Climate change, forest pests and forest production in the Nordic countries

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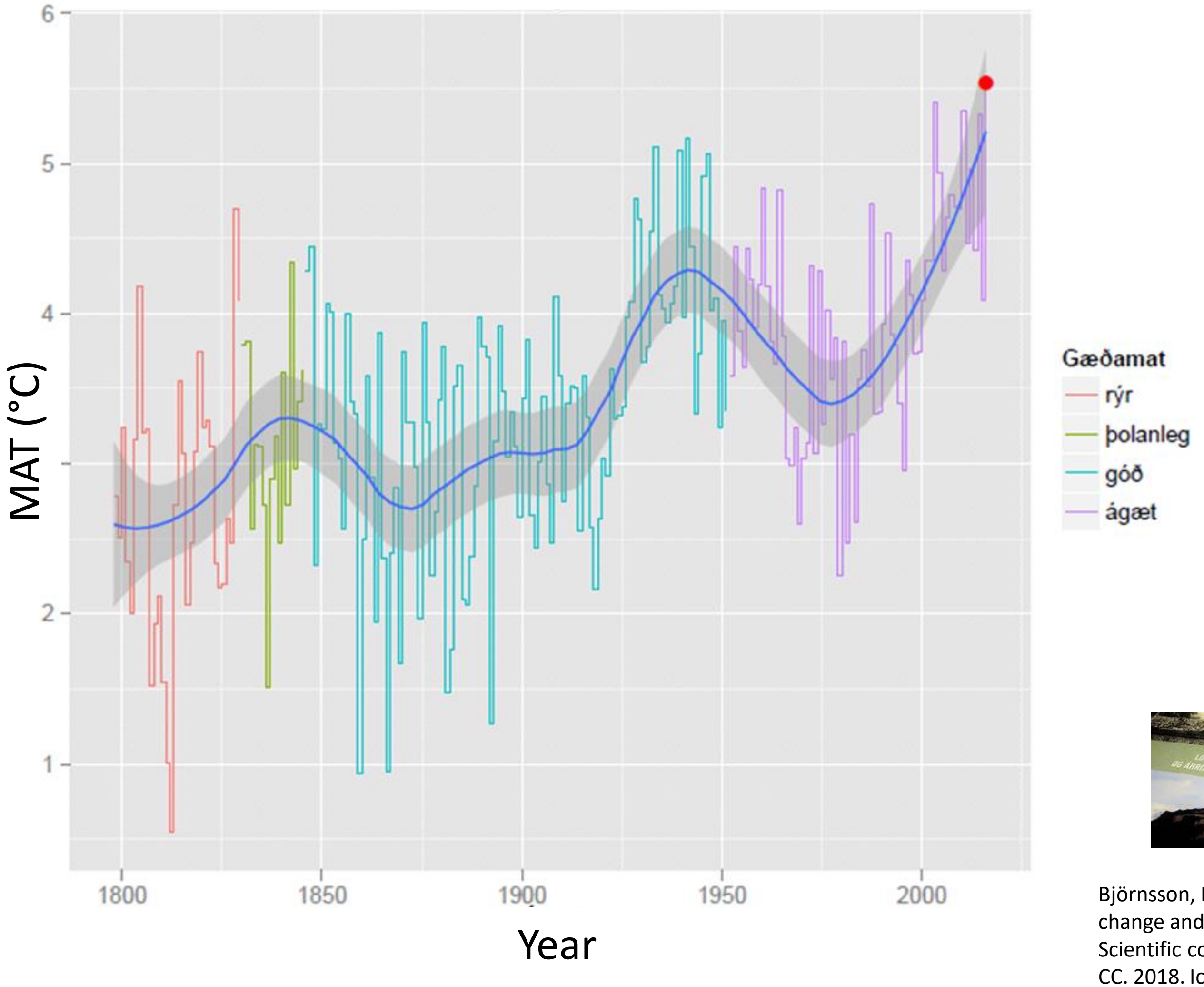
Climate change in the Nordic countries

- Temperature rise more than the global mean
  - Melting of glaciers
  - Increased length of vegetation period
- Percipitation patterns change
  - Increased risk of flooding
  - Long dry periods
- Sea level expected to rise

Iceland during last 200 years

- Good data since 1850s
- Approx. 0.8°C per century warming
  - Comparable to global warming
- Warming during 1981-2015 was 0.47°C per decade
  - Almost 3x the rate of global warming during the same period

Air temperature at Stykkisholmur



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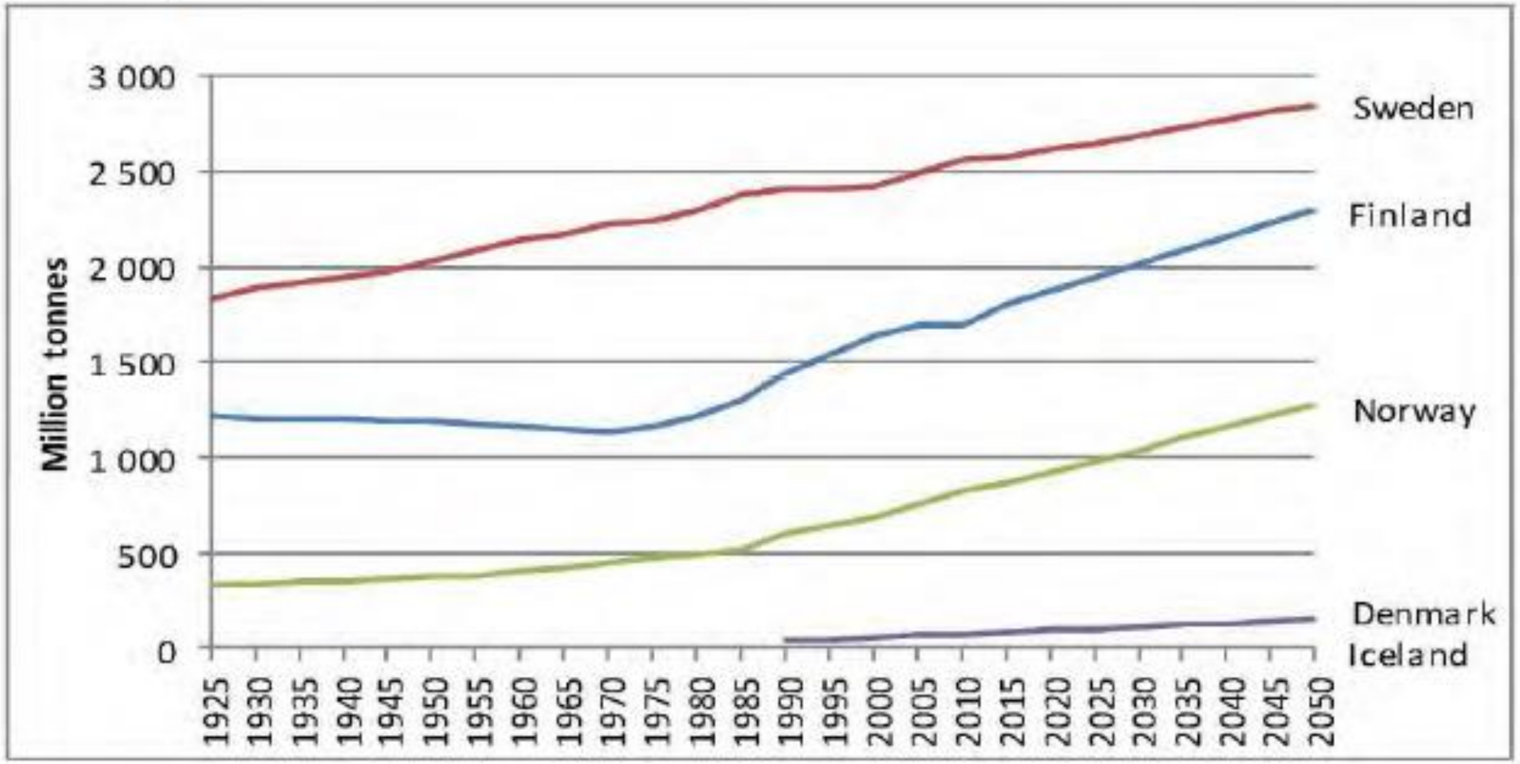
Björnsson, H et.al. 2018. Climate change and its effect on Iceland. Scientific committee report on CC. 2018. Icel.Met.Office

Forest production in the Nordic countries

- Construction
- Energy production
- Furniture
- Paper
- Packaging
- and more

Trend in forest biomass in the Nordic countries



Source: 1990–2010 values are adapted from FAO FRA (2010), 1925–1989 and 2011–2050 values are Indufor's own estimates.

