TreeTime SERVICES INC.

Reforestation in a Stressful and Uncertain Climate

June 11, 2020

Objective

- Provide a background to current and future challenges to site restoration in a warmer, drier climate
- Discuss a suite of strategies and techniques that will increase survivorship of vulnerable seedlings

Current and Future Challenges to Reforestation

- Juvenile plants have a much lower environmental tolerance than adults
- Reclaimed sites are often more stressful for seedlings
- In a changing climate seedlings will be further stressed

Changing Climate

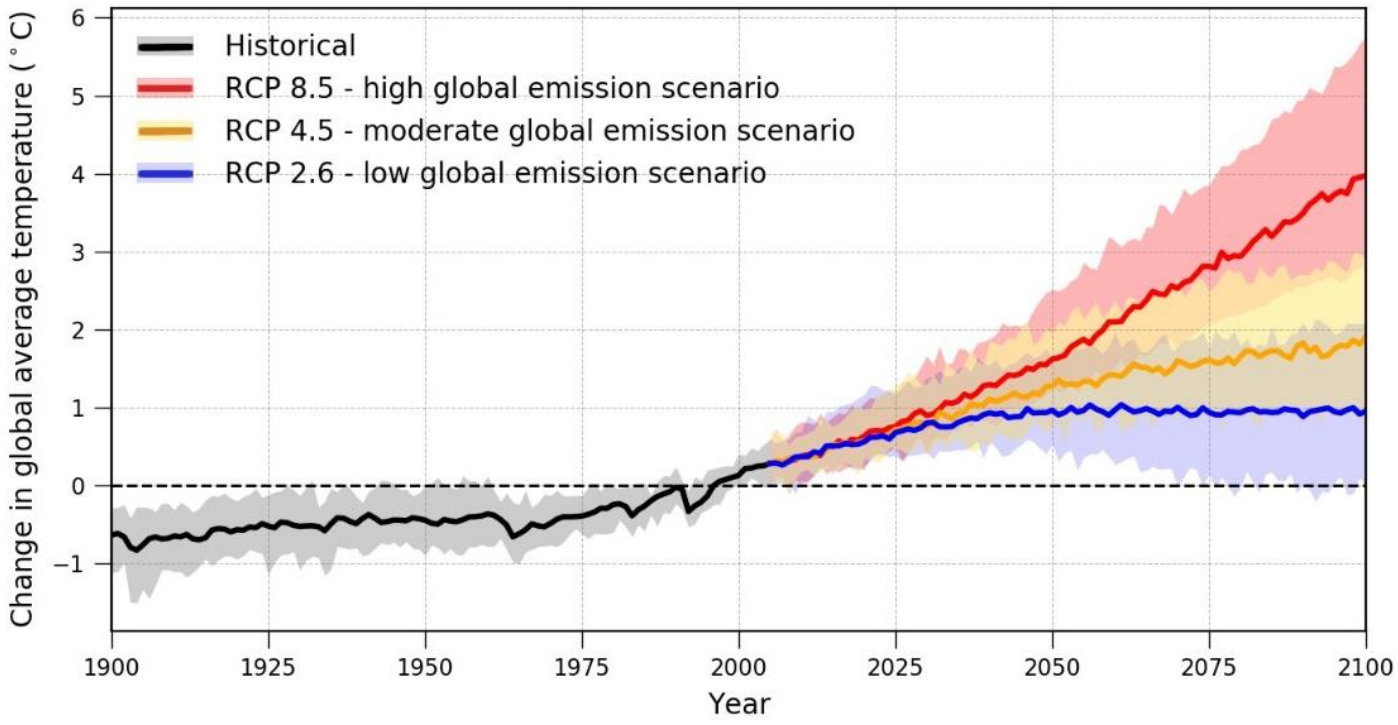
- Average temperatures have already increased globally (0.6-0.9^{o}C) and in the Prairie Provinces (1.9^{o}C since 1948) and Northern Canada (2.3^{o}C)[1,2]

