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Situation of elms in the light of Dutch elm disease in the northern Europe

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FORMAS

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Elms

- *Ulmus glabra*, *U. laevis* and *U. minor*
- natural distribution is in their northern limit
- *U. laevis* is “near threatened” by IUCN Red List of Threatened Species in some countries
- in Sweden all the elms are in the Red List
- not important for wood production
- cultural and ecological values

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Ulmus glabra

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Dead elms in Vana-Vastseliina South-East Estonia in 2018

Ulmus laevis
fall colour

RESISTA®
‘New Horizon’
planted in 2015
Euroroute R1
From France to St. Petersburg

2016
Narva

RESISTA®
‘New Horizon’

2019 Tartu

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Dutch elm disease

- More than a century
- 2 pandemics
  - *Ophiostoma ulmi*
  - *Ophiostoma novo-ulmi*
- Alberta and British Columbia are free of DED?

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Symptoms of DED

yellowing

flagging

CODIT

tyloses

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Spread

- Vectors *(Scolytus* spp.)
  - The native elm bark beetle, *Hylurgopinus rufipes.*
  - The smaller European elm bark beetle, *Scolytus multistriatus.*
  - The banded elm bark beetle, *Scolytus schevyrewi.*
- Root grafts
- International trade

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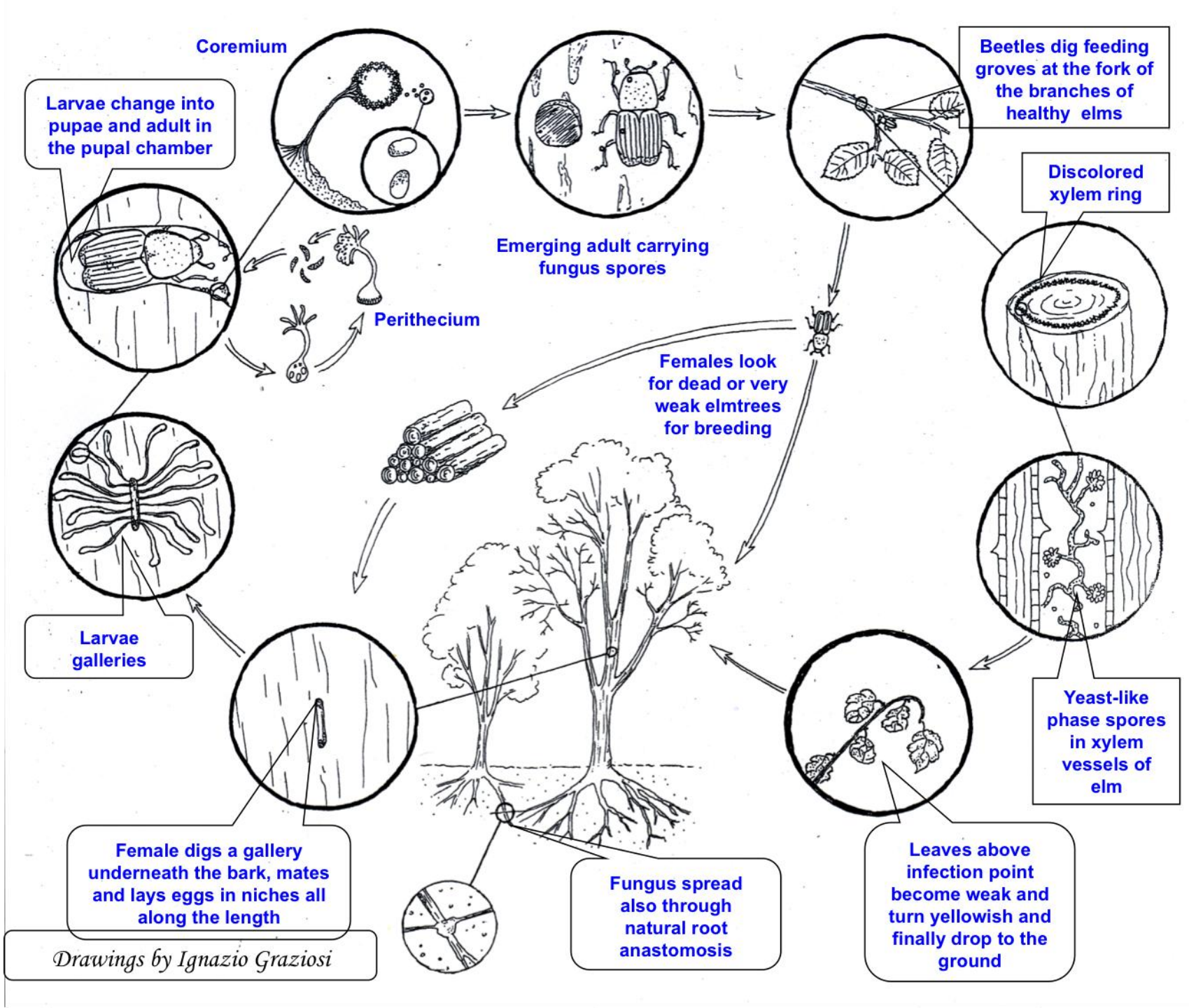
Santini and Faccoli, 2014



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Vectors of DED

Scolytus sp.

entry holes

Bark beetles' larvae "patterns"

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Vectors of the pathogen

in Estonia

- *Scolytus scolytus*
- *S. multistriatus*
- *S. triarmatus*
- *S. laevis*

in Saint-Petersburg

- *Scolytus scolytus*
- *S. multistriatus*
- *S. pygmaeus*

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Bark beetles sampling sites in Estonia and St. Petersburg

