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:	*Cynanchum louiseae/ Vincetoxicum nigrum*
Common name:	Black Swallow-wort
Assessor:	Shauna-Lee Chai
Reviewers:	Lindsey Milbrath
Date:	October 24, 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	0.673	0.728
Parkland	No	0.746	0.789
Foothills	No	0.722	0.759
Grassland	No	0.740	0.761
Rocky Mountains	No	0.664	0.703
Shield	No	0.590	0.661

B. Invasiveness Ranking

	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40(40)	28
2. Biological characteristic and dispersal ability	25(25)	20
3. Ecological amplitude and distribution	25(25)	13
4. Feasibility of control	10(7)	5
Outcome score	100(97)[b]	[a]66
Relative maximum score[2]	68	*Moderately 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 – Not in 1975, but in 2050

b. Rockies - Not in 1975, but in 2050

c. Grassland - Yes

d. Foothills - Yes

e. Parkland - Yes

f. Shield - No

-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: Ecosystem effects have not yet been studied. The species (when densities are high) causes ecosystem-wide reduction in light availability for co-occurring species (Lawlor 2006).

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: climbing habit means it is a strong light competitor reducing light availability for other forbs, shrubs and saplings. It can overtop and smother shrubs forming the dominant cover. It can comprise the dominant cover in the herbaceous understory layer (Lawlor, 2006, Ditommaso et al. 2005). We have essentially no empirical data to date to confirm if there are community impacts of black swallow-wort infestations. It is an assumption based on high density stands of the weed (Lawlor pers. comm.).

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 alter 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:7

Documentation: Establishment of C. louiseae is threatening the endemic Jessop's milkvetch, Astragalus rob- binsii (Oakes) A. Gray at Windsor (VT) on ice-scoured banks of the Connecticut River (Ditommaso et al. 2005). Its ability to form monocultures suggests it alters species composition of communities and

competes for moisture, nutrients and light (DiTommaso et al., 2005; Lawlor 2006). We do have unpublished data for pale swallow-wort but correlations between pale swallow-wort densities and plant community richness and cover often do not show a negative effect unless swallow-wort densities are very high. Plus the question is always whether or how much of the correlated reduction is due to swallow-wort or some other factor (land use history, deer pressure; Lawlor 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: low threat-deleterious effect on monarch butterfly via displaced oviposition and larval mortality and potential reduction of host plant availability through displacement. Also hosts rusts of Pinus spp in Europe. Although some insect and mite pests do utilize black and pale swallow-wort as host plants, their densities are very low (Milbrath 2010). Thus, swallow-worts are not likely to serve as a reservoir for pests. Studies of the related pale swallow-wort suggests a decline in arthropod and grassland bird diversity. Toxic to grazing mammals. (Ditommaso et al. 2005, Lawlor 2006)

Identify type of impact or alteration:

Rationale:

Sources of information:

Total Possible:40

Total:28

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: Reproduces by seed. References to rhizomes (e.g., Lumer and Yost 1995) have not been confirmed, although occasionally a rhizome-like connection can be found between two root crowns of black swallow-wort plants; this has never been seen in pale swallow-wort (LR Milbrath, personal observation). (rhizome propagation has recently been disproved (Cappuccino, 2004)). Vegetative expansion (increasing numbers of stems over time from a root crown) does occur but does not contribute to an increase in plant density, only an increase in stem density (Averill et al. 2011). Seed production per stem is similar between pale and black swallow-wort (Averill et al. 2011). Therefore, it is possible that high density infestations of black swallow-wort could produce >10,000 viable seed/m2 as has been reported for pale swallow-wort (Smith et al. 2006). 2090 seeds per square meter per plant can be produced (Uva et al. 1997).