- By 2100, in Canada average temperature is expected to increase 1.8^{o}C – 6.3^{o}C[1,4]
  - Winter temperatures may increase 2.5-10^{o}C

- The rate of change has little precedent
  - Warmings of 5^{o}C have happened over 5,000 years[3]

Temperature Projection Scenarios

- Global average change in temperature
- Developed based on different emission scenarios
- RCP 8.5 is the closest to our current path



Temperature Projection Scenarios for Canada

- Based on most common “best” and “current” scenarios
- Large regional variation due to local and regional factors

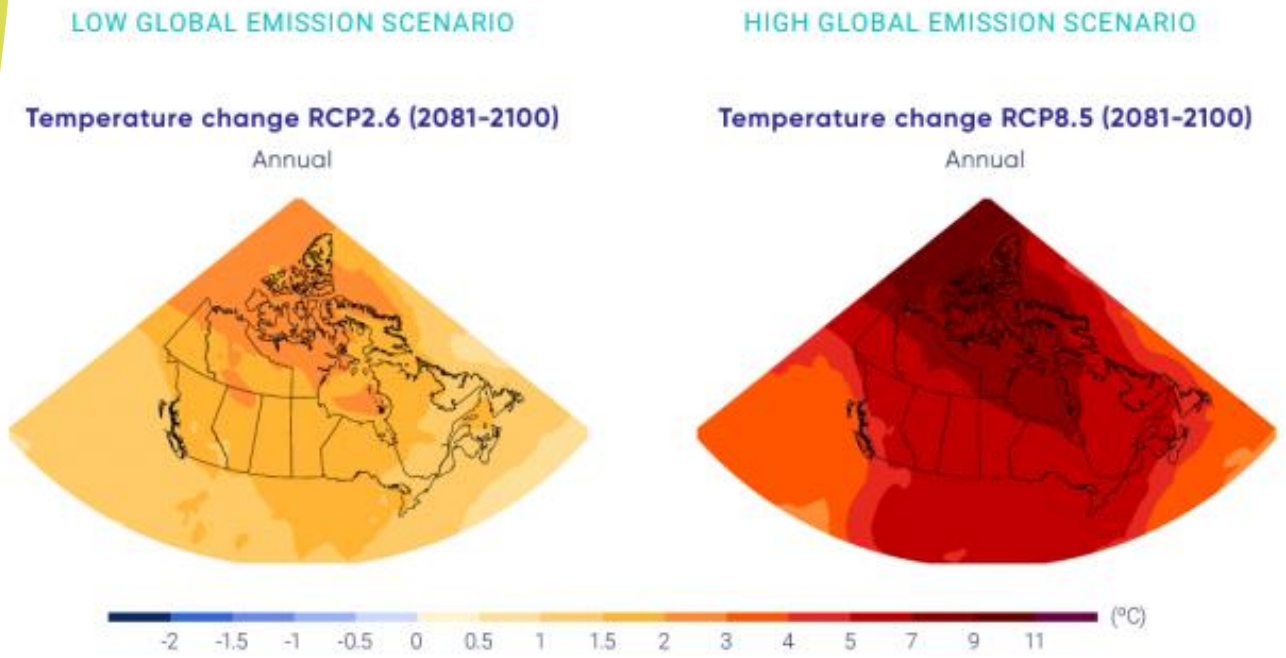


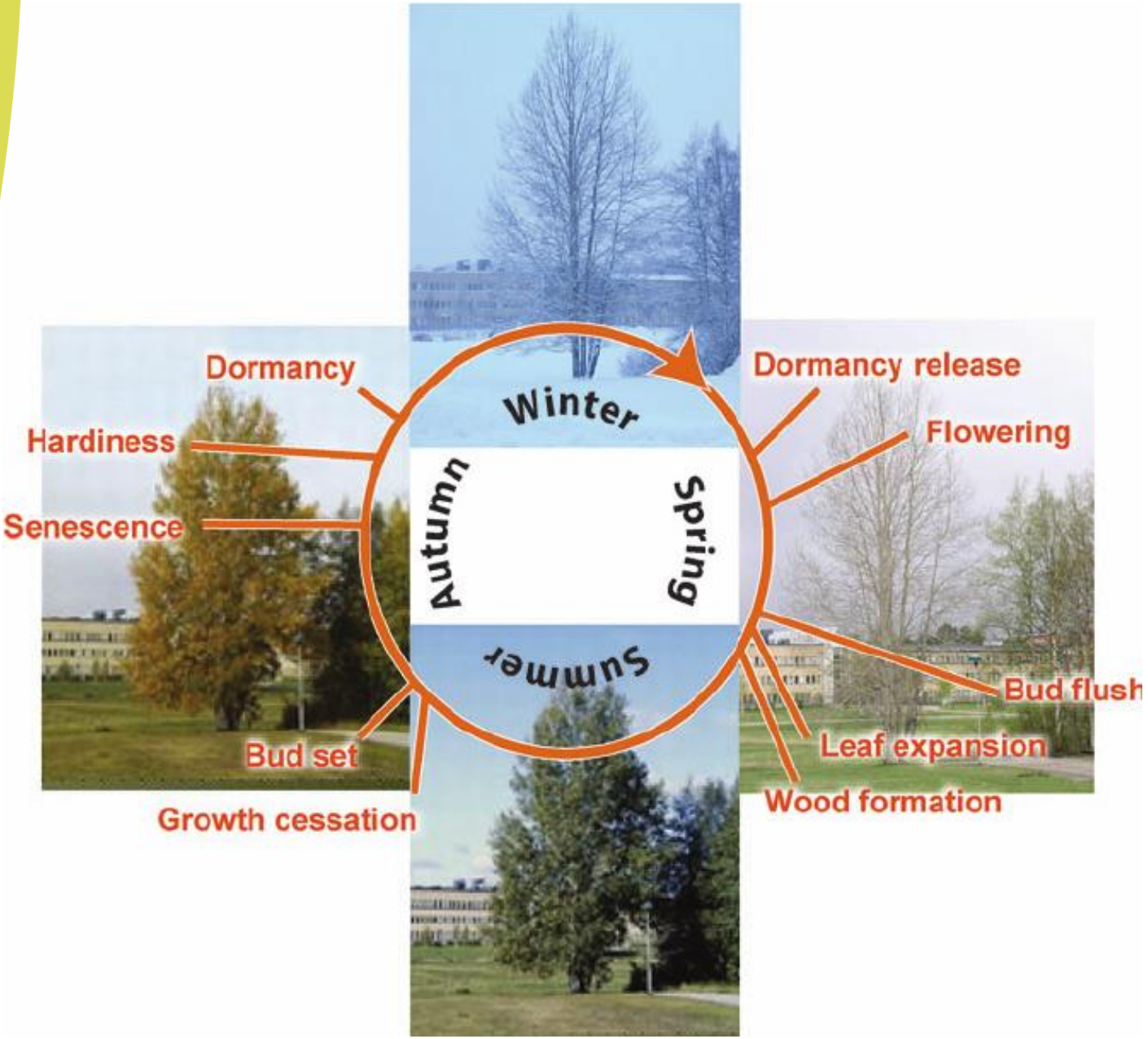
Figure ES.10. Projected annual temperature change for Canada under a low emission scenario (RCP2.6) (left panel) and a high emission scenario (RCP8.5) (right panel) for the late century. Projections are based on the Coupled Model Intercomparison Project (CMIP5) multi-model ensemble. Changes are relative to the 1986–2005 period. From Chapter 4 Figure 4.8.

