Effects of Climate Change on Grasslands

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Grassland work under the Prairies Regional Adaptation Collaborative

Two components:

- How vulnerable are prairie grasslands to climate change?
- What are the options for adapting to climate change?

Collaborators:

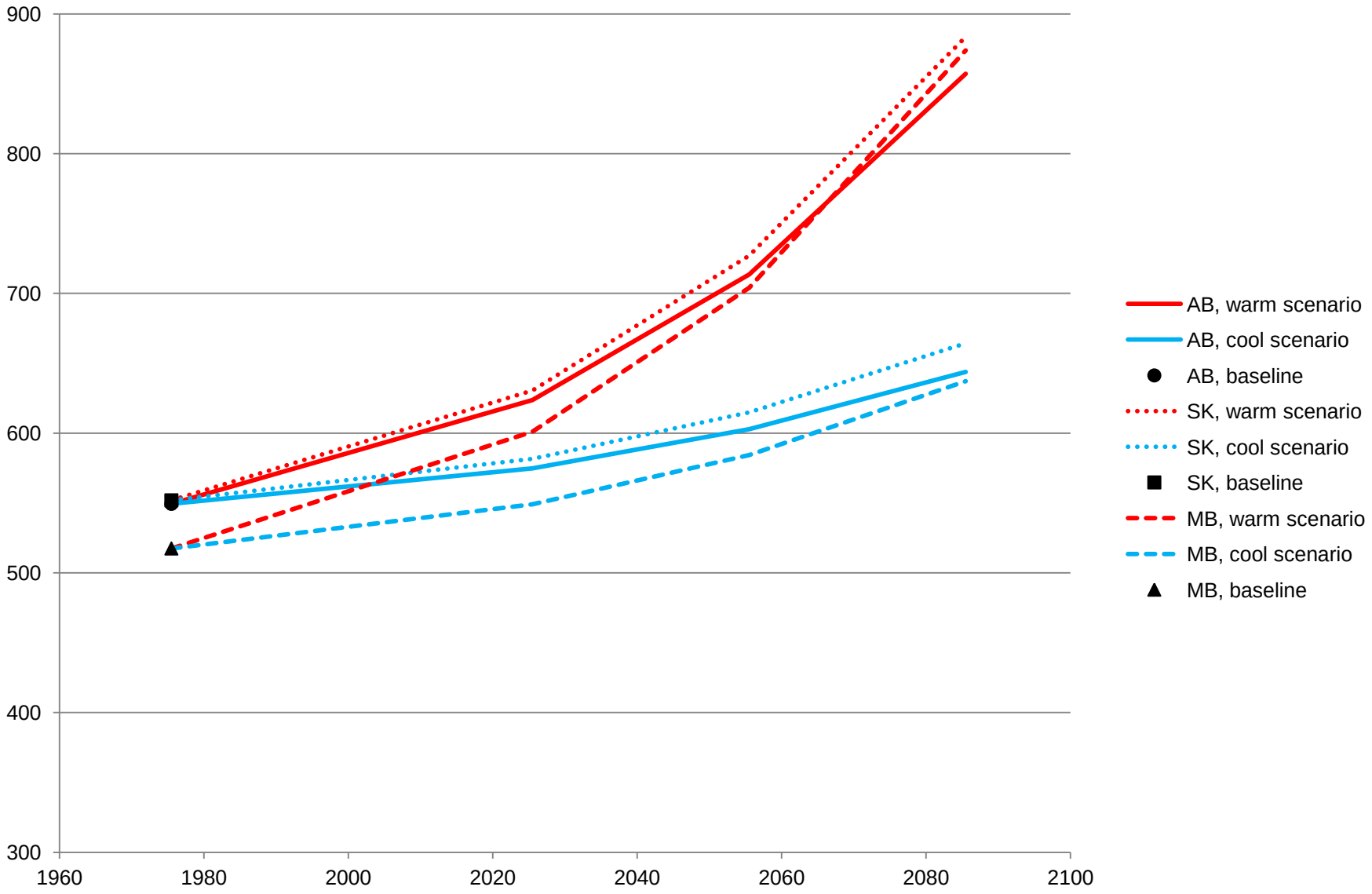
- Manitoba
  - Manitoba Agriculture, Food and Rural Initiatives
  - Manitoba Conservation
- Saskatchewan
  - Saskatchewan Watershed Authority
  - Saskatchewan Agriculture and Food
  - Saskatchewan Research Council
- Alberta
  - Alberta Sustainable Resource Development

