Monitoring the status and expansion of bark beetle problems in north-western Europe
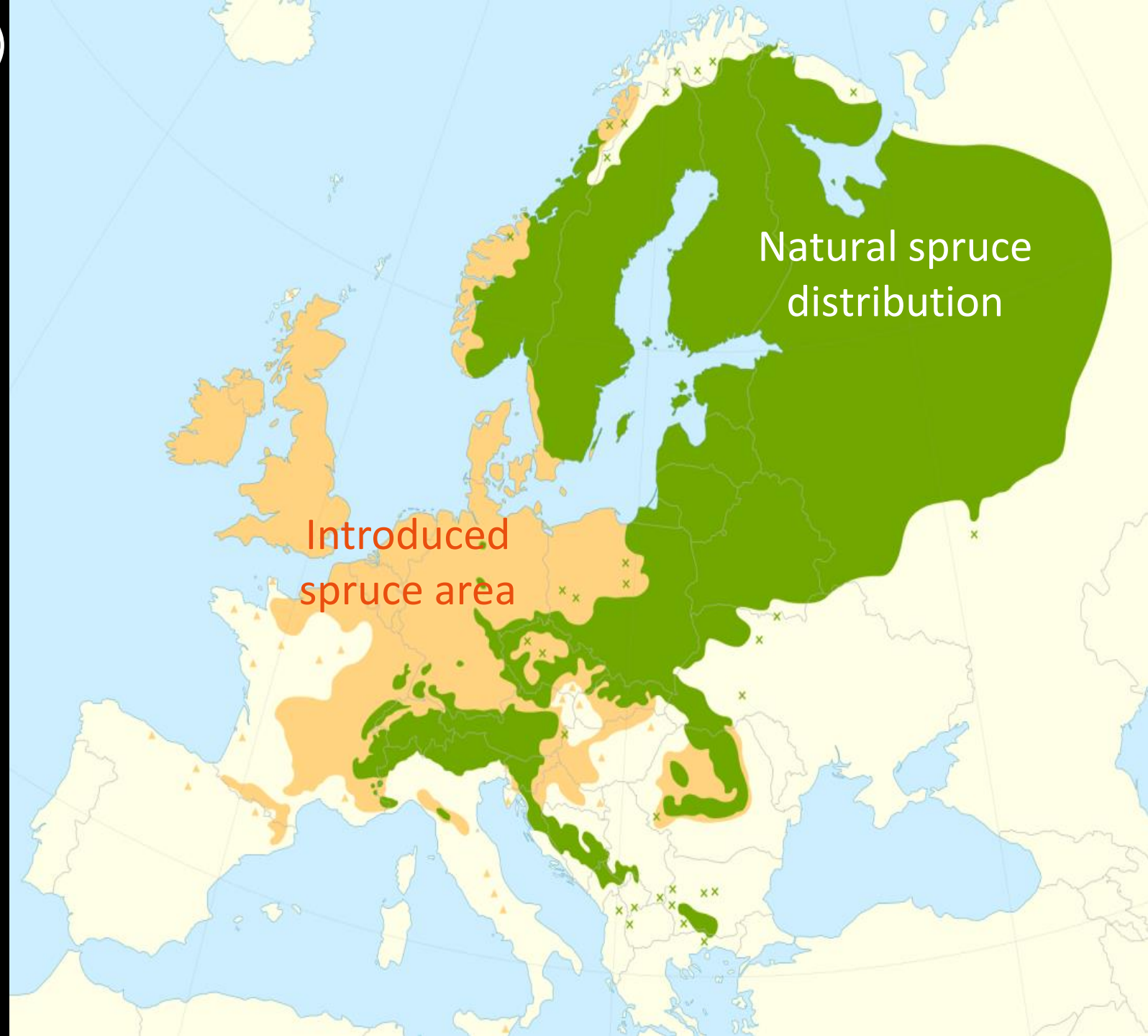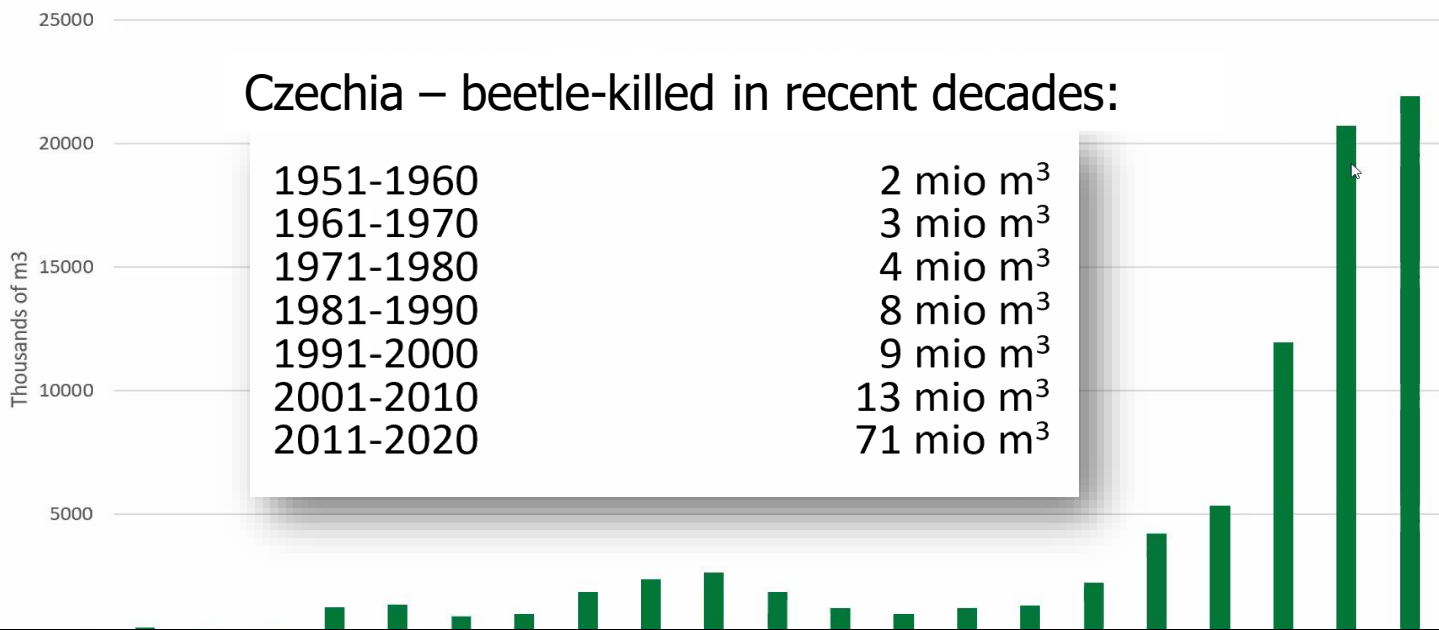
Bjørn Økland

1. Current status and expected development

2. The bark beetle monitoring of Norway

3. Monitoring after drought 2018 and windfelling 2021

4. Further improvements of monitoring

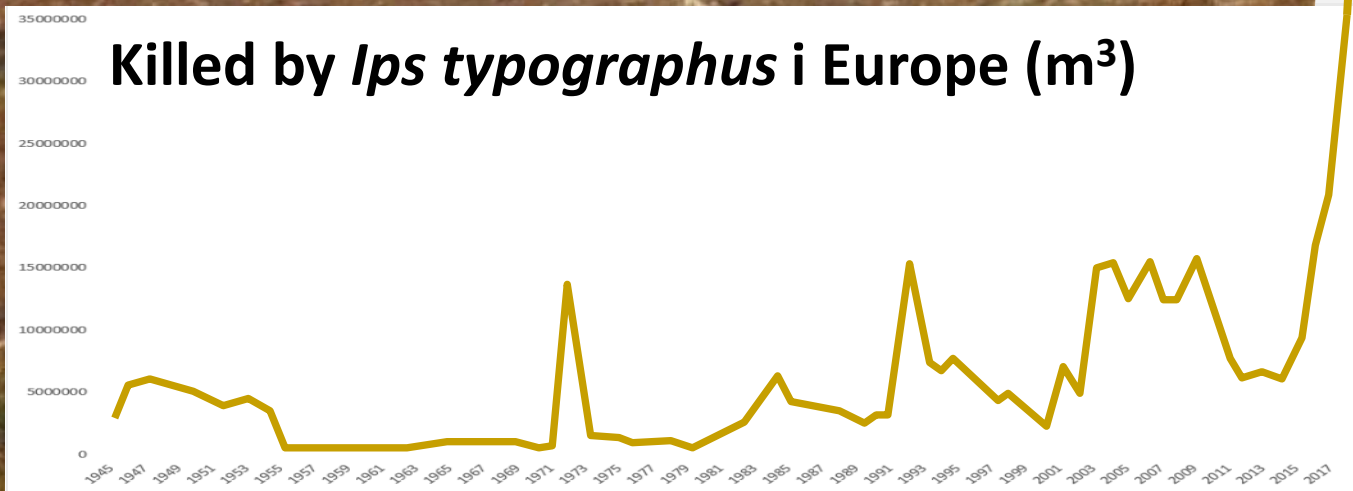# Spruce bark beetle (Ips typographus)

- Found where spruce is found

- So far most spruce killed in Central Europe and southern Scandinavia

- ~ introduced areas of spruce in nemoral and boreonemoral zones

Natural spruce distribution

Introduced spruce area

Czechia – beetle-killed in recent decades:

1951-1960	2 mio m^3
1961-1970	3 mio m^3
1971-1980	4 mio m^3
1981-1990	8 mio m^3
1991-2000	9 mio m^3
2001-2010	13 mio m^3
2011-2020	71 mio m^3

Europe: 200-300 mill. m³ killed in 3 years:

Killed by *Ips typographus* i Europe (m³)

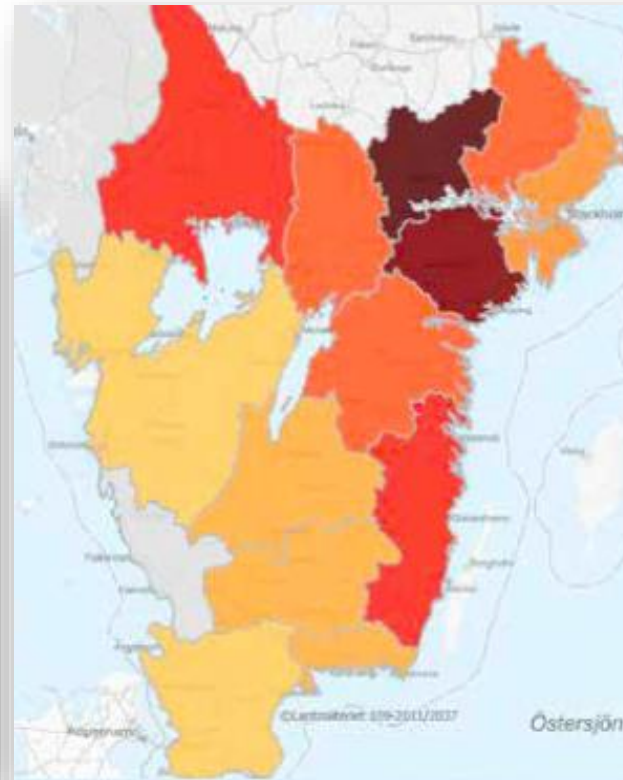# Southern Sweden: much killed and expanding northwards

2018:
3,5 mill. m^3 killed

2019:
7 mill. m^3 killed
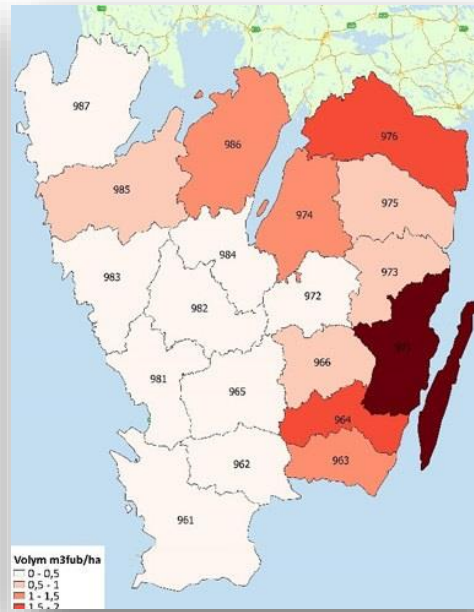
2020:
7,7 mill. m^3 killed

2021:
8,1 mill. m^3 killed

2022:
5,1 mill. m^3 killed

The largest spruce volumes are in the boreal region

- **Europe**: Spruce 25% of the productive forest volume

- **Boreal region**: much higher – e.g. 45 % in Norway

- Drought and bark-beetle problems by further global warming?