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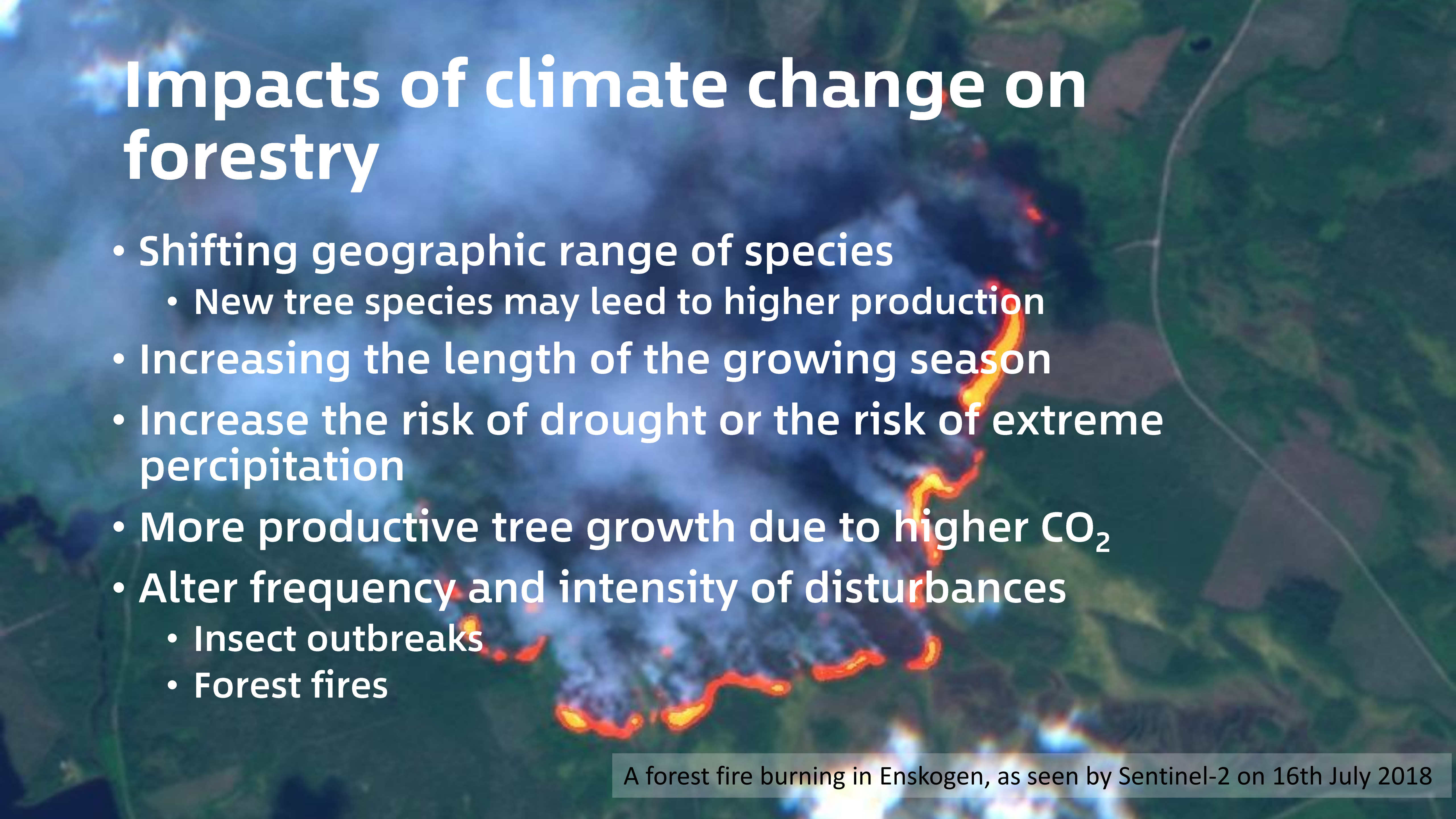
Portin et.al. 2013. The Role of Forests in Climate Change: Nordic Experience. TemaNord 2013:559.

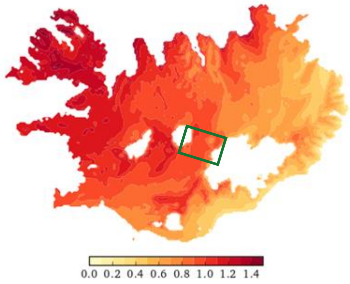
Impacts of climate change on forestry

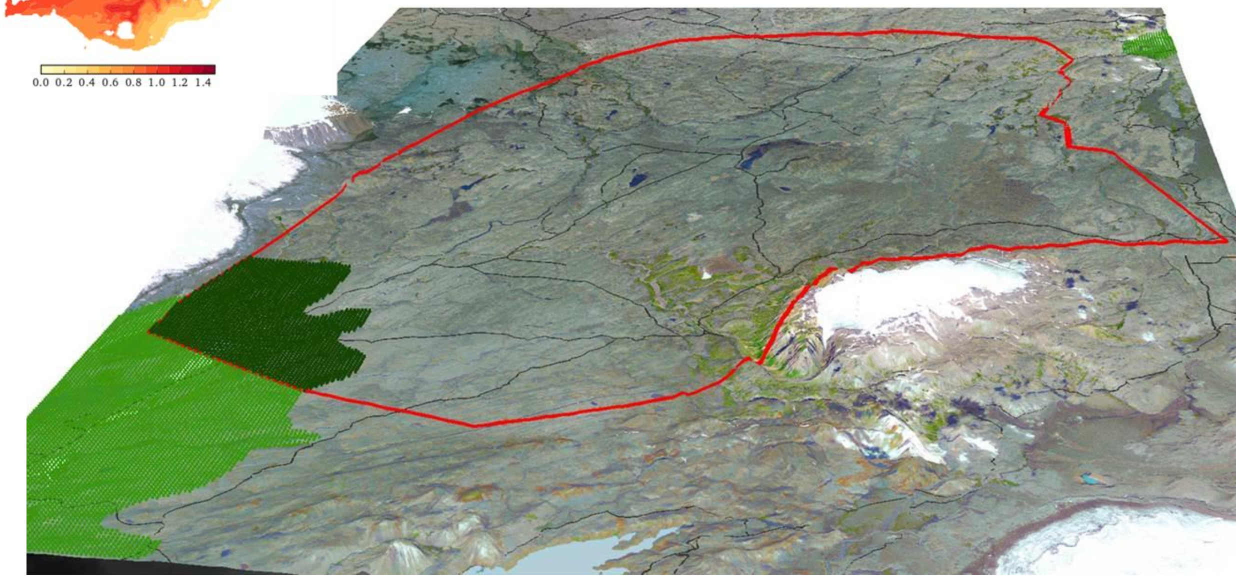
- Shifting geographic range of species
  - New tree species may leed to higher production
- Increasing the length of the growing season
- Increase the risk of drought or the risk of extreme percipitation
- More productive tree growth due to higher CO_2
- Alter frequency and intensity of disturbances
  - Insect outbreaks
  - Forest fires



