can even puncture bicycle tires.

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 \geq 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) Current Climate --- Binary



CLIMEX climate match by county 1975

