



UNIVERSITY OF
SASKATCHEWAN

Global Institute for
Water Security

www.usask.ca/water



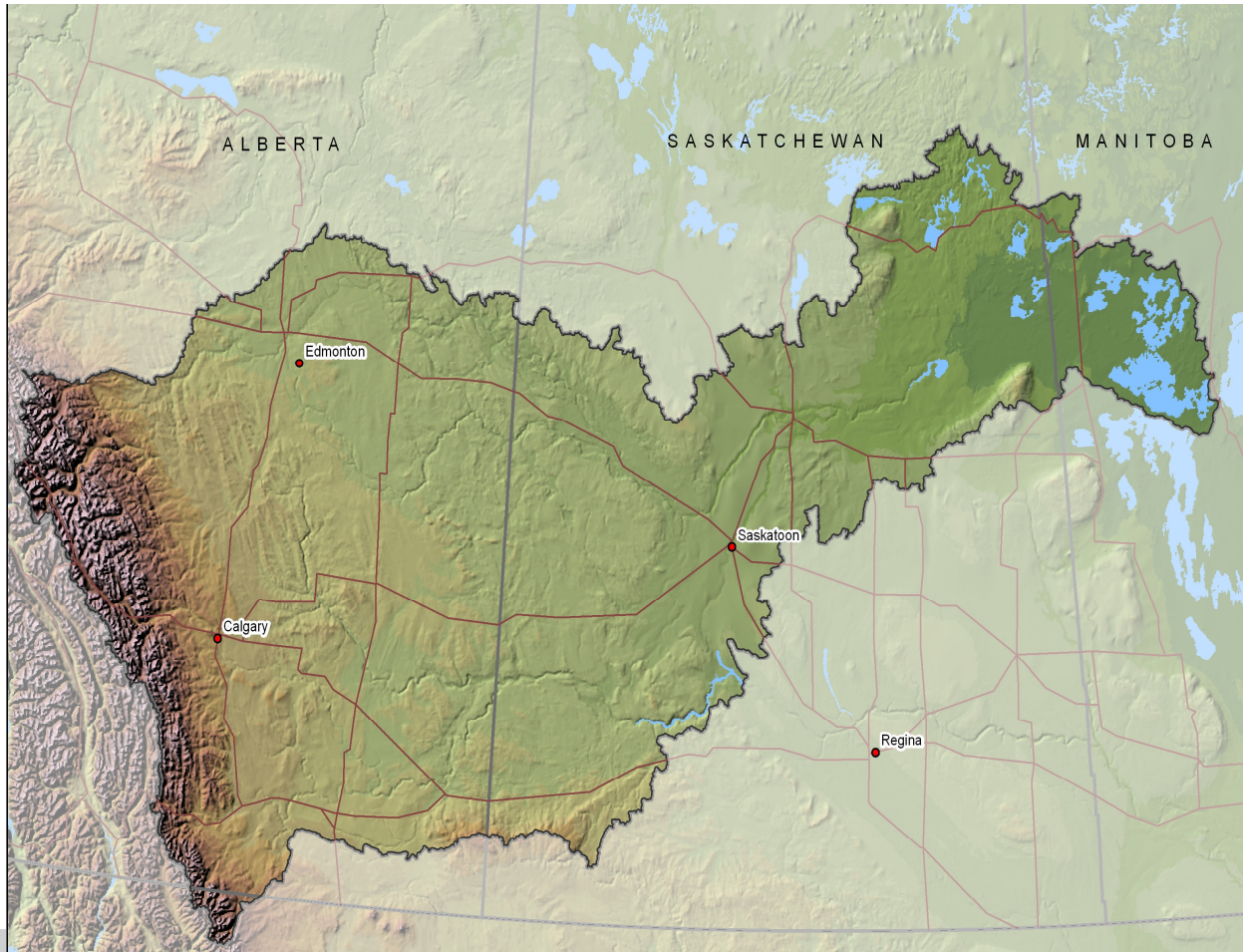
Drought-related research in western Canada

Saskatchewan River Basin RHP & Changing Cold Regions Network

Howard Wheeler and Ron Stewart

Saskatchewan River Basin

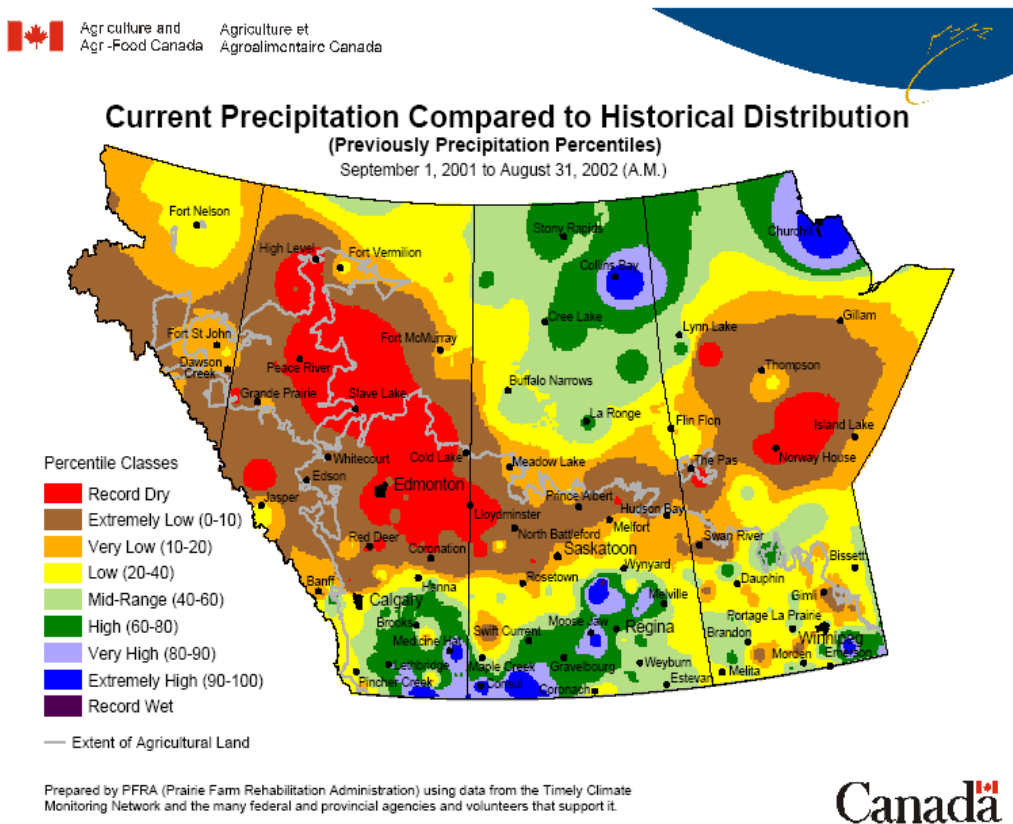
- a GEWEX Regional Hydroclimate Project



- Area 406,000 km²
- Drains from continental divide in Alberta, through Saskatchewan to Manitoba

