# Impending impacts of rising temperatures at the xeric range limits of woody species

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# Outline

- General introduction

  - Impacts of rising temperatures in mountains
  - Altitude-for-latitude temperature model
  - Predicted impacts on lowland distributions

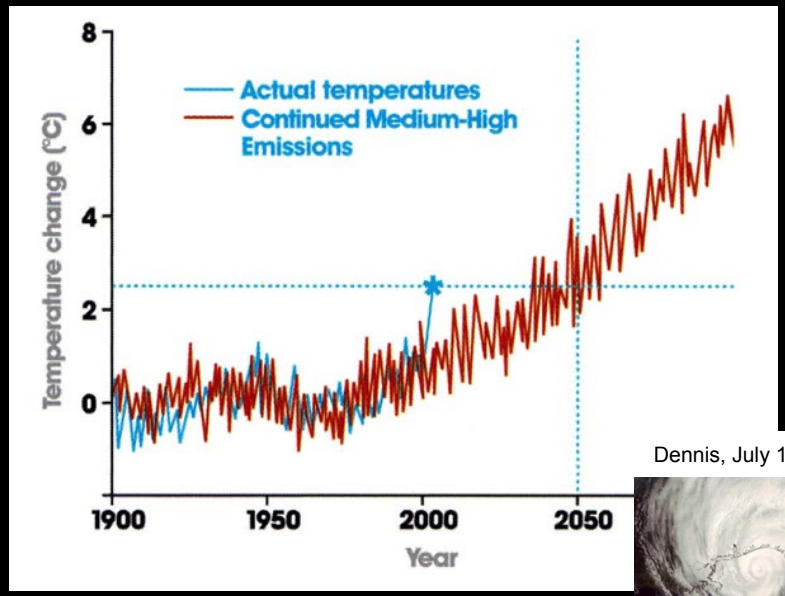
- Range changes underway – focus and bias

- Are widespread lowland range retractions imminent?

  - Are temperature impacts really equivalent?
  - What other factors might modify lowland range changes?

