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:	*Fallopia sachalinensis/Polygonum sachalinense*
Common name:	Giant Knotweed
Assessor:	Shauna-Lee Chai
Reviewer:	Thomas Heutte
Date:	November 8, 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	0.776	0.821
Parkland	No	0.825	0.834
Foothills	No	0.843	0.869
Grassland	No	0.795	0.809
Rocky Mountains	No	0.828	0.838
Shield	No	0.701	0.764

*present in gardens as ornamentals

B. Invasiveness Ranking

	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40(40)	31
2. Biological characteristic and dispersal ability	25(25)	18
3. Ecological amplitude and distribution	25(25)	23
4. Feasibility of control	10(7)	6
Outcome score	100(97)[b]	[a]78
Relative maximum score[2]	80	*Extremely 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

1.2 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: 10

Documentation: Ecological impacts of the 3 knotweeds include reduced recruitment of in-stream woody debris and reduced habitat quality for wildlife. Establishment of these knotweeds may also increase the risk of streambank erosion or flooding when decaying shoots are washed into rivers during high flows (Niewinski 1998). Reviews by areas dominated by giant knotweed had less nitrogen available for uptake by both terrestrial and aquatic organisms than areas dominated by native species (Urgenson et al. 2009)

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: One study supported the assertion that giant knotweed displaces riparian species and has cascading effects on the structure and function of riparian systems. In northwestern Washington, riparian forests with higher giant knotweed stem density had lower juvenile conifer ($P<0.01$), juvenile red alder ($P<0.001$), juvenile broadleaved tree ($P<0.001$), and shrub ($P<0.01$) stem density; lower herb ($P<0.01$) and native herb ($P<0.001$) cover; and lower shrub ($P=0.001$), herb ($P<0.001$), and native herb ($P=0.002$) species richness compared to forests with lower giant knotweed stem density (Urgenson et al. 2009)

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:7

Documentation: Studies in both North America and Europe have documented a decrease in native plant cover or species richness in areas where giant knotweed occurs (Hejda et al. 2009). Mechanisms suggested for native plant exclusion include the accumulation of leaf and stem litter, nutrient limitation, and allelopathy (Vrchotova & Sera 2008)

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: Studies in North America and Europe have documented changes in faunal communities, including a decrease in the diversity and abundance of invertebrates (Kappes et al 2007). Reduces habitat quality for wildlife (Niewinski 1998)

Identify type of impact or alteration:

Rationale:

Sources of information:

Total Possible:40

Total:31

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: In areas with all 3 knotweeds in Pennsylvania, single stems produced 50,000 to 150,000 seeds annually; millions of seeds were produced over a 108-ft² (10-m²) area in some locations (Niewinski, 1998). In Pennsylvania, viable seeds of the 3 knotweeds were not found when male-fertile plants were absent from the site, but many viable seeds were produced when both female and male-fertile plants were present (Niewinski, 1998).

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: Seeds of the 3 knotweeds may be dispersed by wind, birds, insects, or water
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: Humans spread the plants through dumping yard waste, roadside mowing or construction projects, or using fill dirt from riparian areas
Identify dispersal mechanisms:
Rationale:
Sources of information:

2.4 Allelopathic

a. no 0
b. yes 2
u. unknown

Score:2

Documentation: Vrchotova, 2008

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: areas dominated by giant knotweed had less nitrogen available for uptake by both terrestrial and aquatic organisms than areas dominated by native species (Urgenson et al. 2009)
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:1

Documentation:
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: Giant knotweed seed germination is favored by moisture and disturbance (Niewinski 1998)
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: Polygonum cuspidatum Siebold & Zucc., Japanese knotweed. Hybrids of giant and Japanese produce Polygonum bohemicum, possibly more invasive than its parents due to greater genetic diversity.

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:3

Documentation: Plants of all 3 knotweeds that escape cultivation and establish in riparian areas may spread when plant parts are transported downstream (Pysek and Prach 1993). In California, giant knotweed occurred in riparian areas, with the most severe impacts in wetlands in the northwestern part of the state (California Invasive Plant Council. 2006)

Describe type of habitat:

Rationale:

Sources of information:

Total Possible:25

Total:18

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: Introduced as ornamental plant. Giant knotweed was also promoted as a soil binder and fodder plant (FNA 2010)

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:6

Documentation: Japanese knotweed has invaded rivers bars in Sitka National Historical Park (Densmore et al. 2001) and has established additional infestations in the Tongass National Forest (Stensvold 2000). Large stands have been found along the riverbanks in Pennsylvania and Ohio (Seiger 1991).