Funding from Natural Resources Canada

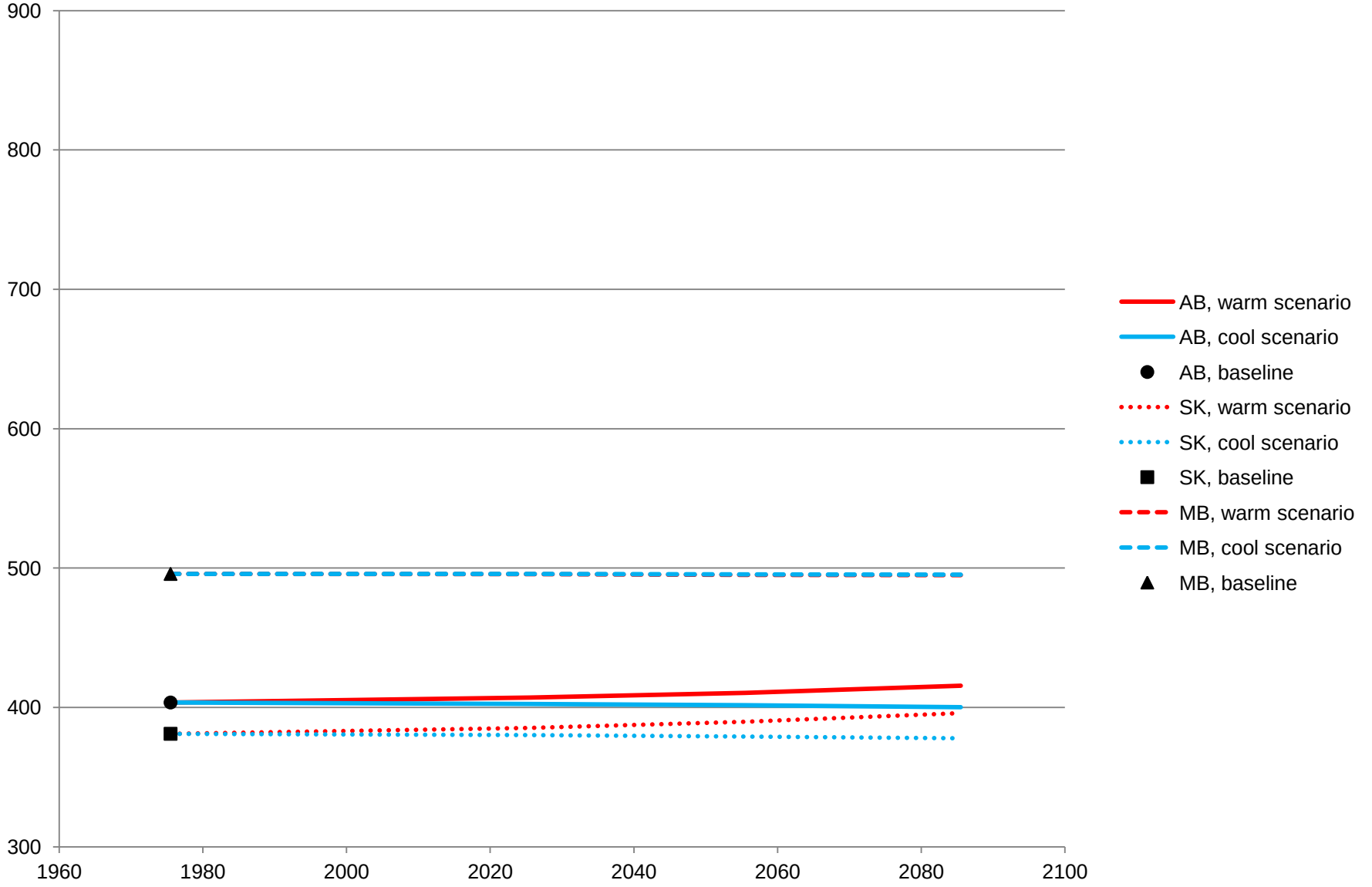
Vulnerability analysis is based on modeling of future climates

- We analyzed many different climate change scenarios.
- We picked two scenarios to represent the range of variation: one cooler, one warmer.

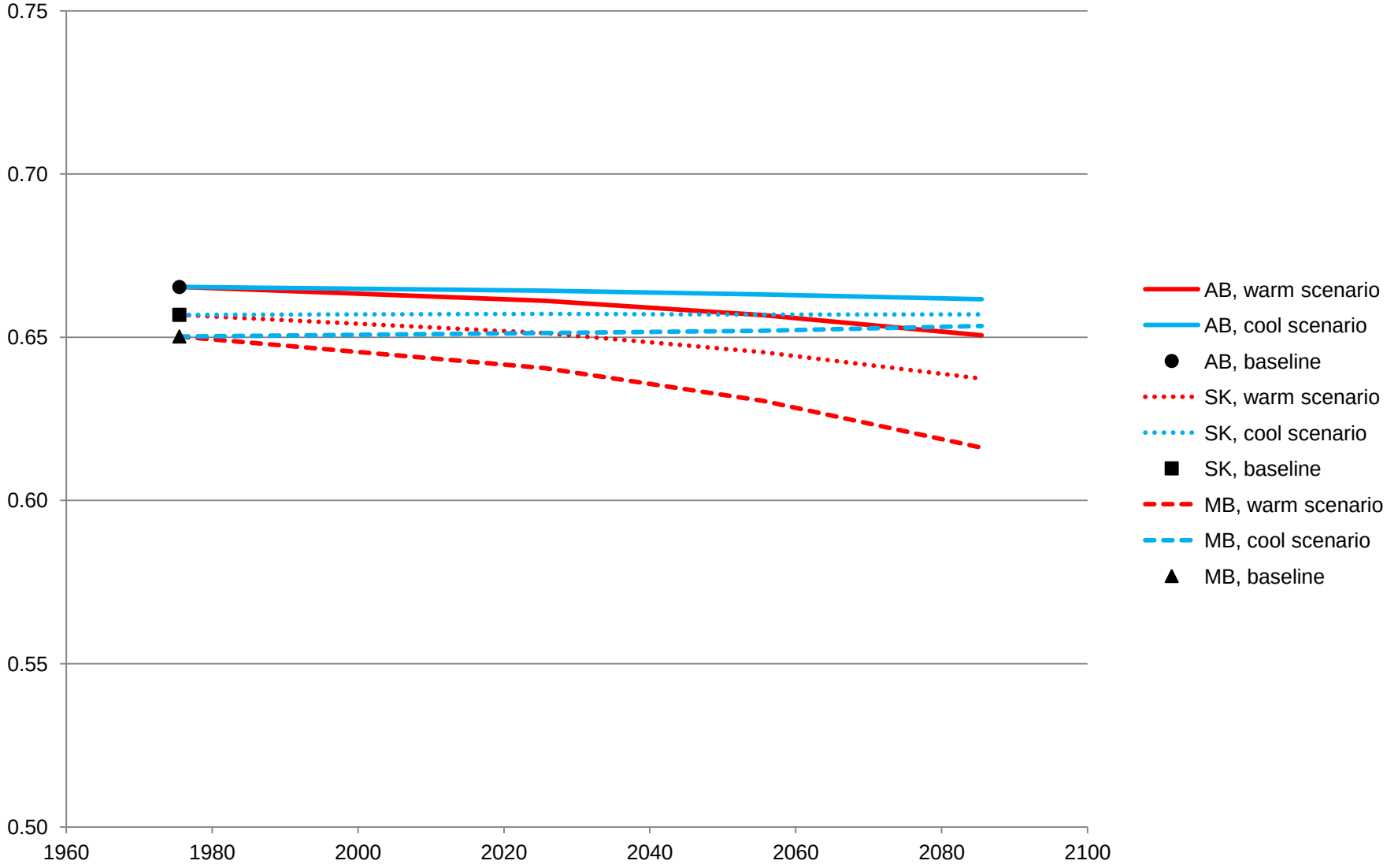
Potential Evapotranspiration (mm)
(average over Prairie Ecozone)