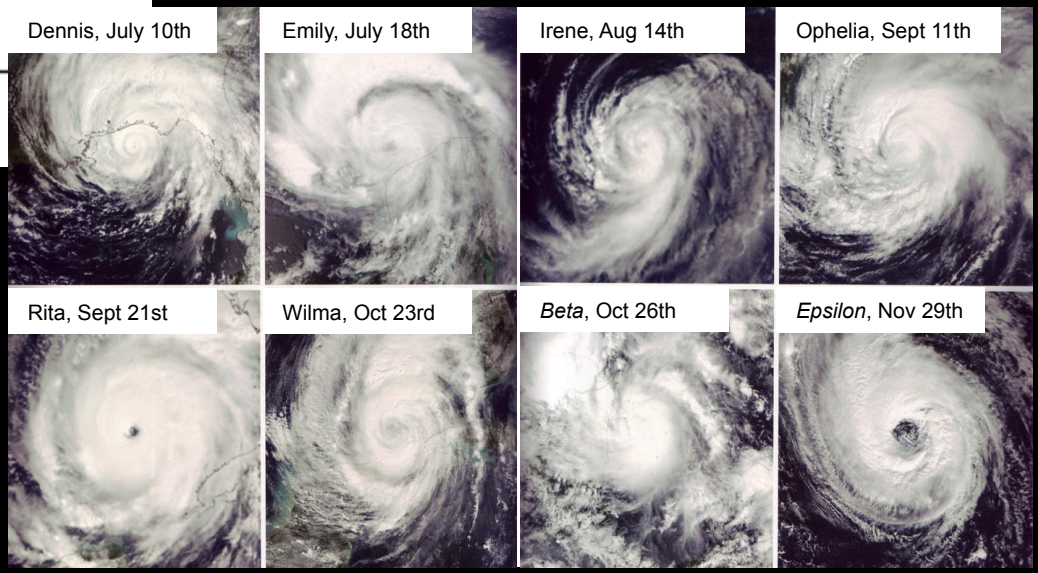
- Implications and directions

# Ongoing changes in climate…



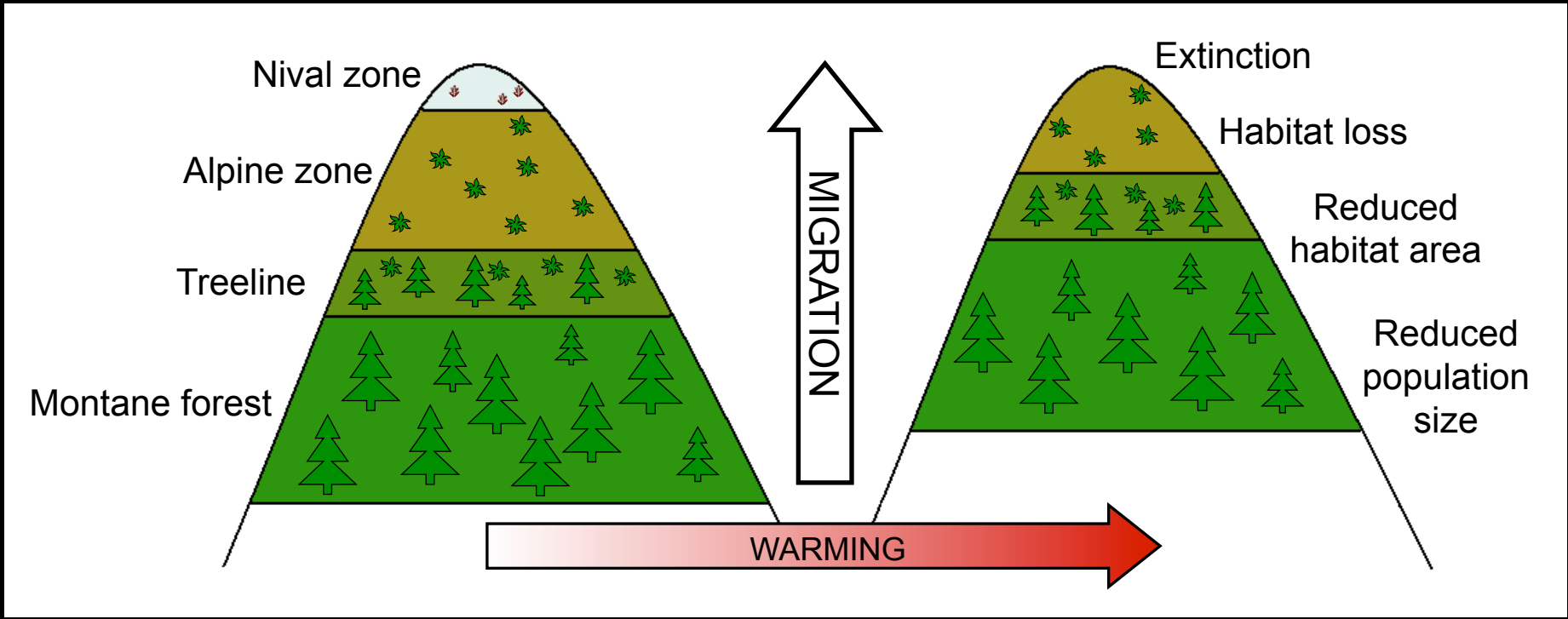

Current rapid anthropogenic warming

Accompanied by an increasing frequency of extreme events




*Combined direct and indirect anthropogenic pressures result in major threats to ecosystems worldwide*

One of the most studied areas of temperature changes in biogeography is their impacts on mountain biota




As temperatures rise, ranges shift upwards in altitude… the so called '*Elevator to Extinction*' now seen in a range of plant species and vegetation types

