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:	*Taeniatherum caput-medusae/ Elymus caput-medusae* In USA, subspecies is*: Taeniatherum caput-medusae ssp. asperum*
Common name:	Medusahead
Assessor:	Shauna-Lee Chai
Reviewer:	Kirk W. Davies
Date:	November 6, 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	0.730	0.798
Parkland	No	0.821	0.872
Foothills	No	0.810	0.841
Grassland	No	0.875	0.900
Rocky Mountains	No	0.687	0.712
Shield	No	0.637	0.724

B. Invasiveness Ranking

	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40(40)	37
2. Biological characteristic and dispersal ability	25(25)	17
3. Ecological amplitude and distribution	25(25)	21
4. Feasibility of control	10(10)	3
Outcome score	100(100)[b]	[a]78
Relative maximum score[2]	78	*Highly 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 – Not in 1975, but in 2050

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: 10

Documentation: High silica content makes it hard to decompose and standing dead biomass is extremely flammable and creates enormous fuel load (Swenson et al 1964). Medusahead has substantially increased frequency of fire in the western United States (Knapp 1998, Davies and Svejcar 2008).

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:10

Documentation: Frequent fires destroy the shrub component of the plant community, and potentially part of the bunchgrass community (Miller et al 1999). It also alters the herbaceous structure by making a more continuous homogeneous medusahead and thatch layer. Whereas native communities have variable height from different species and in drier regions bare ground between herbacoues vegetation (Davies and Svejcar 2008, Davies 2011).

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:10

Documentation: Medusahead-dominated areas have very low species diversity and low value for wildlife habitat (Miller et al 1999). It migrates rapidly, is vigorously competitive and of low forage quality

(Archer 2001). The fires it encourages reduces species diversity (Zimmerman n.d.). Davies (2011) found that increasing medushead abundance greatly decreased native plant abundance and biodiversity.

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: Medusahead is a major concern to the range livestock industry because it can suppress desirable vegetation. It is unpalatable to livestock (Zimmerman, n.d.). When dry, dead vegetation decomposes slowly and forms a persistent dense litter on the soil surface. As the plant matures it develops long barbed awns that can cause injury to the eyes, noses, and mouths of grazing animals (Bovey et al 1960). It is not preferred by wildlife as forage (Savage et al 1969). Increased fire frequency with medusahead invasion has resulted in the loss of shrub habitat for shrub obligate wildlife species, such as sage-grouse (Davies and Svejcar 2008).

Identify type of impact or alteration:

Rational:

Sources of information:

Total Possible:40

Total:37

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: Plants produce up to 6,000 seeds/ft^2 of soil (Major et al 1960)

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, wind, and water disperse the seed, and spread is rapid. A rough awn aids in animal dispersal of seed (Furbush 1953).). Medusahead is also likely to be spread long distance by animals because it often grows in clay soil that adheres, with embedded seeds, to animal's feet when moist (Davies et al 2013).

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: Humans help spread this species by grazing and poor rangeland health. Vehicles are one the major dispersal vectors of medusahead (Davies et al. 2013).

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:3

Documentation: Clausnitzer DW, Borman MM, Johnson DE (1999) Competition between Elymus elymoides and Taeniatherum caput-medusae. Weed Sci. 47: 720-728

Young K, Mangold J (2008) Medusahead (Taeniatherum caput-medusae) outperforms squirreltail (Elymus elymoides) through interference and growth rate. Invasive Plant Sci Manage 1: 73-8

Harris GA, Wilson AM (1970) Competition for moisture among seedlings of annual and perennial grasses as influenced by root elongation at low temperatures. Ecology 51: 530-534

Hironaka M, Sindelar BW (1975) Growth characteristics of squirreltail seedlings in competition with medusahead. J Range Manage 28: 283-285

Leffler AJ, James JJ, Monaco TA (2013) Temperature and functional traits influence differences in nitrogen uptake capacity between native and invasive grasses. Oecologia 171: 51-60

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:1

Documentation: grows densely- 1,500 to 2,000 plants/ft2 (Sharp et al 1969). The formation of thick, persistent, thatch layers with medusahead inhibit growth of rival species (Davies and Svejcar 2008)

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:
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:3

Documentation: E.G. *Elymus repens* –couch grass
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: Archer, Amy J. 2001. Taeniatherum caput-medusae. 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 7].
Describe type of habitat:
Rational:
Sources of information:

Total Possible:25
Total:17

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: Medusahead invasion can reduce the grazing capacity of rangelands by at least 50-80% (Hironaka 1961)