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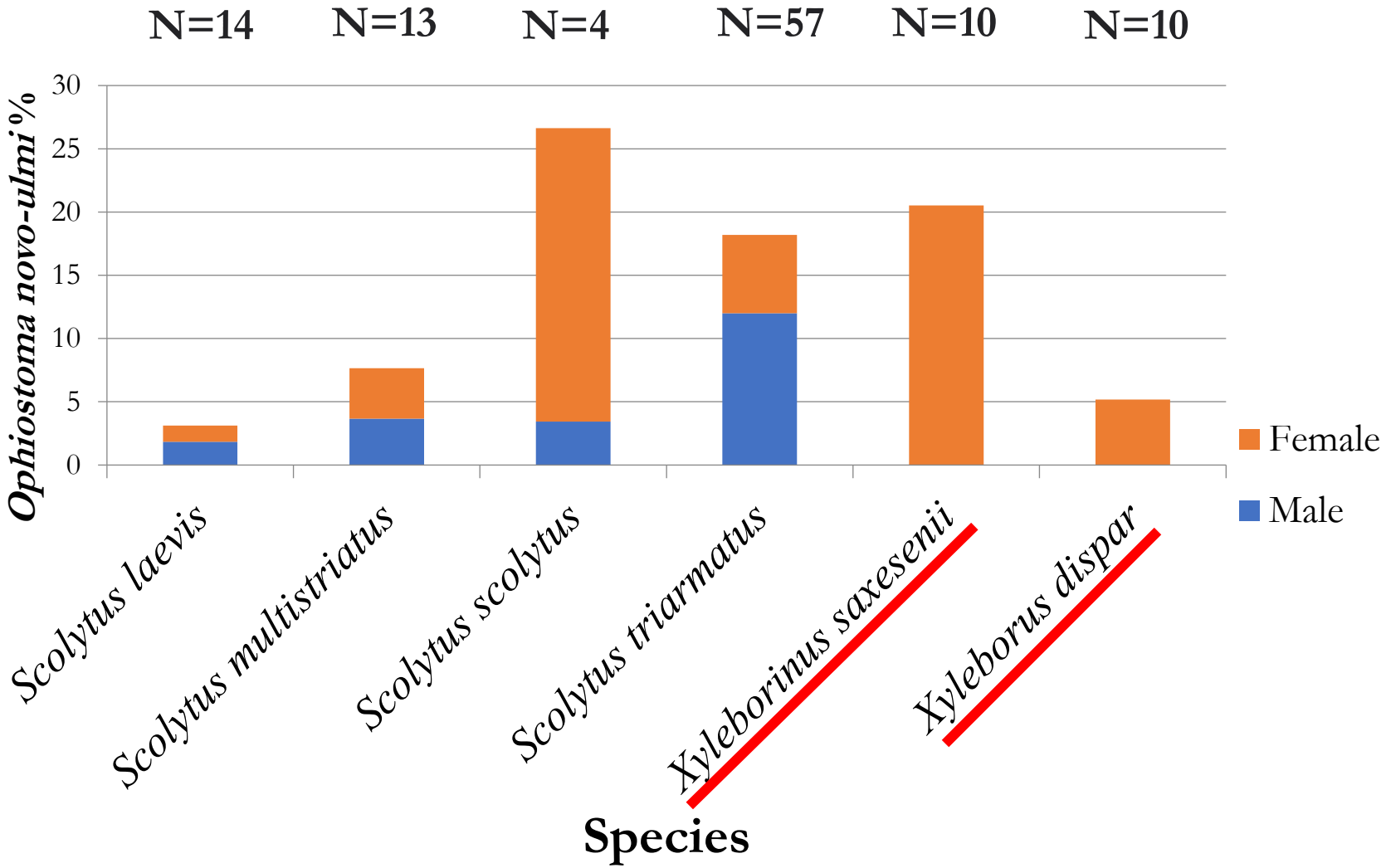
Percentage of *O. novo-ulmi* across different beetle species and gender



DED pathogens in Estonia

- *Ophiostoma ulmi* is reported in EPPO lists since 1979
- *O. novo-ulmi* – identified in 2006 (M. Hanso)
- *O. novo-ulmi* subsp. *novo-ulmi* and *americana* – 2017

DED pathogens in Russia

- in western regions of USSR and South-West of Asia in 1936 *Ophiostoma ulmi*
- *Ophiostoma ulmi* - reported in EPPO lists since 1979

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DED in Nordic countries

- Sweden – interactions between vectors and disease (2016)
- Not officially registered until last year in Finland and Norway

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Health condition of elms

1

healthy

2

branch loss

3

damaged

4

dying

5

dead

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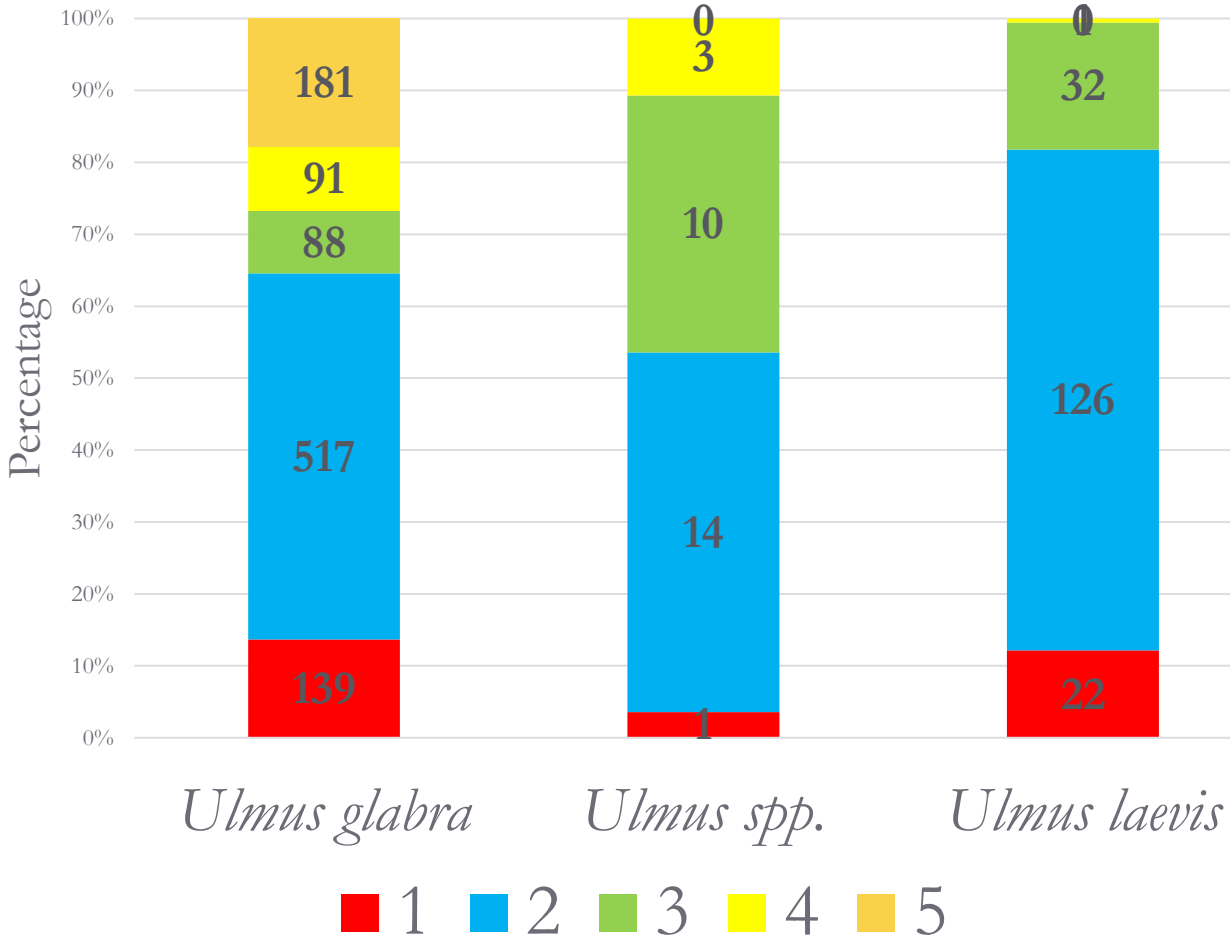
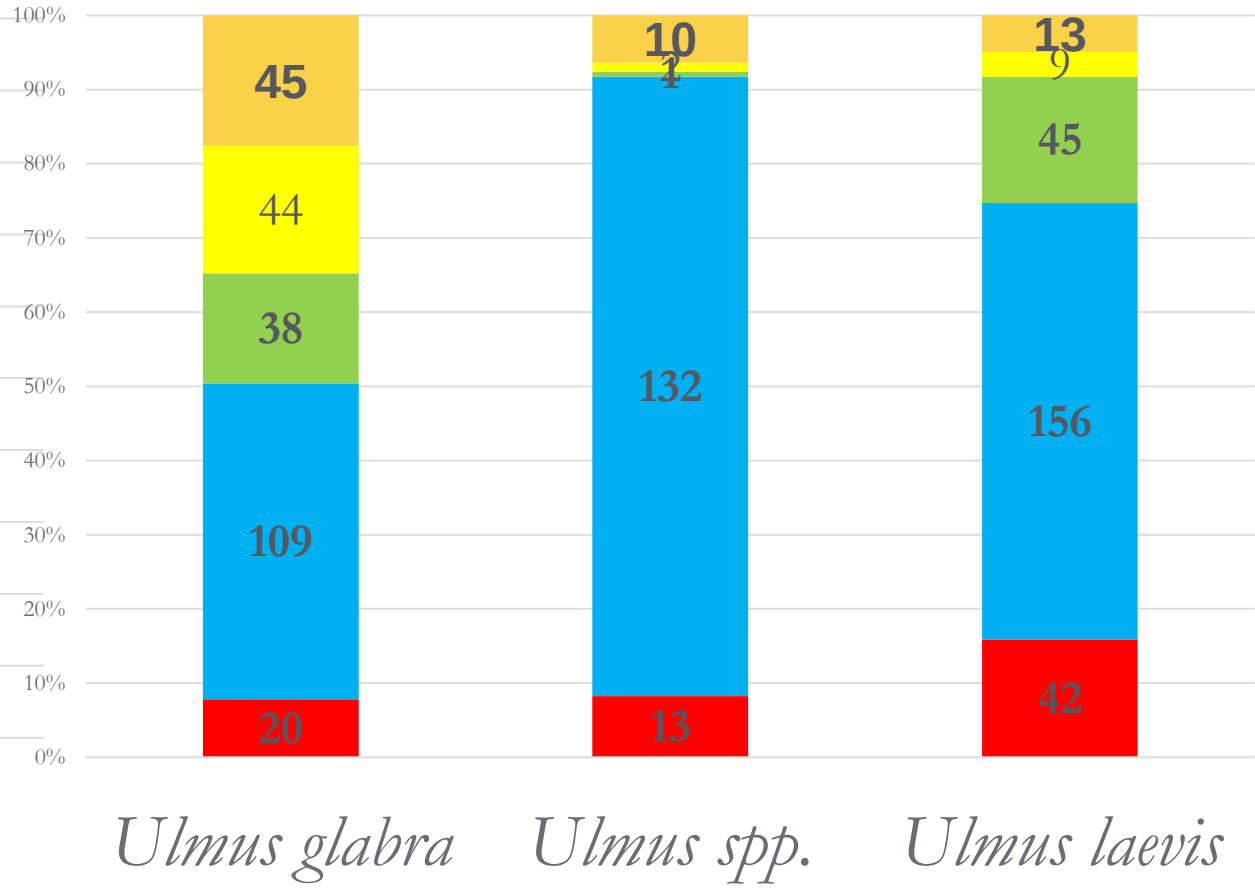
Vitality of elms