Montane distributional changes linked to climate change

*- Montseny Mountains NE Spain*

1943

2003

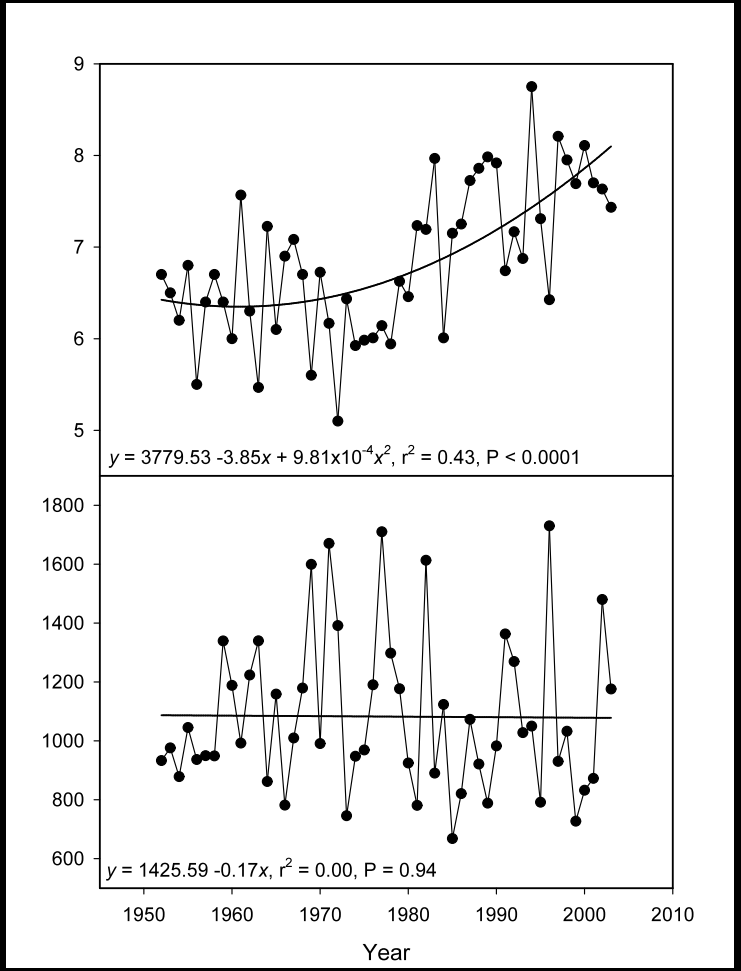
Altitudinal shift of upper beech forest limit by up to 60 m in 60 years - *driven by rising temperatures*

*Increasing aridity accompanying temperature rise*

In Montseny, as many regions, the rapid rise in temperature has not been accompanied by increasing precipitation