Forest Ecology and Management

journal homepage: www.elsevier.com/locate/foreco

Northernmost European spruce bark beetle *Ips typographus* outbreak: Modelling tree mortality using remote sensing and climate data

Aleksei Trubin[a], Pavel Mezei[b,c,d,*], Khodabakhsh Zabihi[a], Peter Surový[a], Rastislav Jakuš[a,b]

North-west spared so far: much spruce, but less killed

Frequent low pressures - more rain and storms

Precipitation gradient correlates with less damage
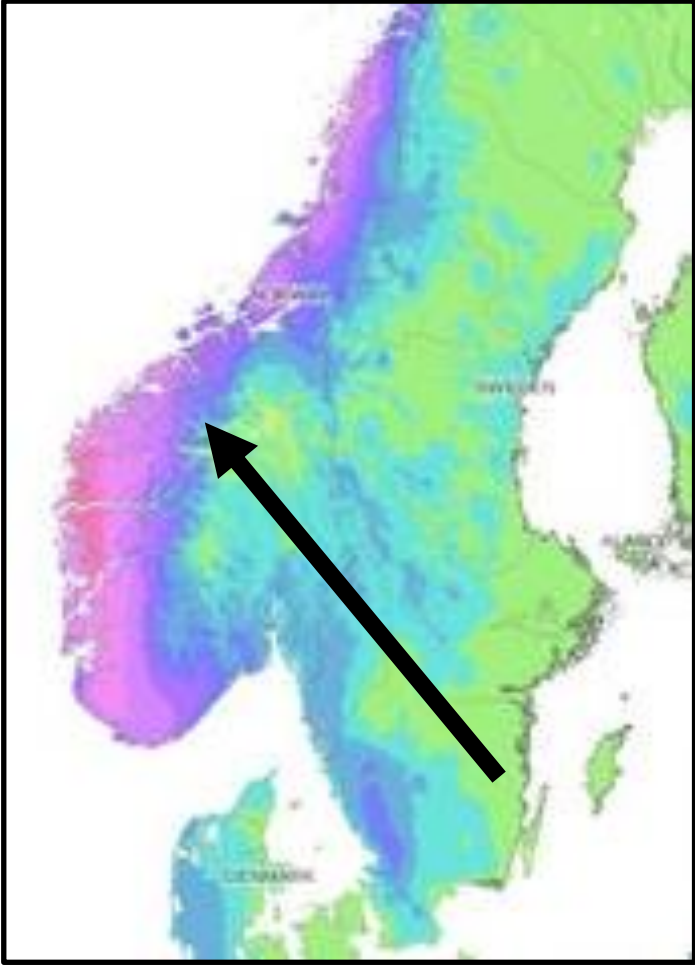
Average yearly precipitation
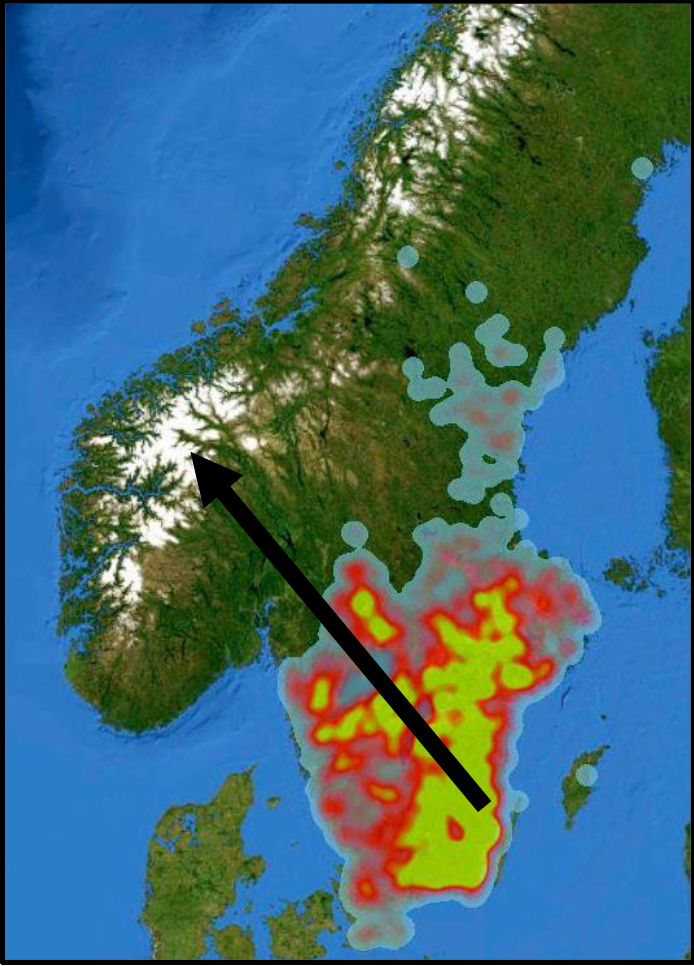
Bark beetle damage 2019

Average precipitation (mm)
Year

- <= 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 650
- 650 - 800
- 800 - 1000
- 1000 - 1200
- 1200 - 1500
- 1500 - 2000
- 2000 - 3000
- > 3000

Warmer: northward outbreak expansion into current boreal zone?

- Two-generation-area extends into core spruce areas?
- Area of high drought risk extends into core spruce areas?

➡ Choice of tree species/ management for the future (next 70-100 years)

2. The bark beetle monitoring in Norway

- 500-600 pheromone traps per year since 1979

- Main purpose: recognize significant increases of typographus

- Traps operated and data entered by forest officers in counties and municipalities
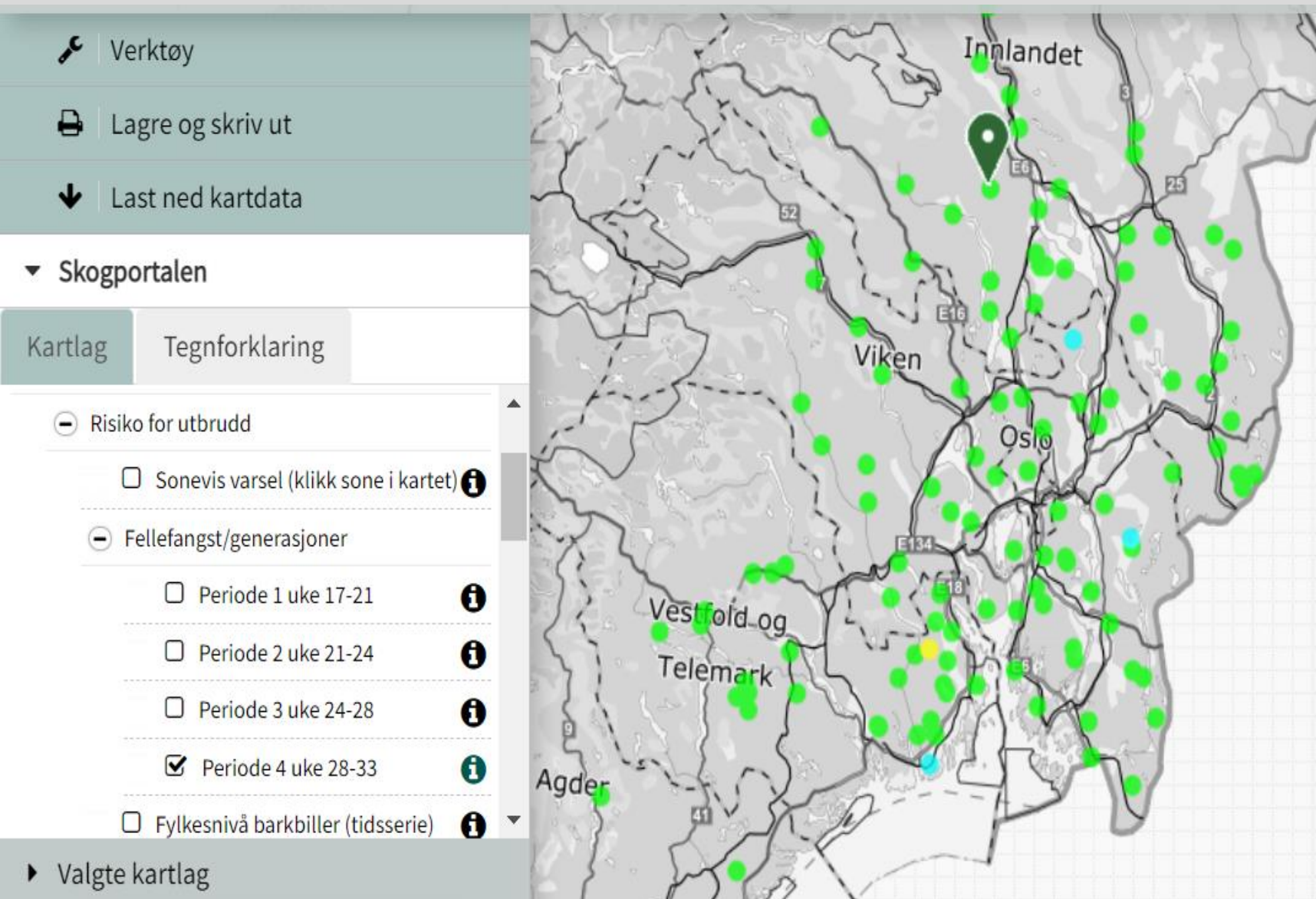
- Also attacks are recorded

Map layers for risk assessment:

- Risk warning (4 times per season)

- Trap catches (per localities)

- Standing spruce volume

- Generation development (voltinism)