In Estonia (2014-2016)



In Russia (2016)



Ulmus davidiana var. *japonica* × *U. pumila* 'New Horizon'

Health of elms in St. Petersburg

- worsened substantially since 1995

YEAR	Afflicted plots
2002	29
2006	42
2007	76
2015	700

- In 2015, 5000< dead elms were cut down

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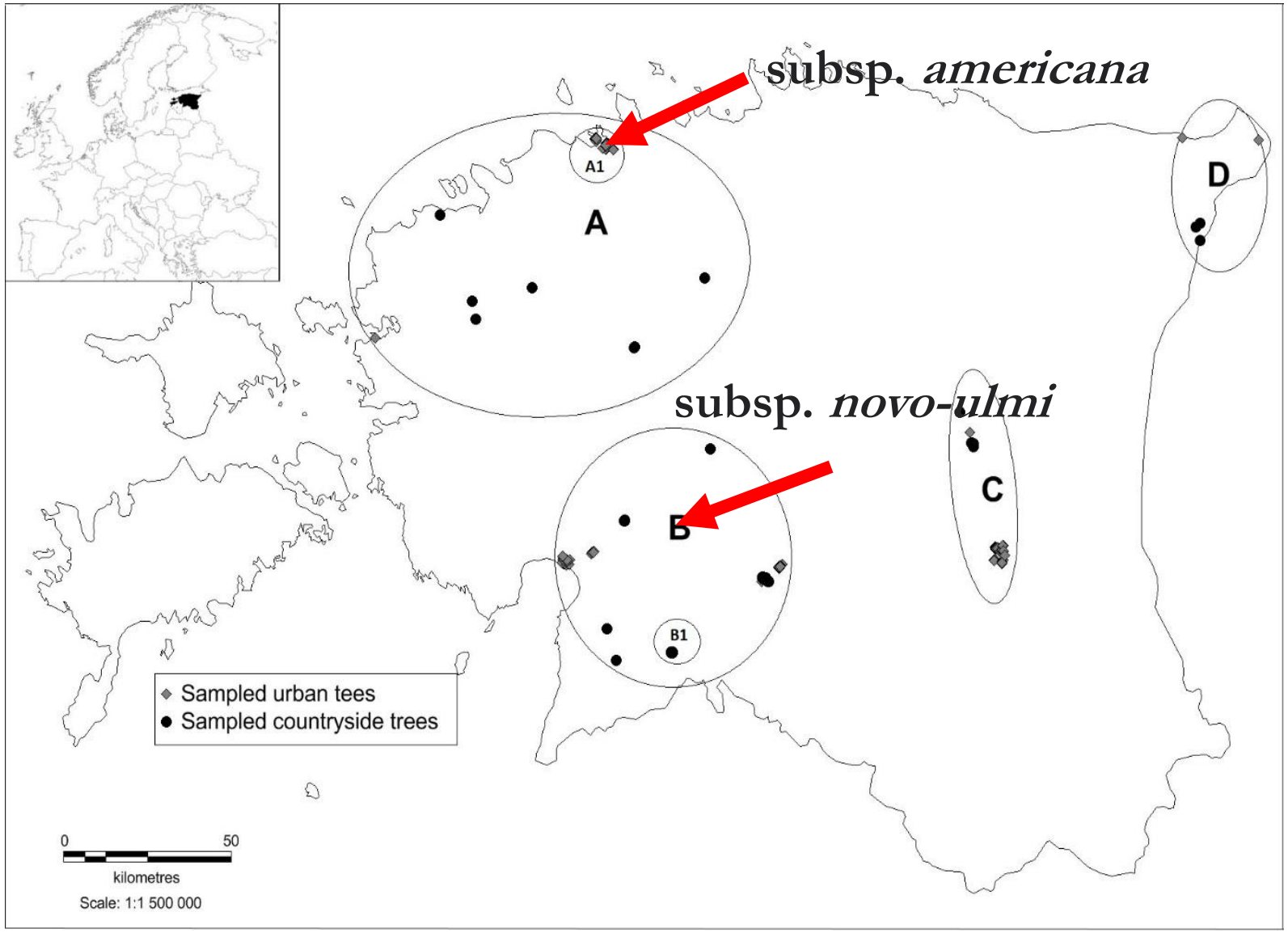
Aggressiveness of DED agents

