

Assessing drought impacts on western Canadian aspen forests



Climate Impacts on Productivity and Health of Aspen (CIPHA)

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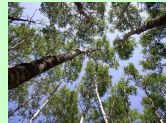
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Trembling Aspen (*Populus tremuloides*)

- Most widespread tree in North America
- 2 billion tonnes of aspen biomass in the Canadian boreal forest
- Important both ecologically and commercially
- Major role in carbon sequestration by Canada's forests
- Increasing concerns about decline of aspen forests across western North America



Healthy aspen forest



Poor aspen regeneration after fire & drought near Whitehorse, Yukon (see Hogg & Wein 2005)



Aspen decline in the Northwest Territories, likely caused by drought, insects and/or flooding from permafrost thawing (June 2016)



Sudden Aspen Decline Following drought in the southwestern US (see Worrall et al. 2013)

Major causes of aspen decline

- Drought
- Tent caterpillar defoliation
- Spring thaw-freeze events
- Wood-boring insects
- Fungal pathogens

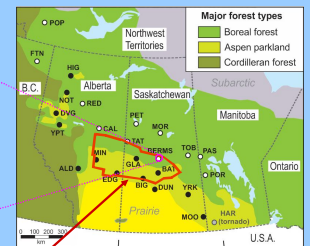
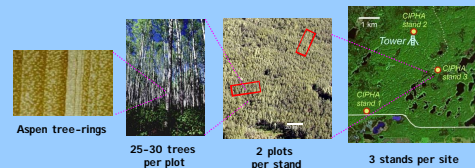


Drought-induced aspen mortality in Alberta (Michaelian et al. 2011)

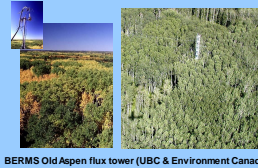
Methods for assessing drought impacts on aspen forests

CIPHA ground plot network

Measured annually 2000-2008, 2012 & 2016

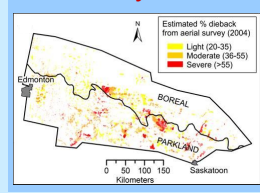


Tower-based monitoring of CO₂ uptake & release

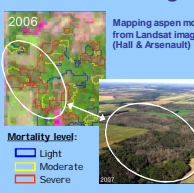


BERMS Old Aspen flux tower (UBC & Environment Canada)

Aerial survey of dieback



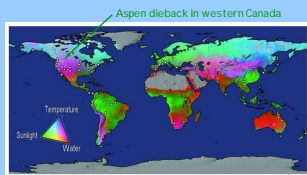
Remote sensing



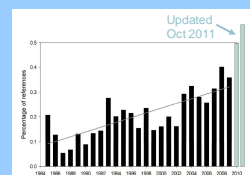
An emerging science issue for the 21st century:

Is climate change leading to global increases in drought-induced forest decline?

Global overview led by Craig Allen, US Geological Survey



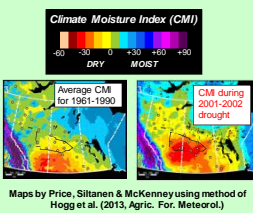
Location of 88 recent episodes of forest die-off induced by extreme drought and heat (Allen et al. 2010)



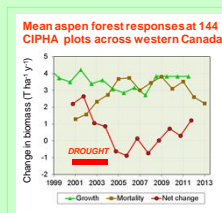
Increase in percentage of scientific papers on forests that have reported on drought & tree mortality (Allen et al. 2010)

Highlights of results from the CIPHA study

- The drought of 2001-2002 was the worst in over a century across a large area.
- Massive aspen mortality resembling fire impacts was recorded across drought-affected portions of the aspen parklands in Saskatchewan & Alberta.
- The drought led to a collapse in the net increment of aspen biomass across the region based on tree-ring analysis & annual monitoring at 150 CIPHA plots (Hogg et al. 2008).
- A spatial analysis showed 45 million tonnes of dead aspen biomass across the 110,000 km² survey area where the drought was most intense (Michaelian et al. 2011).
- Regionally, stem damage by wood-boring insects increased following the drought.



Maps by Price, Siltanen & McKenney using method of Hogg et al. (2013, Agric. For. Meteorol.)



References

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Acknowledgements

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Summary & conclusions

- The 2001-2002 drought has had a major impact on aspen forests in western Canada including massive dieback & mortality along the transition zone between the boreal forest and the prairie grassland.
- Regionally, this drought led to a 30% decrease in aspen productivity.
- Mortality increased following the drought and has remained high for many years following the end of the drought.
- The results are consistent with recent studies showing impacts of drought on NPP & multi-species tree mortality across large areas of the North American boreal forest.
- This work shows the value of using a multi-scale monitoring approach for early detection & reporting of climate-related impacts that have emerged as a concern for forests in many parts of the world

CIPHA web site at <http://cfs.nrcan.gc.ca/projects/124>

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