Alberta Innovates Technology Futures

Predicting new plant invasions in Alberta due to climate change



Shauna-Lee Chai

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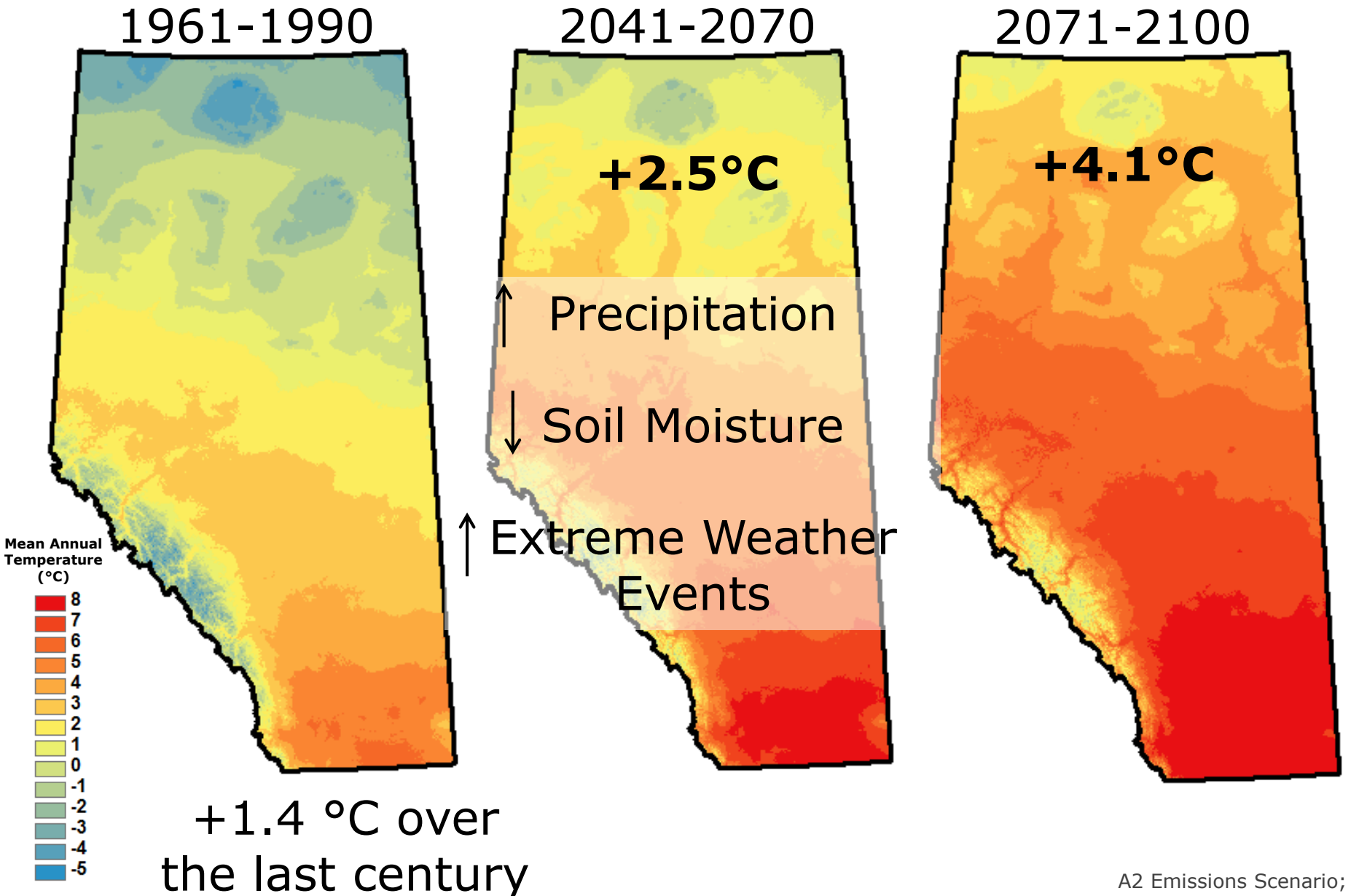
Alberta