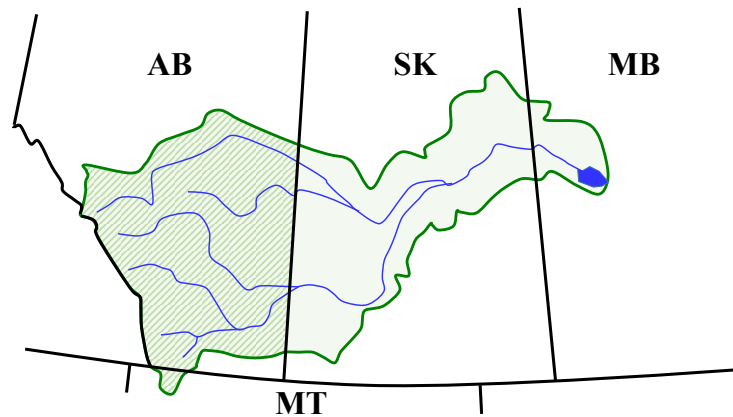
Prairie Drought of 1999-2004

Described as Canada's most costly natural disaster



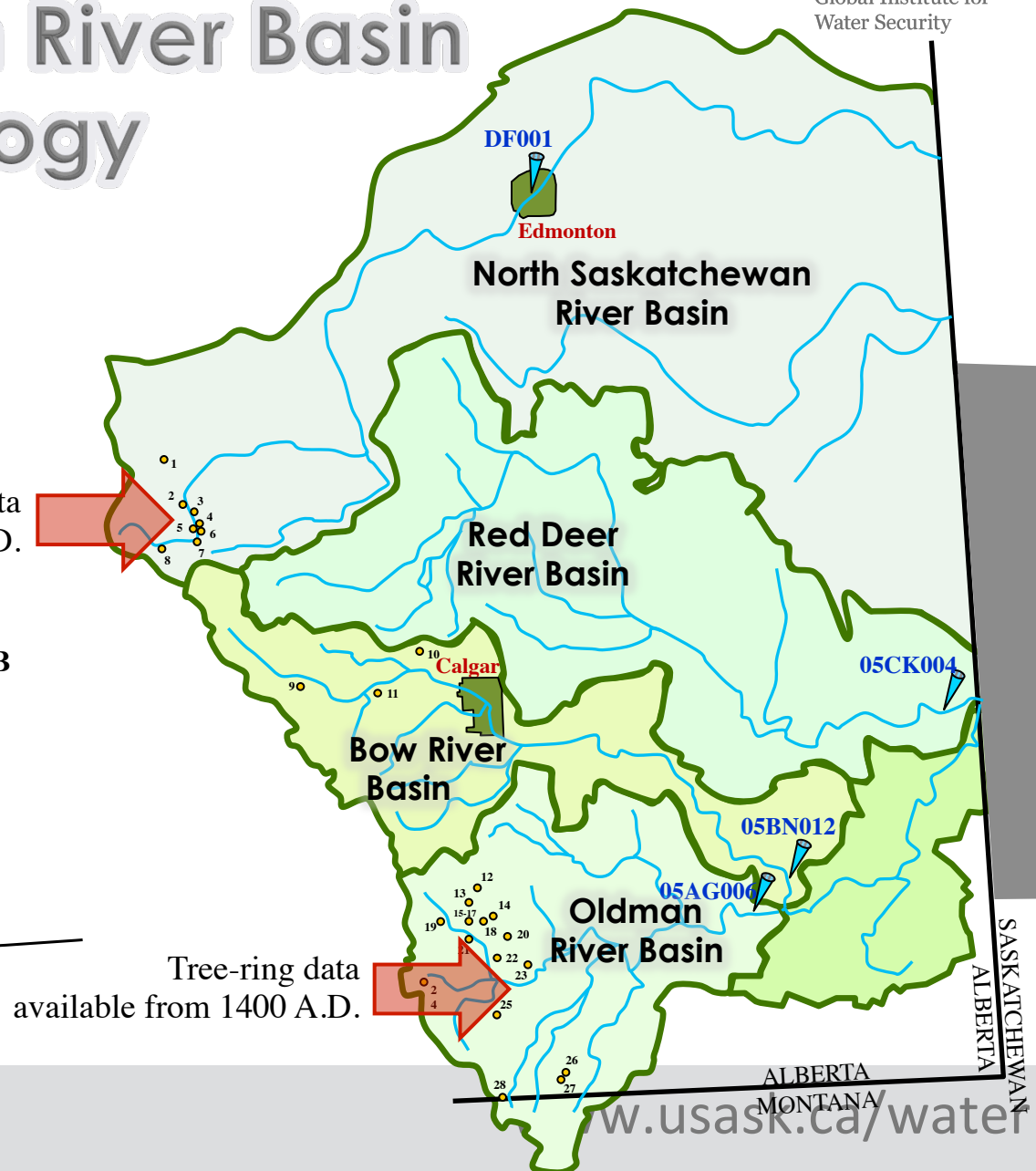
- \$5.8 billion decline in GDP 2001-2002
- \$3.6 billion drop in agricultural production, 2001-2002
- 41,000 jobs lost
- BC, Alberta forest fires
- Saskatchewan dust storms

Saskatchewan River Basin Palaeo-hydrology



Tree-ring data
available from 1100 A.D.

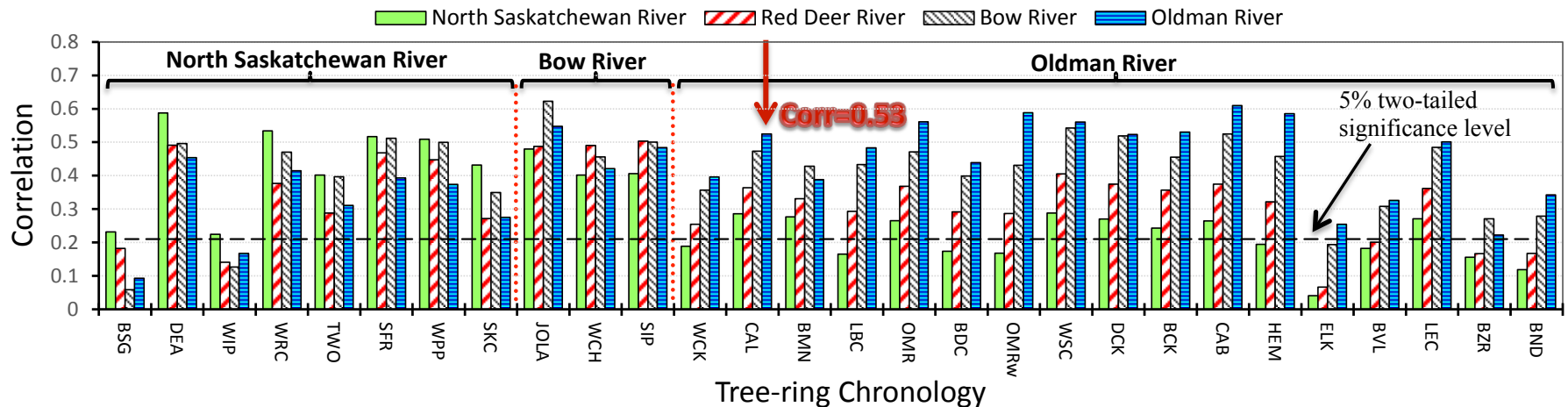
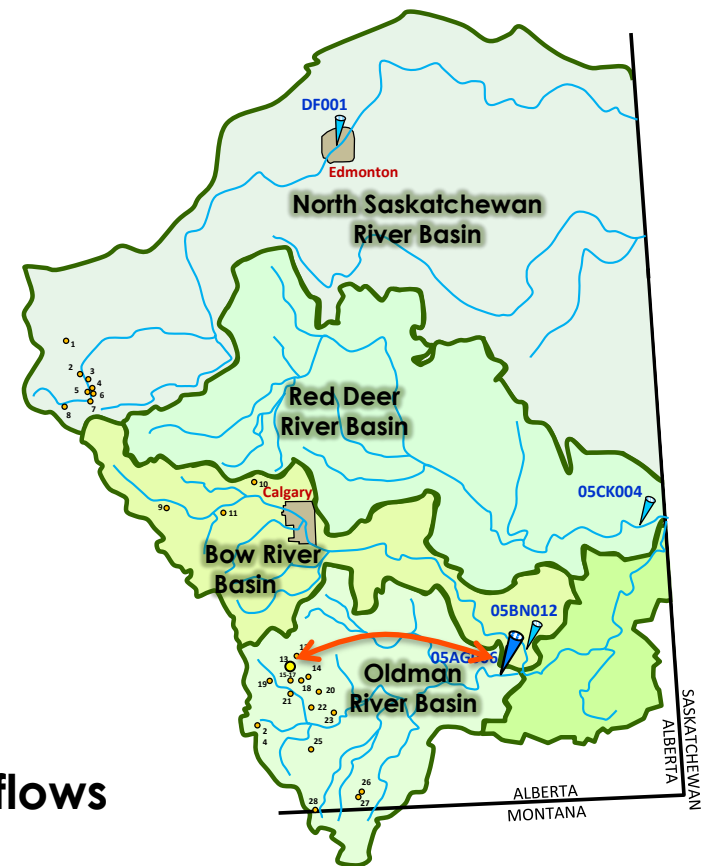
Tree-ring data
available from 1400 A.D.