- County levels

- Compare previous outbreak area

BARK BEETLE MONITORING
Trap catches

BARK BEETLE MONITORING
Risk warning

BARK BEETLE MONITORING
Standing spruce volume

BARK BEETLE MONITORING
Beetle development/generations

BARK BEETLE MONITORING
Trap catches per county

BARK BEETLE MONITORING
Beetle damage 1970's
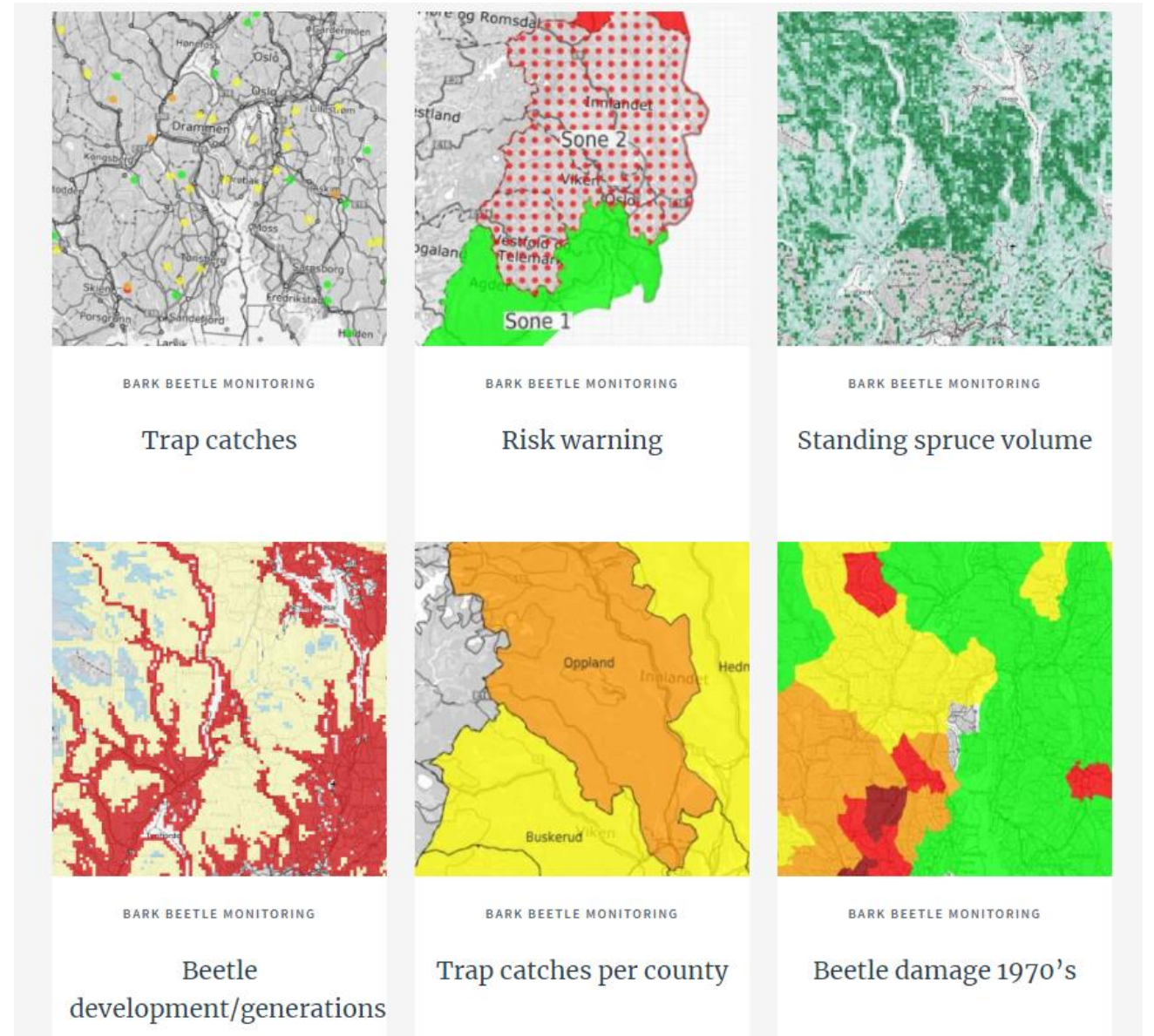
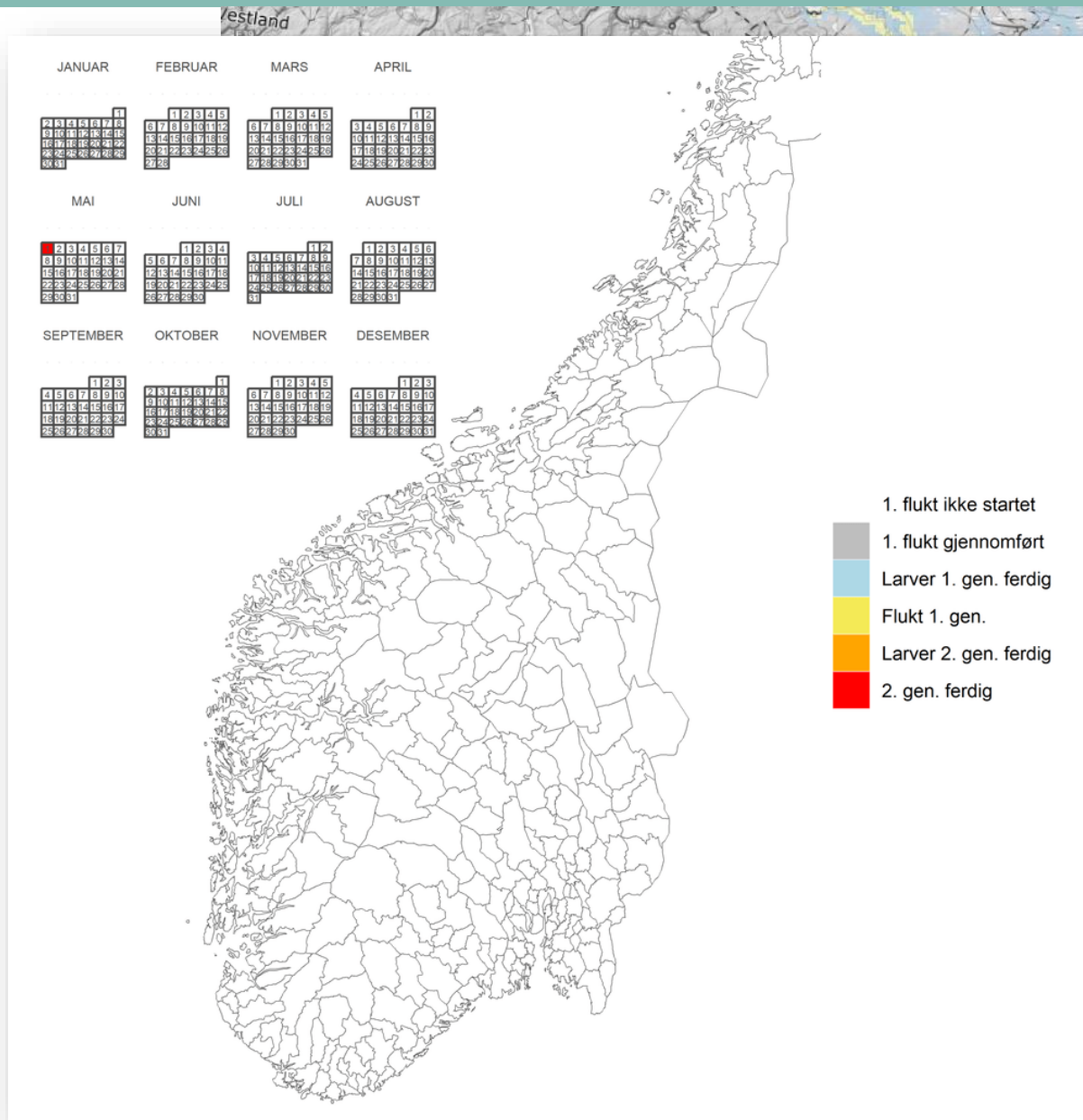Website: www.nibio.no/barkbilleovervaking