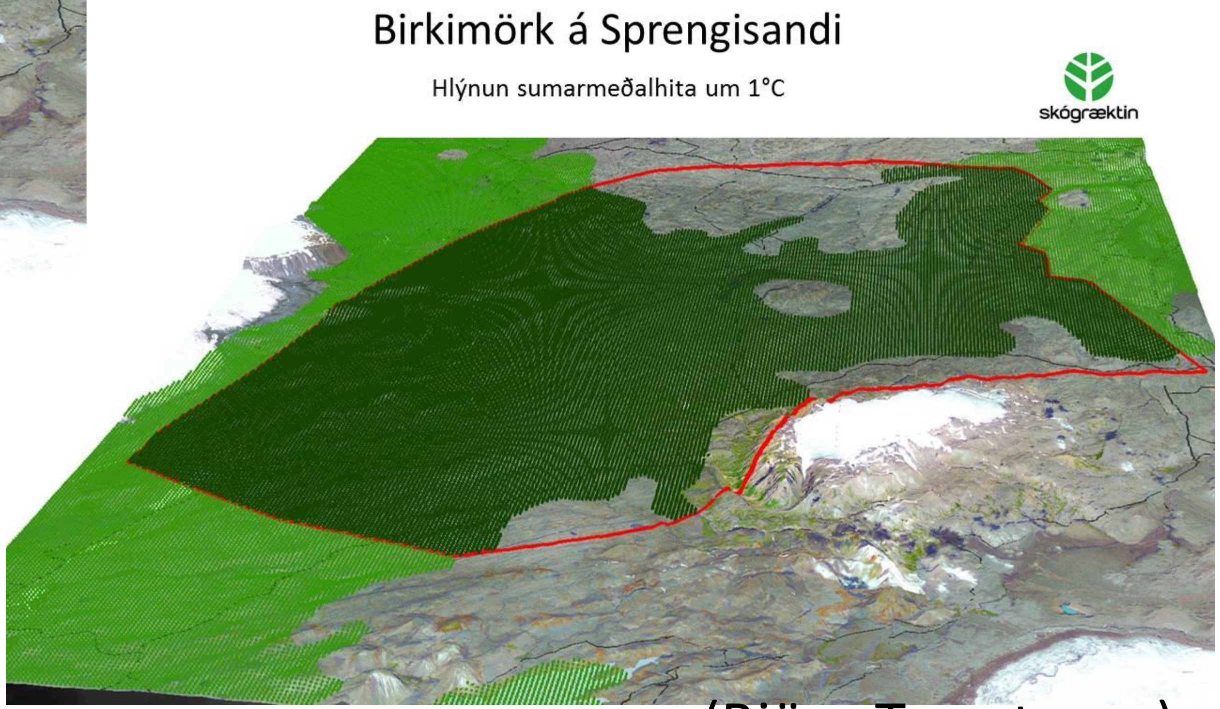
A forest fire burning in Enskogen, as seen by Sentinel-2 on 16th July 2018

Warming and climate thresholds: forest climatic limit





- Iceland's middle is a plateau ca. 500-700 m a.s.l.
- Currently the „limit" between arctic and temperate vegetation is found at ca. 400-500 m – just below this plateu...



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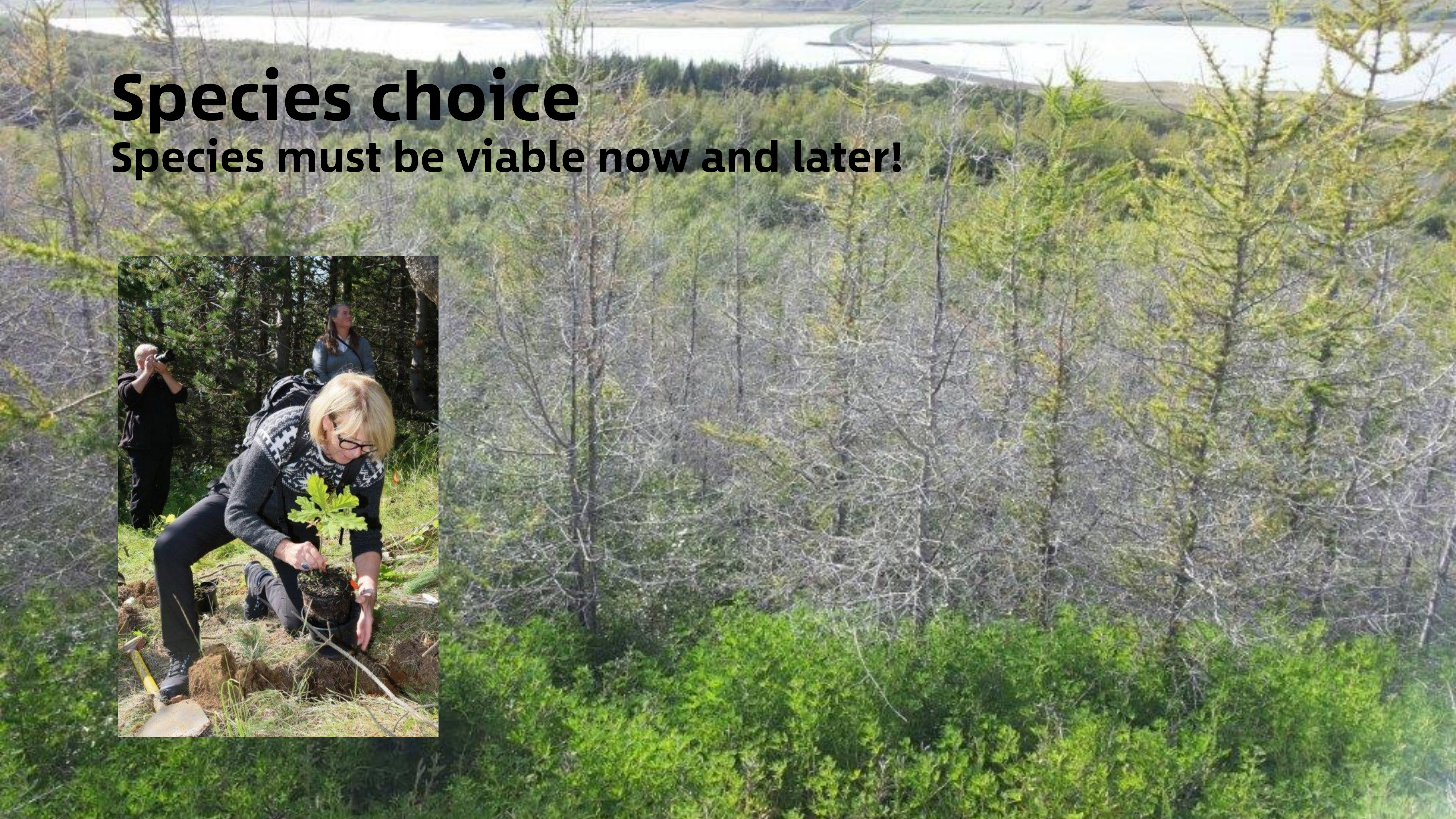
(Björn Traustason)

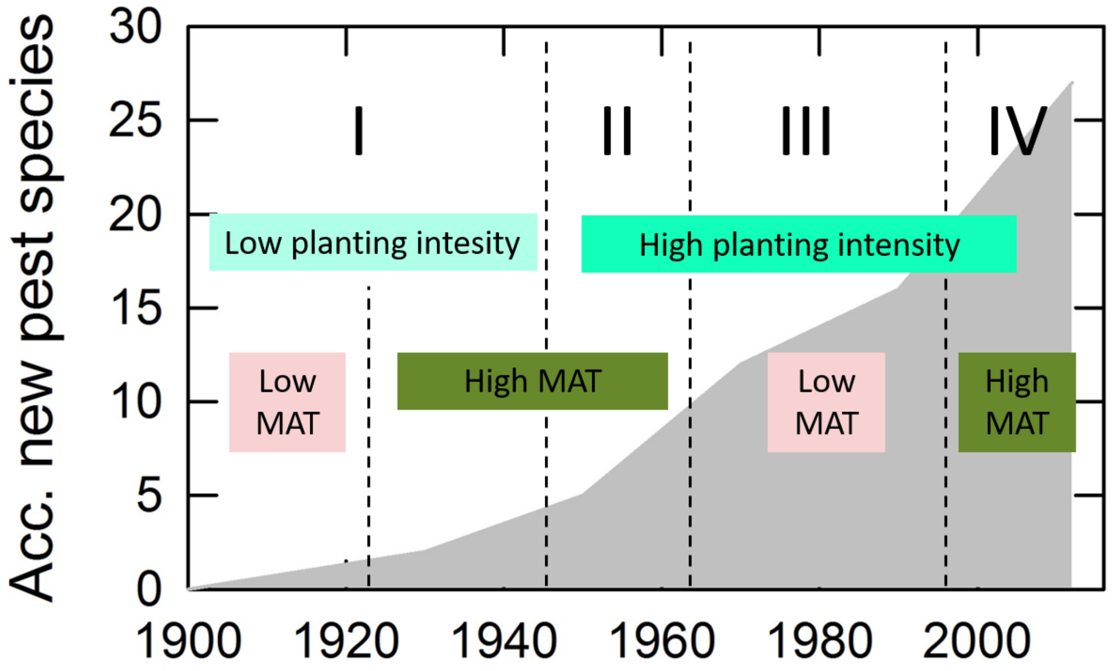
Species choice

Species must be viable now and later!