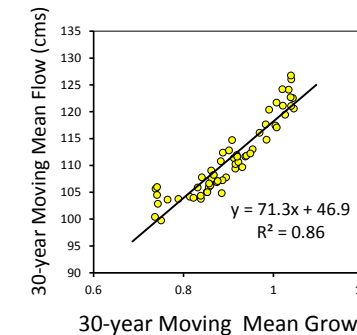
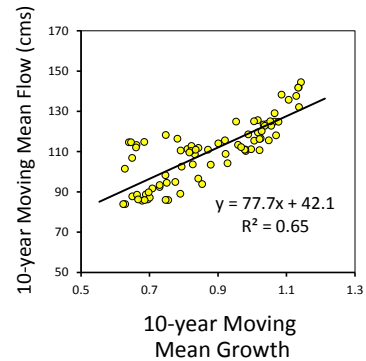
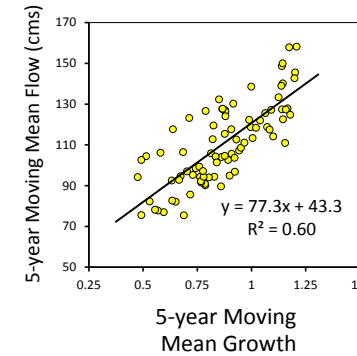
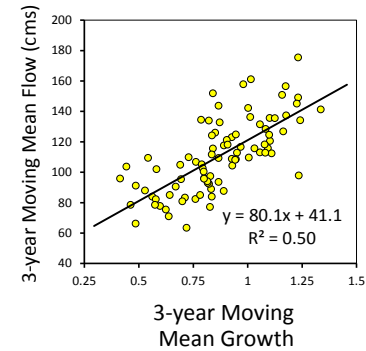
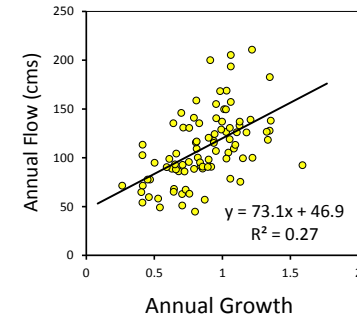
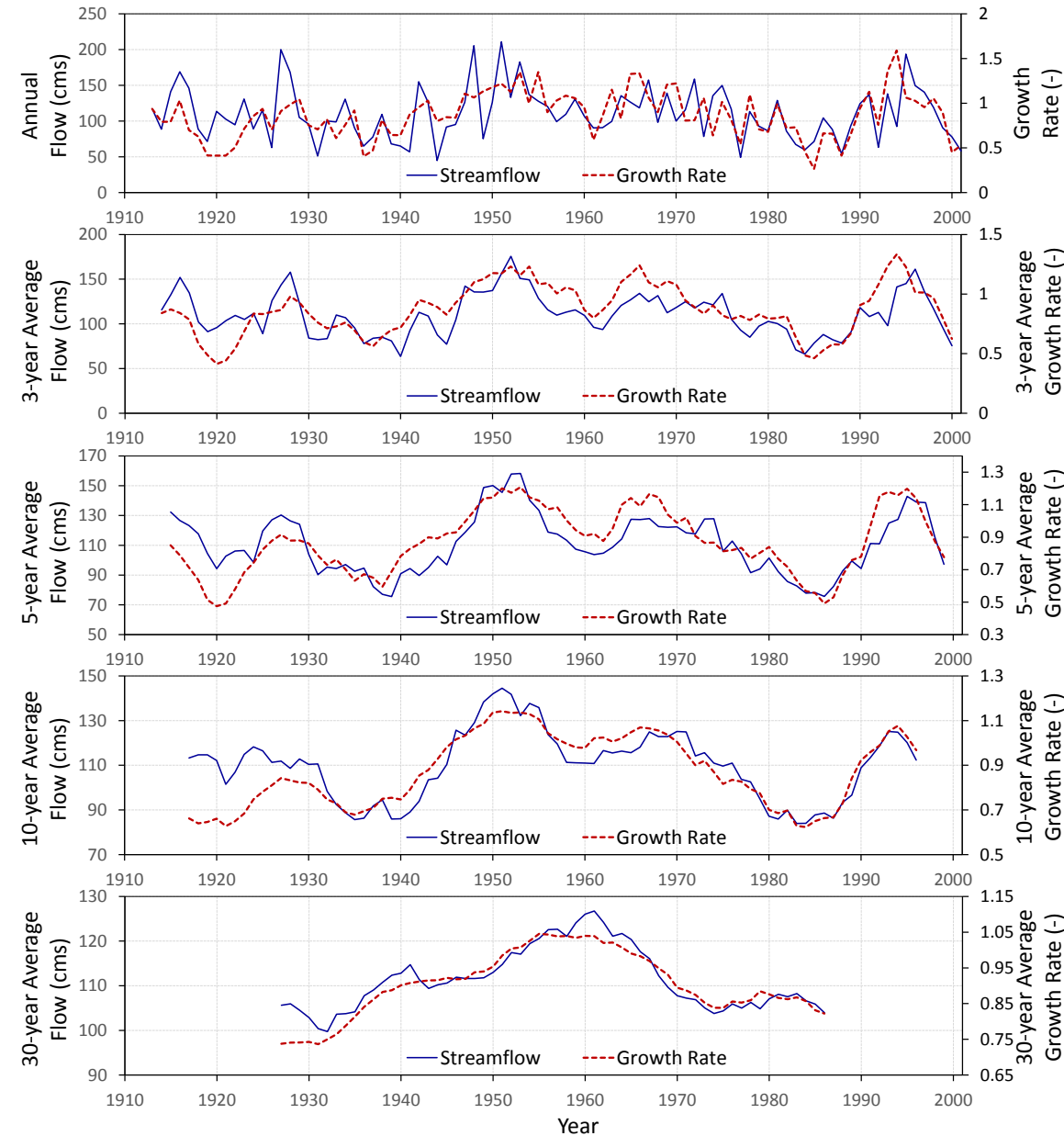
Relationships between Flow and Growth

- Data {
- 28 Chronology Sites
 - 4 Streamflow Gauges

Linear correlation coefficients between the growth rates and the water year flows

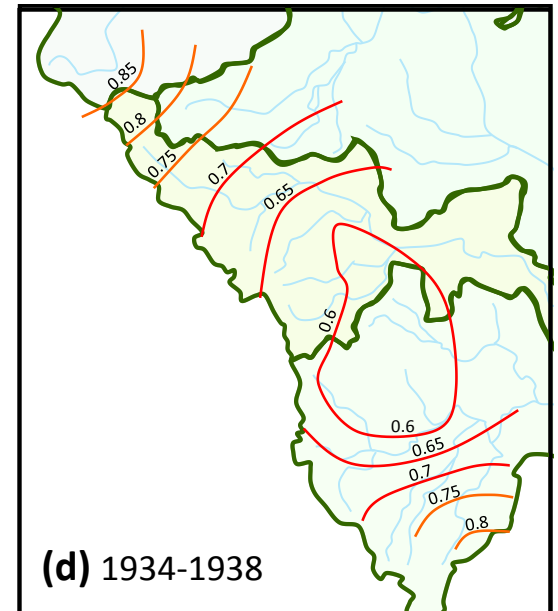
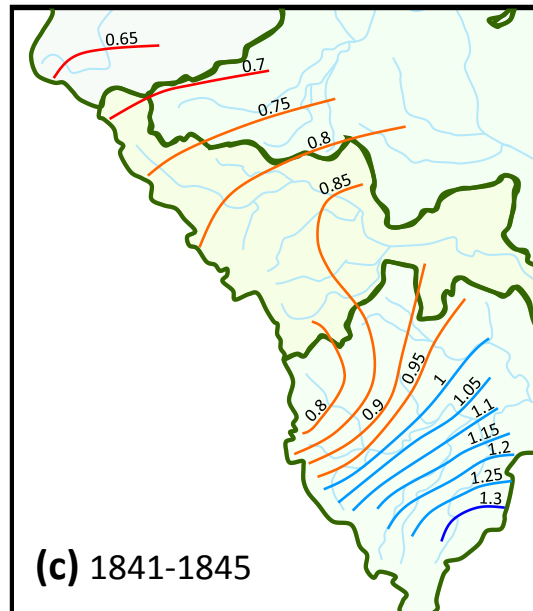
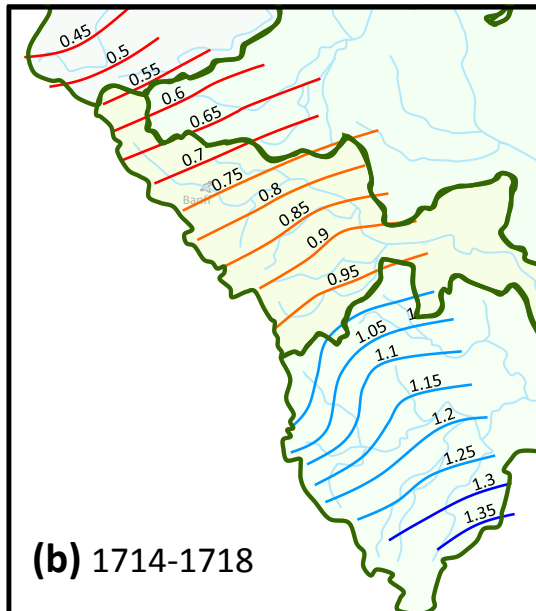
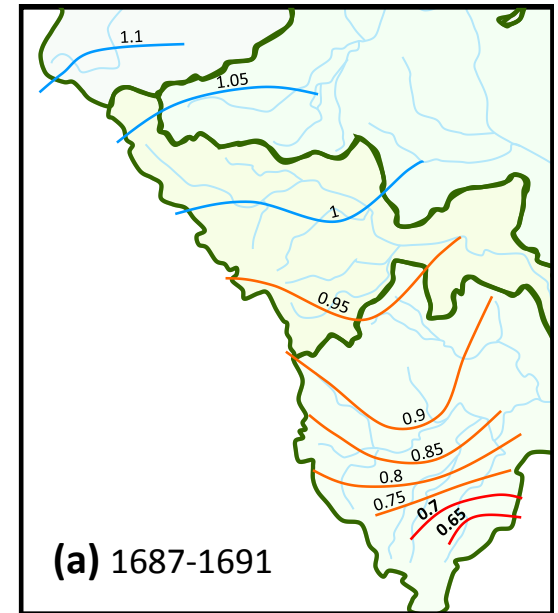
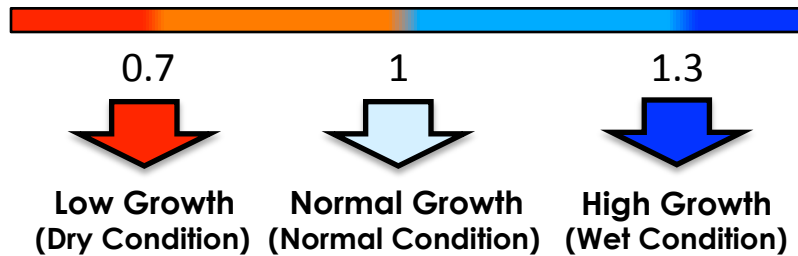