After 24 months the same surveyed elms were found dead

- 28% (18) at sub-site A1
- only 4 (12%) at sub-site B1
- *Ulmus glabra*



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Sampling sites in Russia

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RESISTA®

‘Dodoens’

U. glabra

'Exoniensis’

x

U. wallichiana

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Ophiostoma novo-ulmi

- Isolation of fungi;
- Detection of the pathogen from pure fungal cultures
  - ITS1-F (Gardes and Bruns, 1993) and ITS4 (White et al., 1990);
  - confirmation by sequencing

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Identification of subspecies

- Gene *col1* species-specific primed PCR (Konrad et al. 2002)
  - *Ophiostoma novo-ulmi*
    - subsp. *novo-ulmi*
    - subsp. *americana*

- Difference in 6 nucleotides between the subspecies

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Identification of hybrids

- The *cu* gene region was amplified with the primers (Pipe et al. 1997)
- digested by restriction enzyme *Hph I*

- The PCR products were visualized on 1% agarose gels under UV light

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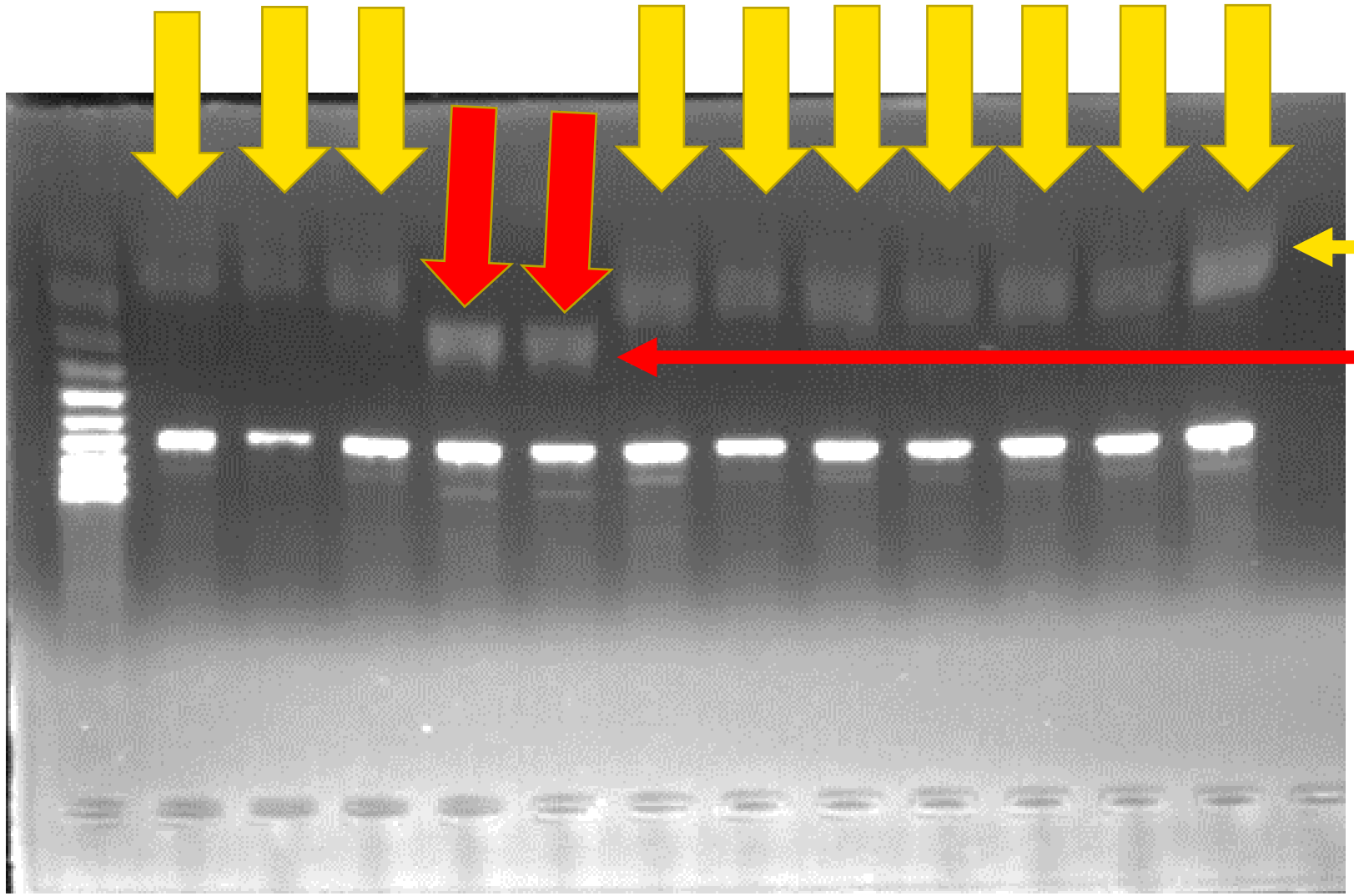
Detection of pathogen hybrid