Particular significance for trailing edges more typically limited by drought

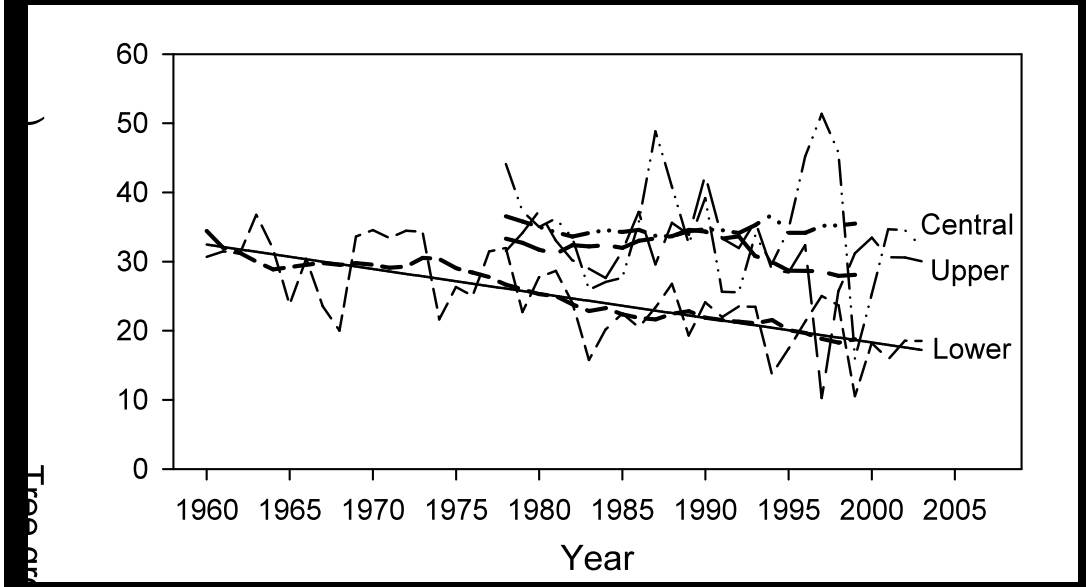
*– the xeric limits*

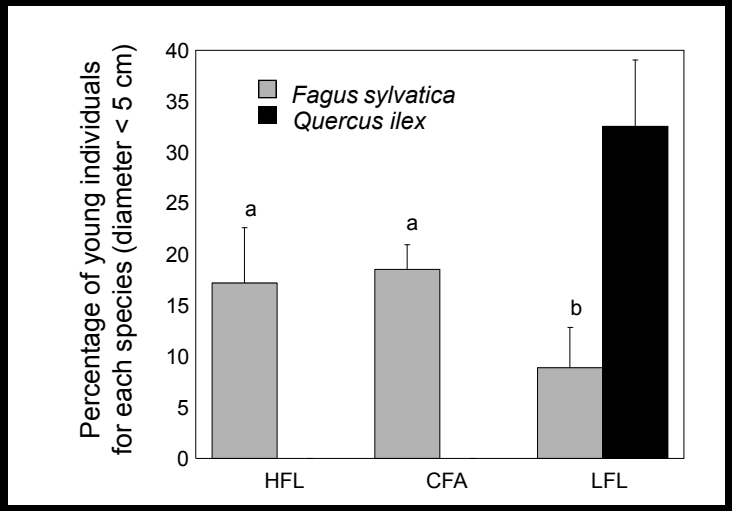



Increase of ca. 1.65 °C by 2003 compared with 1952-1975 mean

*Impact at the xeric limit*

Falling recruitment…




growth decline…

and death

# Altitude-for-latitude comparisons

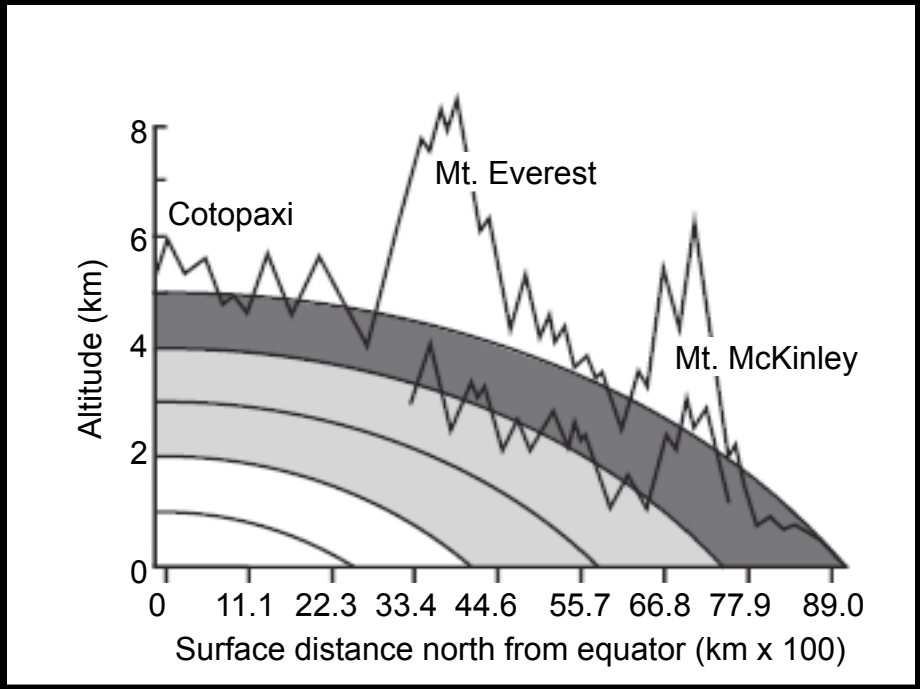
Species' latitudinal distributions compressed into narrow altitudinal bands