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: Japanese knotweed can establish in native habitats (Stensvold 2000, Shaw and Seiger 2002).

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:5

Documentation: Asia, North America (including Alaska), Australia, South Africa, Europe

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 California, Connecticut, Oregon, Washington (USDA PLANTS)

Identify provinces invaded:

Rationale:

Sources of information:

Total possible:25

Total:23

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: unknown (Stone 2010)

Spread by seed is rare, though it has been suggested for Japanese knotweed, and seedlings of giant, Japanese, and Bohemian knotweed have been observed (Niewinski 1998).

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:3

Documentation: The ability for multiple plant parts to regenerate vegetatively plays an important role in the spread and establishment of the 3 knotweeds. Vegetative regeneration is possible from multiple plant parts, including rhizomes, aboveground stems, roots, and leaves (Stone 2010).

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:3

Documentation: It responds well to herbicide application, although follow-up applications are required (Heutte pers. comm.). Several sources suggest that the 3 knotweeds are difficult to eradicate due to their extensive root and rhizome systems, the ability of multiple plant parts to regenerate vegetatively, sprouting immediately or 1 to 3 years after treatment, and the large scale of stand establishment. Control of the 3 knotweeds may require multiple treatments within a single growing season or several years of treatment to be effective. Careful disposal of removed plant parts is important to prevent downstream transport or reestablishment. Control and eradication efforts always face the potential for floods or high water to expose and/or transport buried rhizomes or propagules from upstream populations (Davenport 2006).

Identify types of control methods and time-term required: mowing, digging, covering, and many methods of herbicide application

Rationale:

Sources of information:

Total Possible: 7
Total:6
Total for 4 sections Possible: 97
Total for 4 sections: 78

References:

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

California Invasive Plant Council. 2006. California invasive plant inventory, [Online]. California Invasive Plant Council (Producer). Available: http://www.cal-ipc.org/ip/inventory/pdf/Inventory2006.pdf.

Davenport, Roberta. 2006. Control of knotweed and other invasive species and experiences restoring native species in the Pacific Northwest US. Native Plants Journal. 7(1): 20-26.

Densmore, R.V., P.C. McKee, and C. Roland. 2001. Exotic plants in Alaskan National Park Units. Report on file with the National Park Service – Alaska Region, Anchorage, Alaska. 143 pp.

Flora of North America Association. 2010. Flora of North America: The flora, [Online]. Flora of North America Association

Hejda, Martin; Pysek, Petr; Jarosik, Vojtech. 2009. Impact of invasive plants on the species richness, diversity and composition of invaded communities. Journal of Ecology. 97: 393-403

Kappes, Heike; Lay, Rebecca; Topp, Werner. 2007. Changes in different trophic levels of litter-dwelling macrofauna associated with giant knotweed invasion. Ecosystems. 10(5): 734-744

Niewinski, Amy Thomas. 1998. The reproductive ecology of Japanese knotweed (Polygonum cuspidatum) and giant knotweed (Polygonum sachalinensis) seed. University Park, PA: Pennsylvania State University. 49 p. Thesis

Pysek, Petr; Prach, Karel. 1993. Plant invasions and the role of riparian habitats: comparison of four species alien to central Europe. Journal of Biogeography. 20(4): 413-420.

Seiger, L. 1991. Element Stewardship Abstract for Polygonum cuspidatum. The Nature Conservancy in collaboration with the International Network of Natural Heritage Programs and Conservation Data Centers. Natural Heritage Databases. Arlington, VA.

Stensvold, M. 2000. Noxious weed surveys and projects conducted on the Tongass National Forest 1997-2000. Technical report on file, Tongass National Forest. 2 pp.