Effects of climate change on pests

- Direct influences
  - Better survival
  - Higher reproductive rate
  - Distribution



- Indirect influences
  - Host effects
  - Effects on insect pathogens and natural enemies
  - Effects on competitors

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Sitka spruce (*Picea sitchensis*) in Iceland

Well adapted to current climate in Iceland and highly successful in 3 - 5°C warmer climate of Scotland and Ireland

The highest tree in Iceland is Sitka spruce

Planted in 1949 in SE-Iceland

28.7 m in autumn 2019

26.1 m in autumn 2014

Annual growth ~ 0.5 m for the last 5 years

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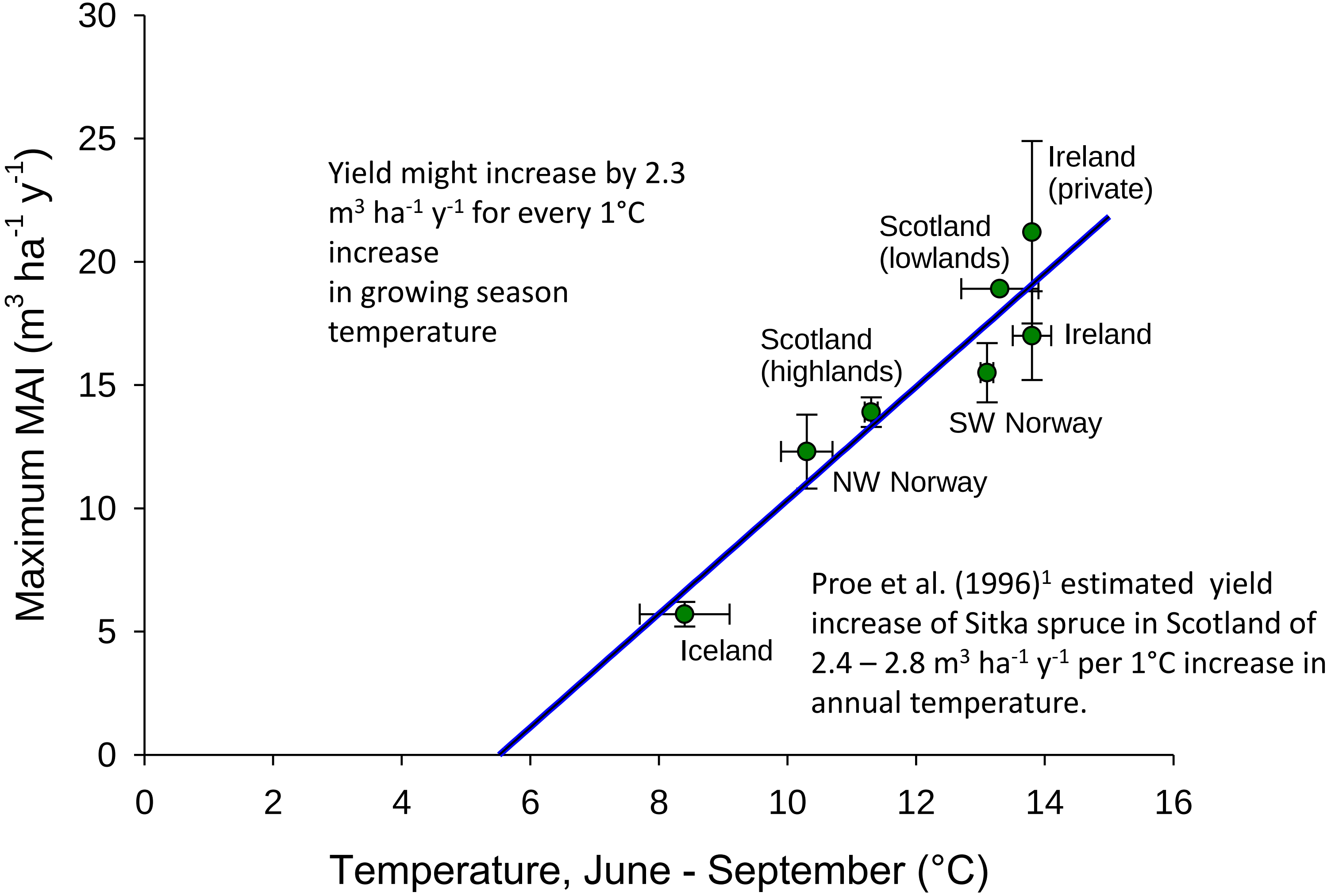
Higher forest productivity

Average yield of Sitka spruce plantations by growing season temperature in the North Atlantic region (with error bars of standard deviations)



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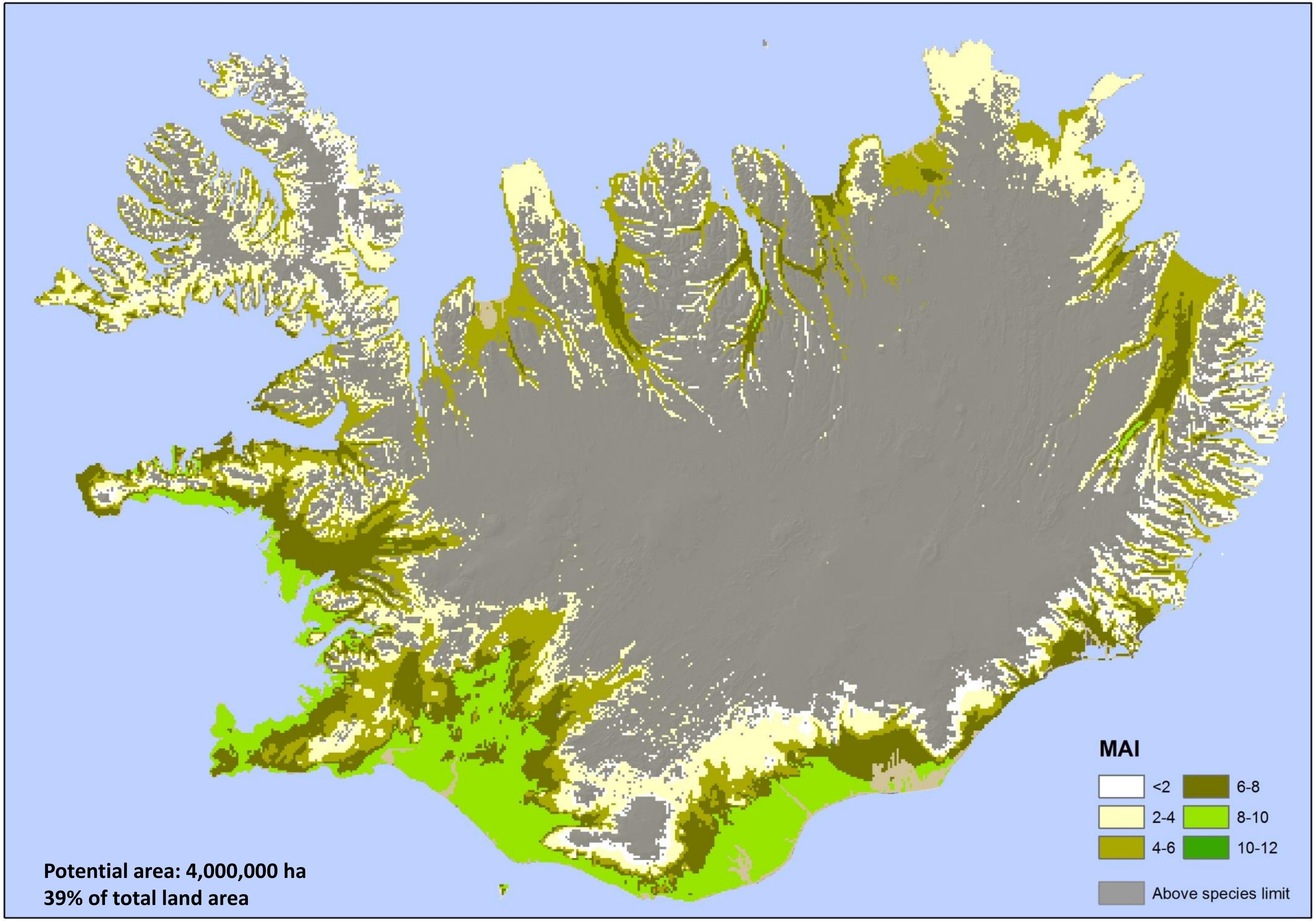
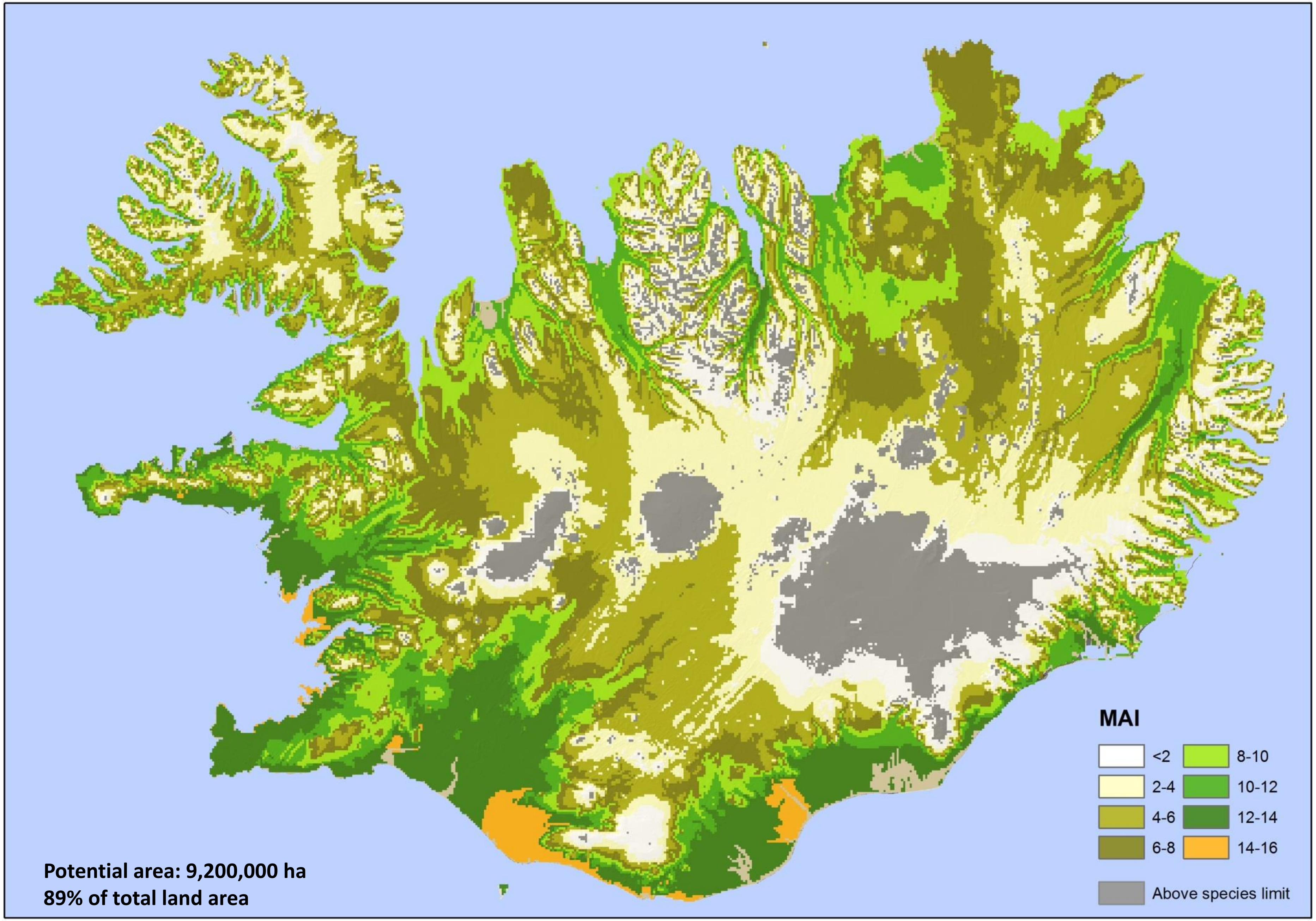
Source: Proe, M. F.; Allison, S. M.; Matthews, K. B., 1996. Assessment of the impact of climate change on the growth of Sitka spruce in Scotland. *Canadian Journal of Forest Research.* 26(11): 1914-1921



