

**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:	<i>Peganum harmala</i>
Common name:	African Rue, Syrian-rue, wild rue, harmal
Assessor:	Shauna-Lee Chai
Reviewer:	John Kartesz
Date:	October 25, 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	0.752	0.779
Parkland	No	0.797	0.852
Foothills	No	0.821	0.829
Grassland	No	0.840	0.874
Rocky Mountains	No	0.786	0.777
Shield	No	0.701	0.733

B. Invasiveness Ranking

Total (Total answered<sup>1</sup> points possible)

Total score

	Total (Total answered <sup>1</sup> points possible)	Total score
1. Ecological impact	40(40)	27
2. Biological characteristic and dispersal ability	25(25)	15
3. Ecological amplitude and distribution	25(25)	16
4. Feasibility of control	10(7)	6
Outcome score	100(97) <sup>b</sup>	<sup>a</sup> 64
Relative maximum score <sup>2</sup>	66	<i>Moderately Invasive</i>

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

<sup>2</sup>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

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

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:3

Documentation: acts primarily on degraded rangelands and waste areas along roadsides. Can crowd out native species (CFIA 2010)

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 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: 7

Documentation: Can become dominant (Abbott et al. 2007)

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:10

Documentation: invades dry grasslands and can become dominant (Abott et al. 2007)

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: Toxic to livestock-horses, sheep, cattle and unsuitable forage to native grazers (Abbott et al. 2007).

Identify type of impact or alteration:

Rationale:

Sources of information:

Total Possible:40

Total:27

## 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<sup>2</sup>)) 1
- c. Moderately aggressive (reproduces vegetatively and/or by a moderate amount of seed, <1,000/m<sup>2</sup>) 2
- d. Highly aggressive reproduction (extensive vegetative spread and/or many seeded, >1,000/m<sup>2</sup>) 3
- u. Unknown

Score: 3

Documentation: Flowers have 45-60 seeds with each plant producing up to 1000 fruits and it reproduces vegetatively (USDA 2012)

Describe key reproductive characteristics (including seeds per plant):

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: dispersed by water running over soil and animals-digestion and fur (Parsons and Cuthbertson 1992). It is not clear if local movement can be attributed to small mammals and birds (Oregon 2010).

Identify dispersal mechanisms:

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:3

Documentation: seeds are available for commercial sale for medicinal properties and dye production (Guclu and Ozbek 2007). Can also be dispersed on vehicles and machinery (Parsons and Cuthbertson 1992). Animals can spread seeds in droppings. Agricultural activities can also spread seeds-hay, livestock movement, burning, tilling (Davidson and Wargo)

Identify dispersal mechanisms:

Rationale:

Sources of information:

2.4 Allelopathic

- a. no 0
- b. yes 2
- u. unknown

Score:2

Documentation: contains allelopathic chemicals that act as natural herbicides and reduce growth of surrounding plants giving it a competitive edge (Oregon 2010)

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:3

Documentation: can survive extreme drought and high temperatures as well as exhibiting allelopathy (Abbott et. al. 2008)

Evidence of competitive ability:

Rationale:

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: can become dominant (Abbott et al 2007). Perennial bushy herb that grows 1 to 1.5 feet tall and 3 to 4 feet in diameter.

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:0

Documentation: grows in degraded rangelands and waste areas along roadsides (CFIA 2010)

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: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: 1

Documentation: Disturbed areas with moist soil are especially susceptible, such as roadsides, riverbanks or streambanks, riparian corridors, waterways, and drainage or irrigation ditches (USDA 2012)

Describe type of habitat:

Rationale:

Sources of information:

Total Possible:25

Total:15

### 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: seeds available commercially for sale and affects rangeland cattle due to non-palatability

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:3

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 disturbances 5
- u. Unknown

Score:3

Documentation: Mostly found in disturbed areas

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: North Africa, USA, Middle East, central Asia, southeast Europe, Mediterranean, Australia

Describe distribution:

Rationale:

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 weed in Arizona, California, Colorado, New Mexico, Nevada and Oregon. Not regulated in Montana suggesting it has not shown serious invasive characteristics there, even if populations are present. Likely to invade Canada-BC and southern prairies (CFIA 2010)

Identify provinces invaded: absent from Canada

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

Score:unknown

Documentation: (Oregon 2010)

Identify longevity of seed bank

Rationale:

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:2

Documentation: pieces of rootstock can resprout if cultivated (Parsons and Cuthbertson 1992). It has a deep growing and robust perennial root system (tap root can grow to over 25 feet downwards) that is a major obstacle to plant control (USDA 2012)

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:4

Documentation: Mechanical removal is a difficult task. The strong, deep taproot and lateral roots must be removed for control. Plants may be cut back to the crown, but regrowth will occur. Tillage will only serve to spread infestations by severing and dragging rootstocks to new areas. Longevity in the seed bank is unknown. Grazing is not an effective control option, due to non-palatability or toxic effects. There are also no available biocontrol agents for this weed. The most effective control strategy is herbicide, applied to the foliage of actively growing plants in the bud stage. It is necessary to repeat this, possibly

several times until the plants are completely killed. Nonselective right-of-way herbicide products have provided good roadside control (Oregon 2010).