Relationships between Flow and Growth



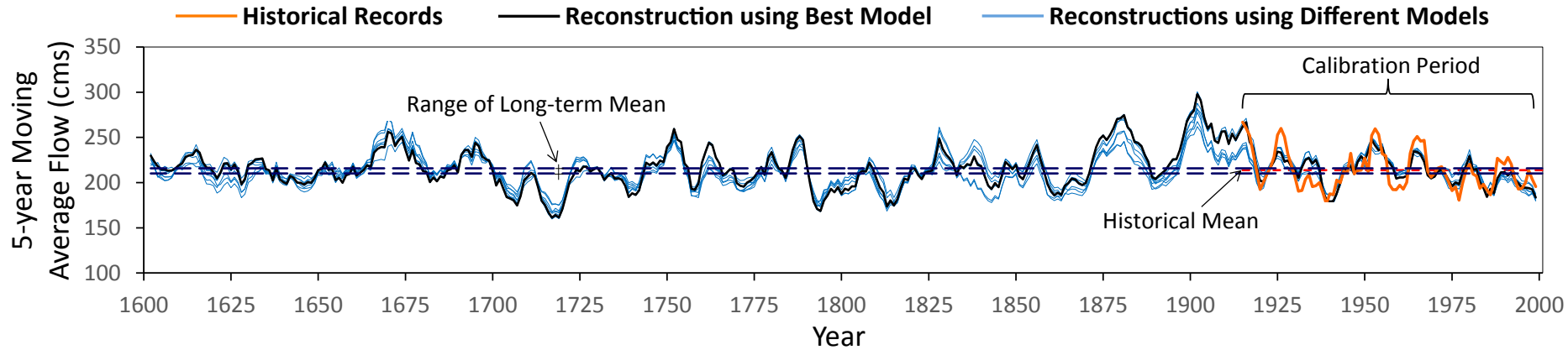
Spatial Variation of Paleo-climate

Contour maps of five-year average growth rates

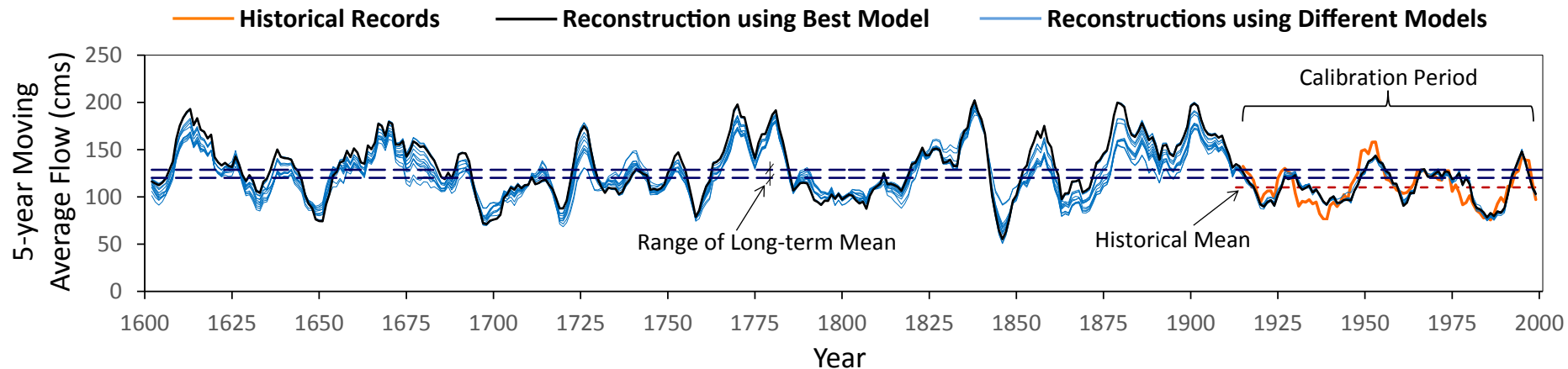


Reconstruction of Paleo-streamflows

North Saskatchewan River

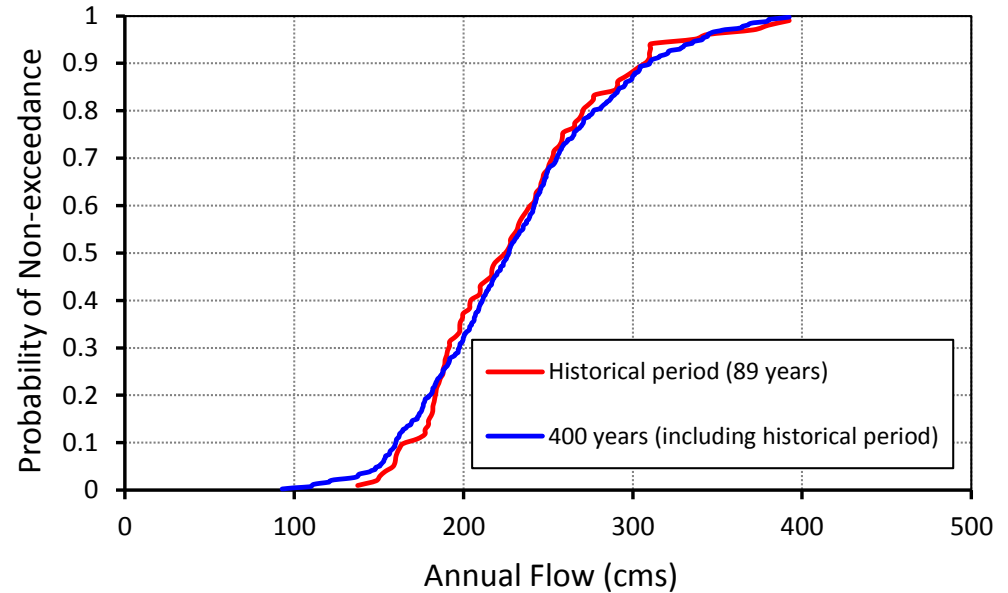


Oldman River

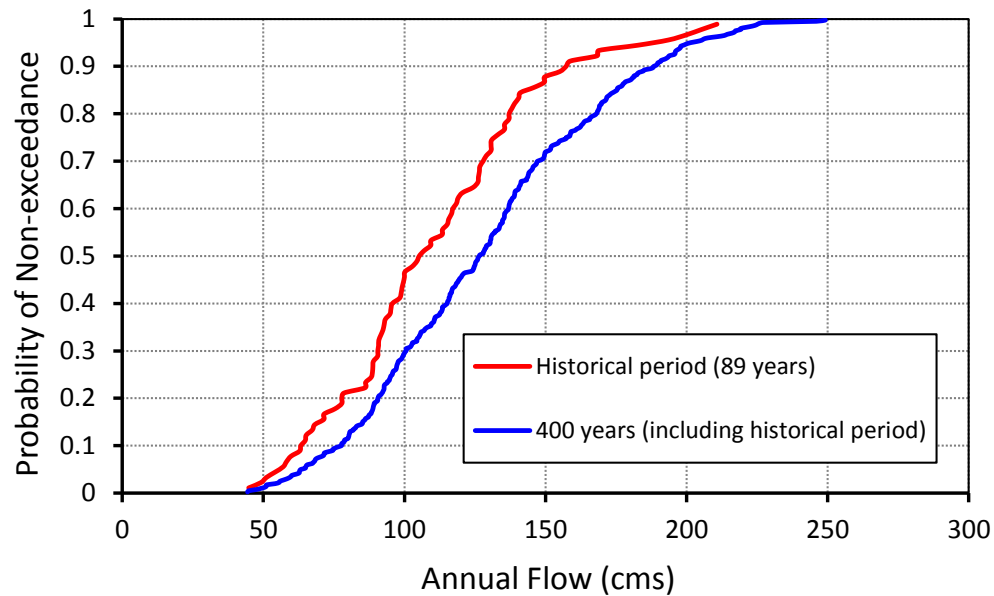


Flow Duration Curves

North Saskatchewan River



Oldman River



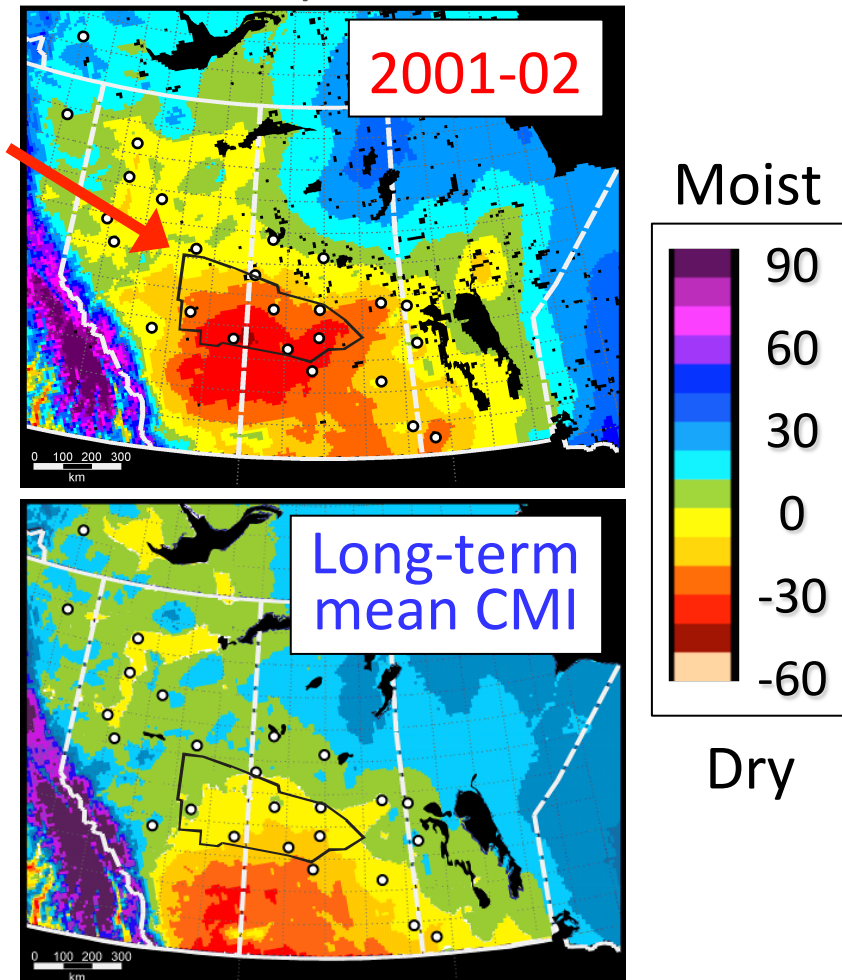
Drought and Forest Dieback

Climate Moisture Index CMI ($P-ET_p$)