subsp. *novo-ulmi*

subsp. *americana*

cu + enzyme *Hph* I

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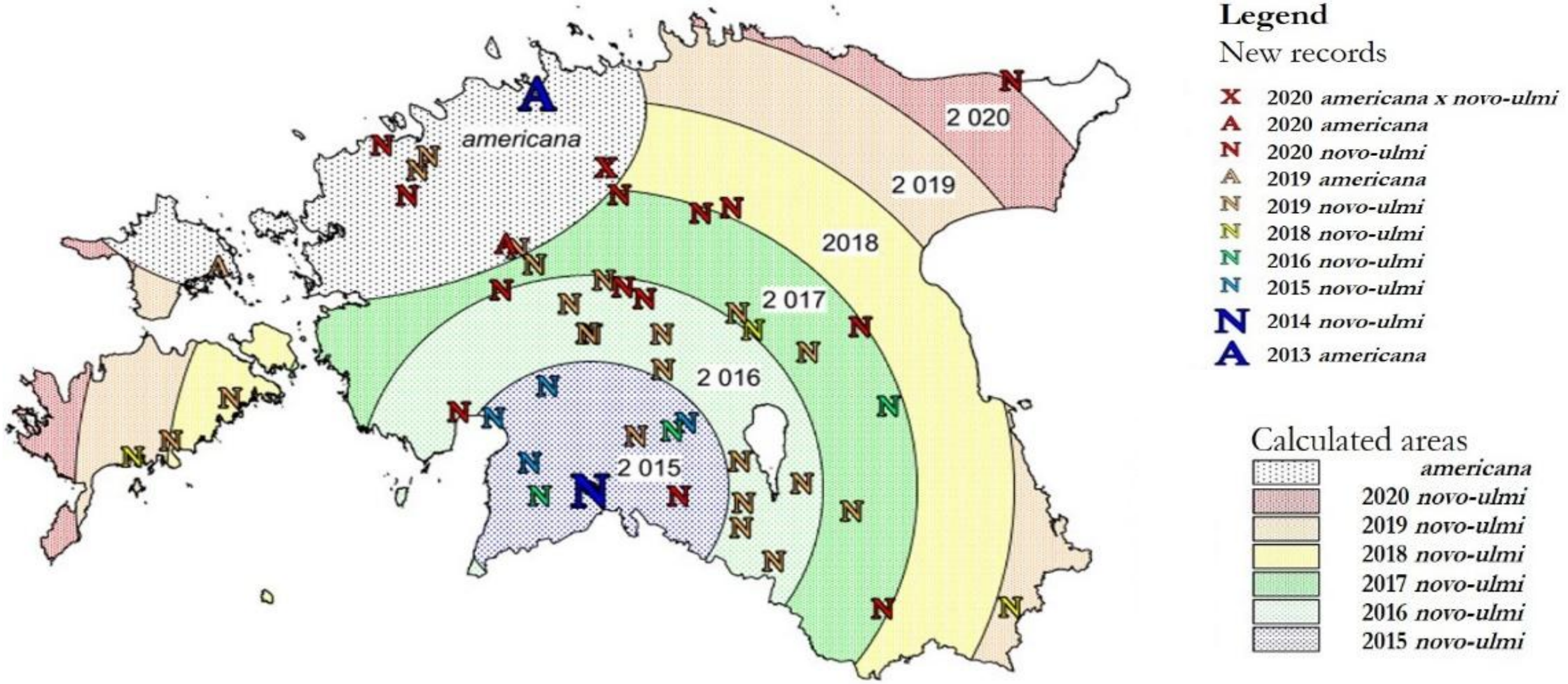
Locations of positive samples for DED agent subspecies in Estonia



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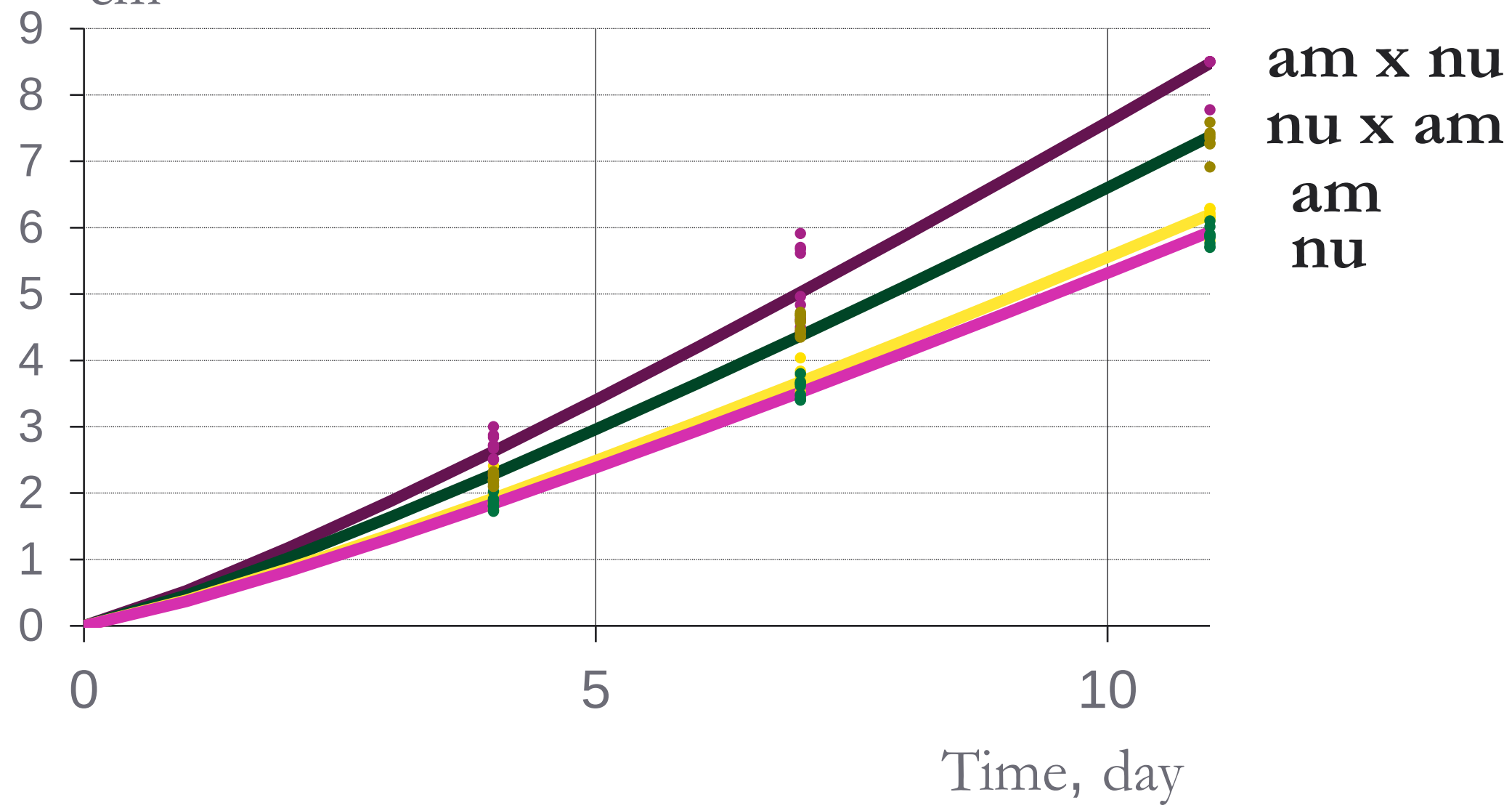
DED pathogens in Russia

- *Ophiostoma novo-ulmi subsp.*
  - *novo-ulmi*
  - *americana*
  - *novo-ulmi* × *americana*
  - *americana* × *novo-ulmi*