Annual Precipitation (mm)
(average over Prairie Ecozone)



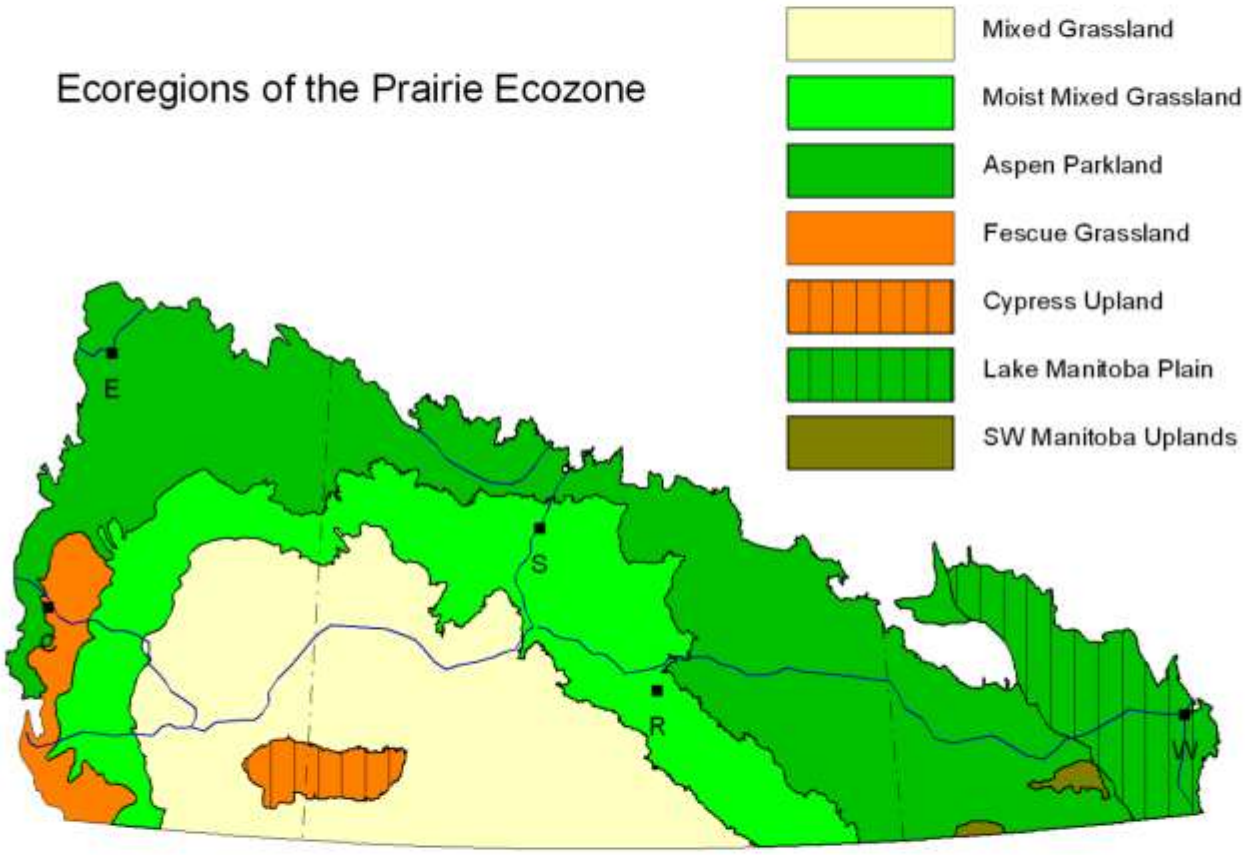
Proportion of Precipitation in May-September (average over Prairie Ecozone)