Linked to decreasing temperature with increasing elevation

(~5 - 6.5 °C per 1000 m)

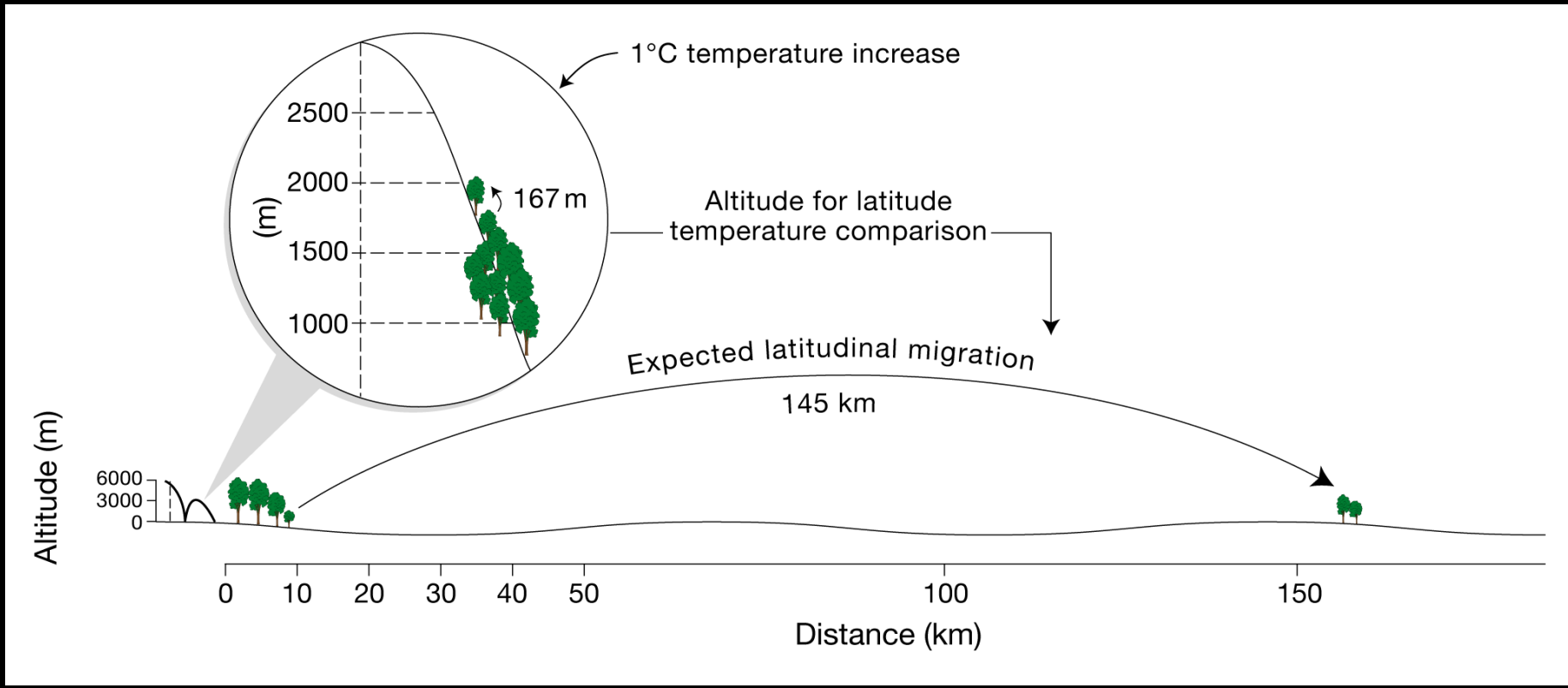
Temperature declines with increasing latitude also