2001-2002 vs.
Long-term Mean
(Ted Hogg, CFS)

- Drought was unusually severe in 2001-2002, driest in >100 years across a large area
- Led to massive, sustained aspen dieback and mortality, especially along the northern edge of the prairies
- CMI maps by D. Price, M. Siltanen & D. McKenney, CFS

Severe
dieback
area



Regional, post-drought decline in aspen growth of 30%, widespread aspen dieback and mortality



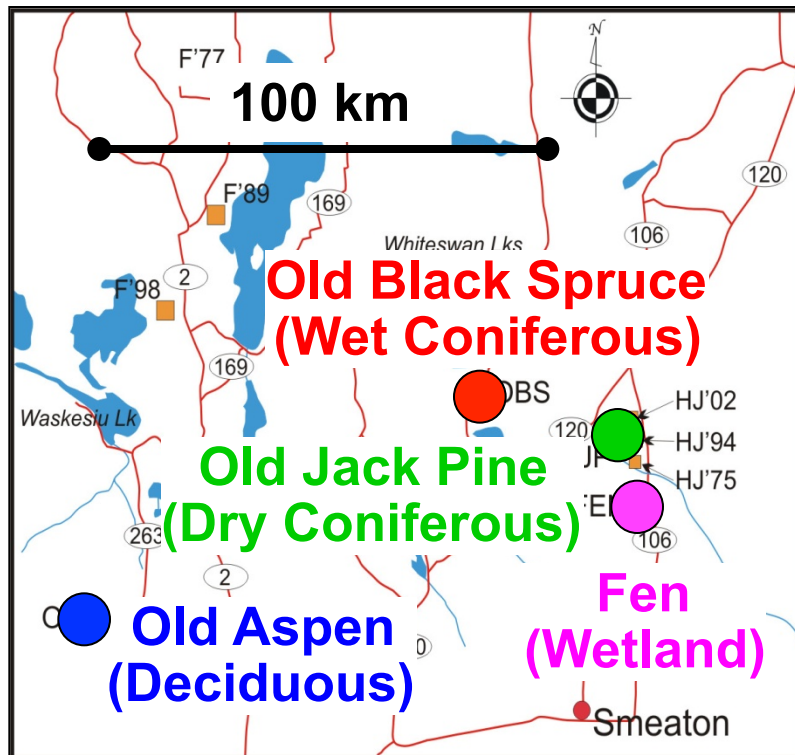
(photo by Mike Michaelian, CFS)

Boreal Ecosystem Research and Monitoring Sites (BERMS, 1994+)

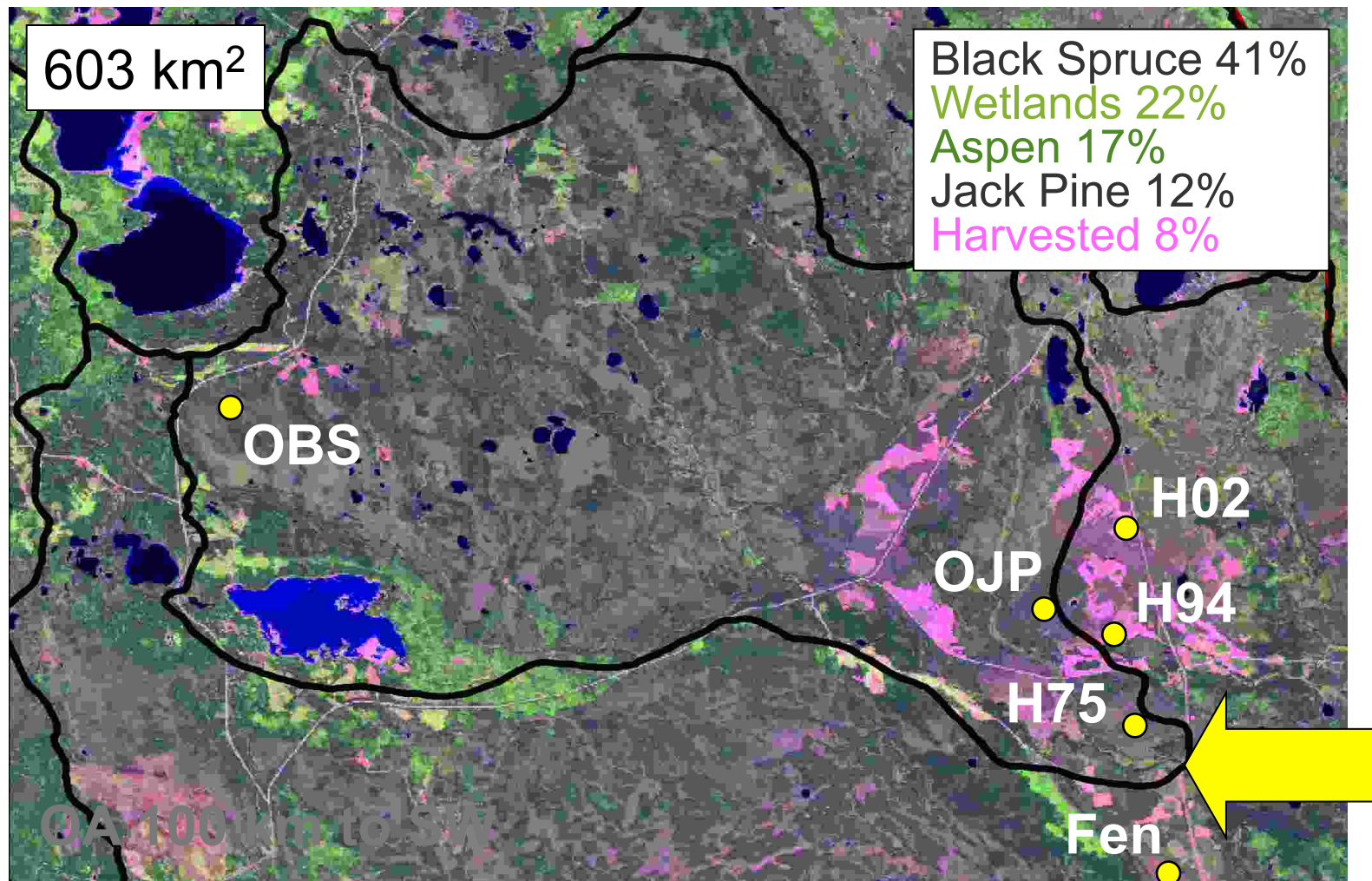


- Southern edge of Boreal Plains Ecozone in central SK

Flux Towers (in operation)