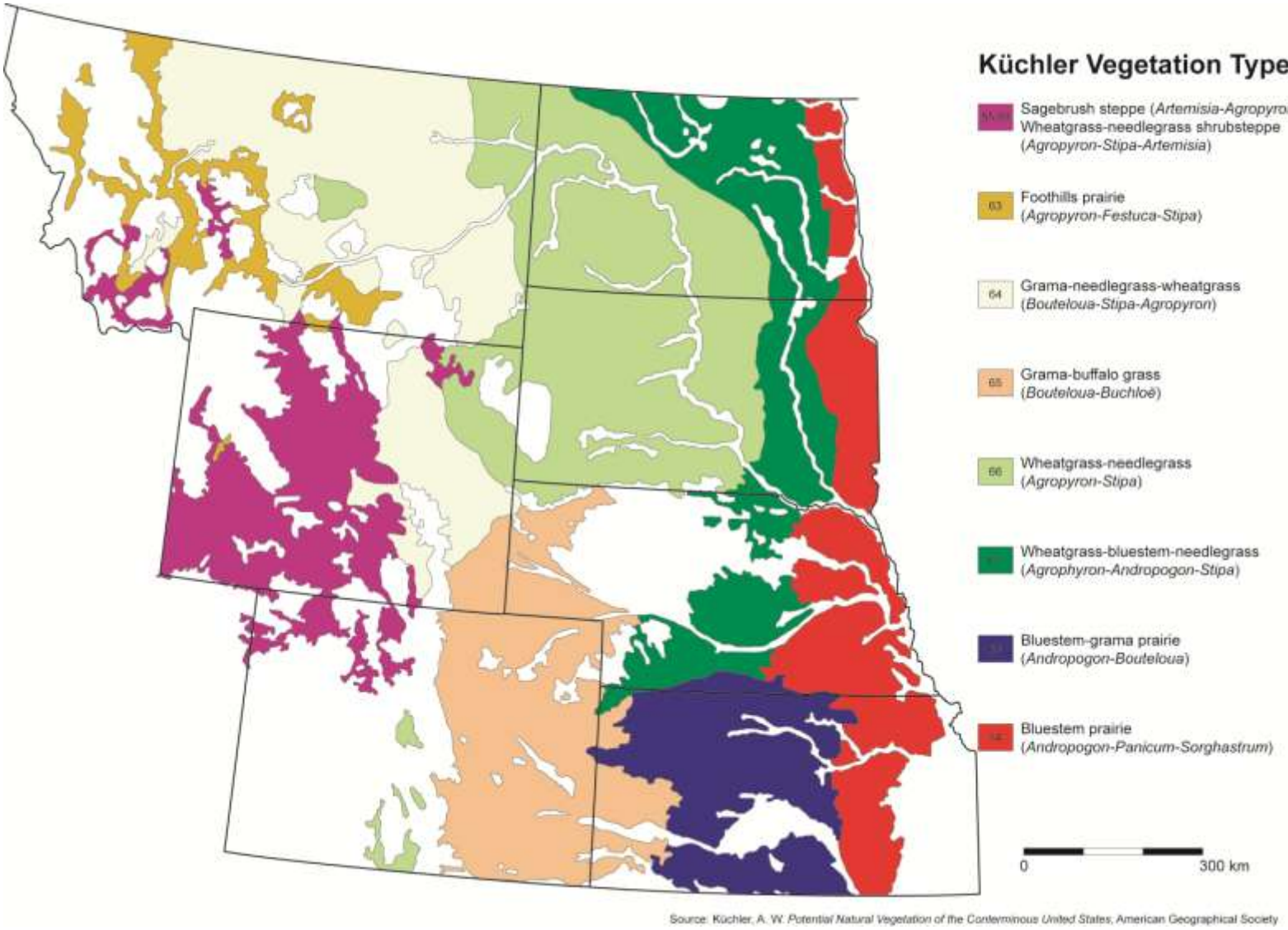
Modeling of vegetation responses to climate change

- Different types of grassland occur in different climatic regions.
- A model was developed to predict the shift in grassland zonation with climate change
- The model was calibrated using data from both Canada and the U.S. - using the U.S. Great Plains as an analogue for the future Canadian Prairies.