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: long distance dispersal by wind facilitated through long hairs and occurs readily (Lawlor 2006)

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:2

Documentation:found close to human habitation in gardens. May be spread by harvesting or hay making; may have been used as an ornamental originally but no such use is known now (Ditommaso et al. 2005)

Identify dispersal mechanisms:

Rationale:
Sources of information:

2.4 Allelopathic

a. no	0
b. yes	2
u. unknown	

Score:2

Documentation: swallowwort root exudates caused significant root length reductions (e.g., 40%for butterfly milkweed and 20% for large crabgrass) and reduced germination (e.g., 25% for lettuce) of indicator species in laboratory studies (Douglass et al. 2011). Also see Gibson et al. 2011. However, it is not certain if allelopathy occurs in the field (processing of soil samples is currently underway-Milbrath pers. comm.).
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: Could be competitive for light due to climbing habit (Ditommaso et al. 2005). Blanchard et al. (2010) indicated that pale swallow-wort is not more competitive than some native plants.
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:2

Documentation: forms dense populations and is a climber (Ditommaso et al. 2005)
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:3

Documentation: Seems to prefer high light environments, some degree of shade tolerance (but not to the extent of pale swallow-wort), grows in some woodland understoreys (Ditommaso et al 2005). Can establish across a wide range of soil pH (Magidow et al. 2013)

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:

Species: *Cynanchum rossicum* (pale swallow-wort), it is more likely to spread to other areas from where it is planted, more competitive and effective at dispersal (DiTommaso et al. 2005)

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: Although referred to as an upland species, it can occur in wetlands (Lawlor 2006, Ditommaso et al 2005). Black (and pale) swallow-wort can occur in areas labelled wetland, but they will be in the drier areas because neither species tolerates perennially wet soils (Milbrath pers. comm.).

Describe type of habitat:

Rationale:

Sources of information:

Total Possible:25
Total:20

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: Noted weed pest in nurseries and pastures. Hosts rusts of Pinus spp in Europe. Although some insect and mite pests do utilize black and pale swallow-wort as host plants, their densities are very low (Milbrath 2010). Thus, swallow-worts are not likely to serve as a reservoir for pests.

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: E.G. pale swallow wort disturbs unique alvar ecosystems in western New York (Great Lakes basin) (Douglass et al. 2009)-different environment to Alberta however. Lack of documentation, but low impacts present (Milbrath 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:3

Documentation: establishes in upland disturbed and undisturbed areas (Ditommaso et al. 2005, Lawlor 2006)

Identify type of disturbance: woodlands, pastures, old fields, shores, flood plains and ruderal areas

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: 0

Documentation: Europe and North America. Cynanchum louiseae appears to be rapidly expanding its range in North America and there is no evidence threat it is near to reaching maximum geographic or ecological distribution; future growth is expected (DiTommaso et al., 2005).

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 in Ontario, Connecticut, Massachusetts, New Hampshire and Vermont (USDA PLANTS)

Identify provinces invaded: Ontario, Quebec

Rationale:

Sources of information: Record for BC is for pale swallow-wort only, and is not considered current (Milbrath pers. comm.).

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:unknown

Documentation: studies not found (Ditommaso et al 2005). For pale swallow-wort, some seed is known to survive up to 3 years (e.g., Averill et al. 2010) but it isn't clear if we could assume the same for black swallow-wort (Milbrath pers. comm.).

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:1

Documentation: re-sprouts however do not assist in population spread (Ditommaso et al. 2005). Readily regrows from axillary buds or crown buds when frosted or cut, but root crown is limited in size (Milbrath, personal observation).

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: Lawlor (2006)- There has been some experimentation on the use of herbicides to control pale swallow-wort populations. In general, these studies suggest that chemical control alone is not effective, and long-term reapplication is needed to sustain control. Mowing will not eradicate populations but can be used to prevent a seed crop if done in early to mid-July. Digging up plants may control swallow-wort populations, though it would likely only be practical for small populations or isolated plants. Because broken root crowns left on or in the ground may sprout, care must be taken to remove and dispose of the entire root crown.