Identify types of control methods and time-term required:

Rationale:

Sources of information:

Total Possible: 7

Total: 6

Total for 4 sections Possible: 97

Total for 4 sections: 64

#### References:

Abbott, L.B., Lepar, D. and Daniel, D.L. 2007. Vegetative and reproductive phenology of African rue (*Peganum harmala*) in the northern Chihuahuan Desert. *The Southwestern Naturalist* 52(2): 209-218.

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](http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_037575.pdf)

CFIA 2010. Draft - RMD-10-04: Pest Risk Management Document for *Peganum harmala* (African-rue) in Canada

Davidson J. and Wargo M. Recognition and control of african rue in Nevada Fact Sheet FS-01-45 <http://www.unce.unr.edu/publications/files/nr/2001/FS0145.pdf>

Guclu, C., and Ozbek, H., 2007. African Rue Projects.

Oregon 2010. Oregon Department of Agriculture Plant Pest Risk Assessment for African rue, *Peganum harmala* 2009 (Revised 2010)

Parsons, W.T., and Cuthbertson, E.G. 1992. Noxious Weeds of Australia. Inkata Press, Melbourne and Sydney, Australia. 692 pp.

USDA 2012. Field Guide for Managing African Rue in the Southwest

#### Notes

Listed as one of the "worst weeds of the West."

weed of rangelands

prohibited noxious weed under the Weed Seeds Order of the Seeds Act in Canada

extremely drought tolerant-Gobi dessert

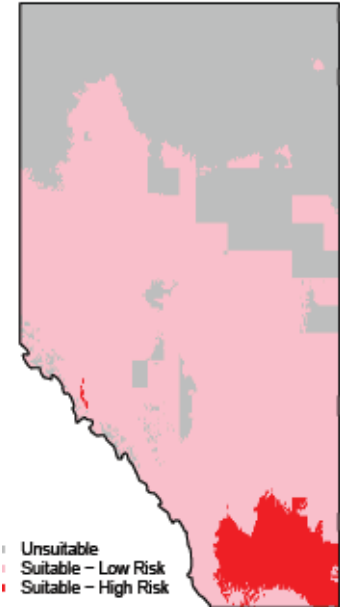
the biology and ecology of this species have not been well documented and much of our knowledge about this plant is anecdotal (Abbott et al 2007)

### Score Interpretation

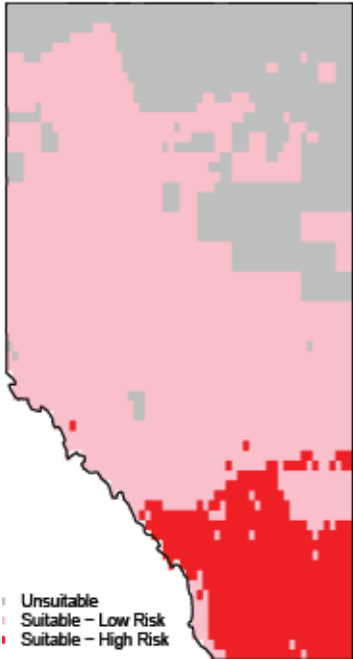
While different users will have different concepts of what constitutes various levels of invasiveness (e.g., what is “highly invasive” vs. “moderately invasive” may differ among management agencies), we divided the ranks into six blocks in Appendix A. We consider species with scores  $\geq 80$  as “Extremely 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**

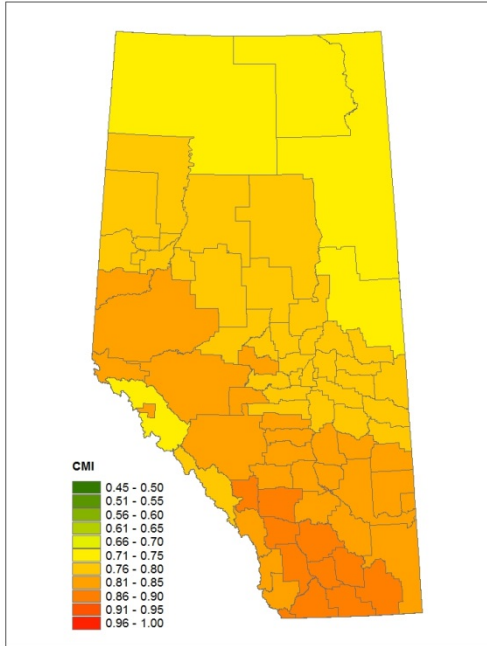


**Future Climate --- Binary**





CLIMEX climate match by county  
1975



2050