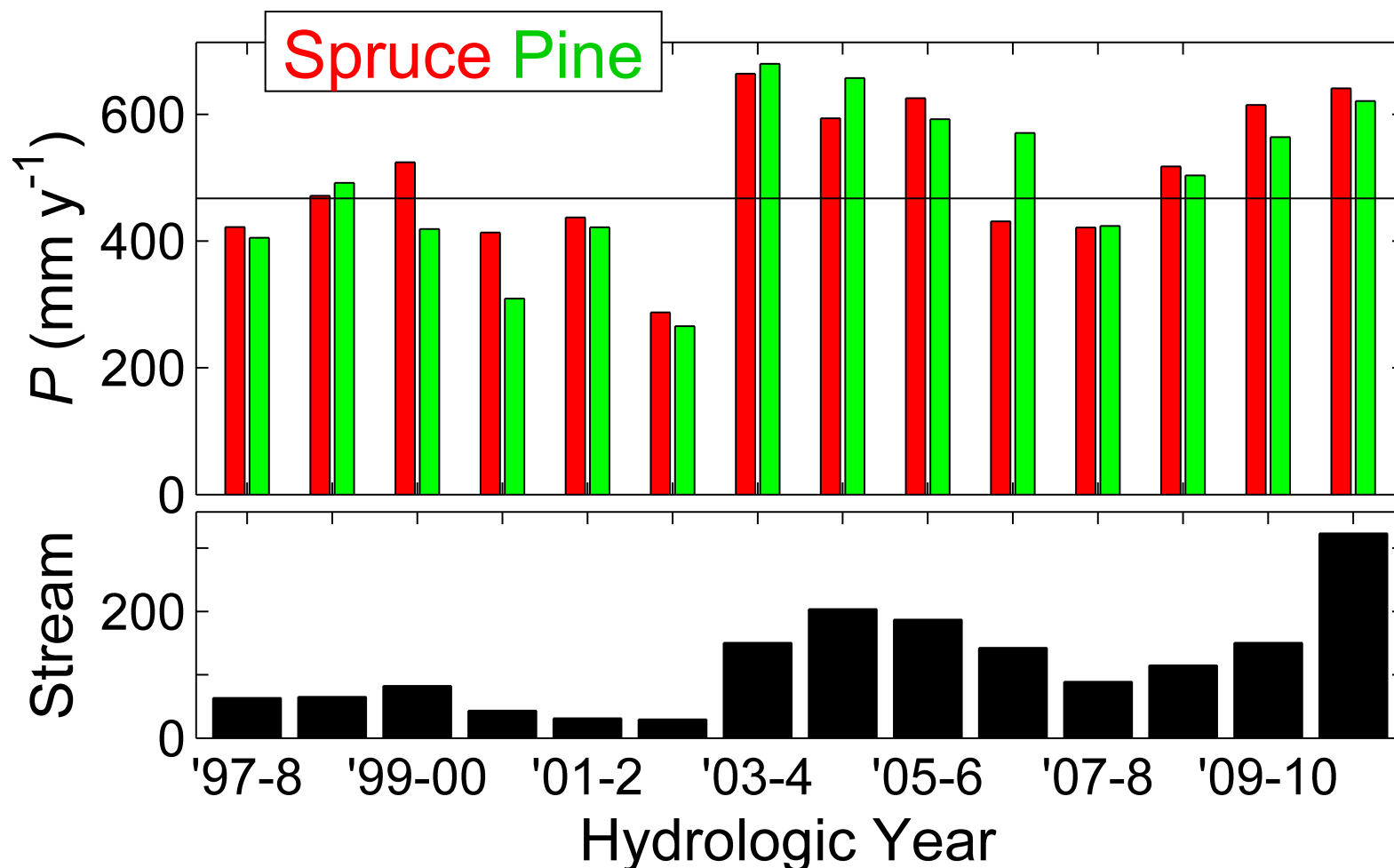


White Gull Creek Watershed

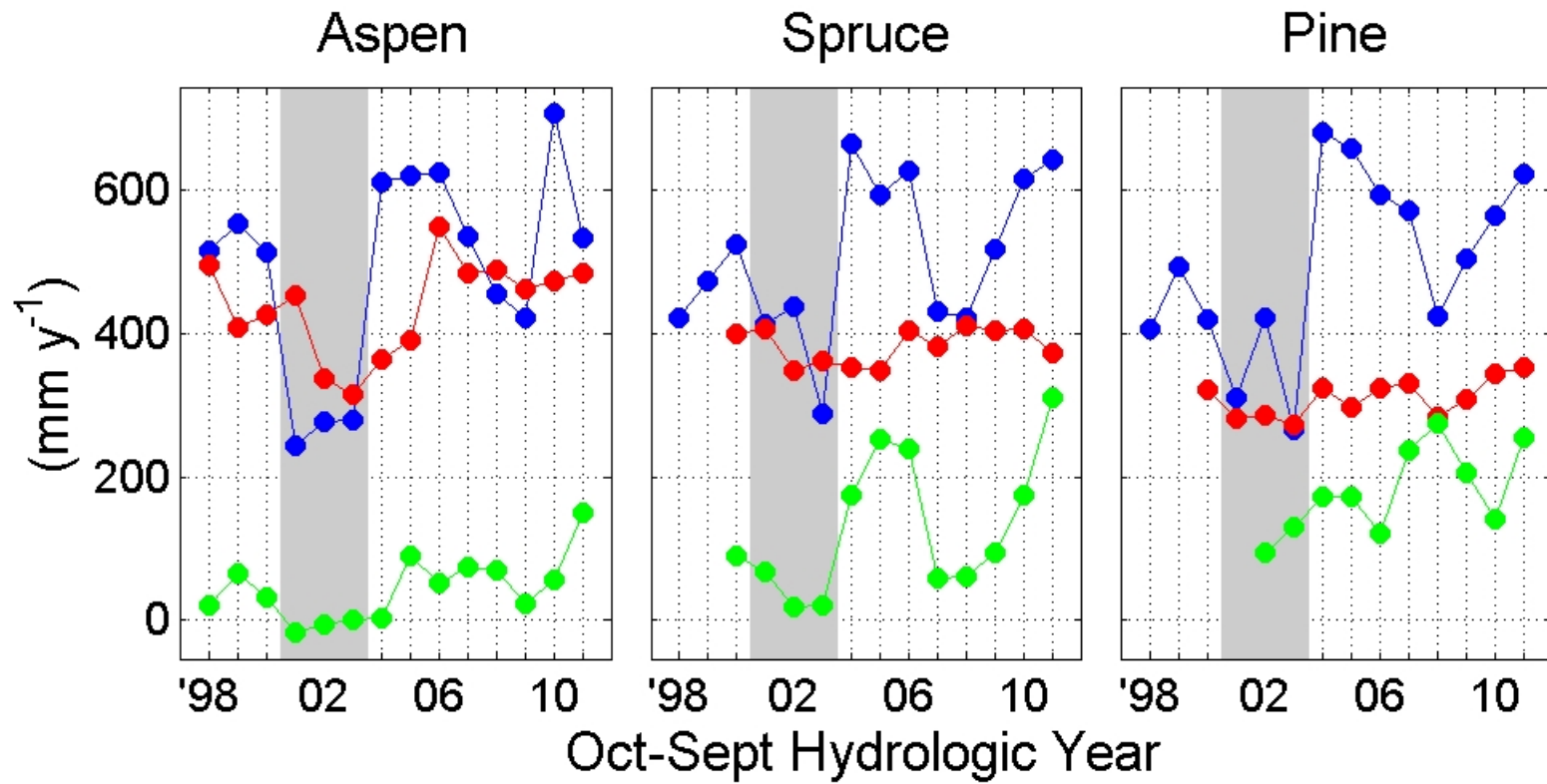


Annual Precipitation and Streamflow

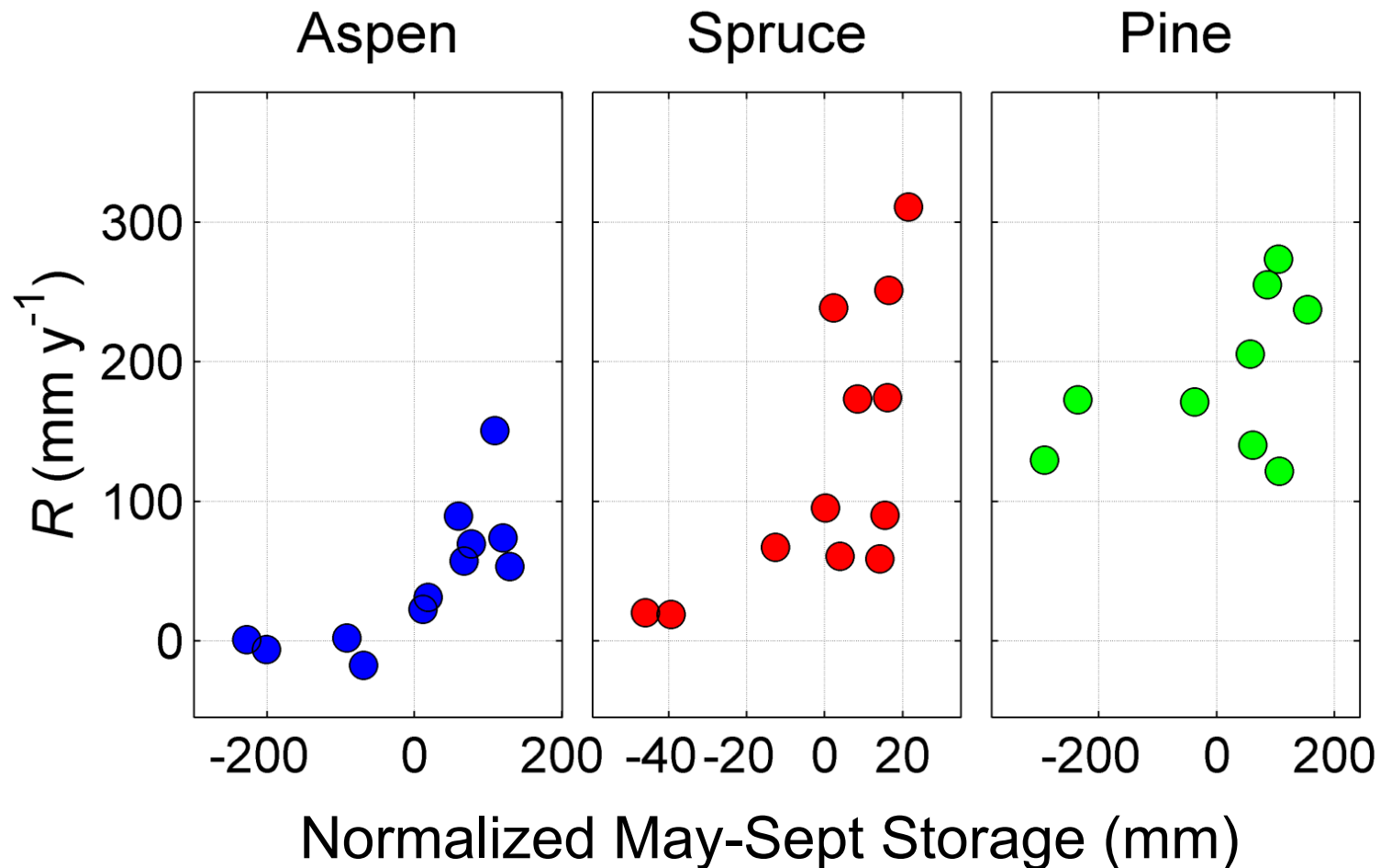
White Gull Creek, Oct-Sept Hydrologic Years