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:6

Documentation: Medusahead maintain its dominance on sites where native vegetation has been eliminated or severely reduced by overgrazing, cultivation, or frequent fires. It has invaded fields, dry roadsides, and disturbed sagebrush slopes in British Columbia, Washington, Idaho, Oregon, and California (Cronquist et al. 1977).). The NRCS plant database (http://plants.usda.gov/core/profile?symbol=TACA8) shows medusahead has invaded areas in Washington, Oregon, California, Idaho, Nevada, Utah, Montana, Pennsylvania, New York, and Connecticut. Invades ecologically disturbed 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:3

Documentation: Davies 2008

Identify type of disturbance:fire
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 and South America, Africa, Europe

Describe distribution: native to Mediterranean region of Europe. Medusahead and cheatgrass (Bromus tectorum), another invasive non-native species, overlap in distribution and habitat requirements. Each can replace other herbaceous vegetation and share dominance with the other.

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 California, Colorado, Nevada, Oregon and Utah (USDA Plants)

Identify provinces invaded:

Rational:

Sources of information:

Total possible:25

Total:21

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:0

Documentation: Short-lived seed bank-viable for at least 1 year (Sharp et al 1957)

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:
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:3

Documentation: A combination of treatments including grazing, burning, mechanical manipulation, herbicide such as atrazine, or glyphosate, pre-emergent such as imazapic and/or reseeding are generally necessary to reduce established stands of medusahead (Christensen et al. 1974, Monaco et al. 2005)

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

Total Possible: 10
Total: 3
Total for 4 sections Possible: 100
Total for 4 sections: 78

References:

Archer, Amy J. 2001. Taeniatherum caput-medusae. 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 7].

Bovey, Rodney W.; LeTourneau, Duane; Erickson, Lambert C. 1960. The chemical composition of medusahead and downy brome. Weeds. 9: 307-311.

Christensen, M. Dale; Young, James A.; Evans, Raymond A. 1974. Control of annual grasses and revegetation in ponderosa pine woodlands. Journal of Range Management. 27(2): 143-145.

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Davies KW, Svejcar TJ (2008) Comparison of medusahead-invaded and noninvaded Wyoming big sagebrush steppe in Southeastern Oregon. Rangeland Ecol Manag 61: 623-629

Davies KW (2011) Plant community diversity and native plant abundance decline with increasing abundance of an exotic annual grass. Oecologia 167: 481-491.

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Furbush, Paul. 1953. Control of medusa-head on California ranges. Journal of Forestry. 51: 118-121.

Harris GA, Wilson AM (1970) Competition for moisture among seedlings of annual and perennial grasses as influenced by root elongation at low temperatures. Ecology 51: 530-534

Hironaka M, Sindelar BW (1975) Growth characteristics of squirreltail seedlings in competition with medusahead. J Range Manage 28: 283-285

Hironaka M (1961) The relative rate of root development of cheatgrass and medusahead. J
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Knapp, Paul A. 1998. Spatio-temporal patterns of large grassland fires in the Intermountain West, U.S.A. Global Ecology and Biogeography Letters. 7(4): 259-273.

Leffler AJ, James JJ, Monaco TA (2013) Temperature and functional traits influence differences in nitrogen uptake capacity between native and invasive grasses. Oecologia 171: 51-60.

Major, J.; McKell, C. M.; Berry, L. J. 1960. Improvement of medusahead-infested rangeland. Leaflet 123. Davis, CA: University of California, California Agricultural Experiment Station. 6 p

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Monaco TA, Osmond TM, Dewey SA (2005) Medusahead control with fall- and spring-applied
762 herbicides on northern Utah foothills. Weed Technol 19: 653-658.

Savage, David E.; Young, James A.; Evans, Raymond A. 1969. Utilization of medusahead and downy brome caryopses by chukar partridge. Journal of Wildlife Management. 33(4): 975-978.

Sharp, Lee A.; Hironaka, M.; Tisdale, E. W. 1957. Viability of medusa-head (Elymus caput-medusae L.) seed collected in Idaho. Journal of Range Management. 10: 123-126.

Swenson, Charles F.; LeTourneau, Duane; Erickson, Lambert C. 1964. Silica in medusahead. Weeds. 12: 16-18

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Young K, Mangold J (2008) Medusahead (Taeniatherum caput-medusae) outperforms squirreltail (Elymus elymoides) through interference and growth rate. Invasive Plant Sci Manage 1: 73-8