Fungal growth rate measurements *in vitro* on MEA at room temperature



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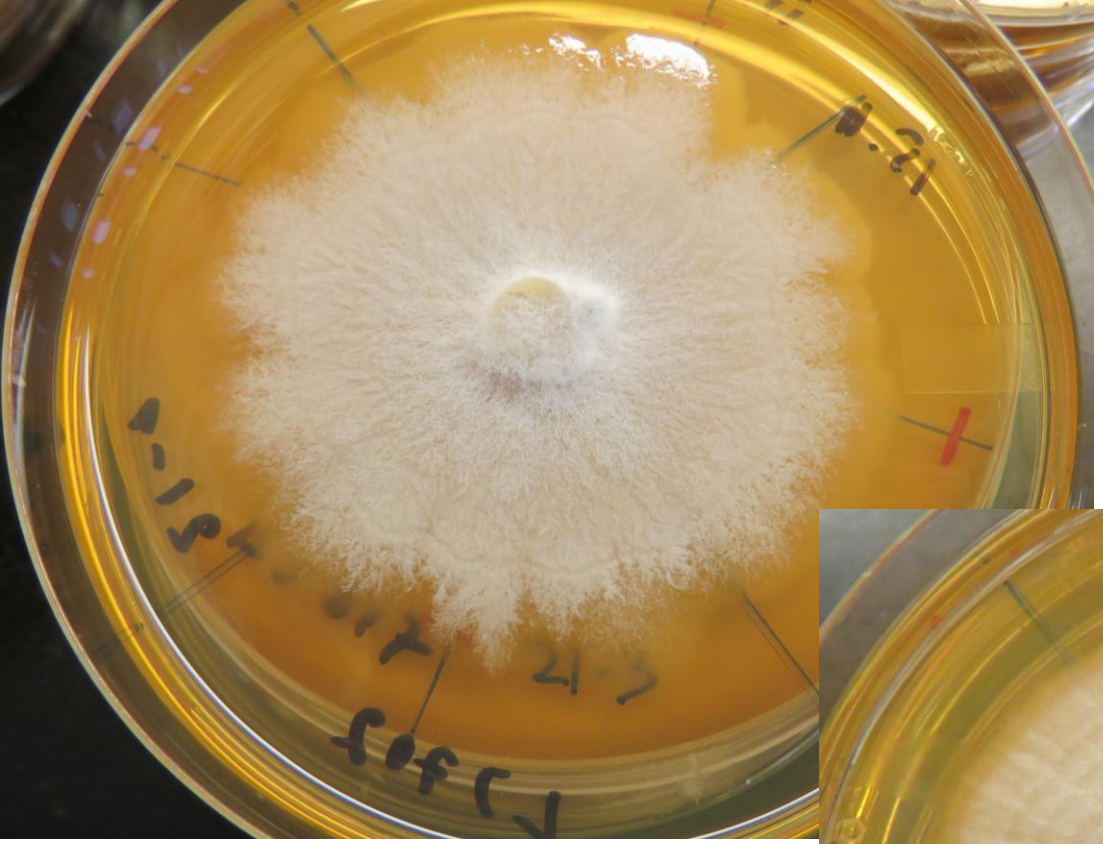
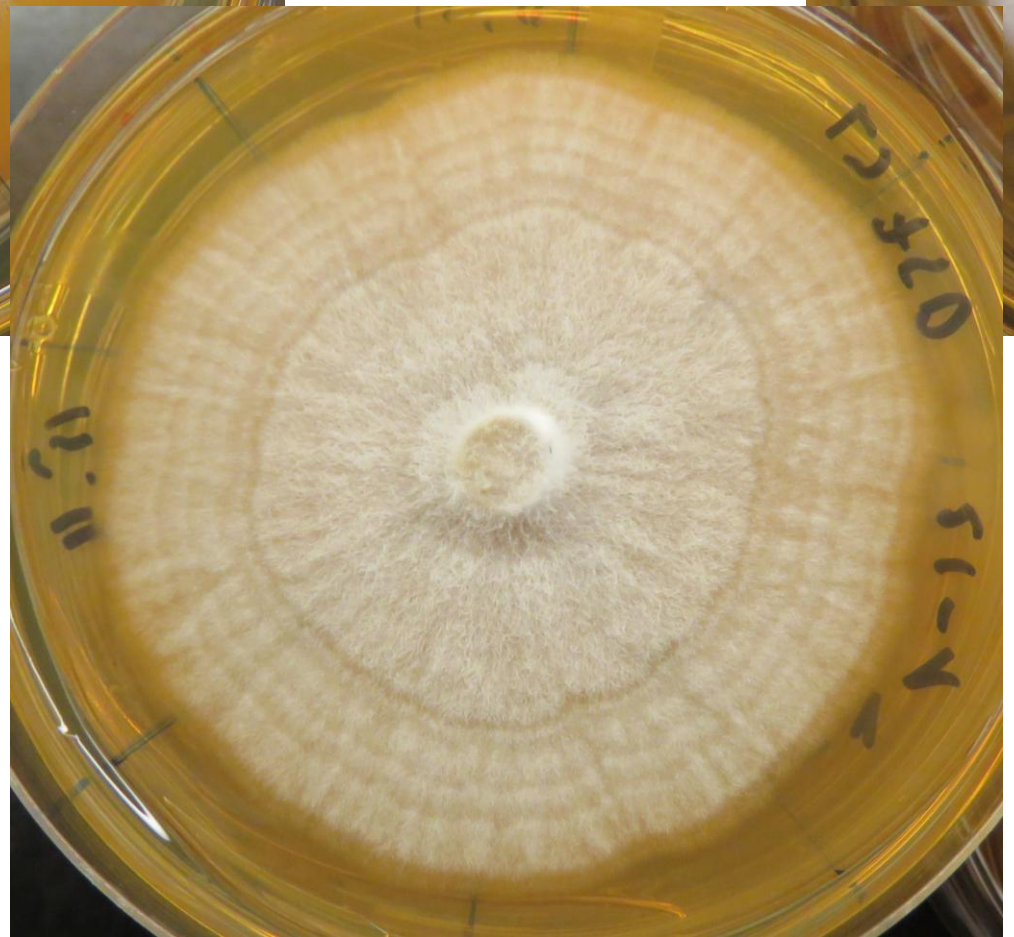
- 960 plates
- 3 repetitions
- 2 different temperatures