Climate vs. Weather

- Climate is average of temperatures and precipitation
- Weather is a short term mix of events (e.g. rainy and cold)
- Average temperature increase will lead to an increase in severity of weather events (i.e. extremes)[4]
  - Drought
  - Heat/cold snaps
  - Precipitation intensity

Plant Phenology and Climate

- Timing of life cycle events that respond to changes in climate and local environment
- Some plants are more adaptable to changes in climate

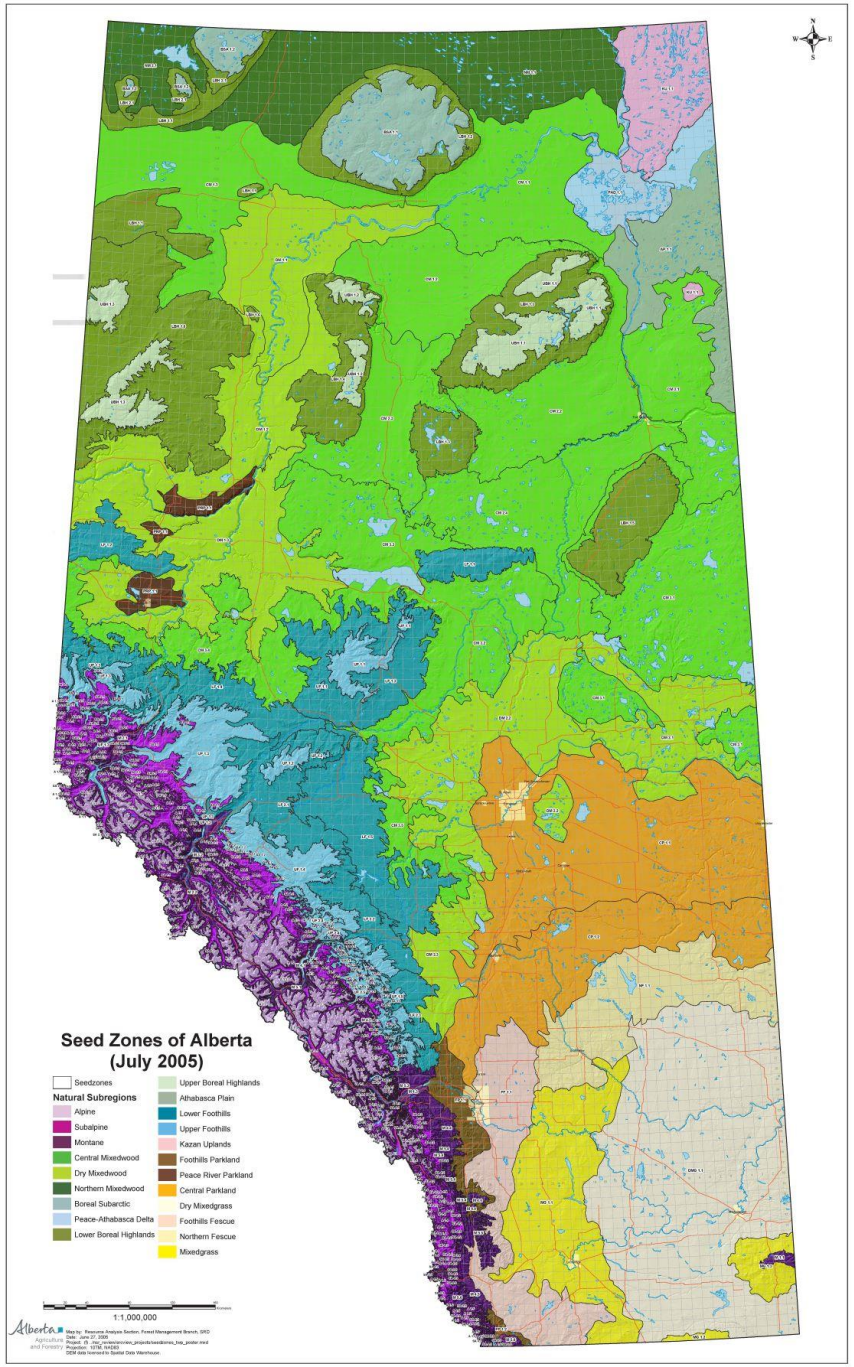


Plant Phenology and Weather

- Though plants are adapted to a climate, extreme weather events can fall outside of this average and disrupt plant development
  - Bud development
  - Seedling shoot development
  - Seedling hardening and dormancy