(~6.5 - 7 °C per 1000 km)




*Modified from Korner (2003) Alpine Plant Life. Springer*

# Implications for lowland range changes




*Montane range expansions and retractions should be mirrored by lowland range changes occurring over distances several orders of magnitude larger…*

# Lowland range changes

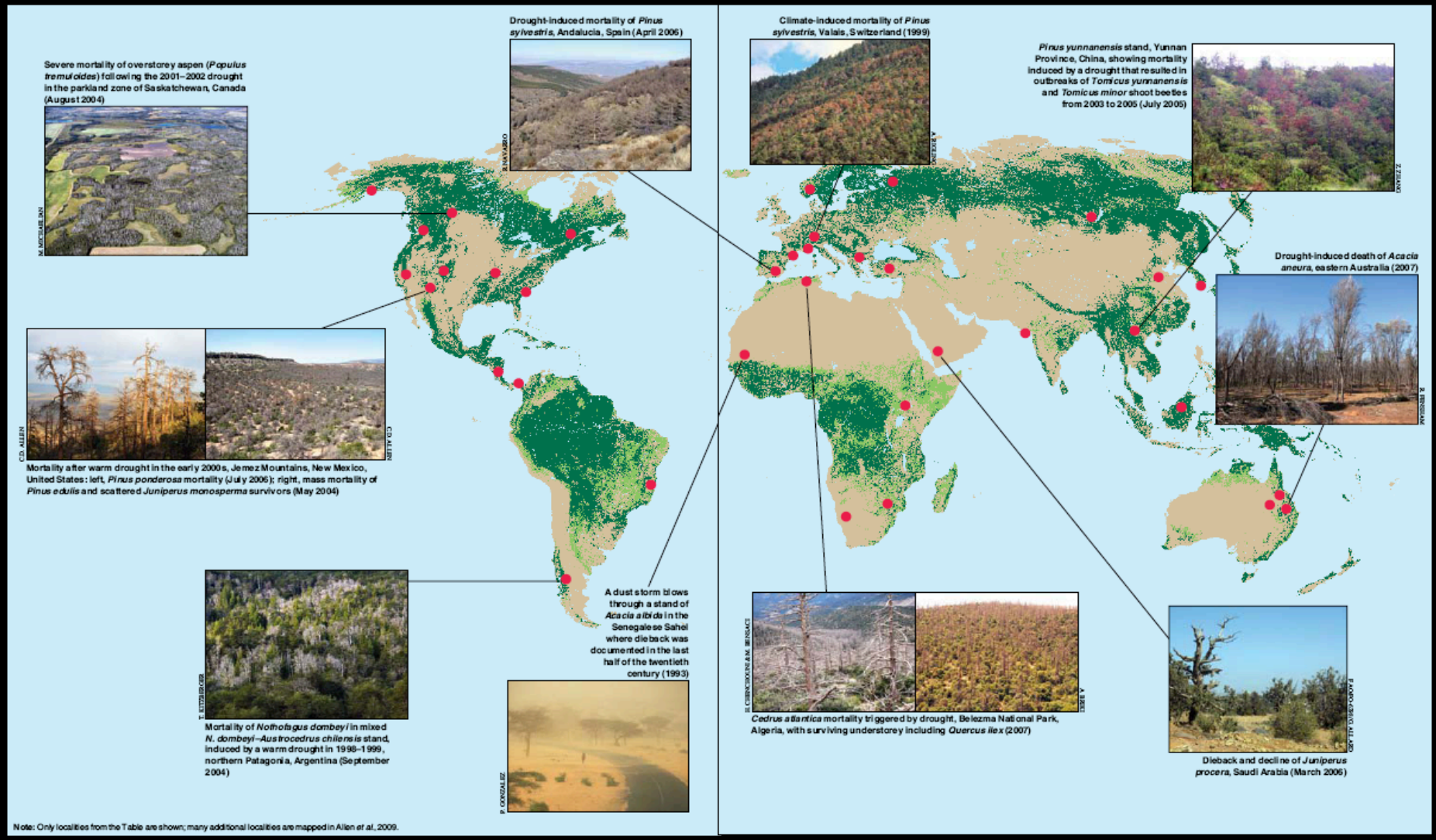
Range expansions reported – e.g. invasion of trees and shrubs into Arctic tundra in Alaska