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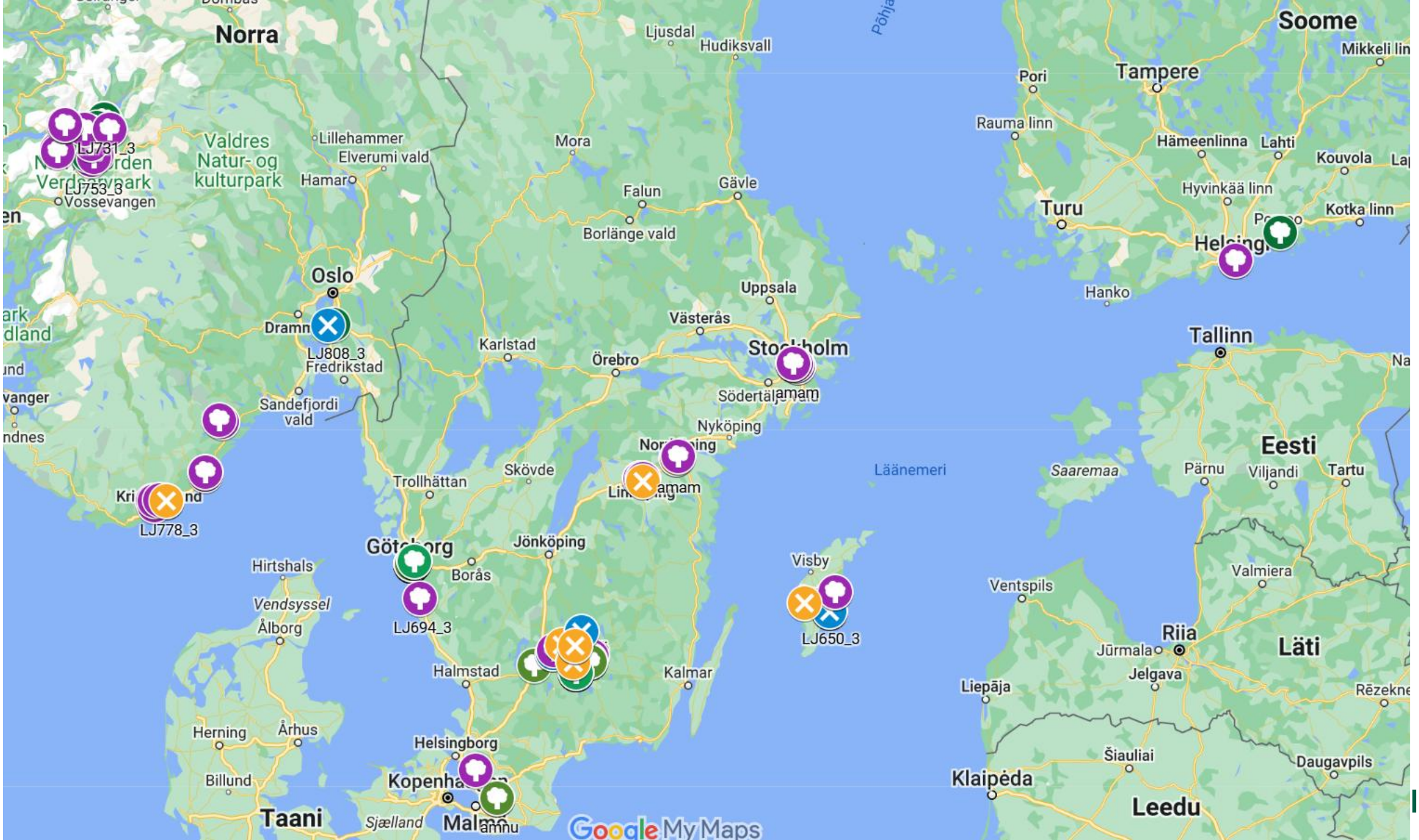
Inoculation tests on apples

Necrosis rates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Suuremõisa
Mustvee
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Audru
Pihtla
Surju
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Liivi laht
Valmiera

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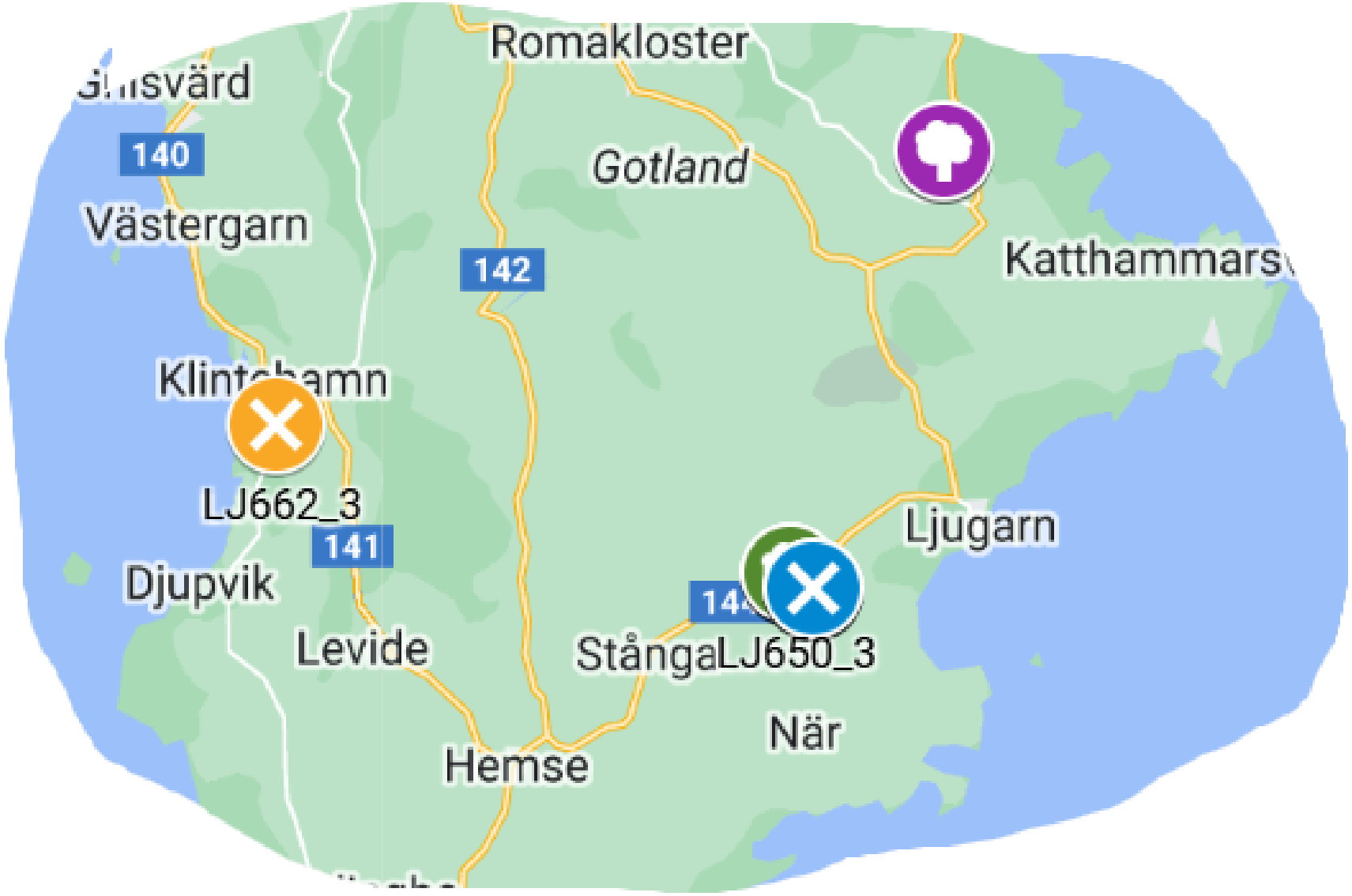
Gotland