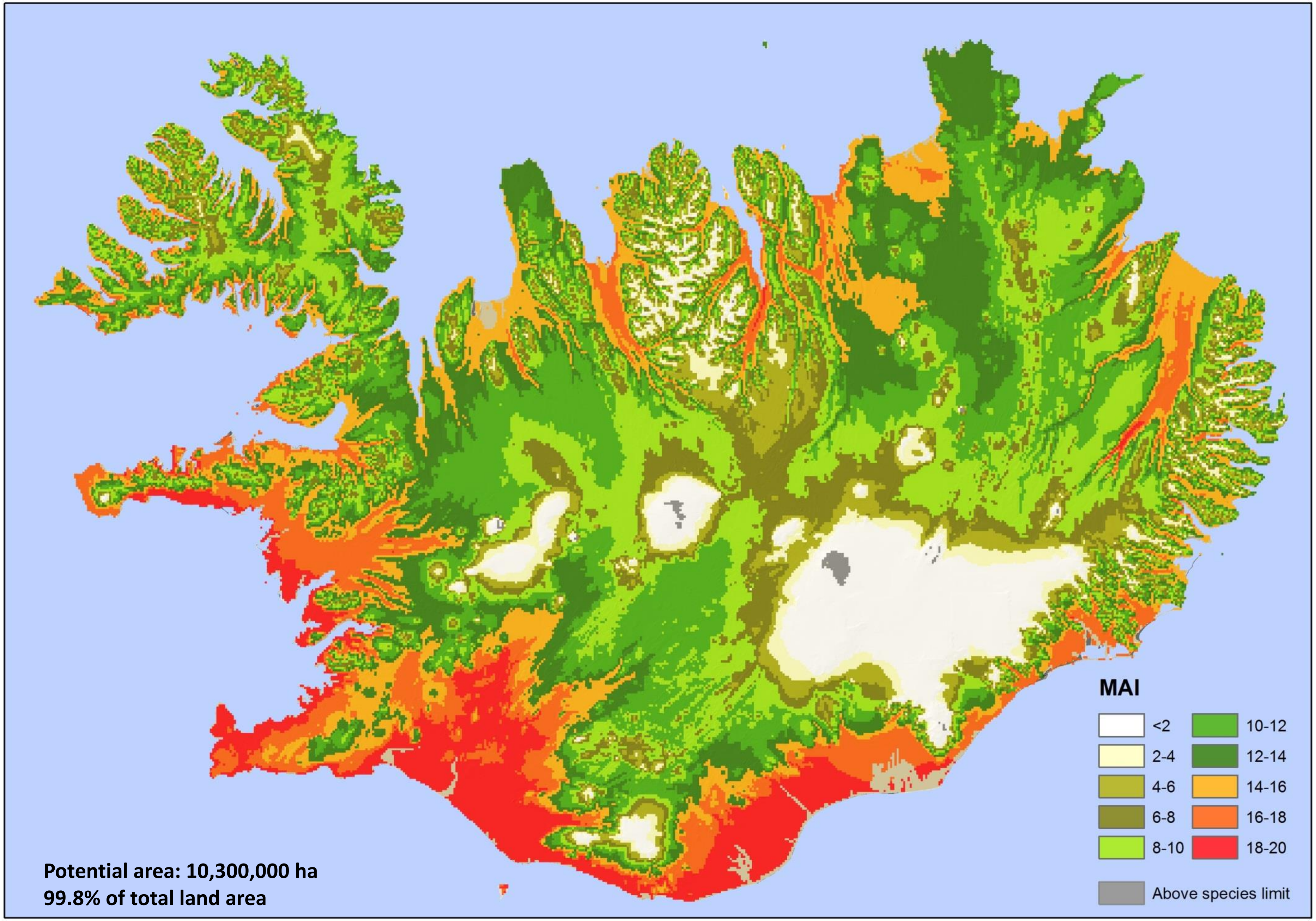
Potential area and yield of Sitka spruce (MAI, $m^3\ ha^{-1}\ y^{-1}$) in present climate (1961 – 2006)

Þorbergur H. Jónsson and Björn Traustason, unpublished data



Potential area and yield of Sitka spruce (MAI, $m^3\ ha^{-1}\ y^{-1}$) in 2°C warmer climate