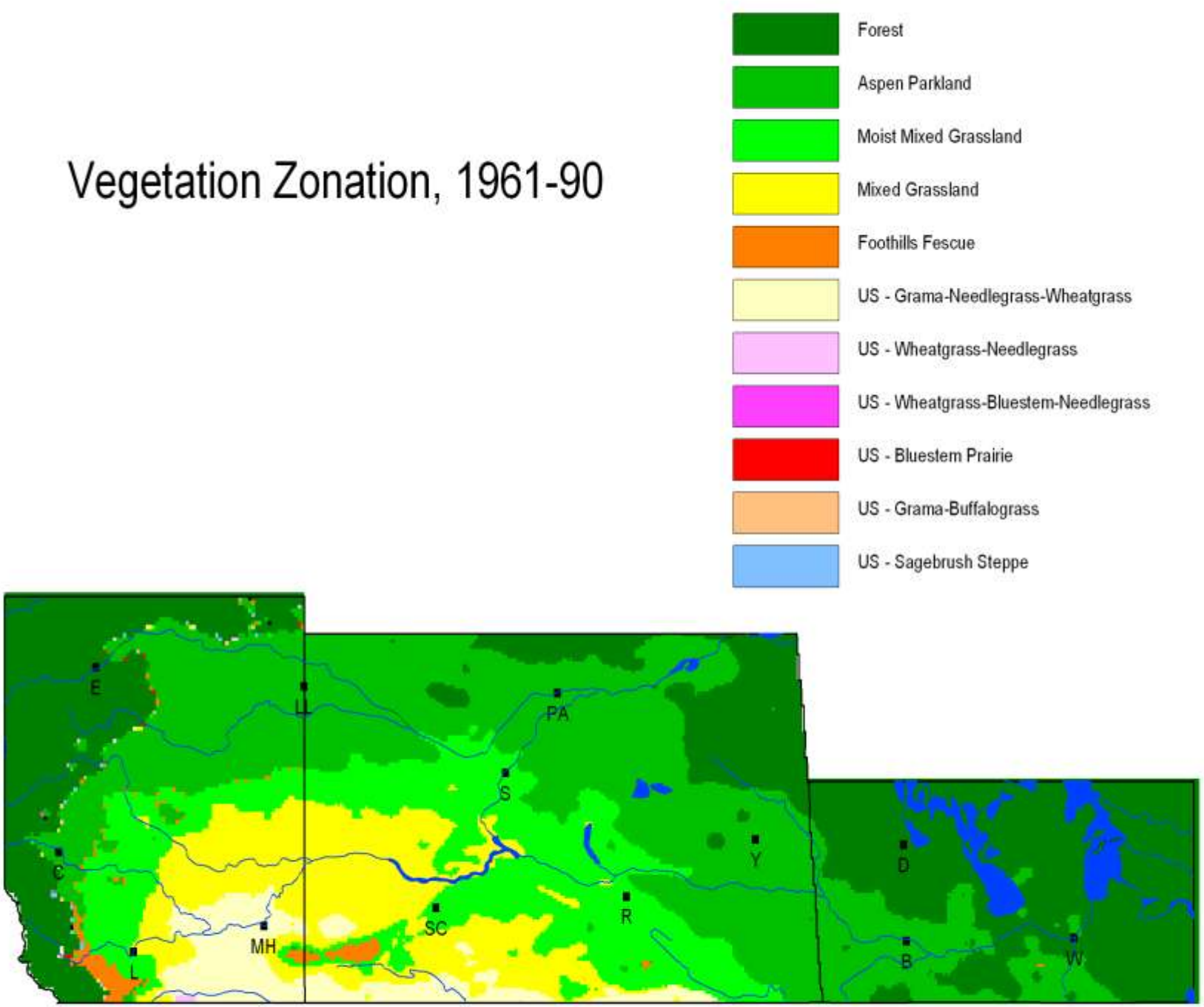
Ecoregions of the Prairie Ecozone



Kuchler vegetation types used for U.S. zonation

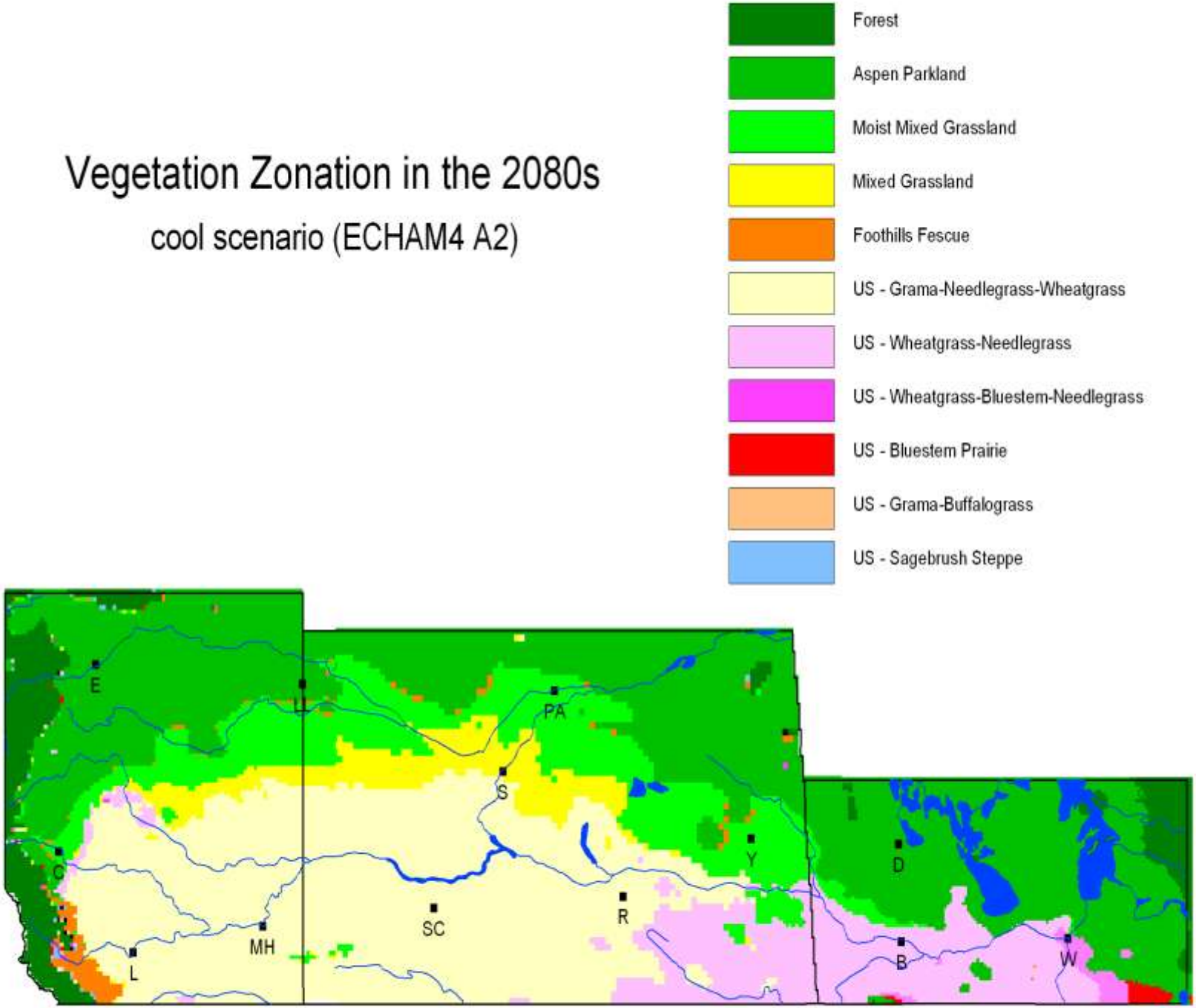


Vegetation Zonation, 1961-90



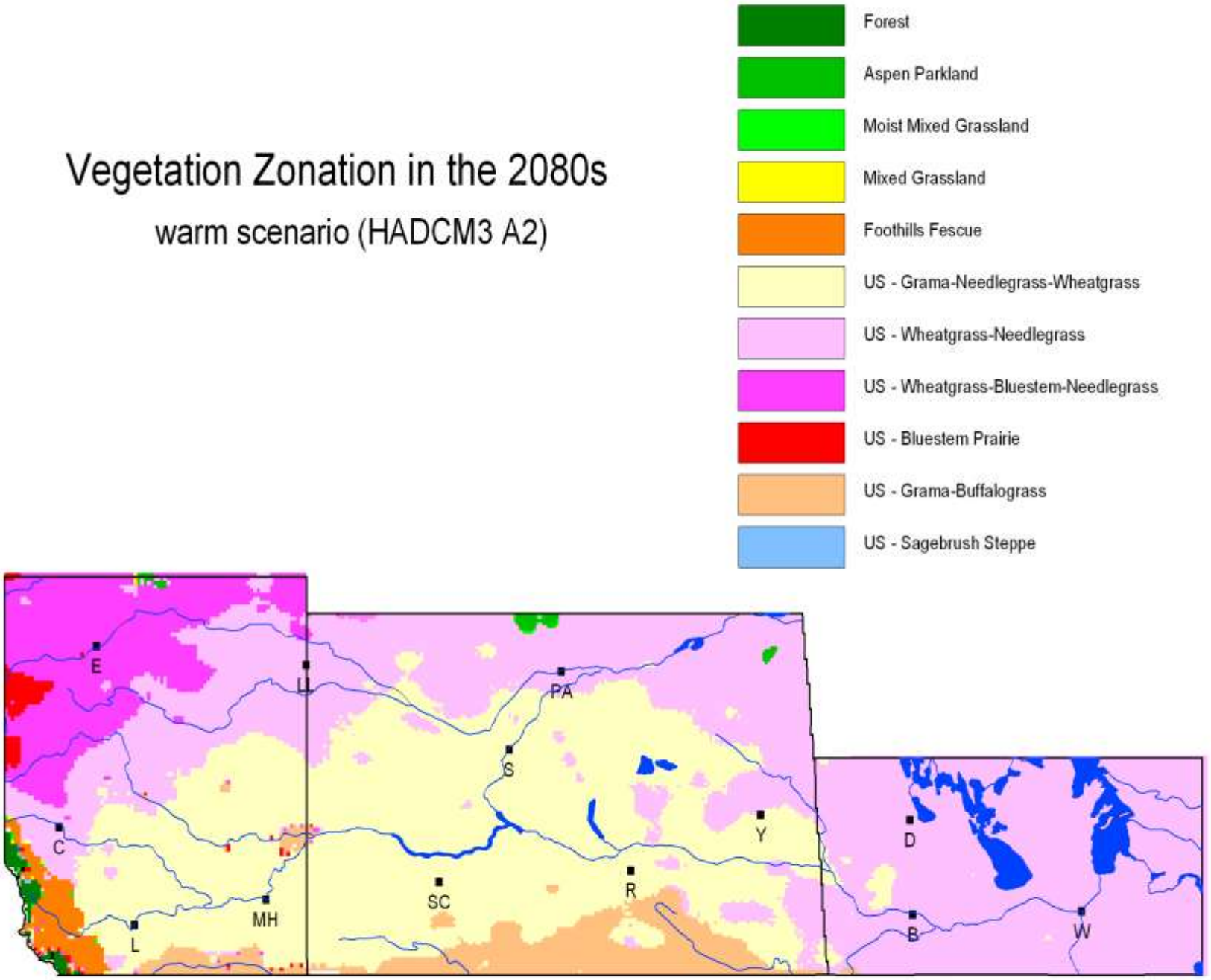
Vegetation Zonation in the 2080s

cool scenario (ECHAM4 A2)



Vegetation Zonation in the 2080s

warm scenario (HADCM3 A2)



The zonation model is not an exact prediction, but it shows probable future trends:

- gradual reduction in tree and shrub cover.
- shifts in structure of grasslands from taller to shorter species.
- decrease in cool-season grasses, increase in warm-season grasses.