Identify types of control methods and time-term required:
Rationale:
Sources of information:

Total Possible:7
Total: 5
Total for 4 sections Possible:97
Total for 4 sections:74

References:

Averill, K.M., A. DiTommaso, C.L. Mohler, and L.R. Milbrath. 2010. Establishment of the invasive perennial *Vincetoxicum rossicum* across a disturbance gradient in New York State, USA. Plant Ecol. 211:65–77.

Averill, K.M., A. DiTommaso, C.L. Mohler, and L.R. Milbrath. 2011. Survival, growth, and fecundity of the invasive swallowworts (*Vincetoxicum rossicum* and *V. nigrum*) in New York State. Invasive Plant Science and Management 4: 198-206.

Blanchard, M.L., J.N. Barney, K.M. Averill, C.L. Mohler, and A. DiTommaso. 2010. Does polyembryony confer a competitive advantage to the invasive perennial vine *Vincetoxicum rossicum* (Apocynaceae)? American Journal of Botany 97(2): 251–260.

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

Cappuccino, N. 2004. Allee effect in an invasive alien plant, pale swallowwort Vincetoxicum rossicum (Asclepiadaceae). Oikos 106:3–8.

Ditommaso, A., Lawlor, F.M. & Darbyshire, S.J., 2005. The Biology of Invasive Alien Plants in Canada . 2 . Cynanchum rossicum (Kleopow) Borhidi [= Vincetoxicum rossicum (Kleopow) Barbar .] and Cynanchum louiseae (L .) Kartesz & Gandhi [= Vincetoxicum nigrum (L .) Moench]. , (Forster 1991).

Douglass, C.H., Weston, L. a. & Wolfe, D., 2011. Phytotoxicity and Potential Allelopathy in Pale (Cynanchum rossicum) and Black swallowwort (C. nigrum). Invasive Plant Science and Management, 4(1), pp.133–141. Available at: http://www.bioone.org/doi/abs/10.1614/IPSM-D-10-00021.1 [Accessed January 2, 2014].

Douglass, C. H., L. A. Weston, and A. DiTommaso. 2009. Black and pale swallowwort (Vincetoxicum nigrum sand V. Rossicum): the biology and ecology of two perennial, exotic and invasive vines. Pages 261– 276 in Inderjit, ed. Management of Invasive Weeds. New York: Springer Science + Business Media B.V

Gibson, D.M., S.B. Krasnoff, J. Biazzo, and L. Milbrath. 2011. Phytotoxicity of antofine from invasive swallow-worts. Journal of Chemical Ecology 37: 871-879.

Lawlor, F. 2006. Fact sheet: Black swallow-wort (Cynanchum louiseae Kartesz & Gandhi), [Online]. In: Weeds gone wild: Alien plant invaders of natural areas. Plant Conservation Alliance, Alien Plant Working Group (Producer). Available: http://www.nps.gov/plants/alien/fact/cylo1.htm

Lumer, C., and S.E. Yost. 1995. The reproductive biology of *Vincetoxicum nigrum* (L.) Moench (Asclepiadaceae), a Mediterranean weed in New York State. Bull. Torrey Bot. Club 122: 15-23.

Magidow, L.C., DiTommaso, A., Ketterings, Q.M., Mohler, C.L., and Milbrath, L.R. 2013. Emergence and performance of two invasive swallowworts (*Vincetoxicum* spp.) in contrasting soil types and soil pH. Invasive Plant Sci Manag 6: 281-291.

Milbrath, L.R. 2010. Phytophagous arthropods of invasive swallow-wort vines (*Vincetoxicum* spp.) in New York. Environmental Entomology 39: 68-78.

Mogg, C, Petit, P, Cappuccino, N, Durst, T, McKague, C, Foster, M, Yack, JE, Arnason, JT, Smith, ML. 2008. Tests of the antibiotic properties of the invasive vine *Vincetoxicum rossicum* against bacteria, fungi and insects. Biochem Syst Ecol 36:383-391

Smith, L.L., A. DiTommaso, J. Lehmann, and S. Greipsson. 2006. Growth and reproductive potential of the invasive exotic vine *Vincetoxicum rossicum* in Northern New York State. Can. J. Bot. 84: 1771-1780.