Þorbergur H. Jónsson and Björn Traustason, unpublished data

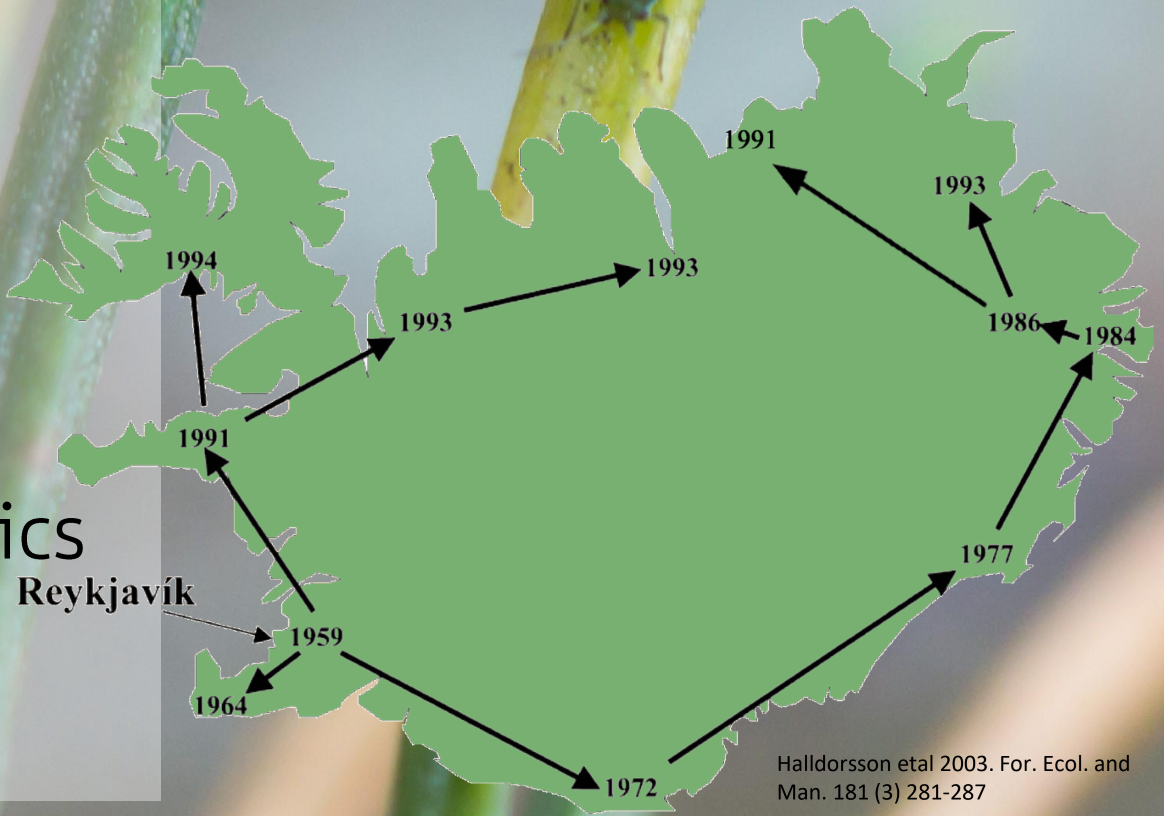


Potential area and yield of Sitka spruce (MAI, $m^3\ ha^{-1}\ y^{-1}$) in 4°C warmer climate

Þorbergur H. Jónsson and Björn Traustason, unpublished data

The green spruce aphid *Elatobium abietinum*

- Native species in Europe
- First found in Reykjavík 1959
- Spread around Iceland
- Feeds of phloem sap
- Winter temperature major influence on population dynamics
  - Killed at -10°C-12°C when feeding



Halldorsson etal 2003. For. Ecol. and Man. 181 (3) 281-287

Outbreak in 2003

Winter temp 2002-03

3,4°C

2,6°C

1,1°C

Aphid frequency

low

medium

high

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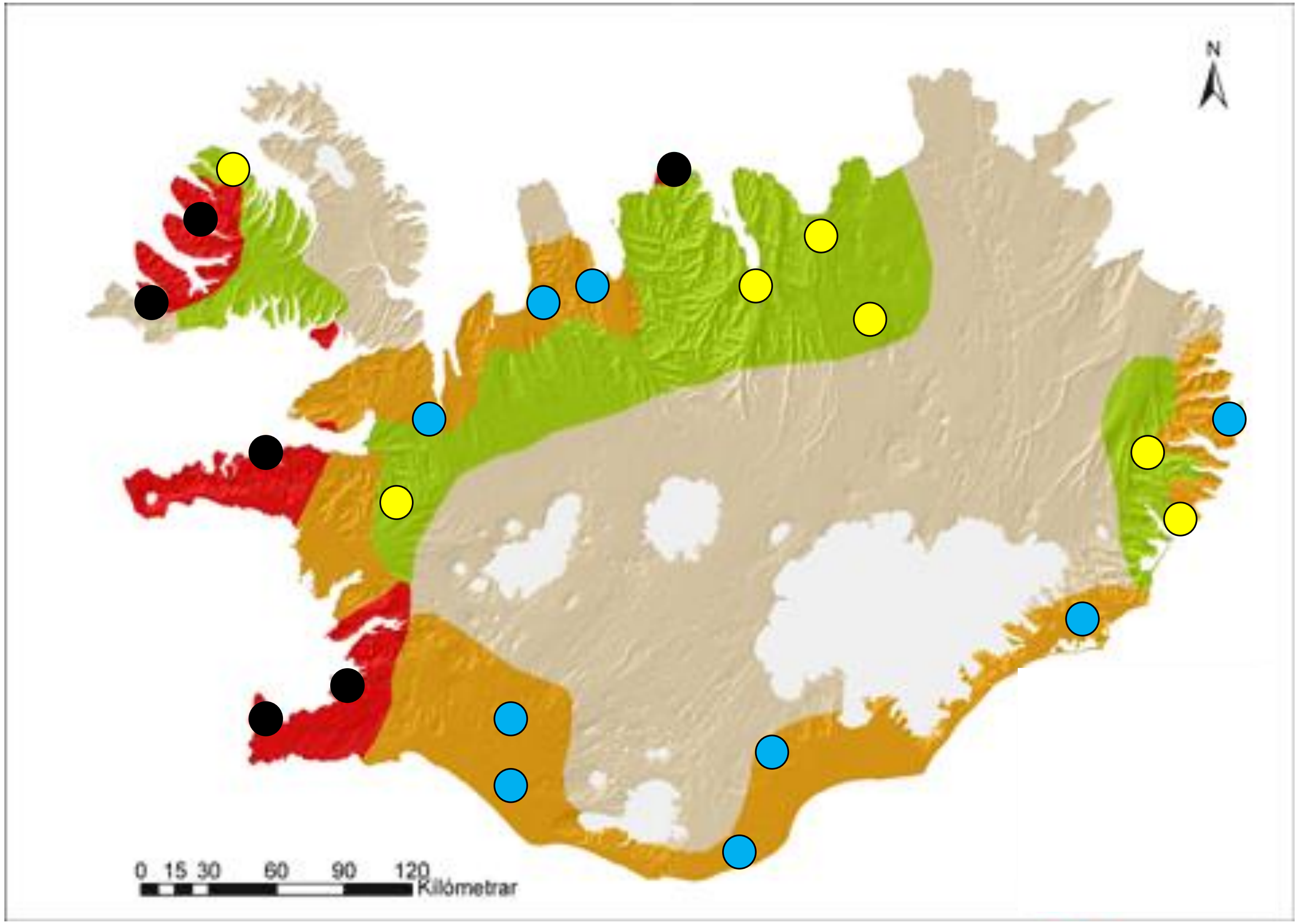
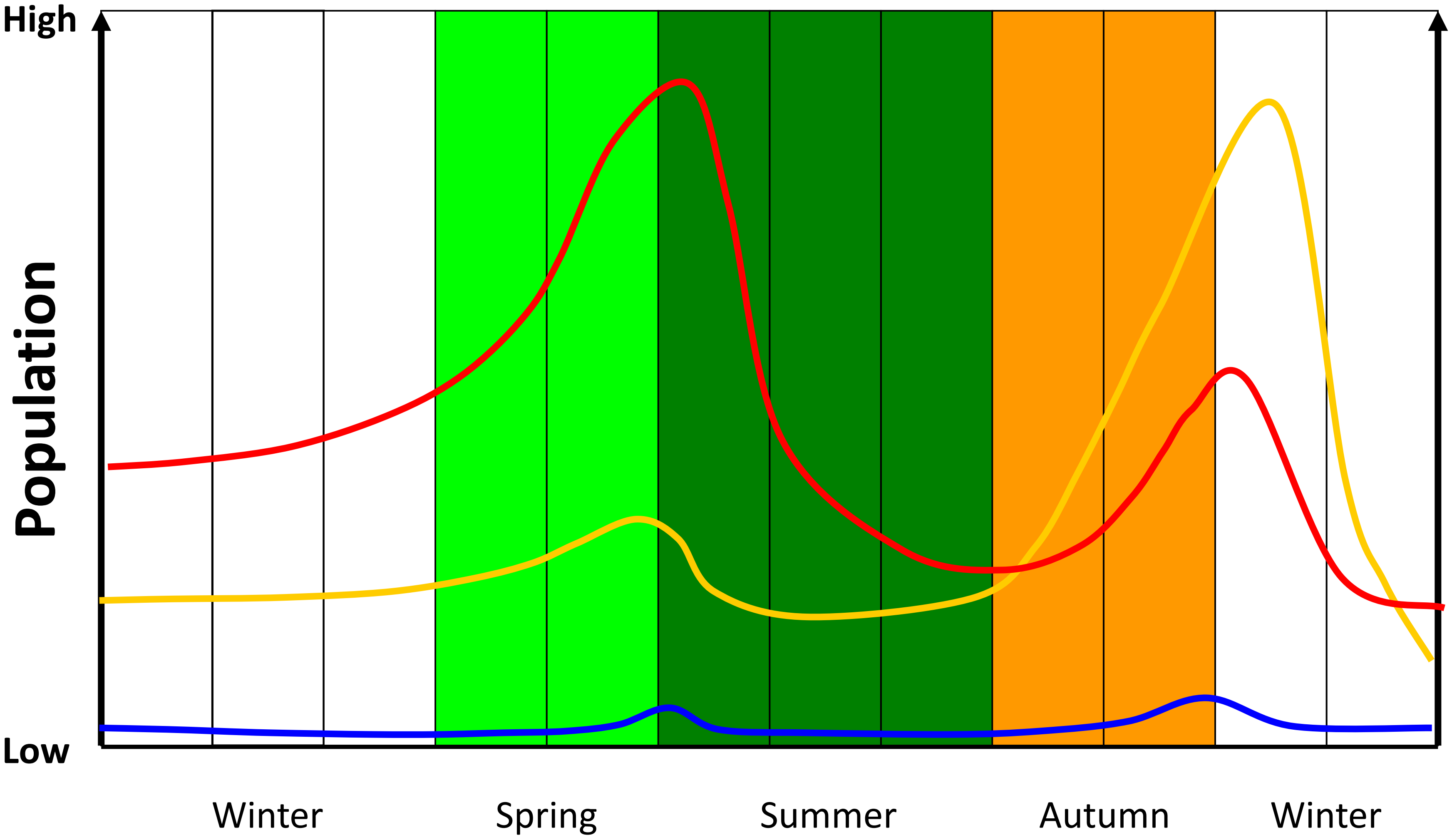