Amount of beetles – trap captures
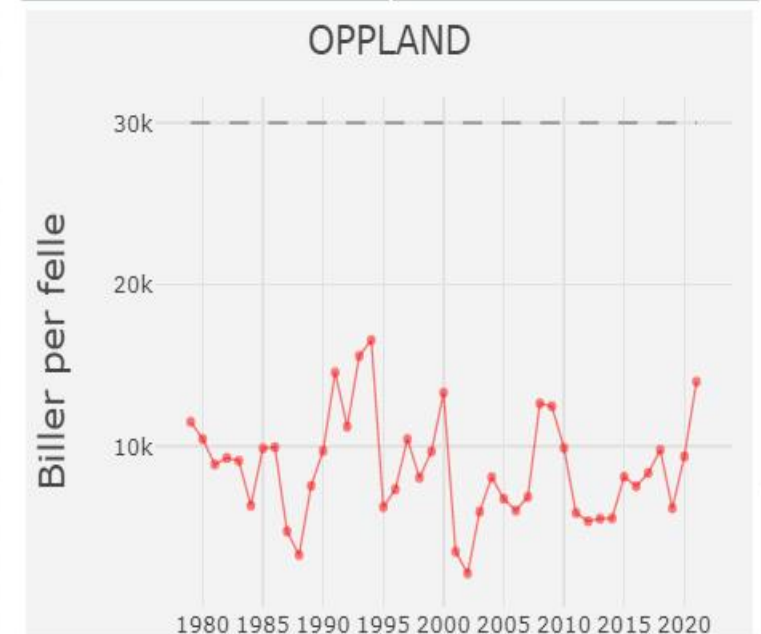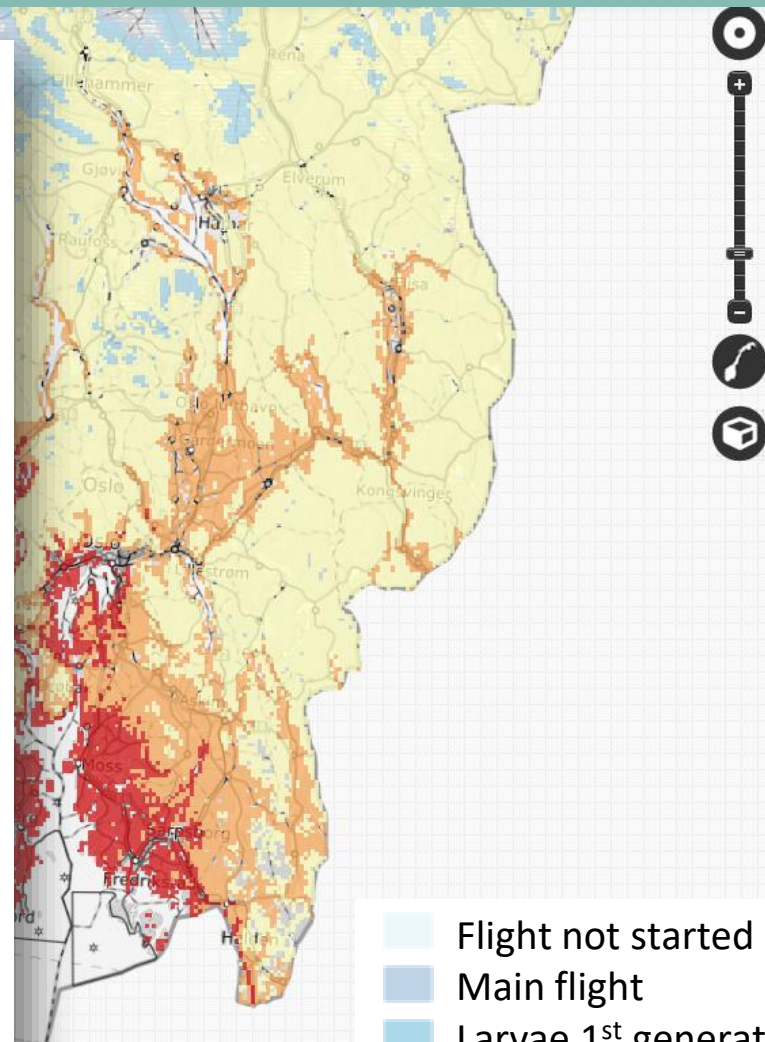
Amount of spruce (cover of > 5 m³ spruce/daa per pixel)
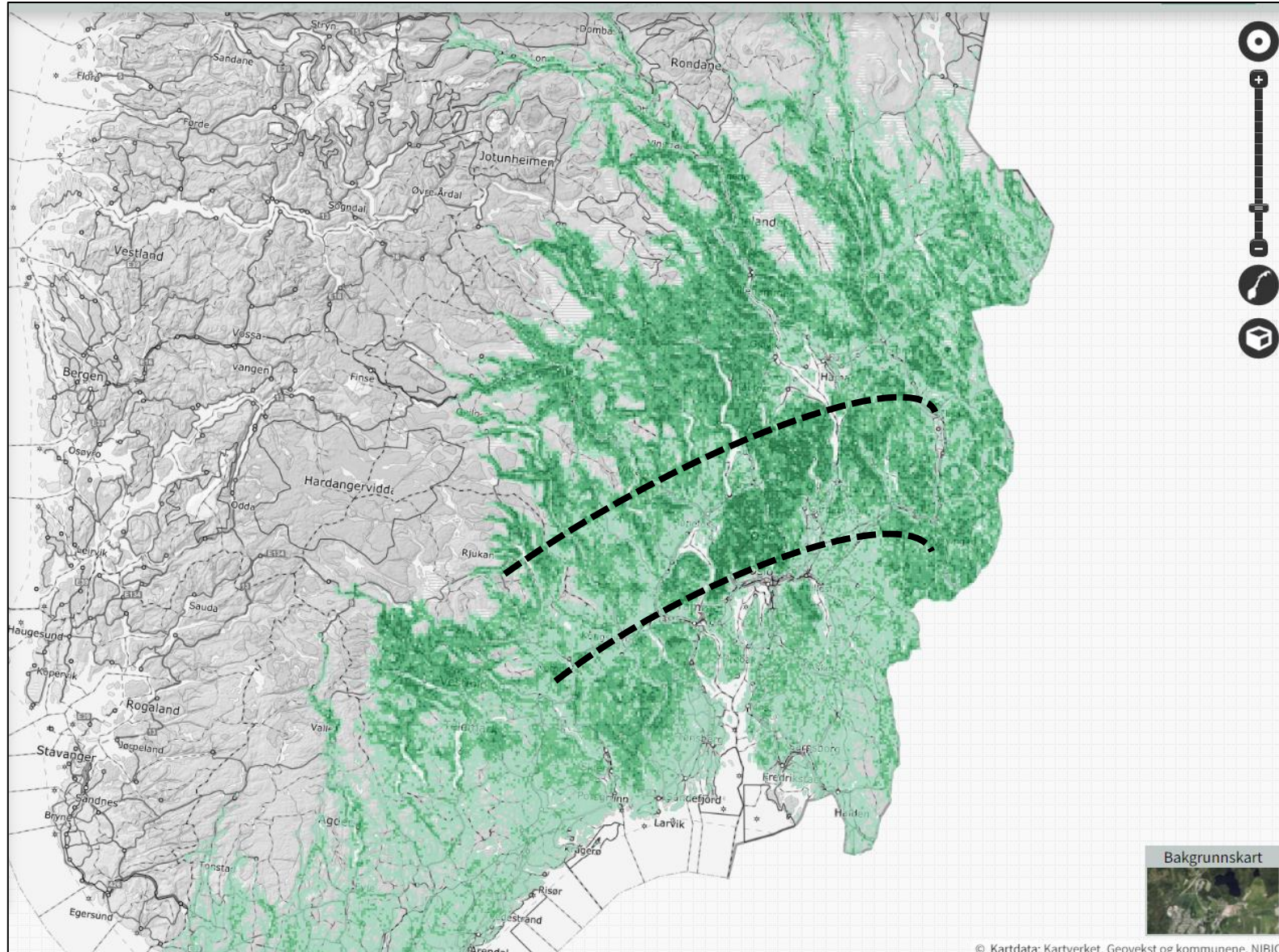
Temperature-based development model (2022)
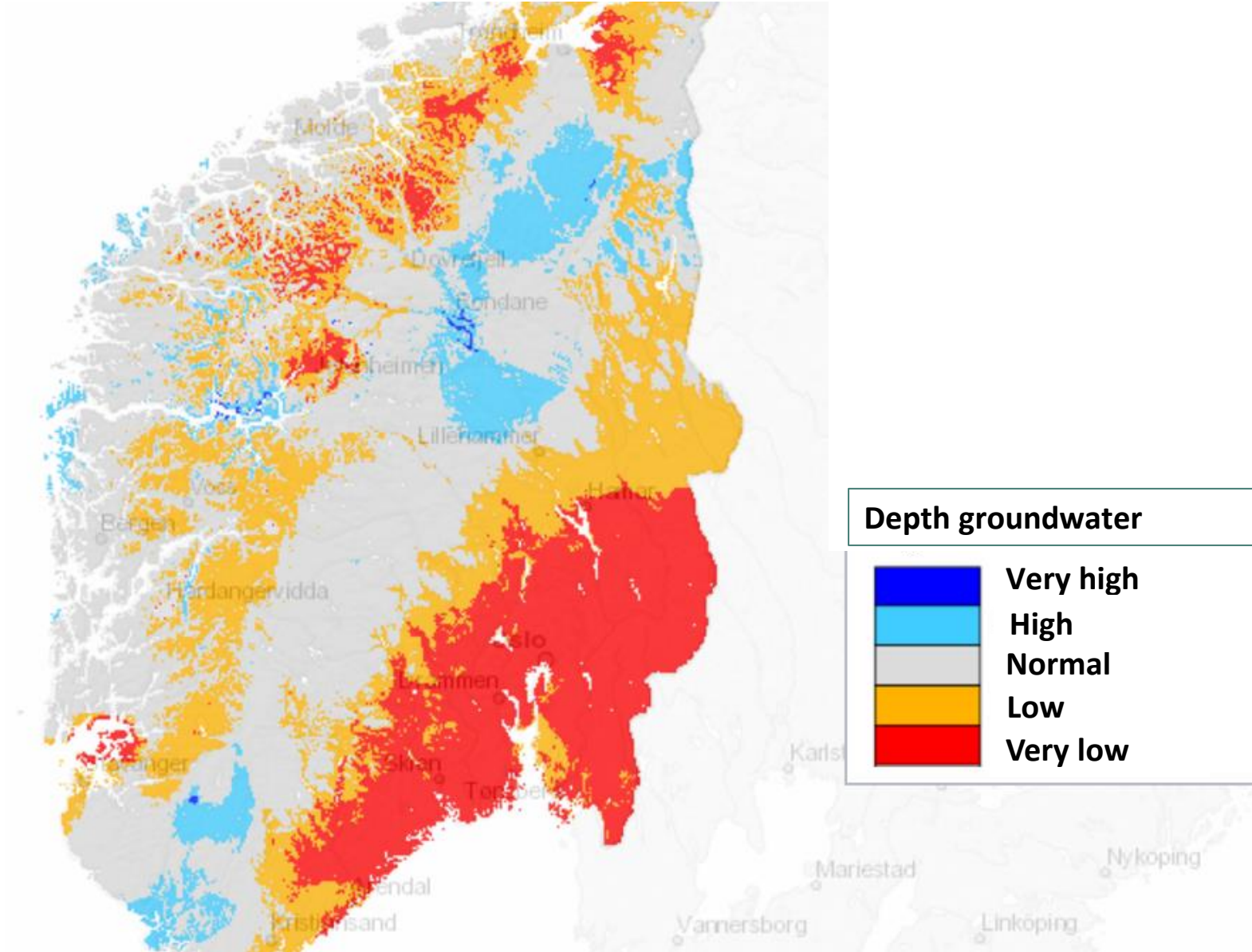

1. flukt ikke startet
1. flukt gjennomført
Larver 1. gen. ferdig
Flukt 1. gen.
Larver 2. gen. ferdig
2. gen. ferdig

Flight not started
Main flight
Larvae 1st generation
Flight 1st generation
Larvae 2nd generation
Flight 2nd generation