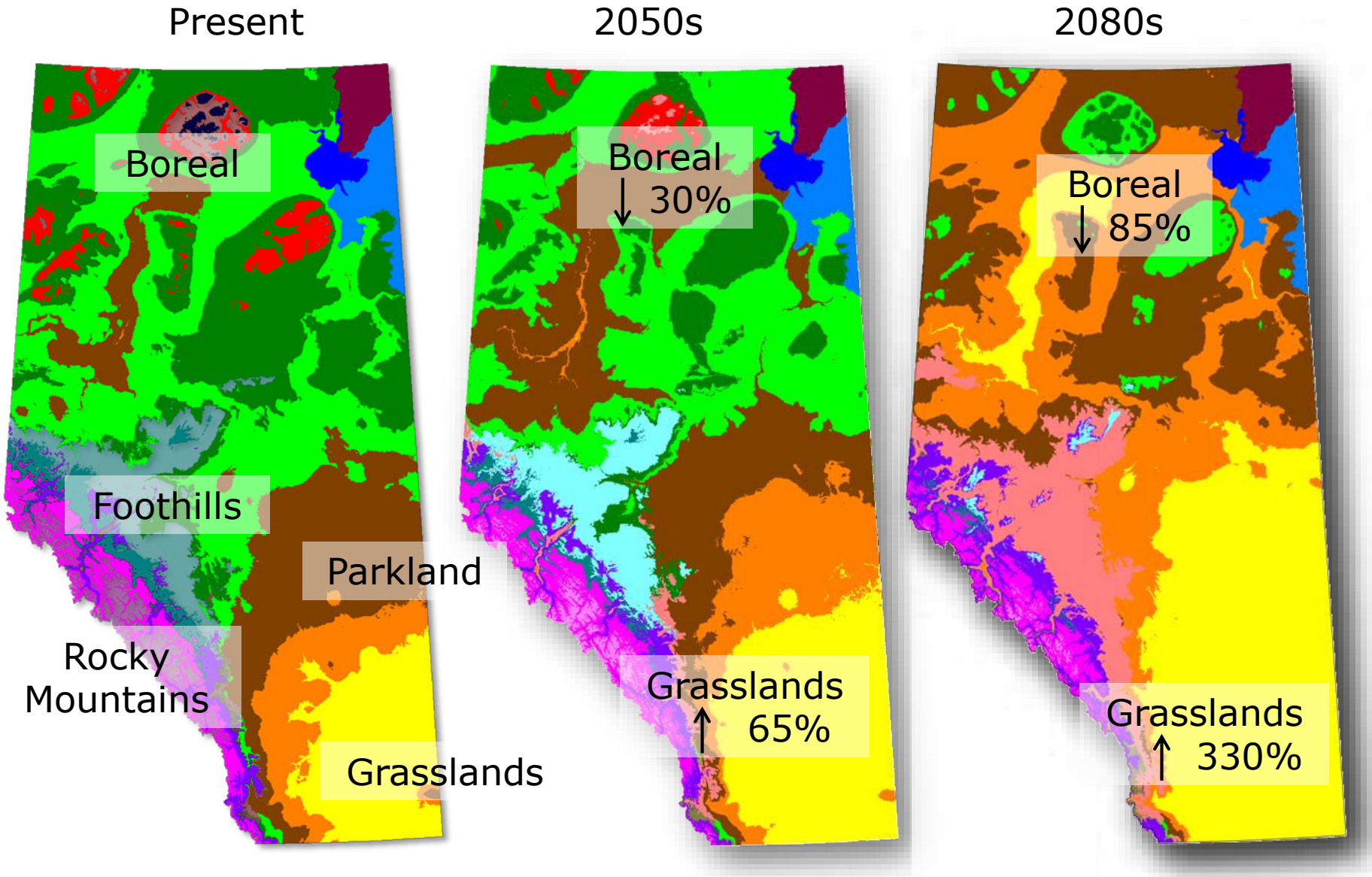
Freedom To Create. Spirit To Achieve.