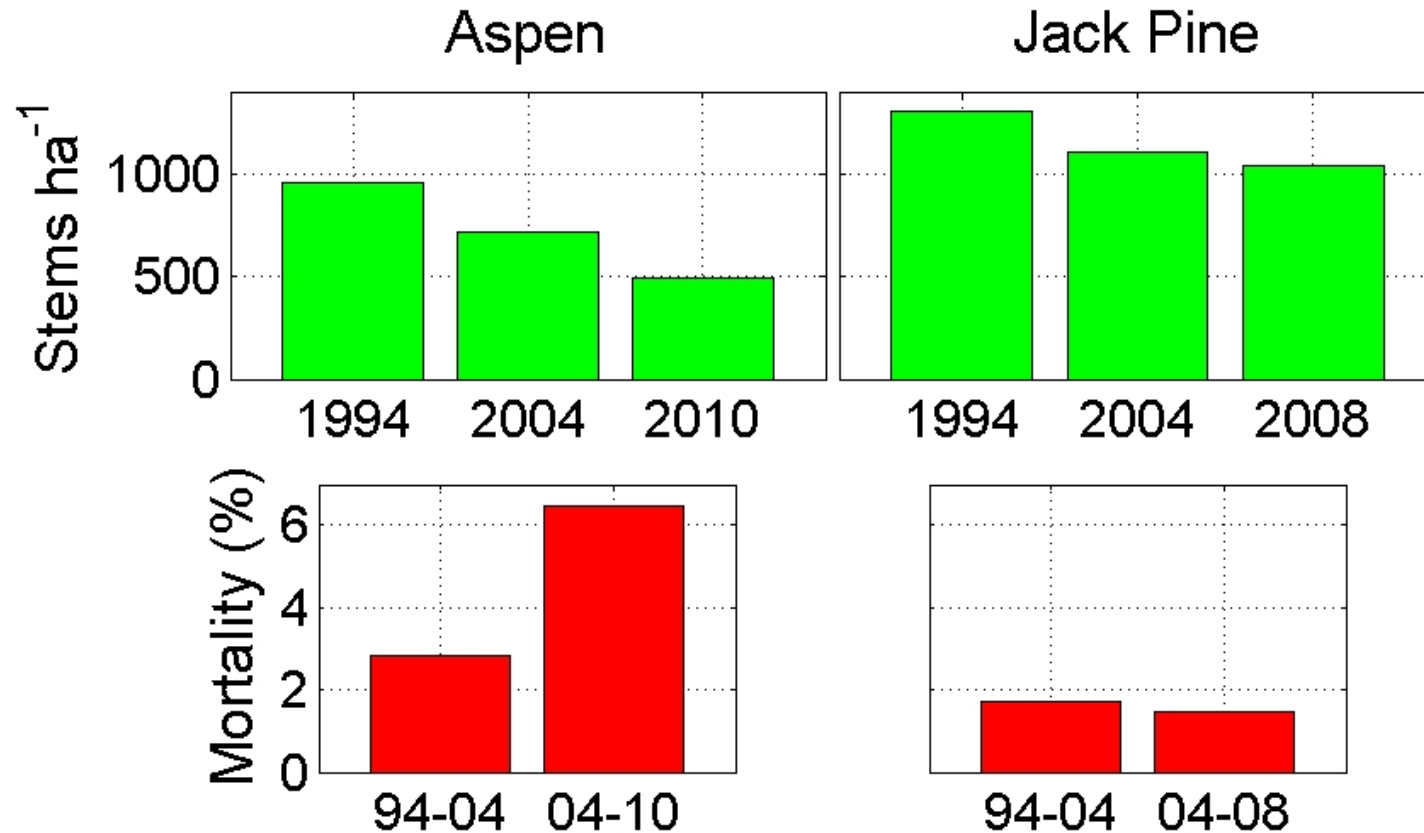
Stand-Level Precipitation, Evapotranspiration and Lateral Outflow ($R = P - E^* - \Delta S$) (Shaded area shows 2001-2003 drought)



Annual Stand-Level Outflow R in Relation to Soil Water Storage



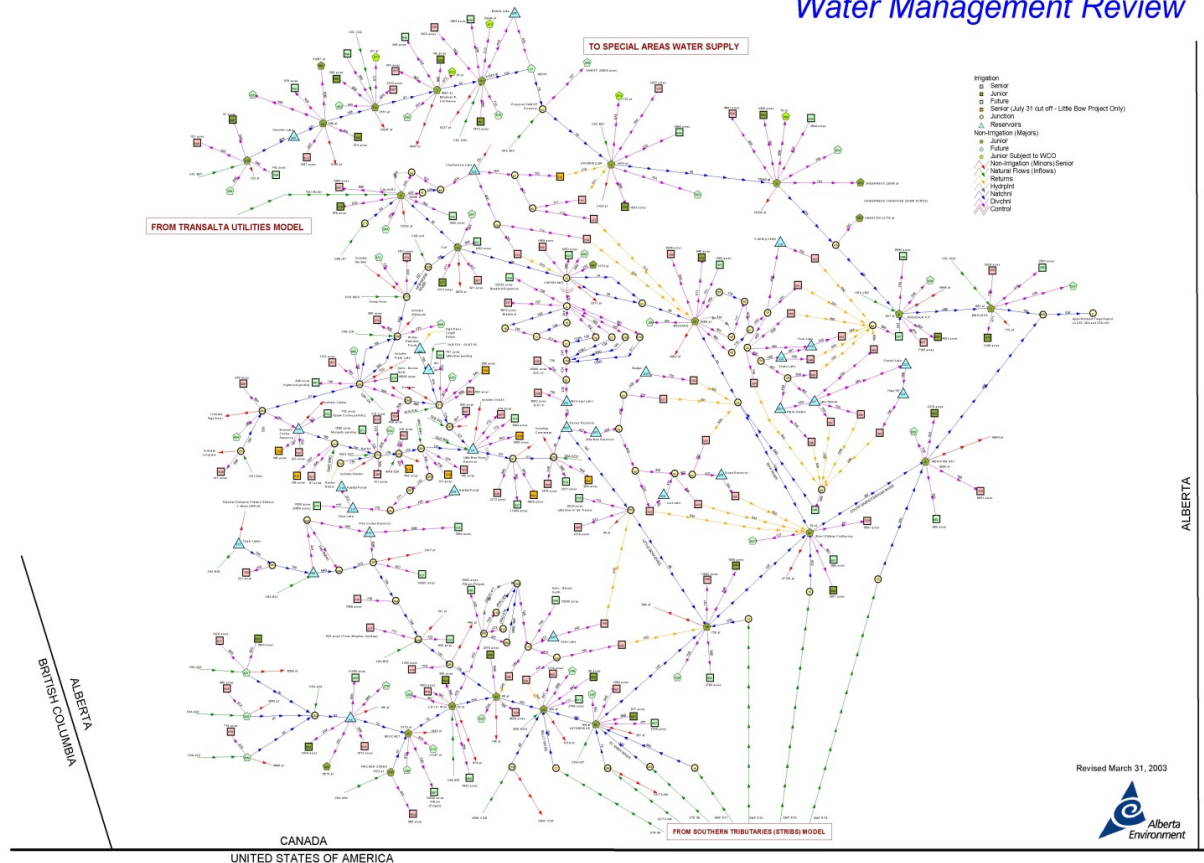
Contrasting Changes in Stem Density and Tree Mortality: Before and After Drought



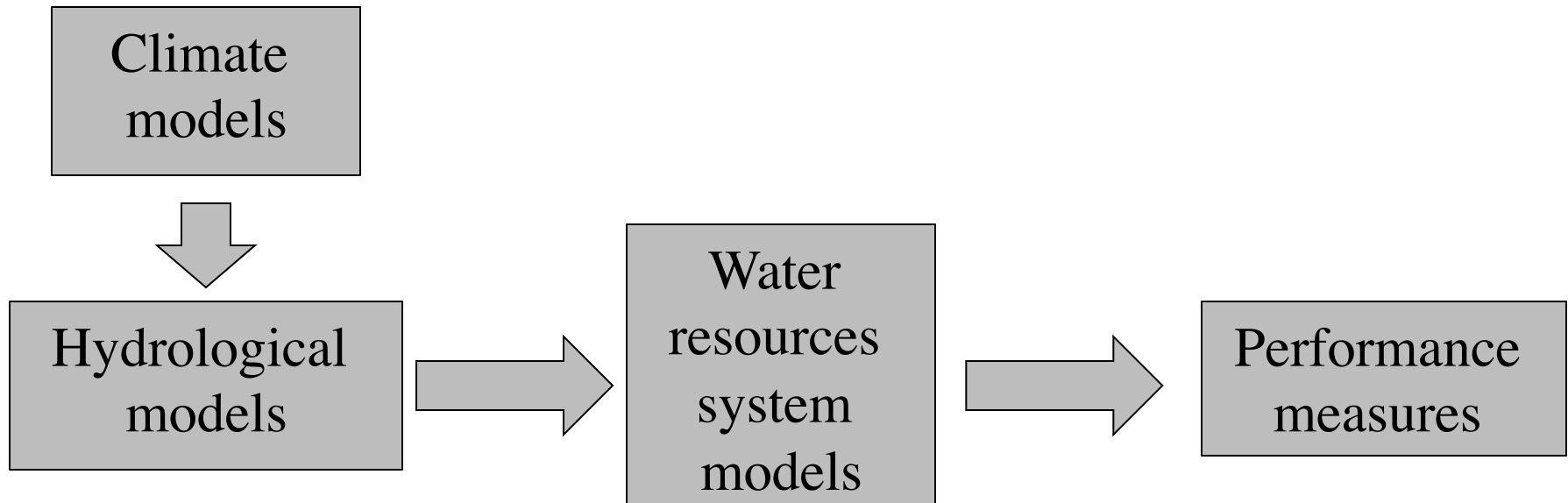
Modelling complex water resource systems