© Kartdata: Kartverket, Geovekst og kommunene, NIBIO

Extreme drought 2018

Depth groundwater

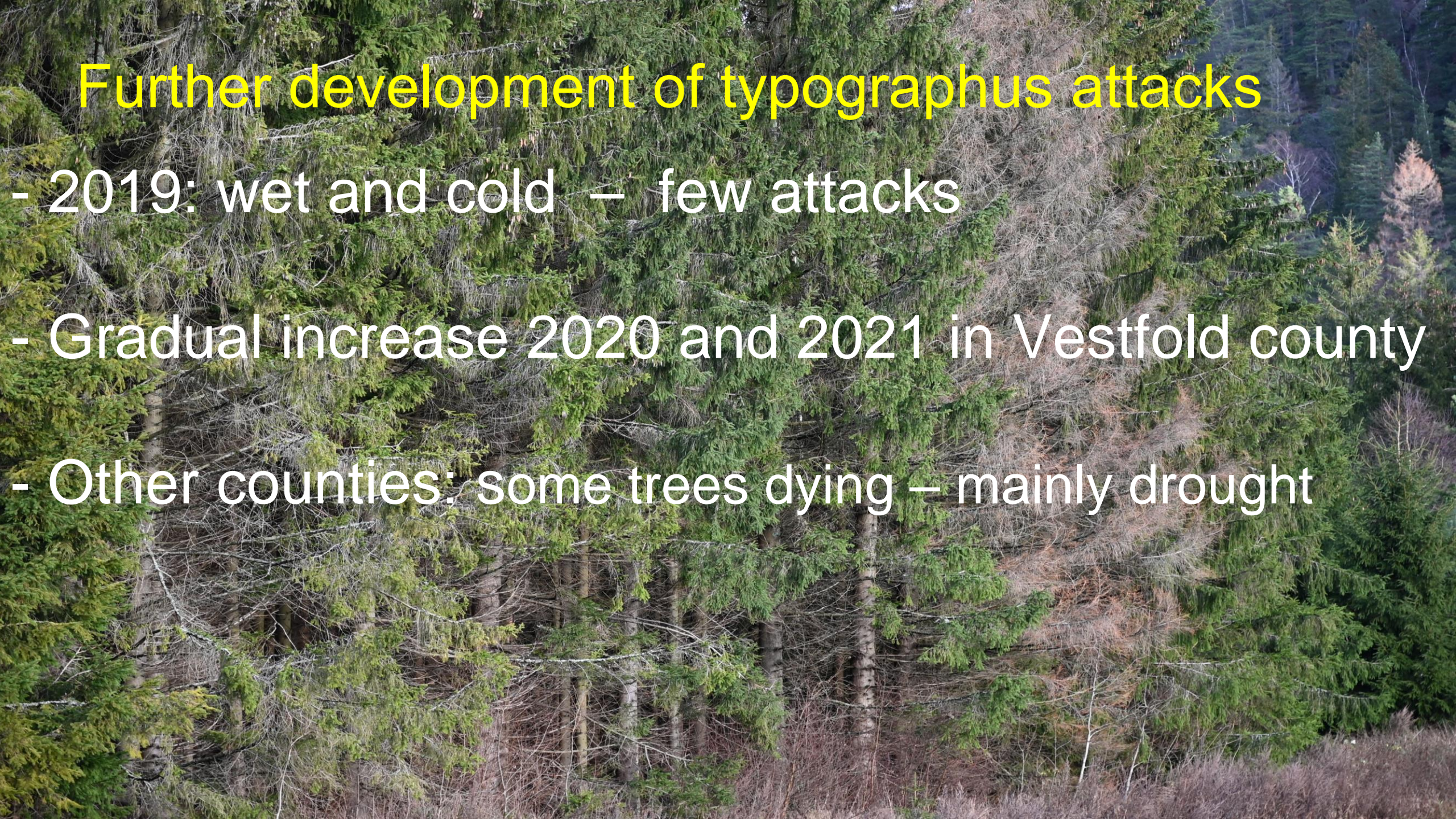|	
🟦	**Very high**
🟦	**High**
⬜	**Normal**
🟧	**Low**
🟥	**Very low**

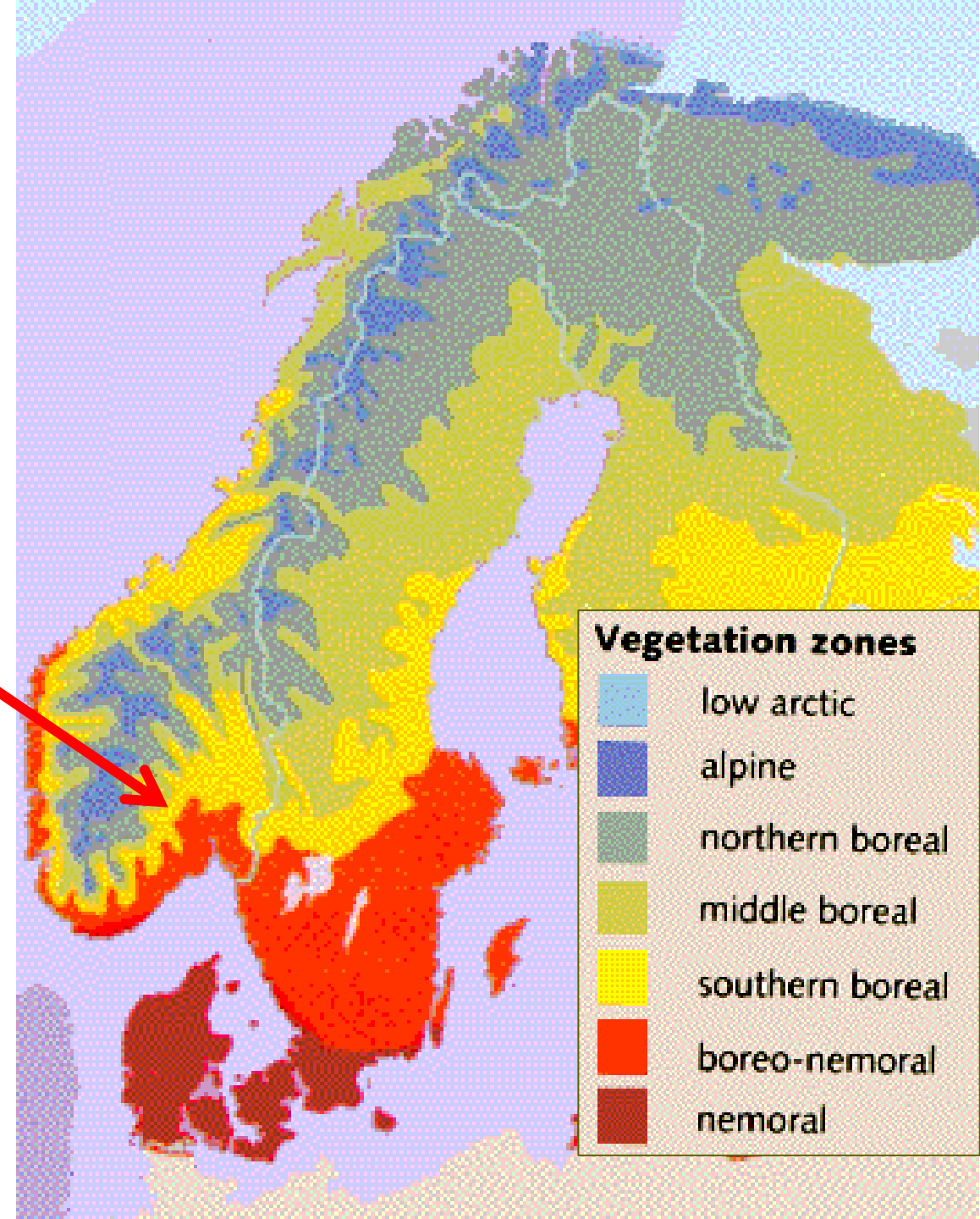# Further development of typographus attacks

- 2019: wet and cold – few attacks

- Gradual increase 2020 and 2021 in Vestfold county

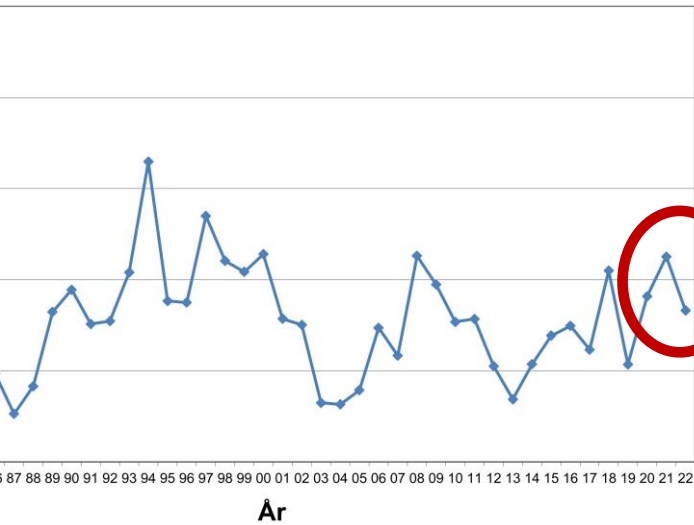- Other counties: some trees dying – mainly drought

Scandinavia after 2018-drought

- Most damages in southern Sweden

- Some in Vestfold county

- All are areas in boreo-nemoral zone

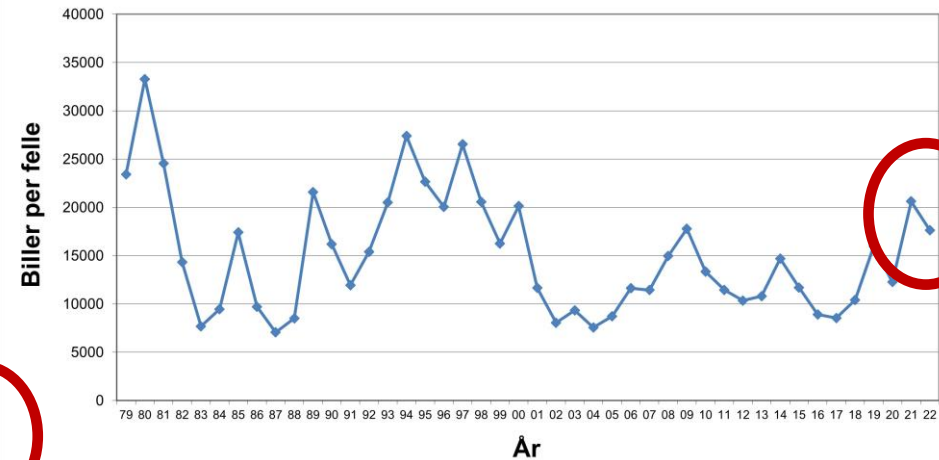- Spruce more exposed to drought-damages in boreo-nemoral zone

Vegetation zones

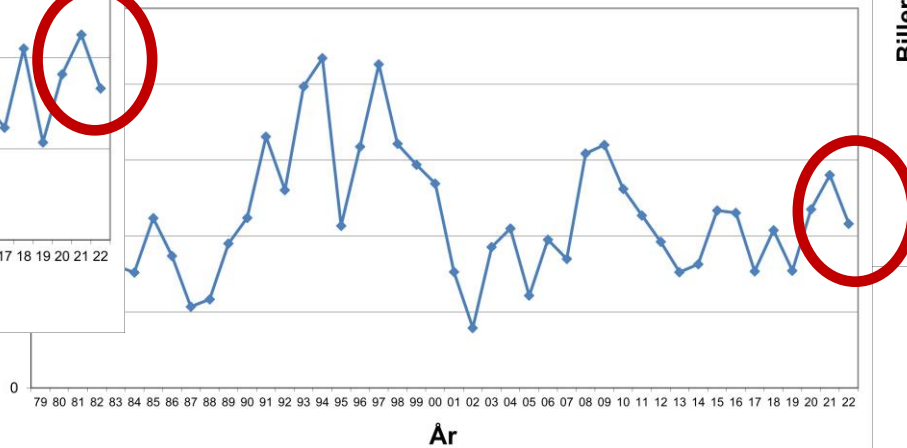- low arctic
- alpine
- northern boreal
- middle boreal
- southern boreal
- boreo-nemoral
- nemoral