Climate Change in Alberta



A2 Emissions Scenario;
Ensemble of 19 GCMs

Alberta's Ecosystems

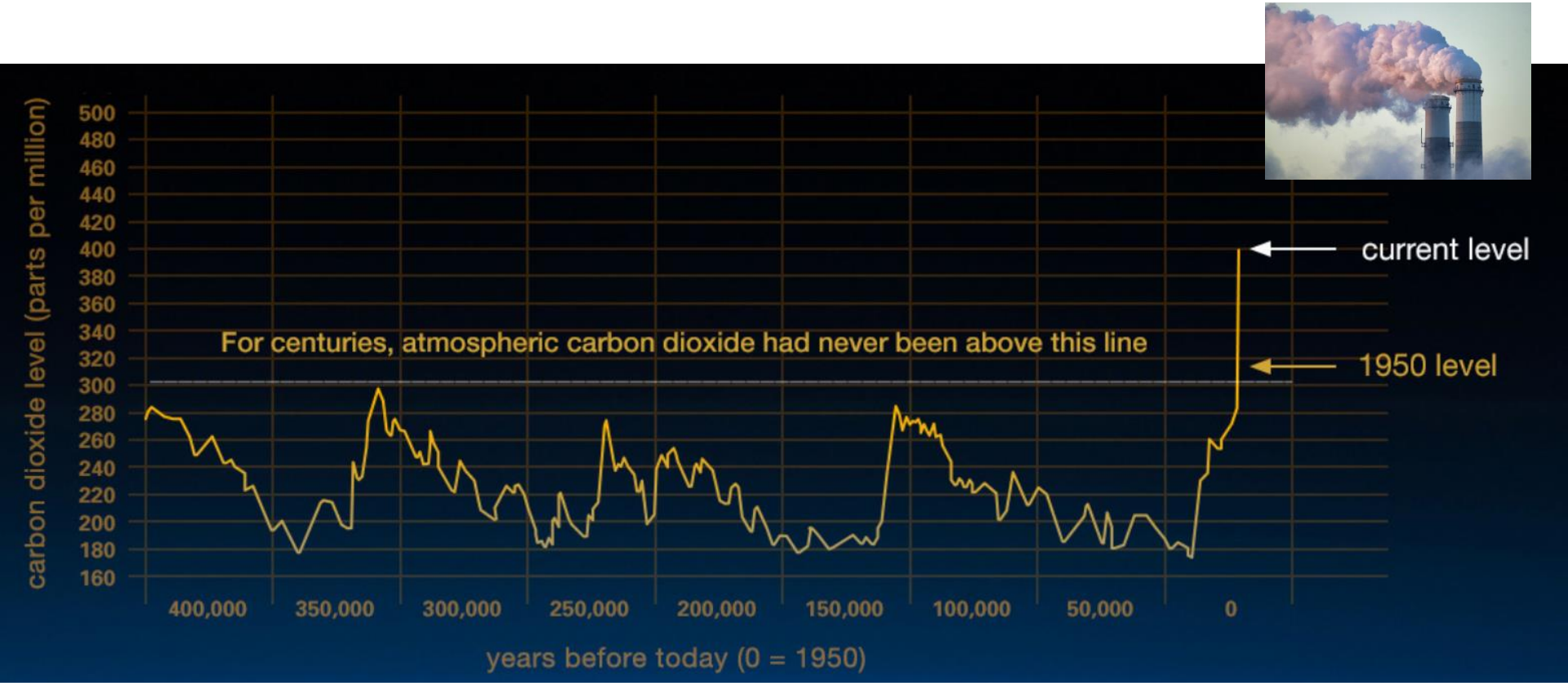


(Schneider, 2013)

A2 Emissions Scenario; ECHAM 5 GCM

What’s the big deal (for biodiversity)?

Human-induced and fast paced



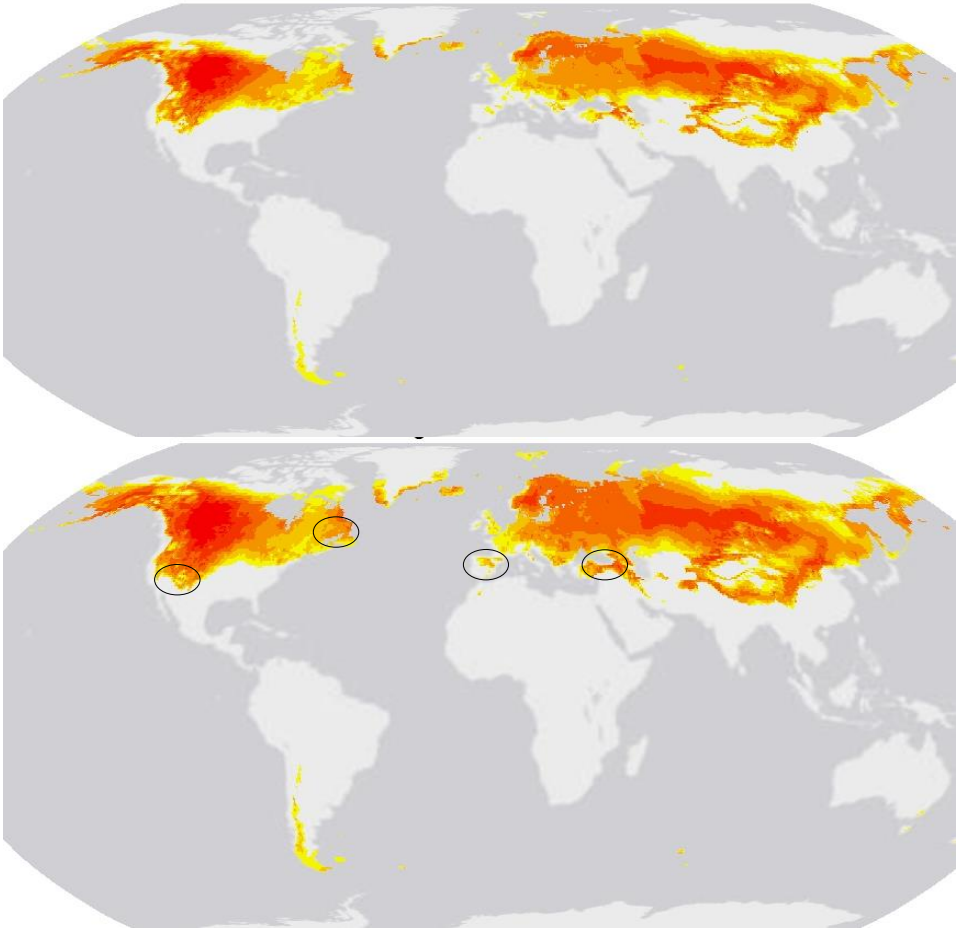
Vostok ice core data/J.R. Petit et al.; NOAA Mauna Loa CO2 record.)