Seed Zones in Alberta

- Limits movement of plant material to distinct geographic areas
- Developed to ensure adaptability and ensure genetic integrity
- Legislated



Challenges to Reforestation in a Reclaimed Site

- Limited shelter/microsites
- Limited organic matter/LFH
- Competition
- Soil compaction

Proposed Silvicultural Tool Kit

- There is no sure solution with no certainty
- Many proven methods exist to increase likelihood of establishment and resiliency
  - Diversity of species
  - Resiliency of seedling genetics
  - Site preparation and maintenance
  - Project timing

Tool Kit – Species Diversity

- One species means one niche – limits establishment and resiliency
- Ensure species are suitable for site

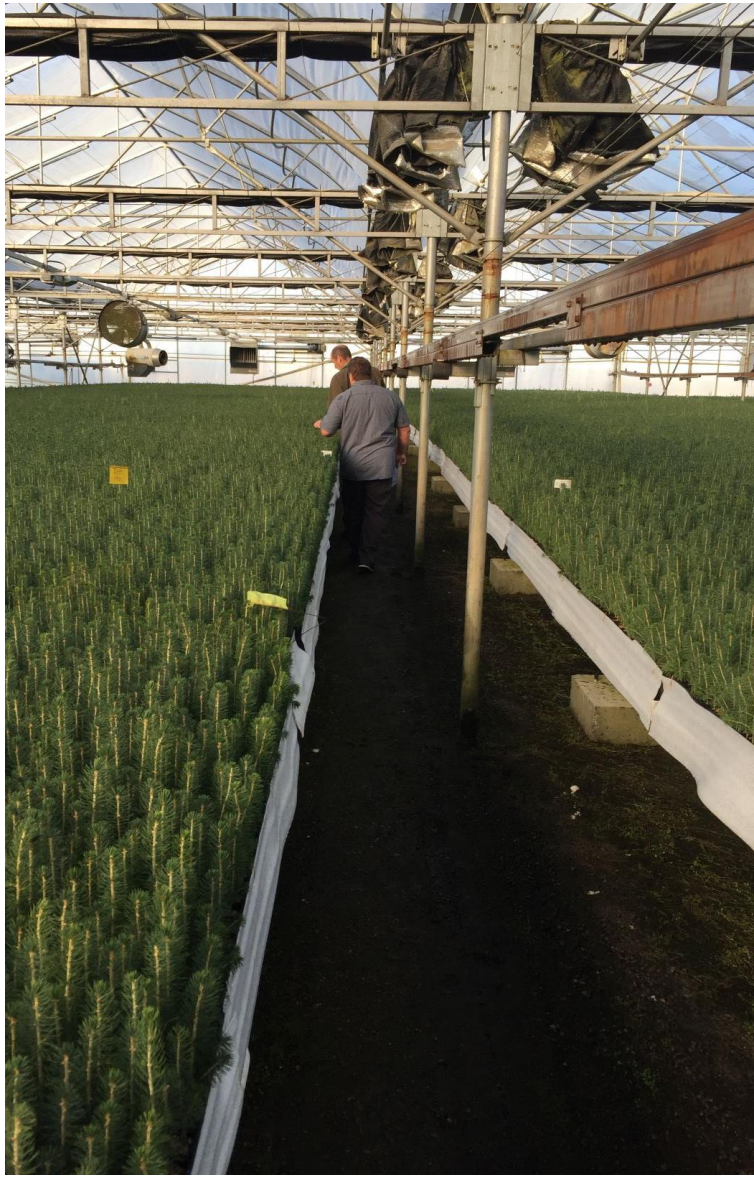
Seedling Genetics

- Timing of plant phenology is genetically linked, though some species more than others
  - i.e. *Populus, Betula* and *Corylus*
- Legislation limits movement of species and genetics