Synchronous decline in 2022
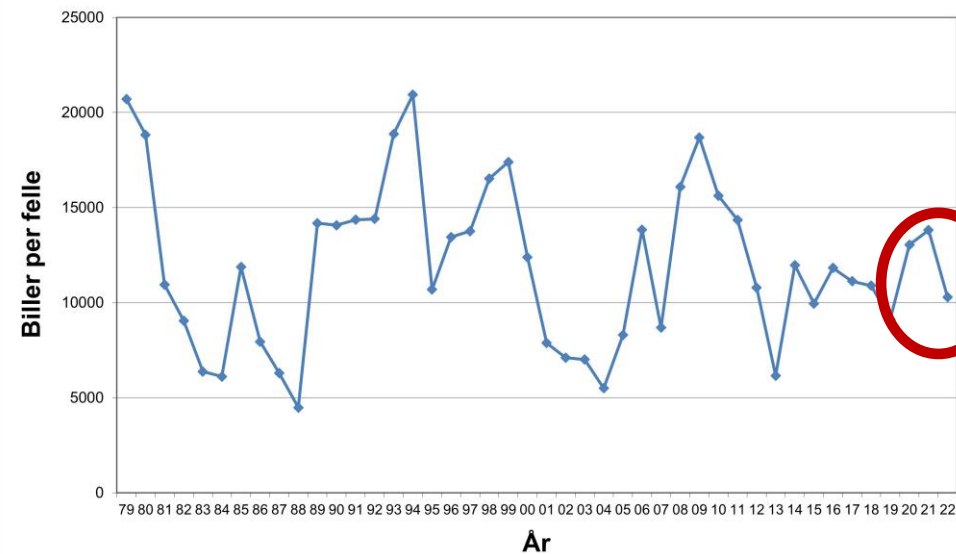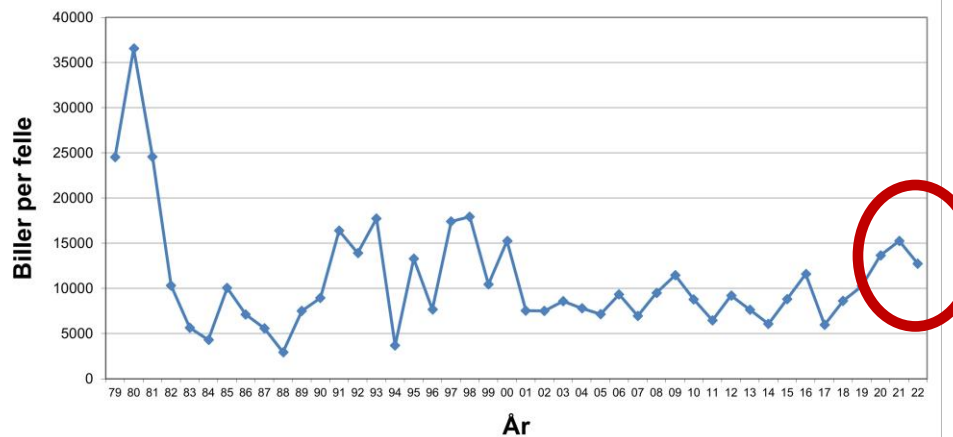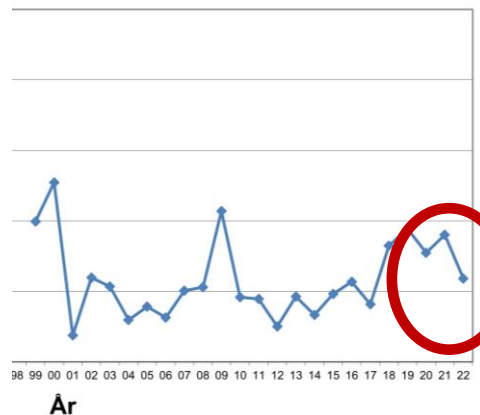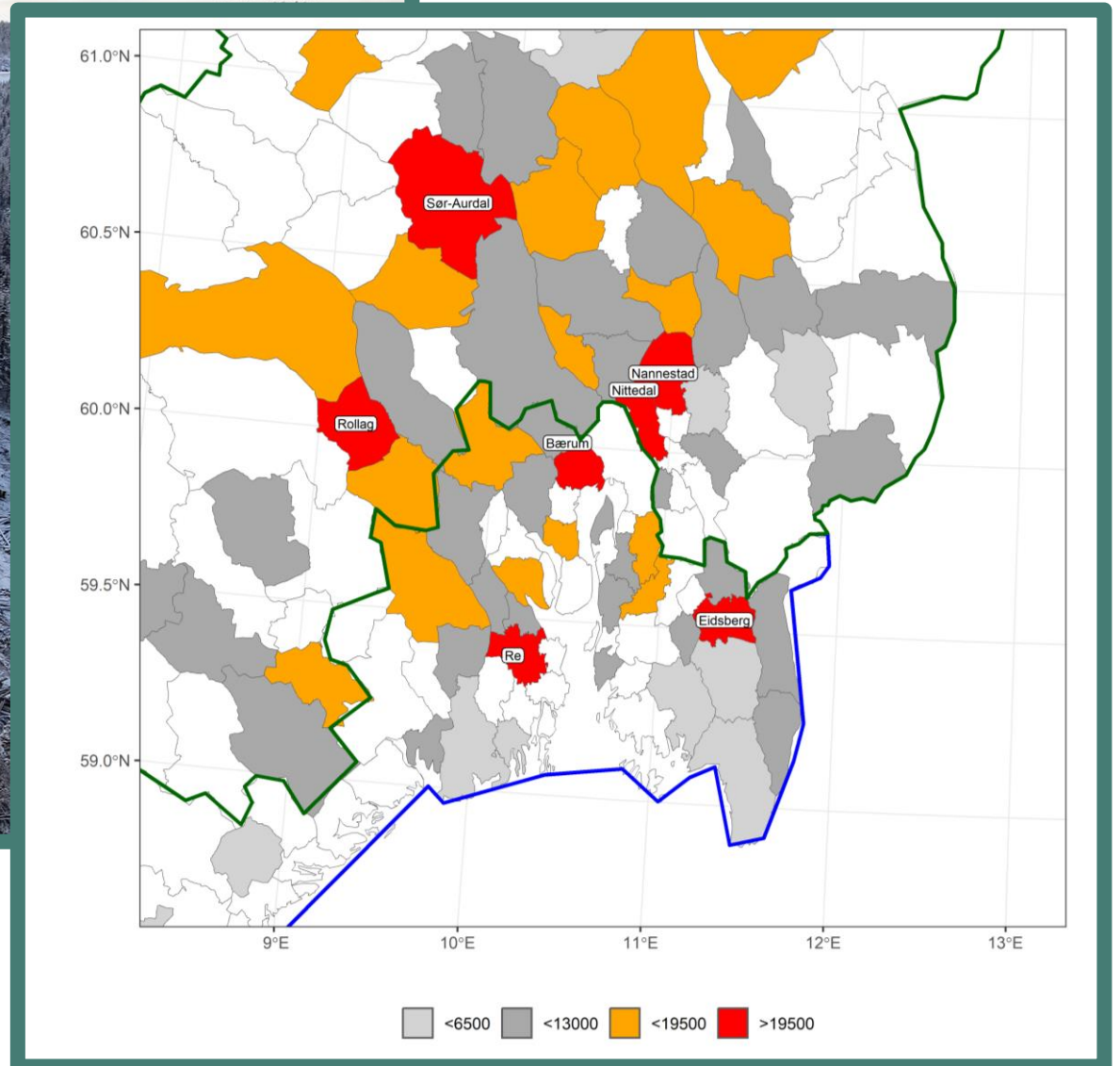
Analyses of ~20 years monitoring trap data: lag of three years
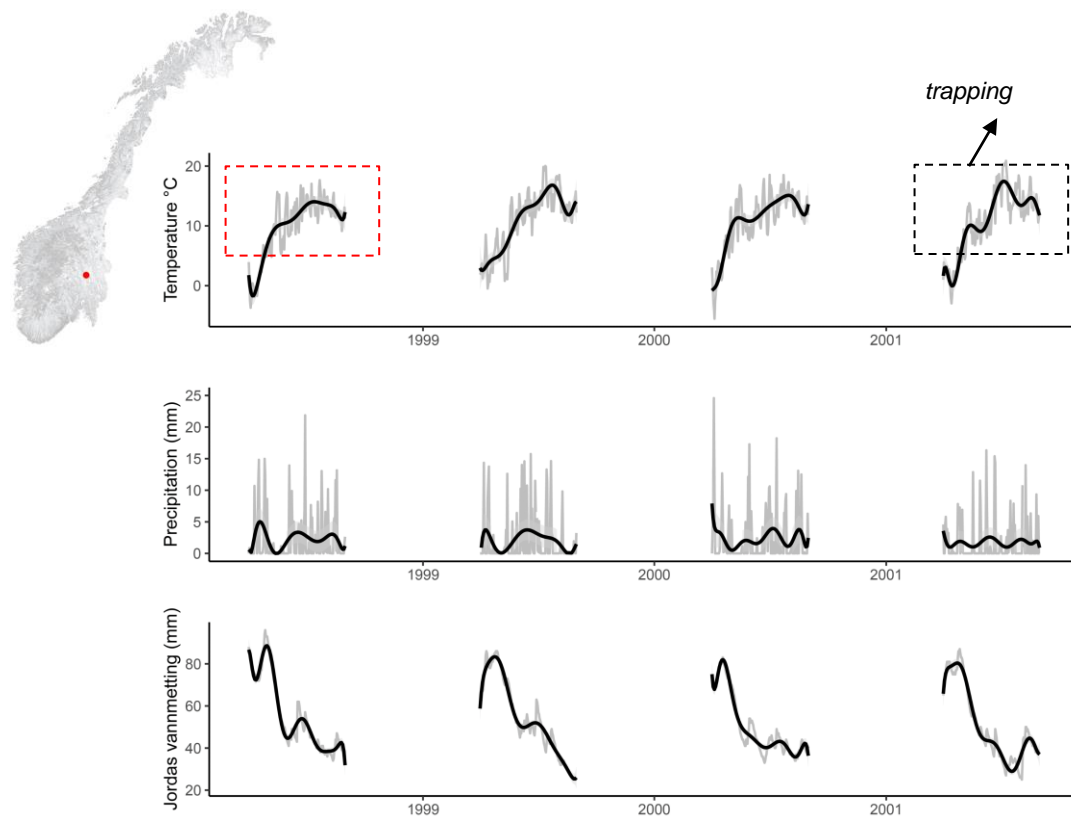
Gohli, Økland, Krokene & Heggem. Future transition to bark beetle outbreaks in Europe's boreal forests – identifying climatic and management-related risk factors In review

Also lagged effect after windfelling 2021

Windfelling 2021

Trap captures 2023

4. Further improvements of monitoring

– Map layer for drought stress on spruce – network sensors in forest

– Drones: Forest structure and frequency of killed spruce (research)