Barriers to movement

Five consequences of climate change for invasive species

(Hellmann et al. 2008)

1. New Climate Matches



1975

2050

Areas include:
North America
NL
Spain, France
Turkey

2. Benign non-native species becoming invasive

- Sleeper weeds (Roger et al. 2015)

Agronomic grasses planted along roadways, pipeline corridors and seismic lines in reclamation will act as seed source for grassland expansion into the boreal (Schneider 2015)

3. New distribution of existing invasive species

"It may be possible to open up new agricultural areas north of Prince Albert. As the length of the growing season increases, perhaps the present boreal plain can be made the new breadbasket of the country." (Carr 2004)

4. Higher CO_2 could decrease herbicide efficacy

of root relative to shoot biomass at elevated [CO_2]. Overall, the study indicates that carbon dioxide–induced increases in root biomass could make Canada thistle and other perennial weeds that reproduce asexually from belowground organs harder to control in a higher [CO_2] world.

Ziska et al. 2004

5. Establishment of new invasive species

UNIVERSITY OF ALBERTA

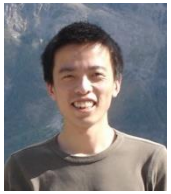
Scott Nielsen

Erin Bayne

Jennine Pedersen

Ryan Fisher

Jessica Stolar



Diana Stralberg

Jian Zhang

Rick Schneider

ABMI

Dan Farr
Project Lead

Amy Nixon
Project Coordinator

Chris Shank

Alberta Innovates Technology Futures

Shauna-Lee Chai

UNIVERSITY OF SASKATCHEWAN

Jeff Lane

MIISTAKIS INSTITUTE

Guy Greenaway

Tracy Lee

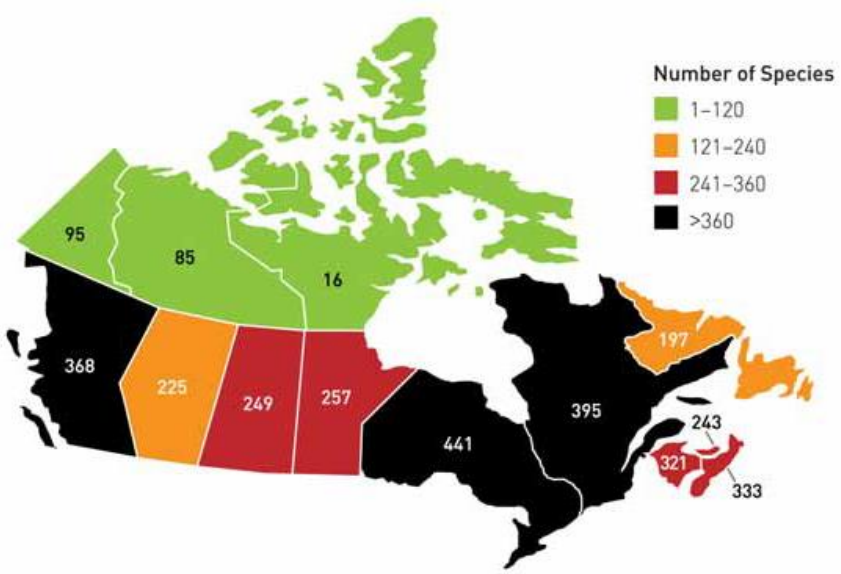
Greg Chernoff

Ken Sanderson

Rachelle Haddock

Invasive plant response to climate change

- 3-4 ºC warmer climate by the end of this century (IPCC 2013)
- Warming most intense at high northern latitudes
- Extreme events will disturb native communities