South Saskatchewan River Basin in Alberta

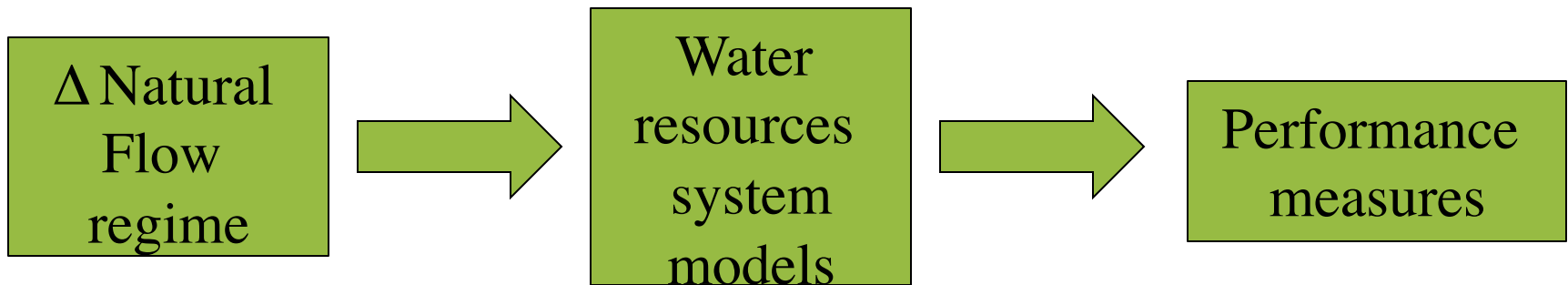
South Saskatchewan River Basin Water Management Review



Scenario-based assessment

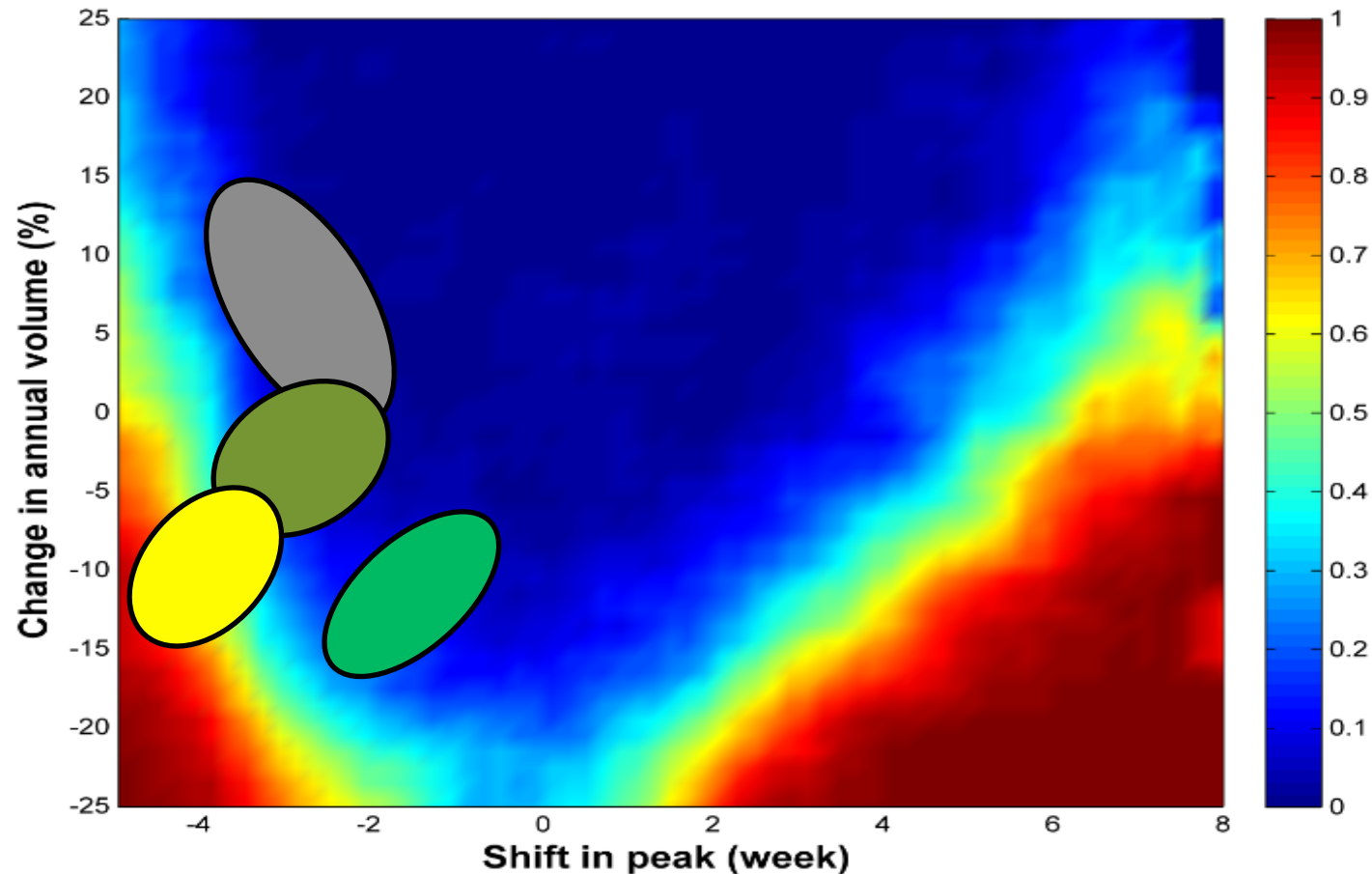


Vulnerability assessment



Vulnerability analysis – SSR in Alberta

Probability
of system
failure under
changing
headwater
flows
(annual
peak,
Peak timing)



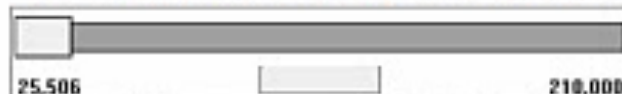
View Layout Model Tools Windows Help



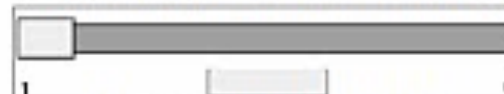
"Coefficient of South Saskatchewan River at AB-SK border"



"Coefficient of North Saskatchewan River at AB-SK border"



"Irrigation Area (ha) near Lake Diefenbaker"

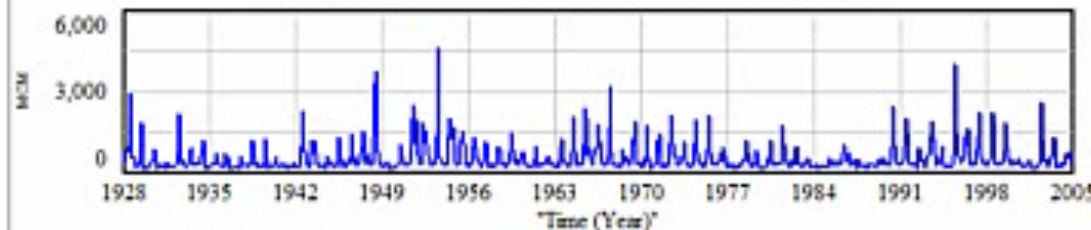


Coefficient of Residential demand



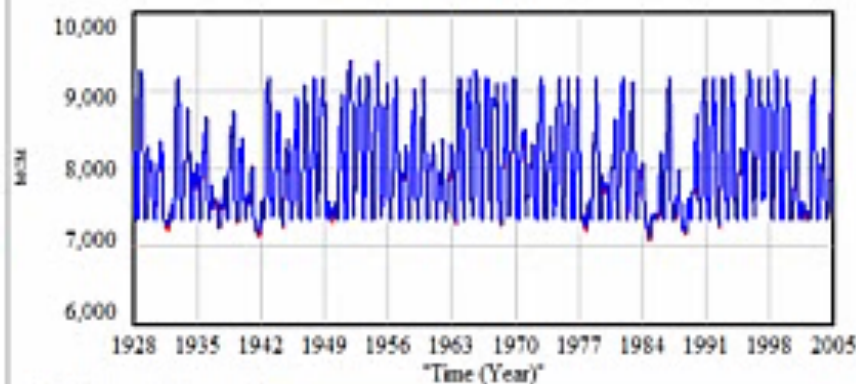
Coefficient of Temperature

South Saskatchewan River Inflow at AB-SK border



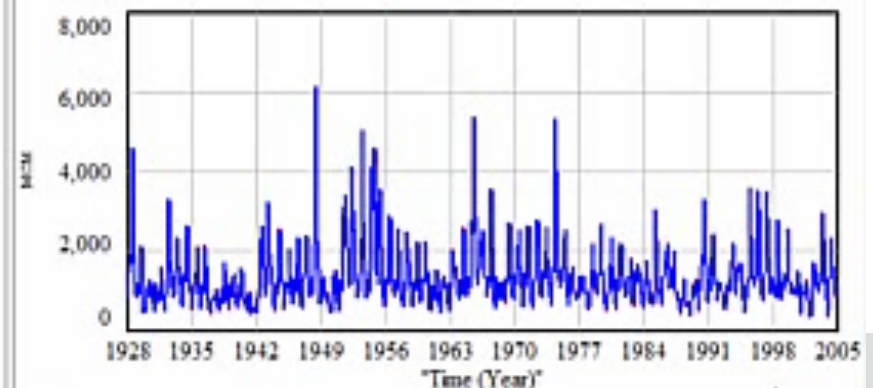
Alberta Apportionment inflow : simulation_scenario1
 "Alberta to Saskatchewan Inflow (Full conditions)" : simulation_scenario1

Lake Diefenbaker



Lake Diefenbaker : simulation_scenario1
 "Lake Diefenbaker volume (Full conditions)" : simulation_scenario1

Manitoba



Final point Manitoba : simulation_scenario1
 "Final Point border Manitoba (Full conditions)" : simulation_scenario1

Downstream – a play by Kenneth T. Williams

- 2014 forum theatre production, *Downstream*, took audience members through an exercise in decision-making when drought and floods threaten.
- Four performances across Western Canada - Calgary & Medicine Hat, Alberta, Saskatoon & Cumberland House, Saskatchewan.