– Sentinel-2 satellite monitoring – killed spots too small

– Predictive models in future? – reference to killed forest is missing

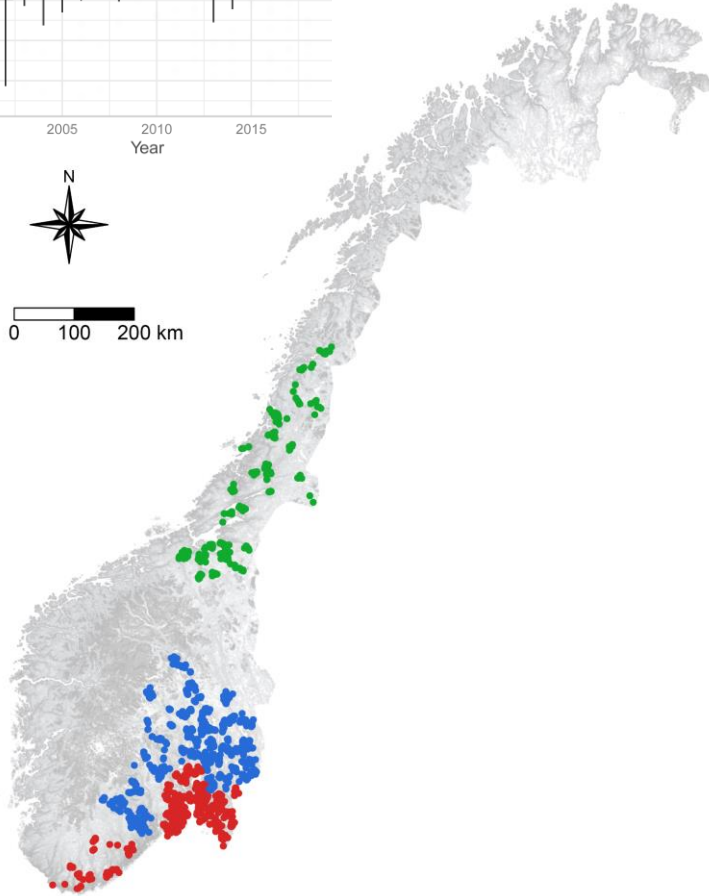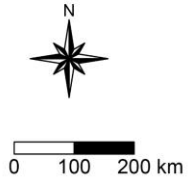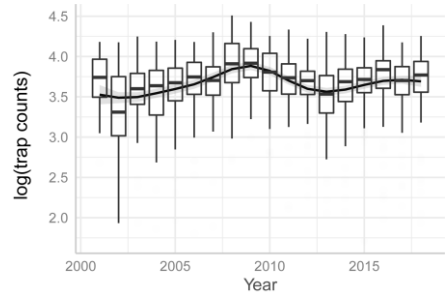– Development of system-specific model for the region
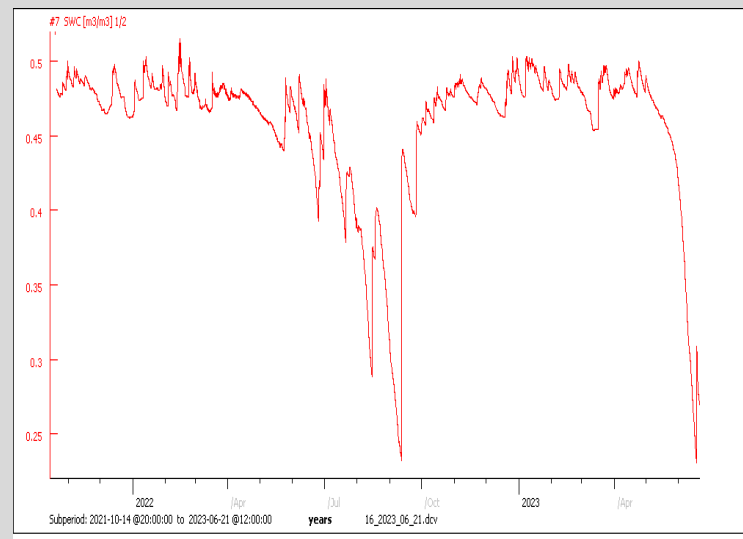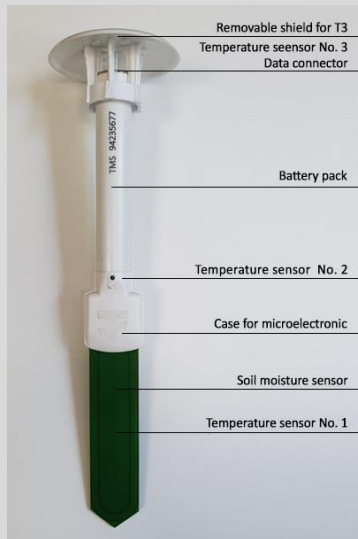
Paal Krokene

Jostein Gohli

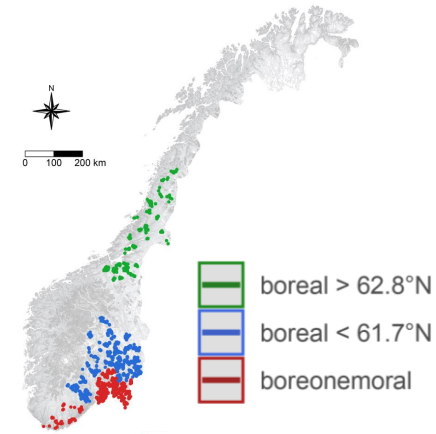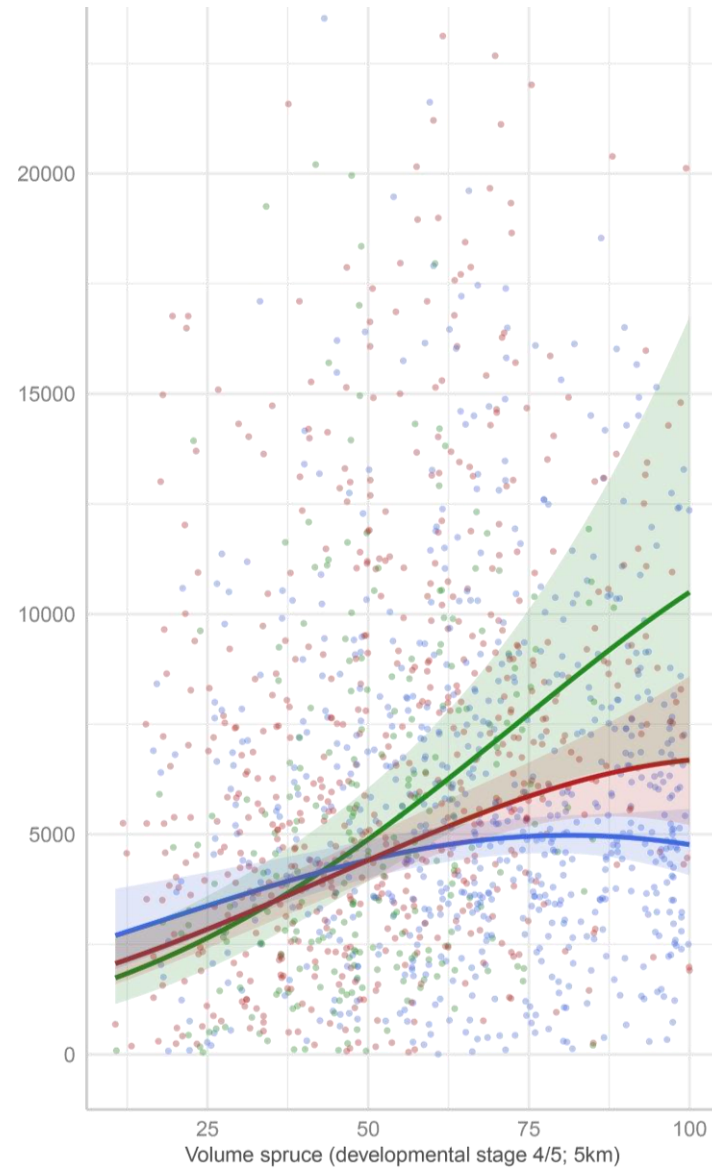# Study of main factors: data bark beetle monitoring, SR16, etc.

Gohli, Krokene, Heggem, Økland. Future transition to bark beetle outbreaks in Europe's boreal forests – identifying climatic and management-related risk factors. In review

- **Volume spruce**
- **Clearcut edges**
- **Volume spruce in reserves**
- **Vegetation zone**
- **Temperature**
- **Precipitation**
- **Soil moisture**
- **Latitude**
- **Longitude**
- **Elevation**
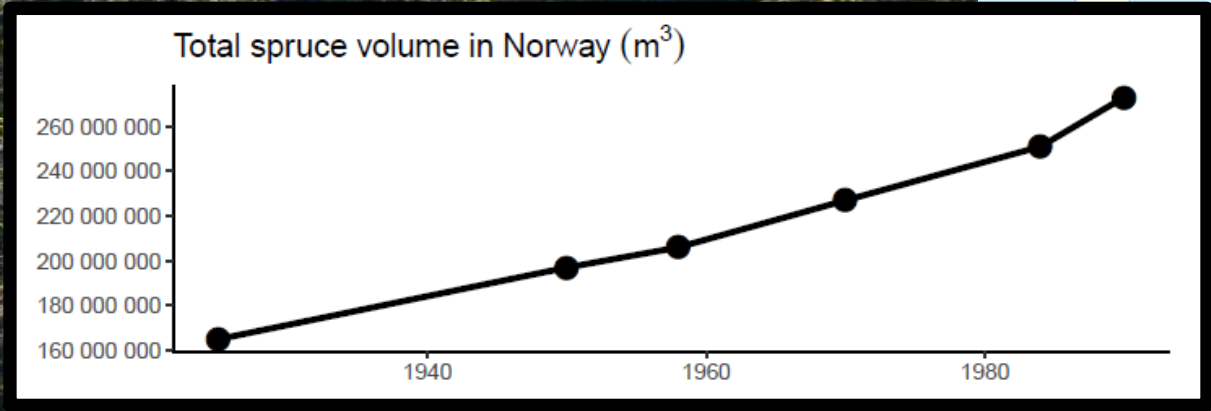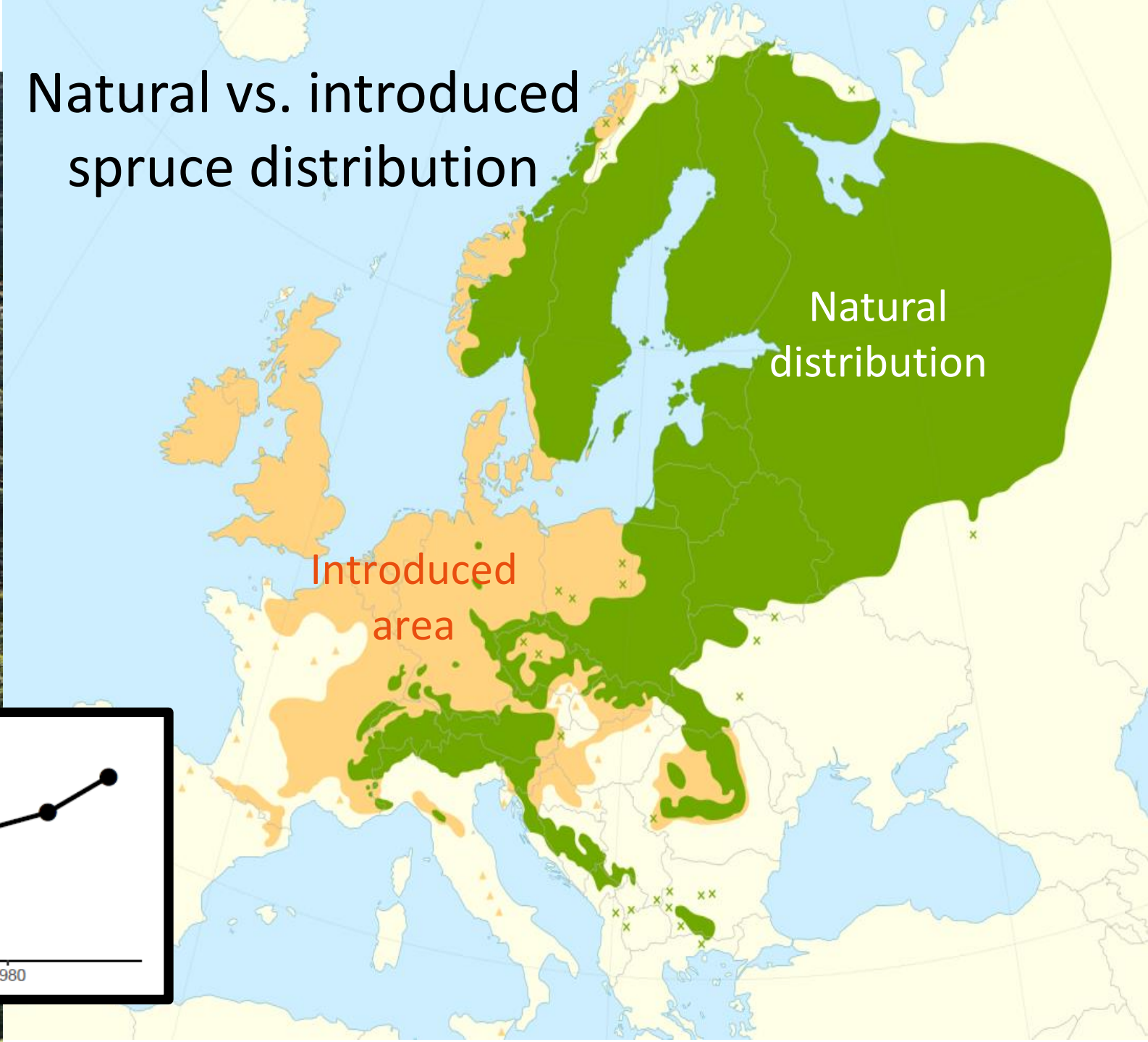
Important: Volume spruce