Notes

annual

monocot

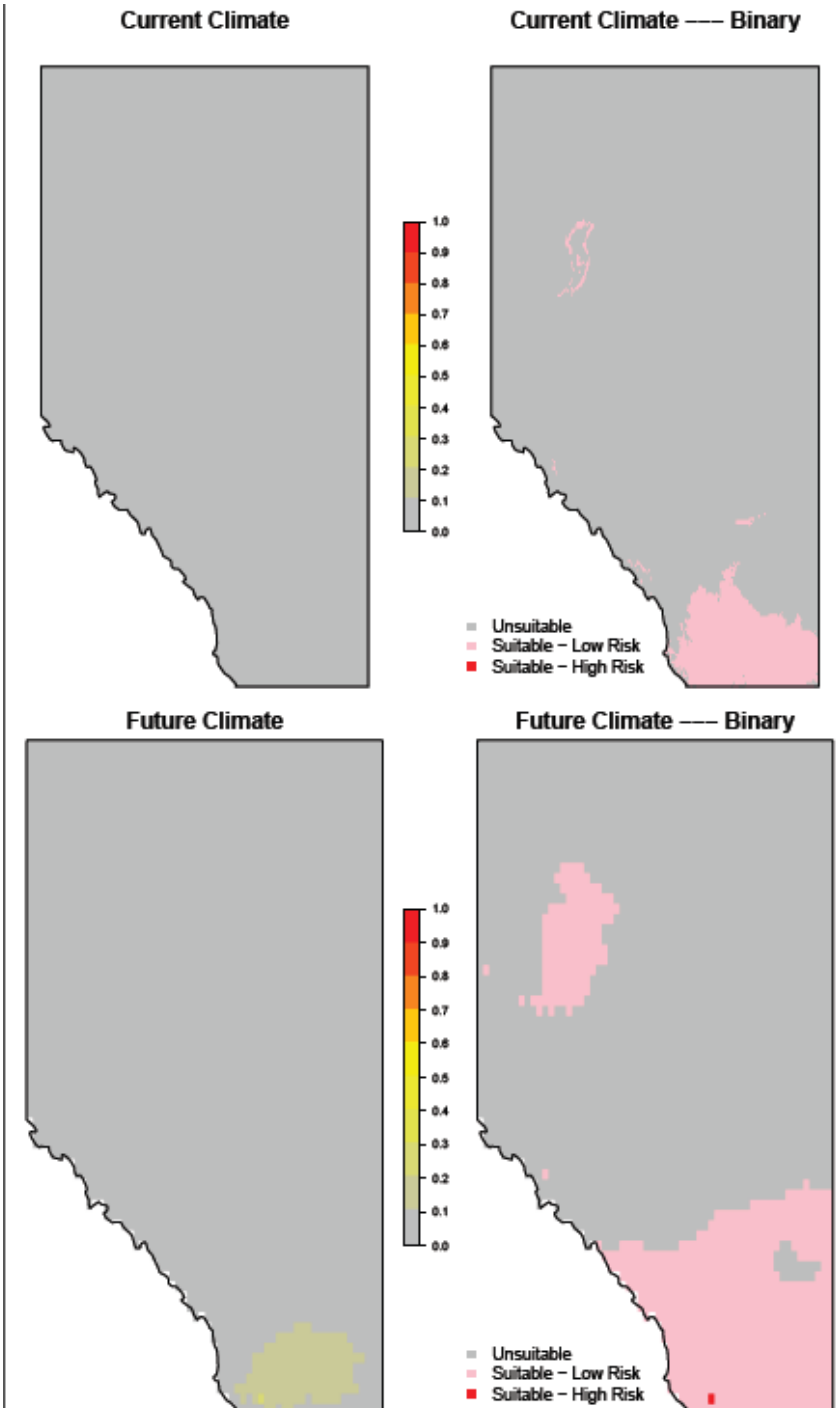
Medusahead and cheatgrass are often in competition with each other

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 Alaska. 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.

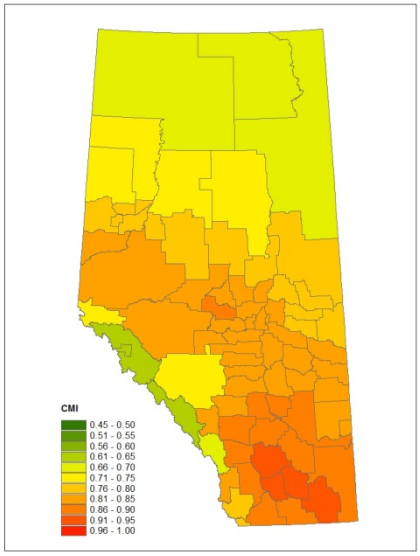
Species Distribution Models

Current=1975, future=2050


Current Climate
Current Climate ---- Binary
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Unsuitable
Suitable – Low Risk
Suitable – High Risk
Future Climate
Future Climate ---- Binary
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Unsuitable
Suitable – Low Risk
Suitable – High Risk

CLIMEX climate match

1975



2050