- gradual introduction of plant and animal species currently found only in the U.S.

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Changes in grassland production

- Grasslands in moister regions produce more forage than those in drier regions.
- Annual production determines sustainable stocking rates, so it affects the incomes of livestock producers.
- A model was developed to predict the changes in production with climate change.

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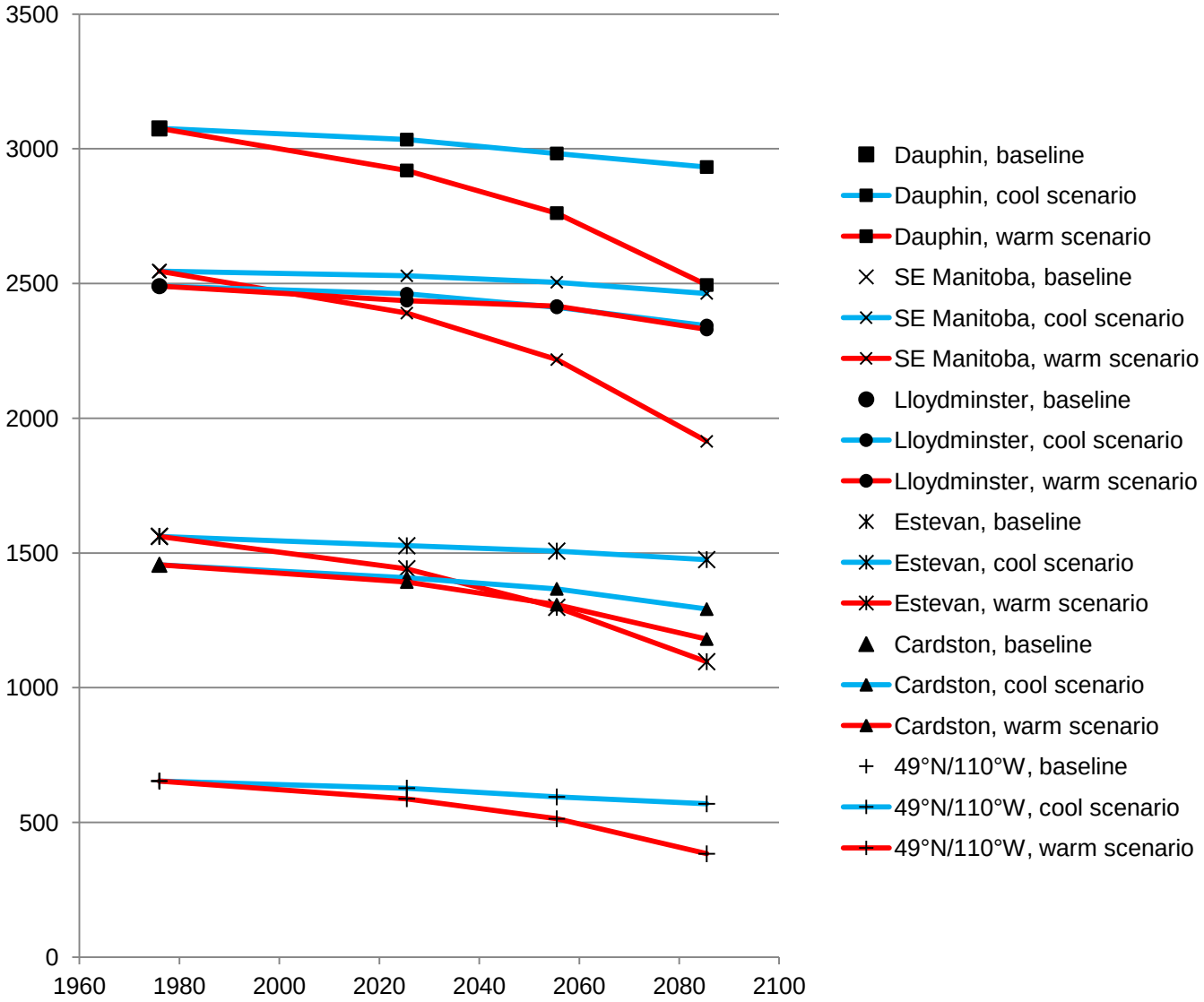
Average Grassland Production on Loam (kg/ha)