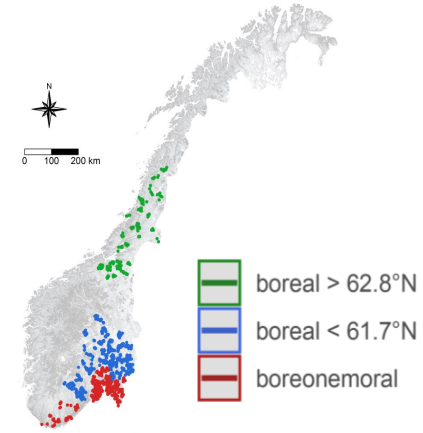**Significantly positive effect on abundance of bark beetles**

Natural vs. introduced spruce distribution

Natural distribution

Introduced area

Extensive spruce planting

Total spruce volume in Norway (m³)

Important: Clearcut edges
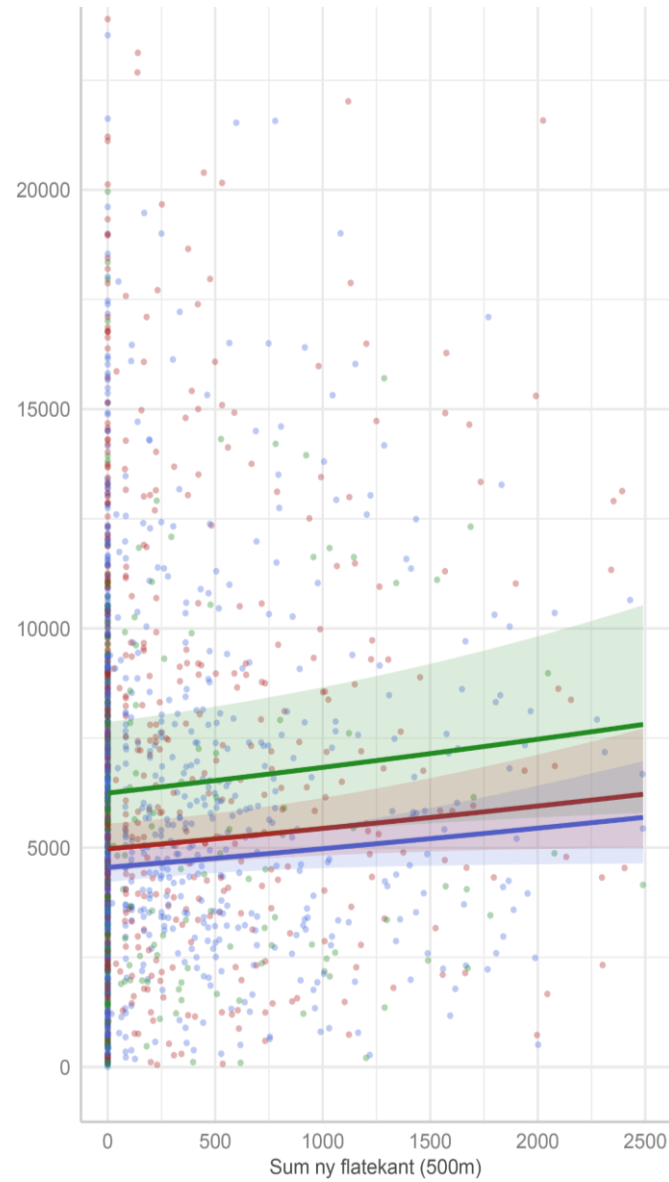

Significantly positive effect on abundance of bark beetles

Spatial configuration of bark beetle infestations differs considerably between outbreaks triggered by storms and droughts
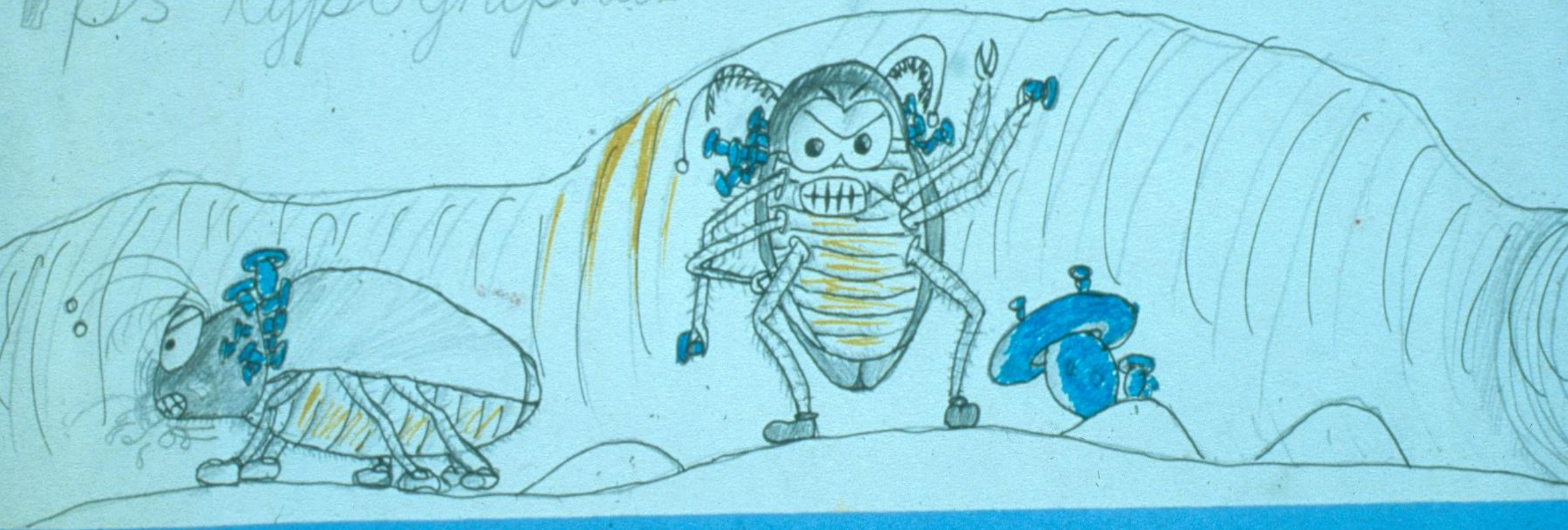
- **Storm-induced infestations** increased more with spruce volumes in the landscape

- **Drought-induced infestations** increased more with clear-cuts in the landscape and spruce heights
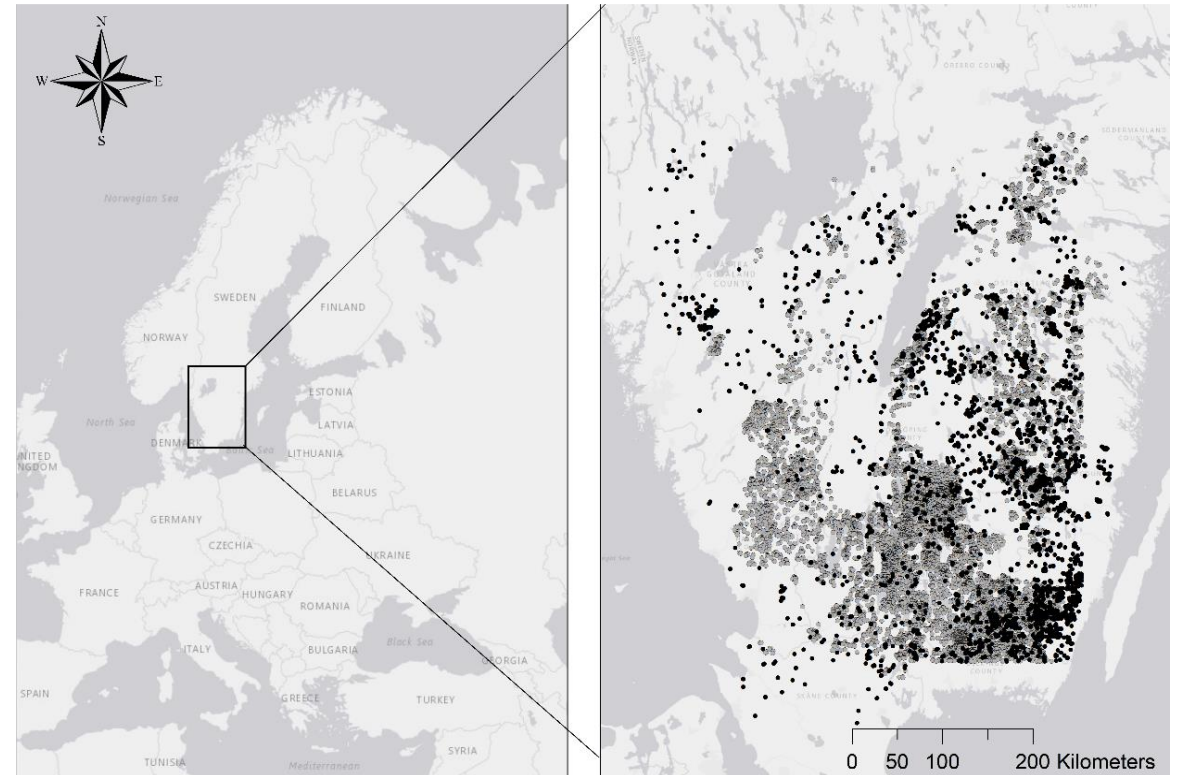
Reason: differences in distribution of susceptible trees

Ips typógraphus

Thank you!