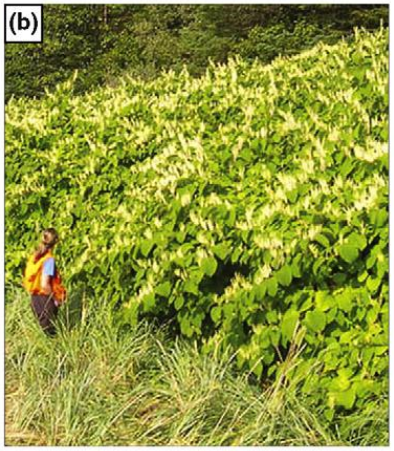
Note: Canada has 486 invasive alien plant species.

(Canadian Food Inspection Agency 2008)

Invasive plant response to climate change

- Poleward expansion of invasive species
- Traits predispose them to benefit from climate change

High seed production e.g. cheatgrass



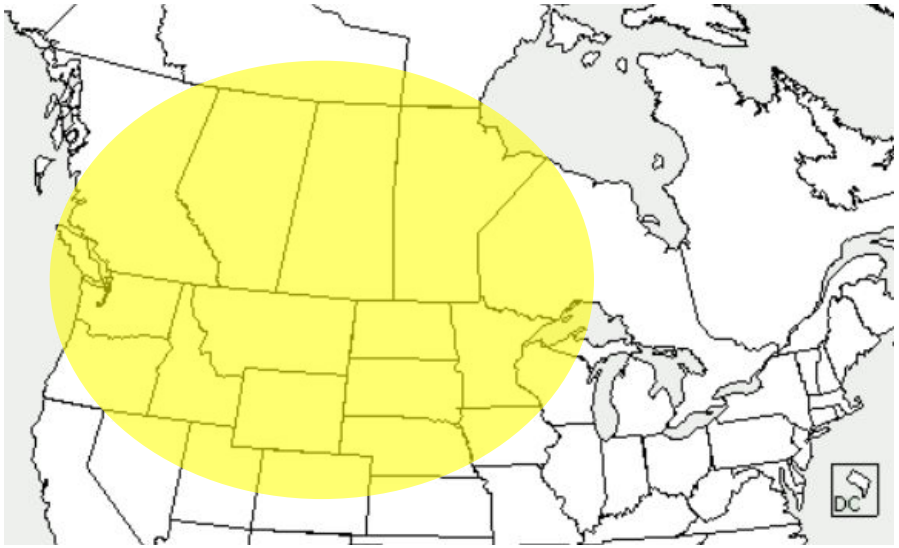
Rapid growth e.g. Japanese knotweed

Nodding thistle invasion is facilitated by generalist pollinators

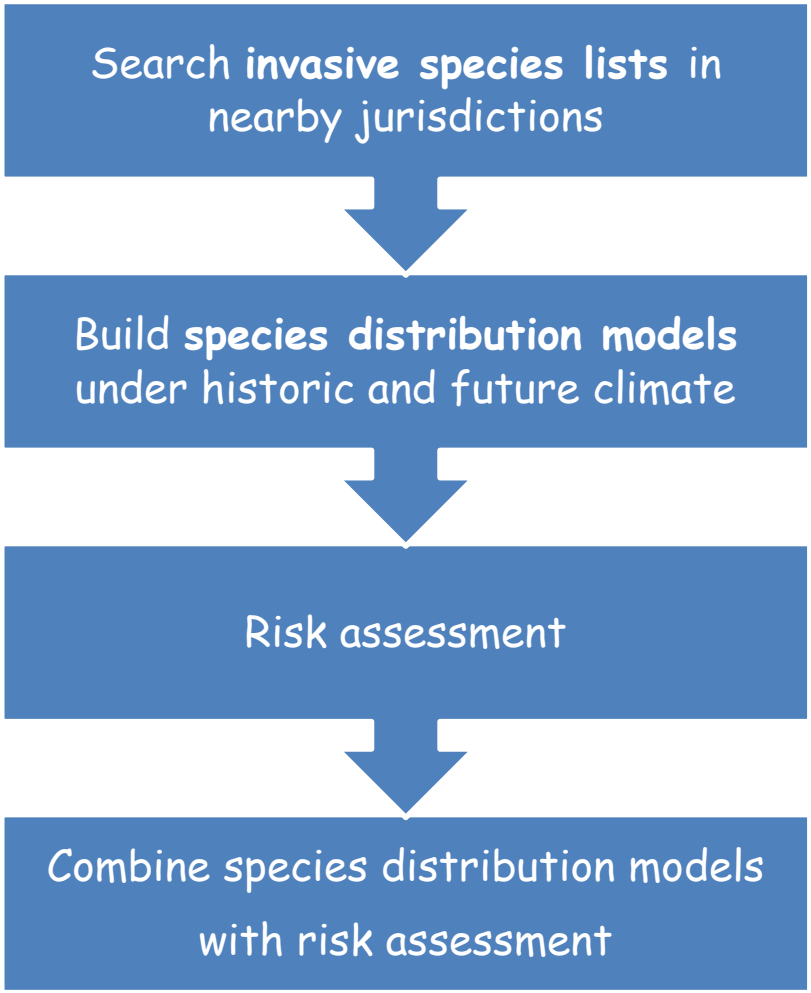
(Bradley et al. 2009)