Urgenson, Lauren S.; Reichard, Sarah H.; Halpern, Charles B. 2009. Community and ecosystem consequences of giant knotweed (Polygonum sachalinense) invasion into riparian forests of western Washington, USA. Biological Conservation. 142(7): 1536-1541.

USDA PLANTS database

Shaw R.H. and L.A. Seiger. 2002. Japanese Knotweed – Biological Control of Invasive Plants in the Eastern United States. In Van Driesche, R. et al., 2002. Biological Control of Invasive Plants in the Eastern United States, USDA Forest Service Publication FHTET-2002-04, 413 pp.

Stensvold, M. 2000. Noxious weed surveys and projects conducted on the Tongass National Forest 1997-2000. Technical report on file, Tongass National Forest. 2 pp.

Stone, Katharine R. 2010. Polygonum sachalinense, P. cuspidatum, P. × bohemicum. 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].

Vrchotova, N.; Sera, B. 2008. Allelopathic properties of knotweed rhizome extracts. Plant, Soil and Environment. 54(7): 301-303.

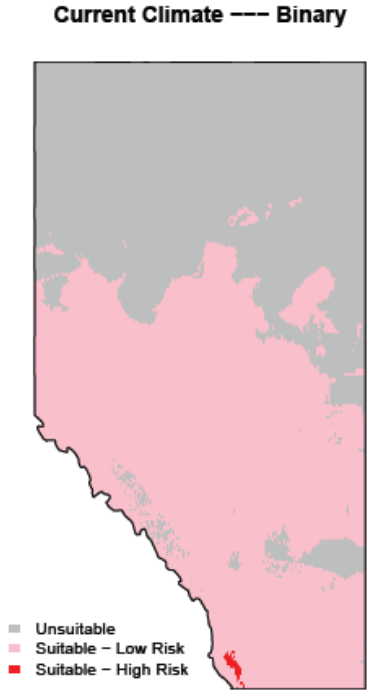
Notes

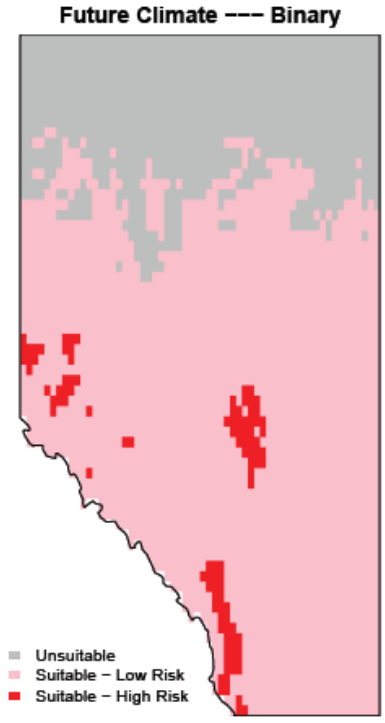
Giant knotweed is a stout, rhizomatous, perennial geophyte. Observations from the Czech Republic suggest that giant knotweed roots grow "deep" into the soil. Rhizomes have a diameter of 3 inches (8 cm) and may spread 50 to 65 feet (15-20 m) laterally.

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.

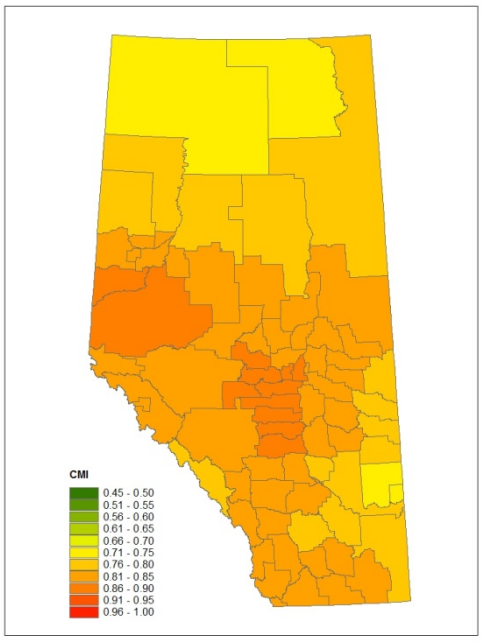
Species Distribution Models
Current=1975, future=2050





CLIMEX climate match

1975



2050