Winter temp and population dynamics

MWT above 3°C
Natural enemies
Spring outbreak

MWT 1-3°C
Lack of natural enemies
Autumn outbreak

MWT below 1°C
No outbreak



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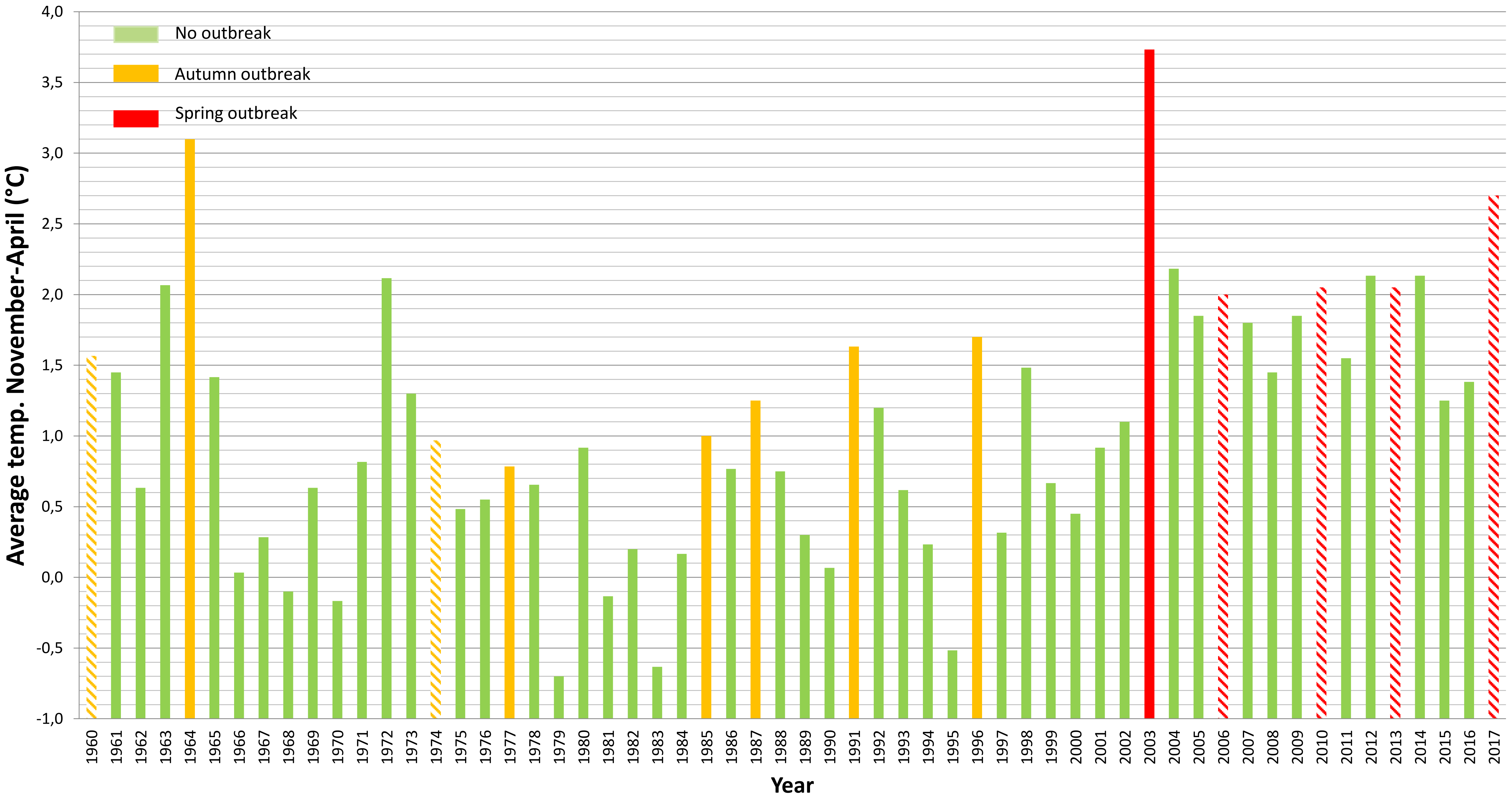
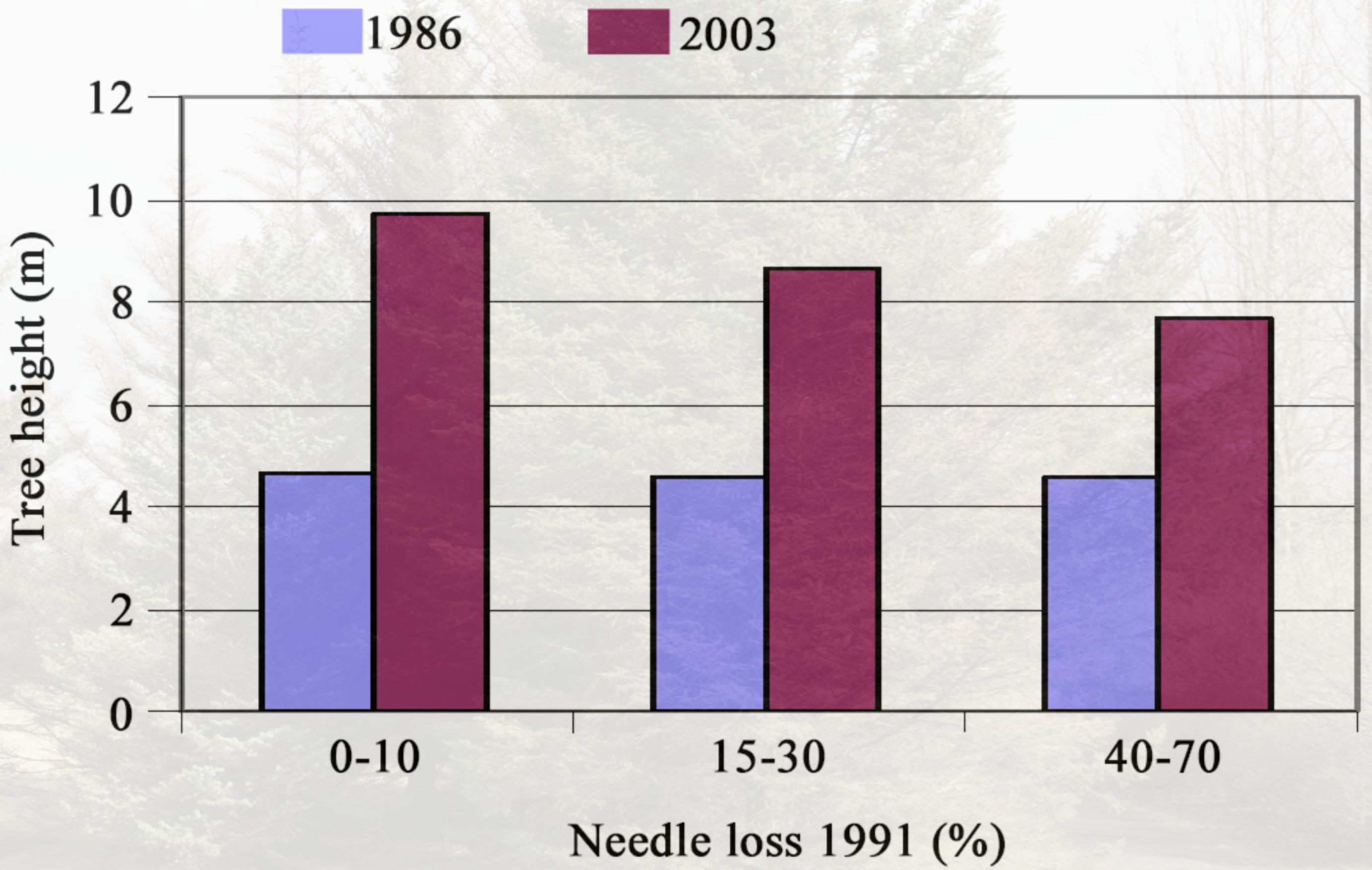
Outbreaks in Reykjavík