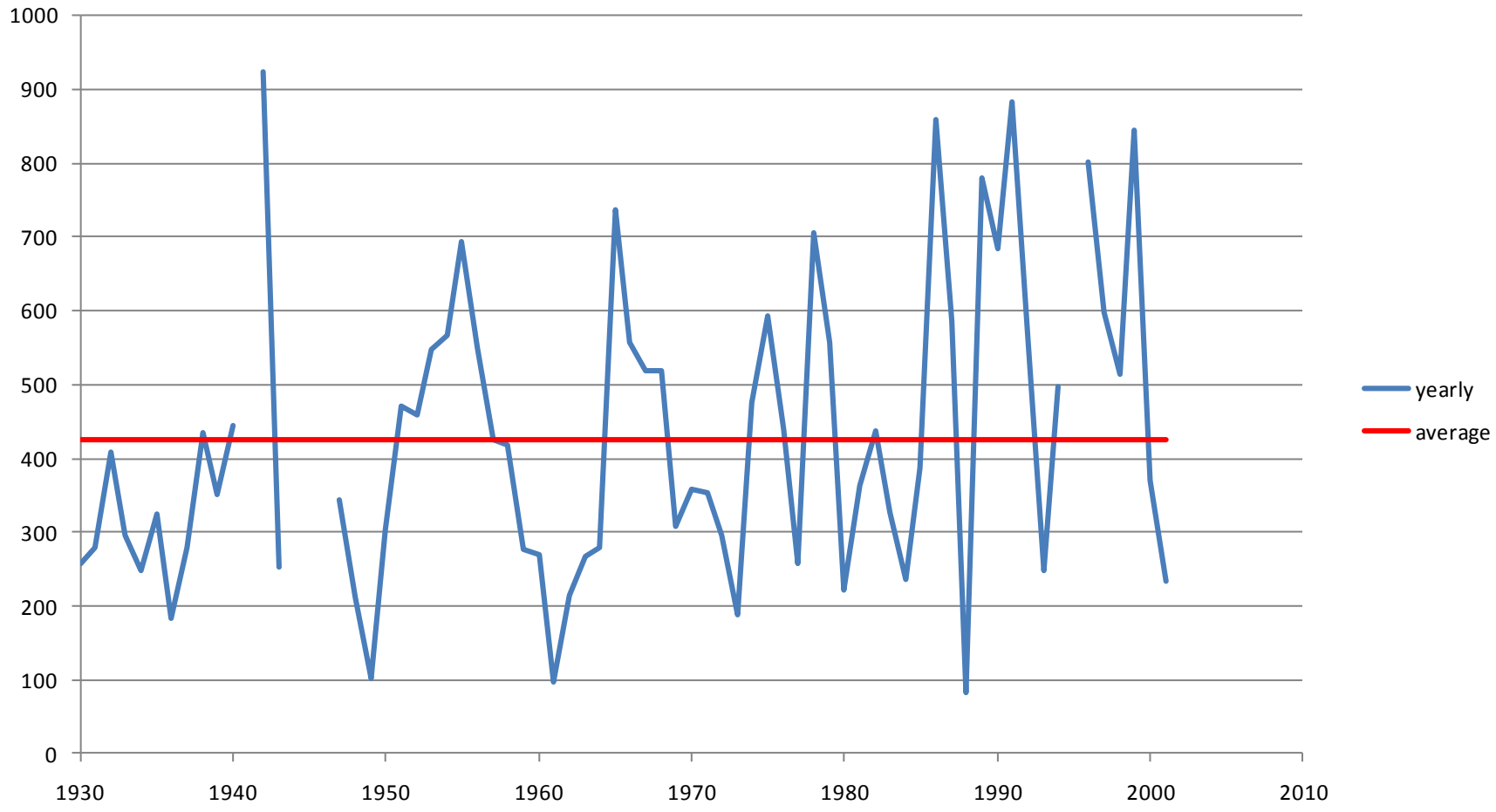
Carbon fertilization effect

- These models do not account for the fertilizing effect of increasing carbon dioxide concentrations.
  - Increased rate of photosynthesis
  - Improved water use efficiency
- Field experiments with CO_2 enrichment chambers show increased grassland production.
- But nutrient uptake and forage quality may decline, so cattle would have to eat more.
- Overall effect is uncertain, but carbon fertilization may help to offset the effect of a drier climate.