Predicting new invasive plants due to climate change

- Expanded spatial and temporal scales
  (Heller & Zavaleta 2009)

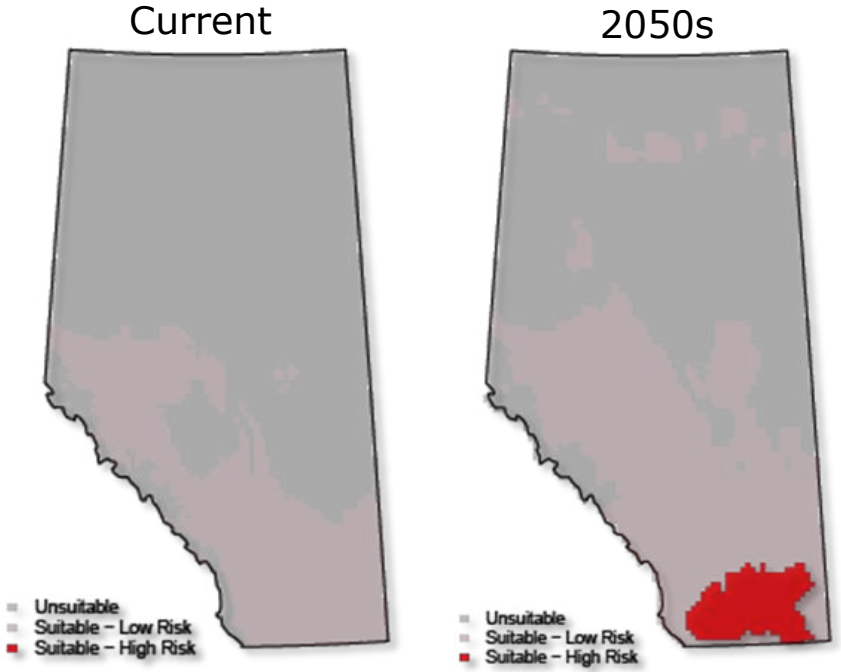


Study Approach



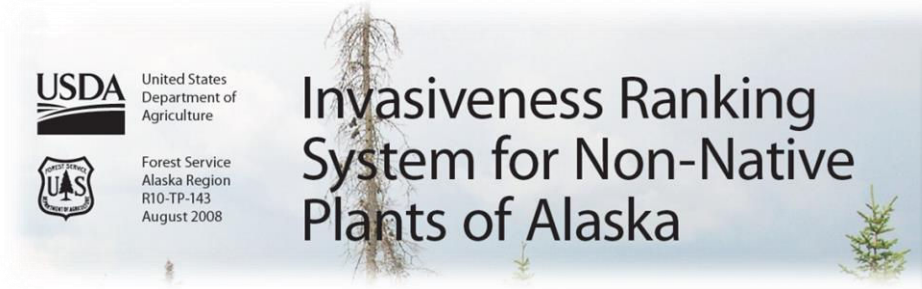
Species Distribution Modeling

- Maximum entropy (machine learning, presence only data, suitable vs unsuitable areas)
- Least training presence threshold (Pearson et al. 2007) - to identify a larger area of potentially suitable habitat for invasive species
- Sensitivity-specificity sum maximization (Liu et al. 2013) - identify the “worst” sites which were more likely to be at high invasive risk
- Predictive performance 0.682 - 0.984, with most showing excellent discrimination (AUC>0.9)




Syrian bean caper

Risk Assessment



(Carlson et al. 2008)

- Adapted for Alberta
- Biodiversity impacts
- Assessment of species not yet here
- Climate pre-screening
- Externally reviewed

Appendix1. Invasiveness ranking system for Alberta

Alberta non-native plant invasiveness ranking form
(Adapted from Carlson et al. 2008)

Scientific name:	
Common name:	
Assessor:	
Reviewers:	
Date:	

Outcome score:

A. Climatic Comparison

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

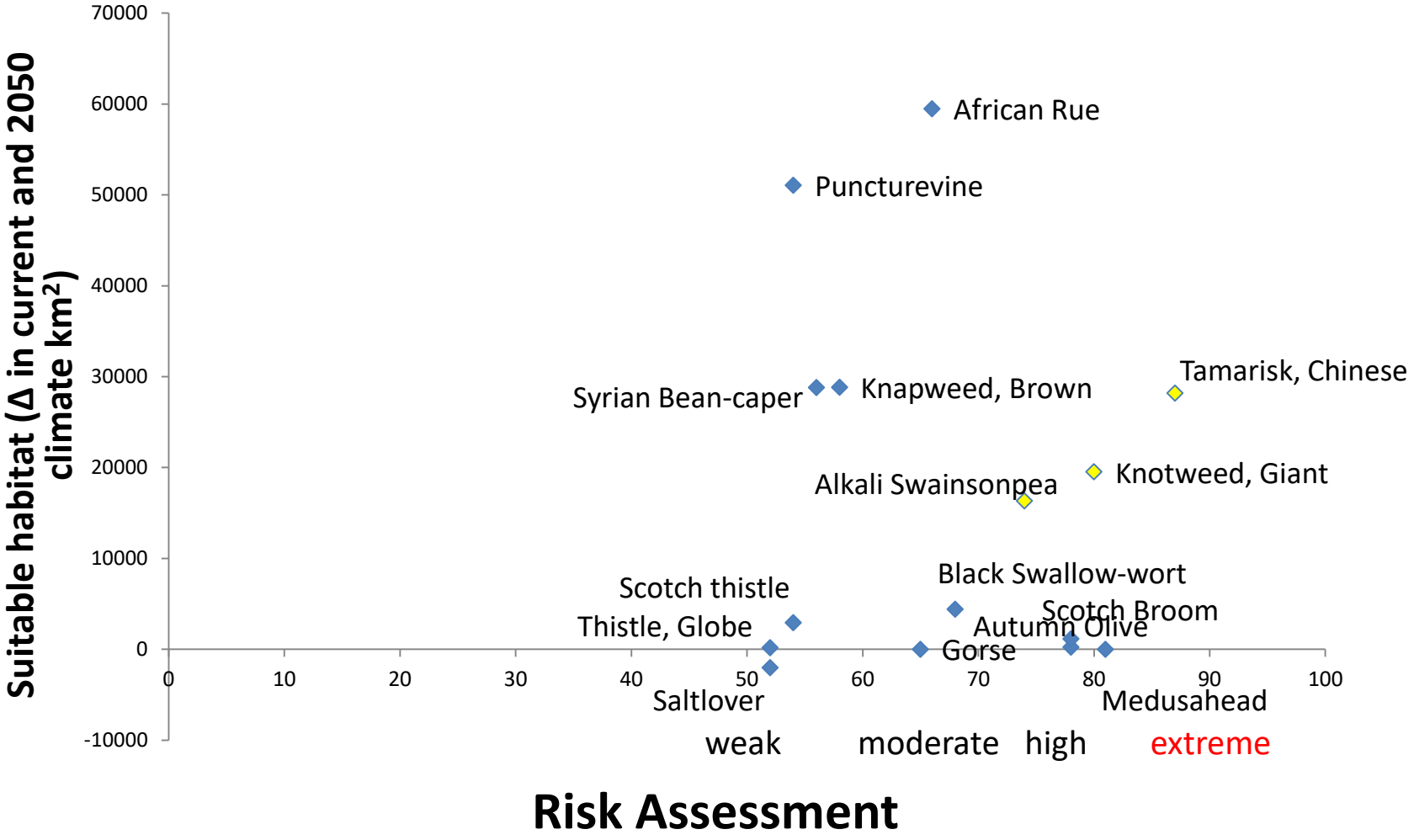
	Collected in Alberta regions	CLIMEX similarity in current climate	CLIMEX similarity in 2050
Boreal			
Parkland			
Foothills			
Grassland			
Rocky Mountains			
Shield			

B. Invasiveness Ranking	Total (Total answered[1] points possible)	Total score
1. Ecological impact	40()	
2. Biological characteristic and dispersal ability	25()	
3. Ecological amplitude and distribution	25()	
4. Feasibility of control	10()	
Outcome score	100()[b]	[a]
Relative maximum score[2]		

[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

Invasive plant risk assessment under climate change



Chai et al. 2016

Priority Invasive Species

Tamarisk (*Tamarix chinensis*) extremely invasive, 64% increase in suitable area, prohibited noxious

- Lowers water table
- Increases wildfires

Giant knotweed (*Fallopia sachalinensis*) extremely invasive, 22 times the suitable area, prohibited noxious