Damages due to green spruce aphid

Hallormsstaður

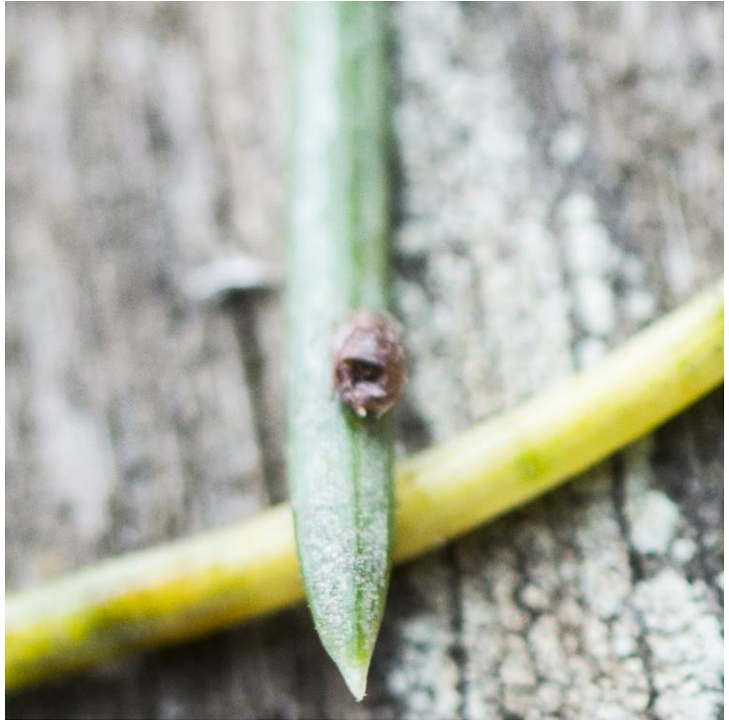
- Outbreaks in 1987 and 1991
- Height measured first in 1992 and every year until 2003
  - Measured back to 1986
- Needle loss had significant effects on tree growth



Halldorsson etal 2003. For. Ecol. and Man. 181 (3) 281-287

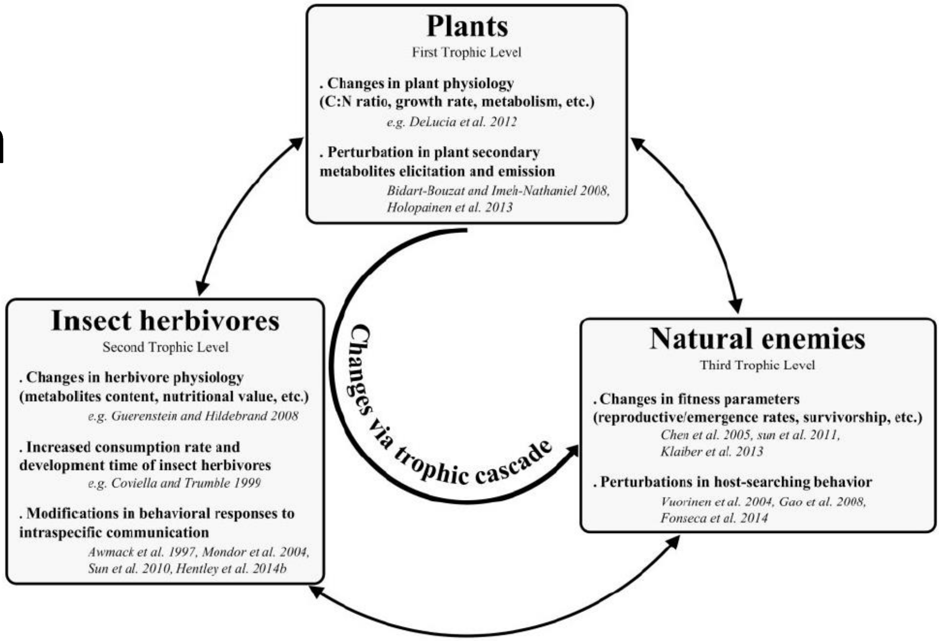
Natural enemies

- Two species of insect pathogenic fungi found on green spruce aphid
  - *Entomophthora planchoniana* and *Neozygites fresenii*
- Parasitic wasps
- Goldcrest (*Regulus regulus*)
- Ladybirds (*Coccinella undecimpunctata*)



Climate change and natural enemies

- Higher levels of CO_2 do not enhance abundance or efficiency of natural enemies to locate hosts or prey
- Increased ozone levels lead to modification in the herbivore-induced volatile organic compounds which may impact attractiveness of herbivores to natural enemies
- Other GHG (such as SO_2 and NO_2) tend to reduce the abundance of natural enemies



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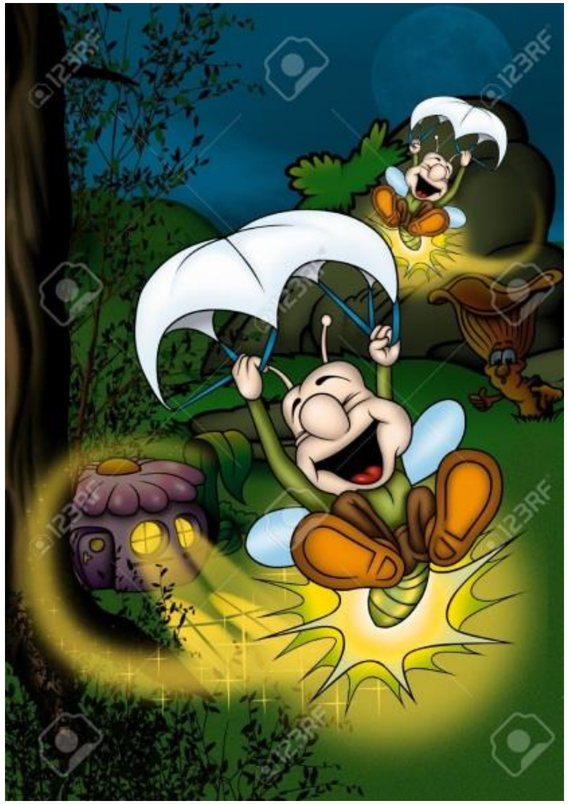
Boullis, A., Francis, F.,Verheggen, F. J. 2015 Climate Change and Tritrophic Interactions: Will Modifications to Greenhouse Gas Emissions Increase the Vulnerability of Herbivorous Insects to Natural Enemies?. Environmental Entomology 44 (2) pp: 277-286

Climate change, forest pests and forest production in the Nordic countries

- Faster growth of trees
  - Provided we have the right species/provinances
- Pests and diseases
  - New pests and/or changed behaviour of old ones
- Natural enemies



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