Reports of regional dieback events linked directly or indirectly to drought:

*Figures deleted (aspen dieback courtesy of T. Hogg)*

*- but not range retractions*

# Rapid dieback events




*(From Allen, 2009: Unasylva 231/232 (60), 43-49)*

# Why are lowland range retractions not reported?

Are other altitudinal changes important?

- *E.g. faster warming at high altitude*

Greater silvicultural impacts in lowlands?

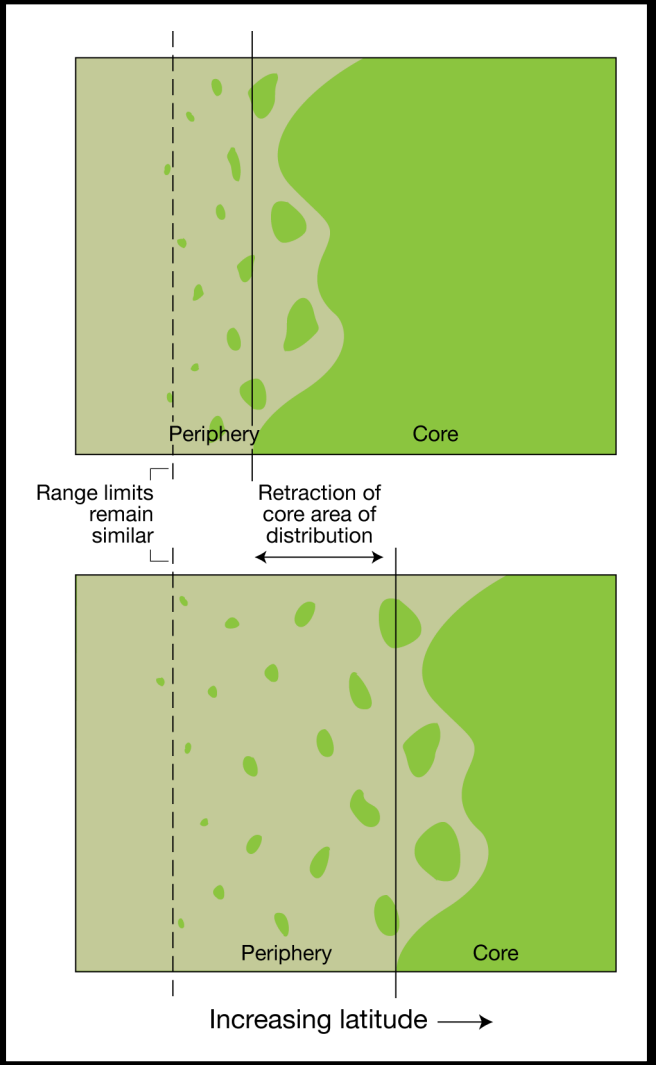
- *Forest conversion - artificial range edge*
- *Artificially maintained reproduction*

Response lags due to fast birth but slow death

Topographical complexity = detection difficulty →

Lack of coordinated research?