Uva, R.H., J.C. Neal, and J.M. DiTomaso. 1997. Weeds of the Northeast. Cornell University Press: Ithaca, New York. 397 pp.

Notes:
Natureserve I-rank: High
http://www.natureserve.org/explorer/servlet/NatureServe?sourceTemplate=tabular_report.wmt&loadTemplate=species_RptComprehensive.wmt&selectedReport=RptComprehensive.wmt&summaryView=tabular_report.wmt&elKey=151919&paging=home&save=true&startIndex=1&nextStartIndex=1&reset=false&offPageSelectedElKey=151919&offPageSelectedElType=species&offPageYesNo=true&post_processes=&radiobutton=radiobutton&selectedIndexes=151919

milkweed, vine, both shade and light tolerant, grows in woodland understoreys

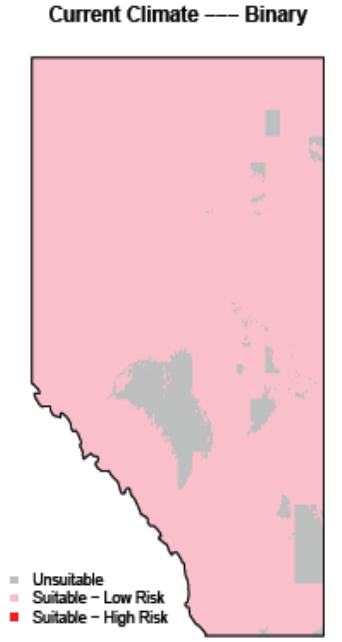
Native Range: This species is native to western European Mediterranean regions (Lawlor, 2006). Tewksbury et al. (2002) list native distribution as southwestern Europe in France, Italy, Portugal, and Spain.

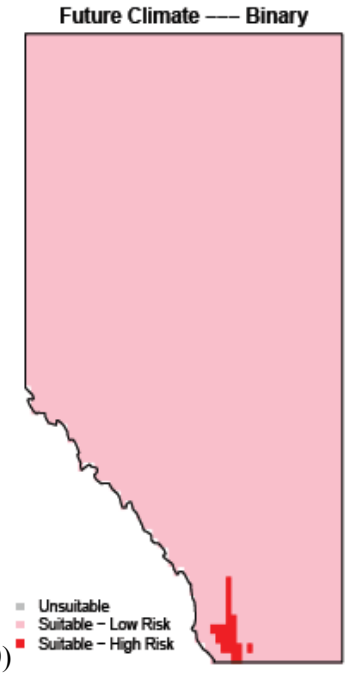
Most of the literature, is biased toward pale swallow-wort (V. rossicum), so it is basically assumed that known effects apply to black swallow-wort as well, which is the best that can be done currently. In New York, black swallow-wort is not as common as pale, nor are the infestations of black as extensive as they are for pale swallow-wort, for whatever reason (Milbrath pers. comm.).

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

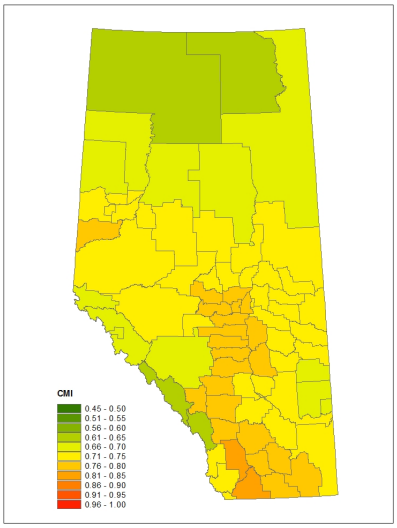




(current climate =1975, future climate=2050)

CLIMEX Climate Match

1975



2050