Seedling Genetics – Improved Seed

Improved seed exists for conifers

Increases environmental niche and deployment



Site Preparation

Creating microsites to protect vulnerable seedlings

Microsites - Spreading of coarse woody debris

Microsites - Mounding

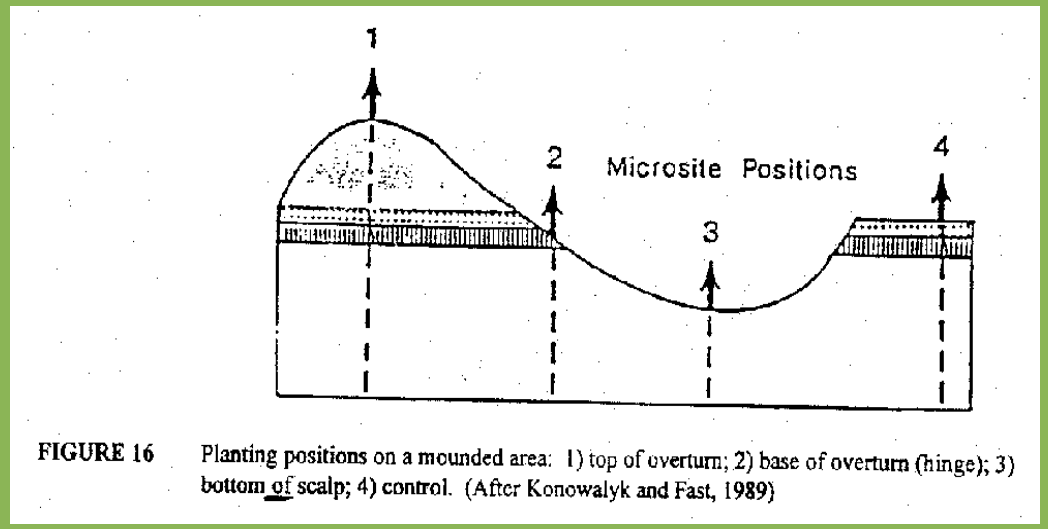


FIGURE 16 Planting positions on a mounded area: 1) top of overturn; 2) base of overturn (hinge); 3) bottom of scalp; 4) control. (After Konowalyk and Fast, 1989)

Site Preparation – Remove Competition

Site Preparation – Reduce Compaction

- Increase rooting depth
- Increase water permeability

Planting Regime

- Planting areas
  - Planting conifers in more protected areas
  - Placement of deciduous in more exposed areas
- Planting density
  - With higher rates of mortality increase planting density

Project Timing

- Greater importance of syncing soil placement and site preparation with planting
- Less summer planting of deciduous

Summary

- Climate has already changed and will continue to do so
- Plants are adapted to a range of environmental factors, and risk falling outside
- To reduce risk of stand failure, there are several options available
  - Reduce site limiting factors
  - Create microsites
  - Increase species diversity
  - Increase genetic diversity and/or range

References

1 – Sauchyn, D., Kulshreshtha, S., and (and contributing authors). 2008. Prairies. In: From Impacts to Adaptation: Canada in a Changing Climate 2007, pp. 275–328. Lemmen, D. S., Lacroix, J., and Bush, E., Eds. Government of Canada, Ottawa, ON. <http://adaptation.nrcan.gc.ca/assess/2007/pdf/ch7 e.pdf> Accessed October 24, 2008

2 – Bush, E. and Lemmen, D.S., editors (2019): Canada's Changing Climate Report; Government of Canada, Ottawa, ON. 444 p

3 – Holli Riebeek. 2010. NASA, Earth Observatory: Global Warming Article

4 - Andrew Park, Klaus Puettmann, Edward Wilson, Christian Messier, Susanne Kames & Amalesh Dhar (2014) Can Boreal and Temperate Forest Management be Adapted to the Uncertainties of 21st Century Climate Change?, Critical Reviews in Plant Sciences, 33:4, 251-285

Thanks!

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