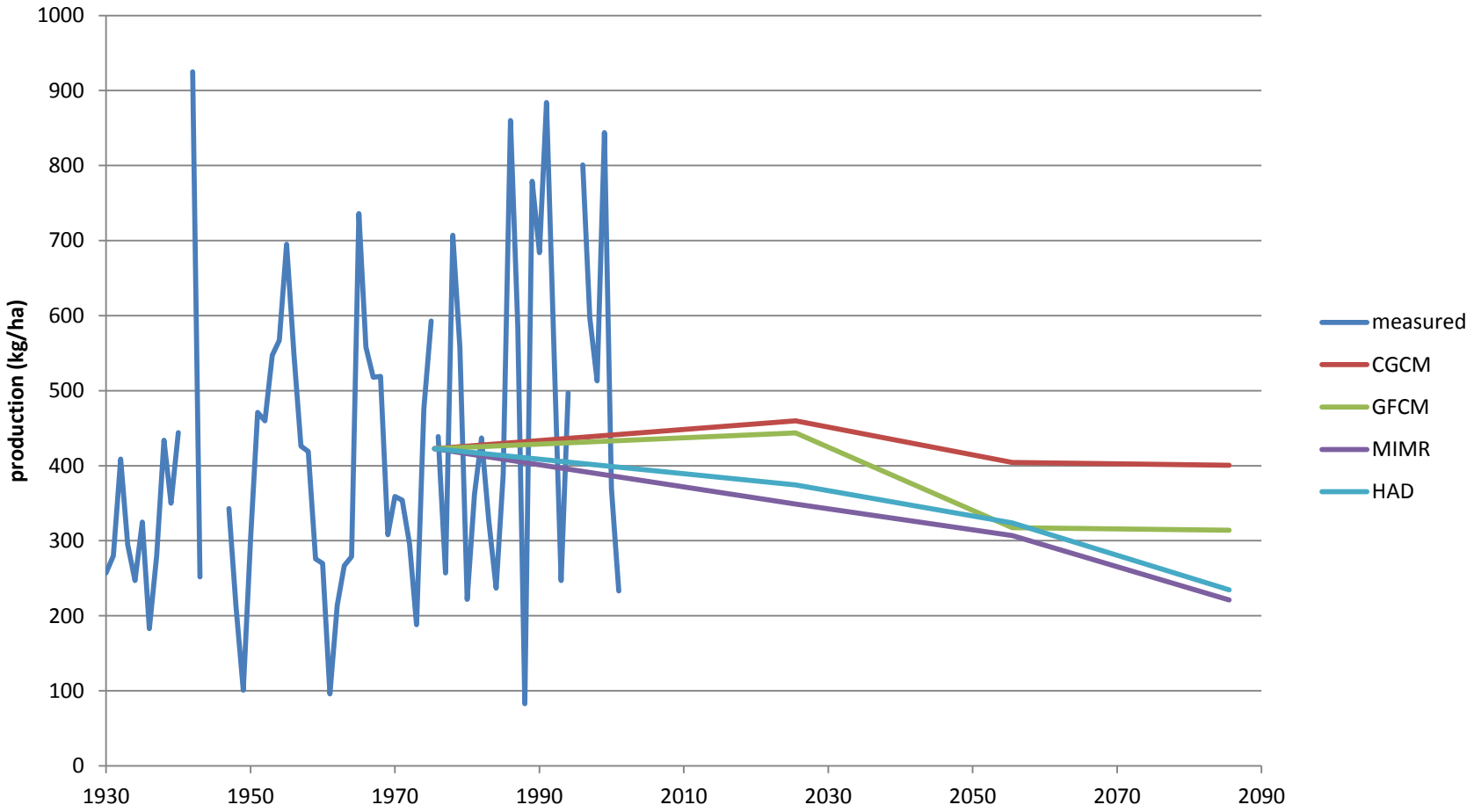
Effects of Extreme Events

- These models represent the average climate – what about year-to-year variation?
- Some studies indicate that climate change will increase variability in precipitation.
- This may lead to more frequent and more intense droughts.
- Extreme wet years can also cause problems.
- These extreme events could be more important than the changes in average productivity.

Immediate effect of drought is reduced production (Manyberries example)



Yearly Production at Manyberries, AB, and Effect of Climate Change on Average Production



Long-term effect of drought is change in vegetation composition

- Changes during the drought of the 1930s were well documented:
  - Shift from taller grasses to shorter grasses.
  - Increase of early-growing species: Sandberg's bluegrass, June grass, sedges.
- Impacts of drought were made worse by the heavy grazing practiced at that time.

Recovery from the 1930s drought: 48 stands of Mixed Prairie in Alberta and Saskatchewan (Coupland 1959)

	1944	1955-1956
Needle-and-thread	29%	13%
Blue grama	24%	15%
June grass	9%	9%
Low sedge	3%	3%
Thread-leaved sedge	2%	2%
Plains reedgrass	1%	5%
Wheatgrasses	15%	23%
Western porcupine grass	14%	27%

The problem of invasive plants

- Climate change could be a stress that makes communities more susceptible to invasion.
- Invasive species have a number of advantages under climate change:
  - Faster evolution
  - Efficient dispersal
  - Can use disturbed habitats as stepping stones

- So invasion problems could become even more severe than they already are.
- However, invasion is most severe in the moister grasslands – increasing drought could actually reduce the risk of invasion.

Climate change and wetlands

- Weather controls wetlands:
  - moisture balance→ number of ponds → number of ducks
- Models predict decreasing pond numbers and duck populations with climate change.
- Interaction with land use: drainage of wetlands exacerbates the impact of climate change.

Adaptation options – the three Rs:

- Short term – **resist** the effects of climate change
- Medium term – increase **resilience**, allowing system to return to previous state following disturbance
- Long term – help the system to adaptively **respond** to change rather than resisting it

Short term adaptations – actions of producers to cope with extreme events

- Reducing numbers of livestock
- Moving livestock to alternative grazing
- Purchasing feed
- Hauling water

Medium term adaptations – actions by producers and governments to increase the resilience of the system

- Changing herd structure – higher proportion of yearlings
- Sustainable grazing management to improve rangeland health
- Converting marginal cropland to perennial forages
- Planning for increased feed reserves
- Improving water storage and distribution systems
- Community pasture programs
- Detection and control of invasive species
- Crop insurance and assistance programs
- Drought monitoring and prediction tools

Long term adaptations

- Predictions of future change are too variable and uncertain for development of long-term prescriptive plans.
- Be aware that directional changes may be happening, and have monitoring systems in place so you can detect them and adjust policies accordingly.
- In the meantime:
  - keep grassland systems healthy
  - don’t reduce your future options (e.g. by eliminating grasslands)
  - help grasslands to respond to change.

Helping grasslands to respond

- Prairie grasslands have a high capacity to respond to climatic variability by shifts in proportions of species.
- But eventually new species will have to move northward.
- Habitat fragmentation will impede this response.
- Conserving as much grassland as possible, and maintaining connections between patches, will facilitate migration.

Grassland fragmentation (SW Manitoba)