- *Geographical scale of research*
- *Logistical difficulties between nations*



# Impacts of rising temperatures at the xeric limit

- Increased susceptibility to pests and pathogens

  *- predisposition to attack + reduced resilience*

- Fall in net carbon sequestration ability

  *- reduced growth + increased death and decomposition*

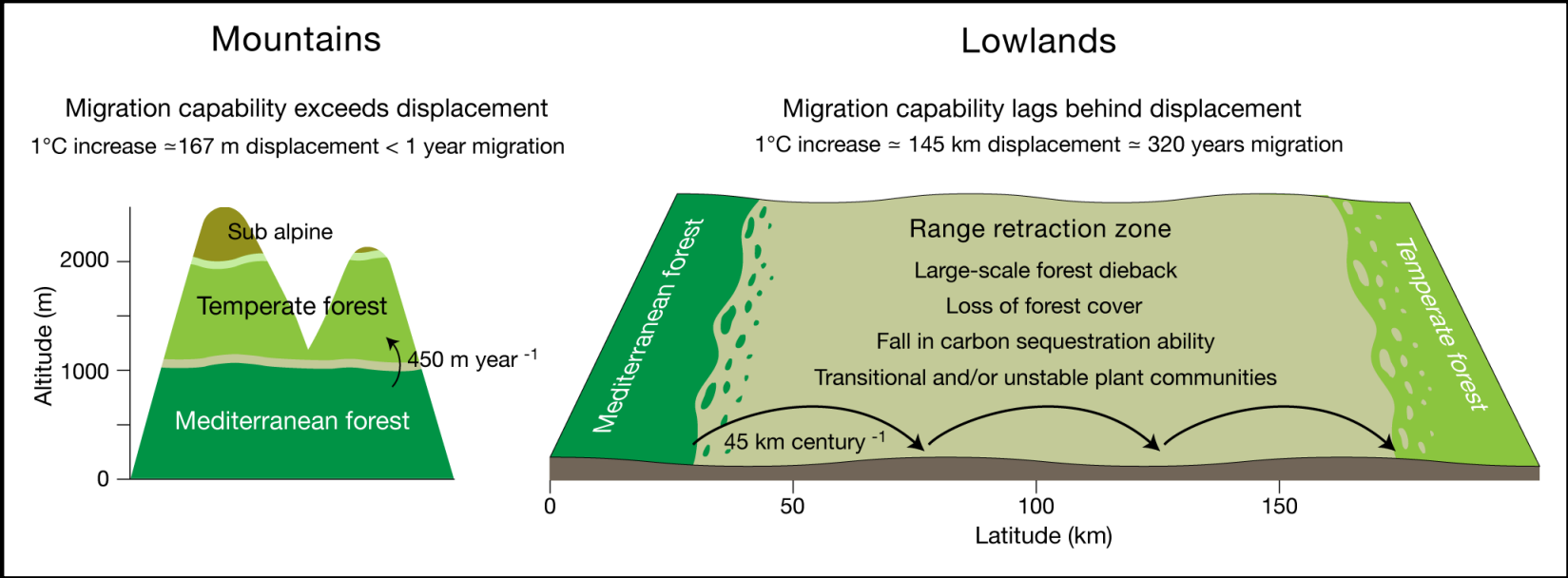
- Decreased ecosystem stability – ecosystem service impacts

- Species replacement – vegetation shifts

- Loss of genetic resources

*Greater impact in lowland regions…*

# Implications of rapid range retractions




Mountains:

- rapid retraction at the xeric limit impacts a relatively small area
- rapid replacement by neighbouring competitors

Lowlands:

- rapid retraction leads to widespread dieback over 100s to 1000s $km^2$
- rapid replacement unlikely due to area effect

# Summary and implications

Range expansions and retractions underway in mountains

Widespread lowland range retractions may be imminent

Impacts can be substantial – from loss of diversity and vegetation shifts to decreased stability and loss of ecosystem services

Failure to detect may result from failure to research!

Directions:

Improved range edge delineation

Monitoring of distributions *e.g. remote sensing* groundtruthed in populations – *e.g. dendroecology*

Identify the balance of demography and genetics

Explicit consideration of ecology in modelling studies

Assessment of genetic and evolutionary implications - *What are we losing?*

*Thanks to…*

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*Figure deleted (aspen dieback courtesy of T. Hogg). Figures in this presentation are not to be reproduced without permission of the author*