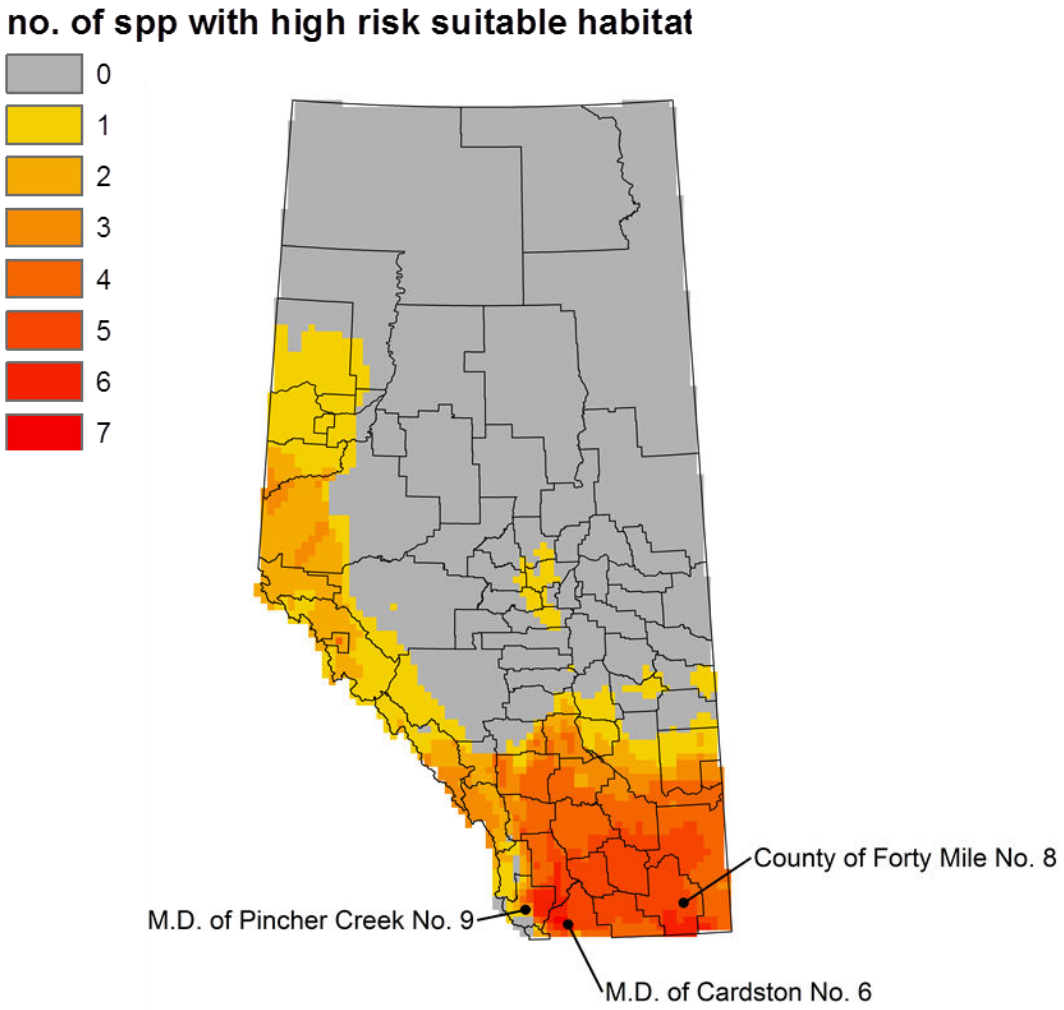
- Outcompetes native pasture species, low palatability
- Extensive roots

Alkali swainsonpea (*Sphaerophysa salsula*) highly invasive, 21% increase in suitable area, proposed prohibited noxious

- Alters nutrient cycling
- Invades wetlands

Priority locations in 2050

Alberta's southern region (grasslands) remains the most vulnerable



Management implications for invasive species in Alberta

- Methodology to **appraise current management** of invasive species using a climate change lens
- Applicable to
  - *Weed Control Act*
- Pre-emptive management strategies

  E.g. Targeted localized eradication of high priority invasive plants at the recruitment stage following extreme climate events

Guiding principles on non-native species, climate change and biodiversity management

- Communities are predicted to receive numerous immigrant species due to climate change (Thomas 2011)
- **Eradicate, tolerate or accept**
- **Managing change vs. retaining past community composition**
- Deciding on a management response should be done on a **case by case** basis (Walther et al. 2009)

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Thanks and Questions

Full paper with Risk Assessments & Species Distribution Models available at:

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0165292