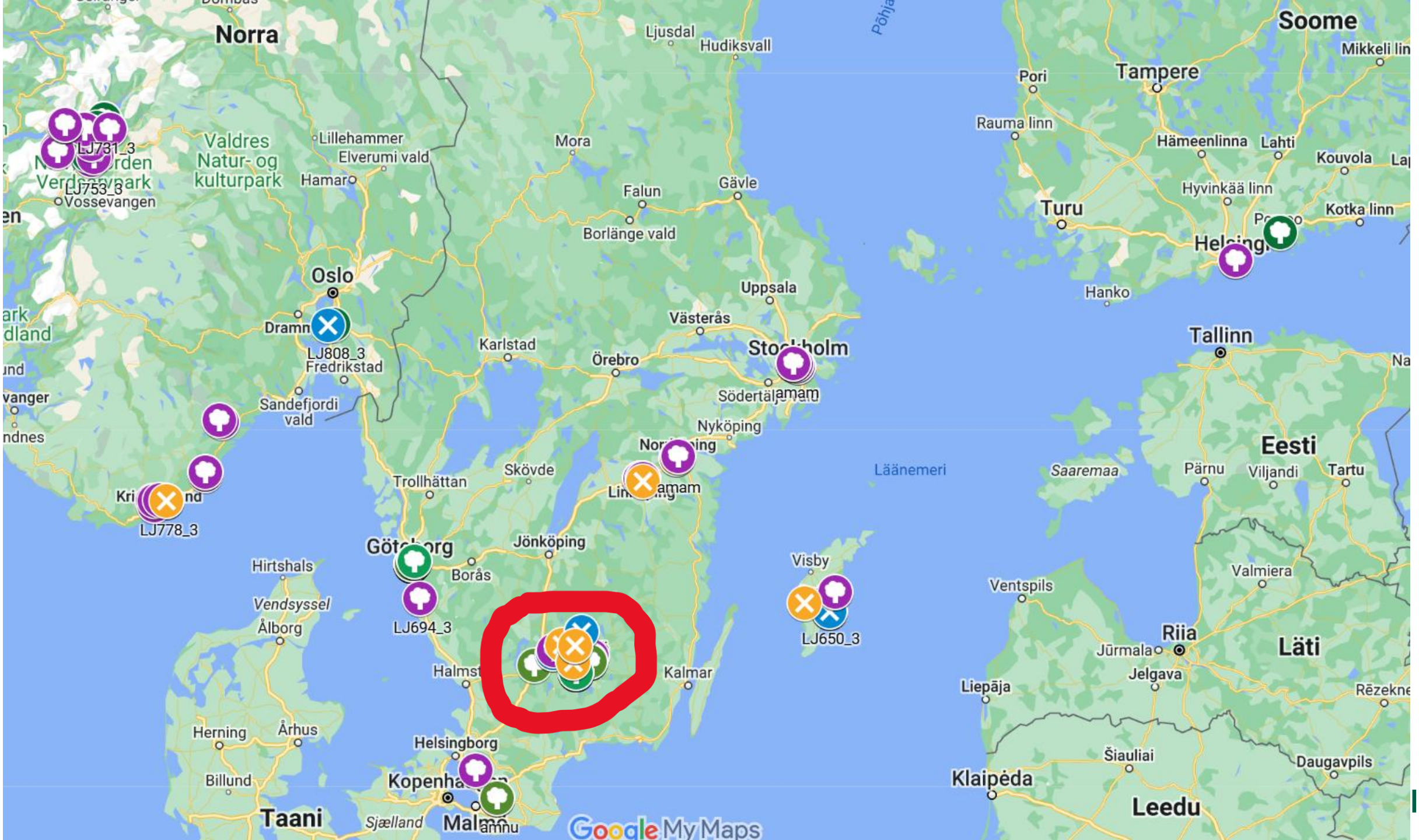


amam

amnu

nunu

nuam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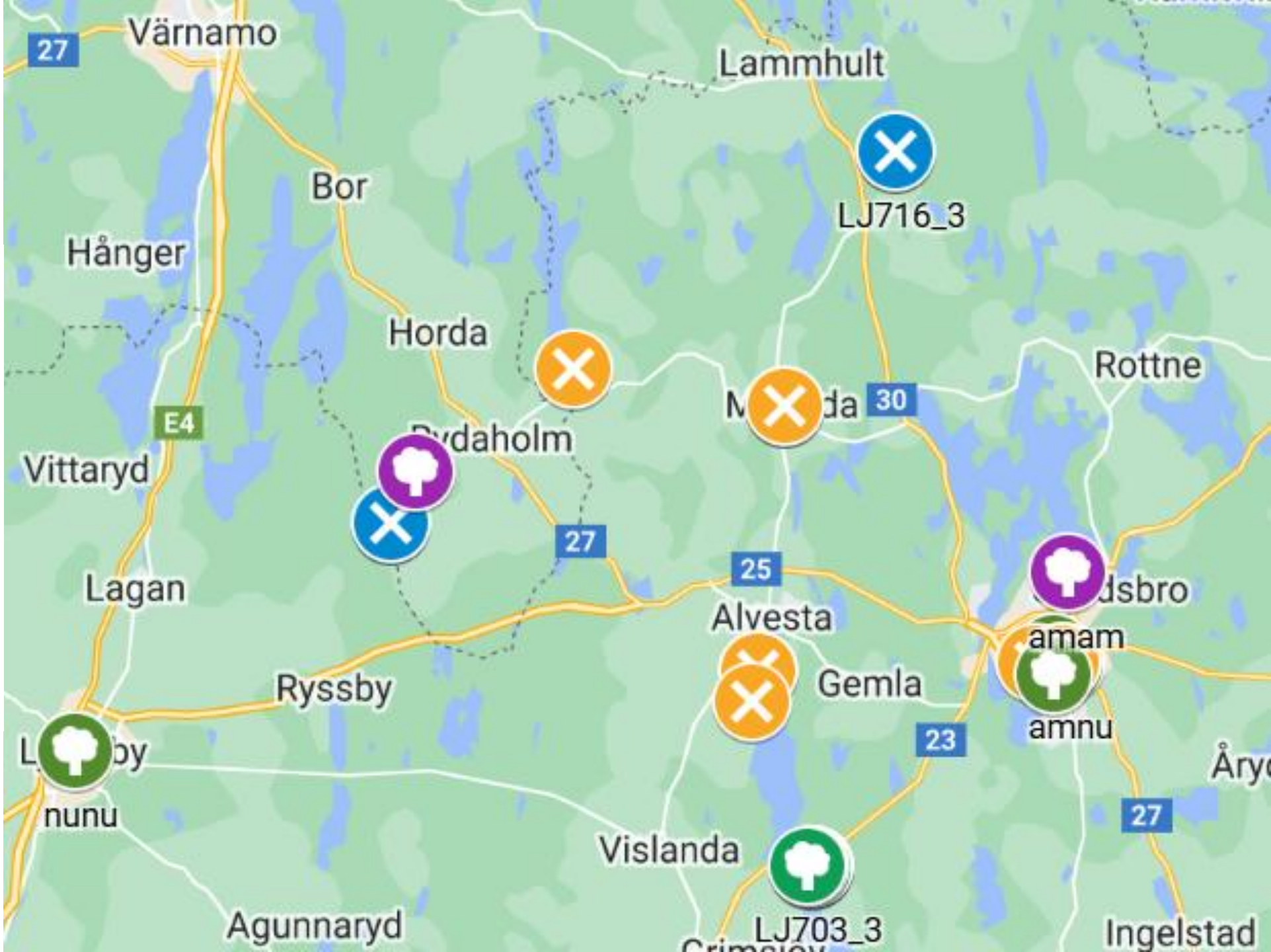

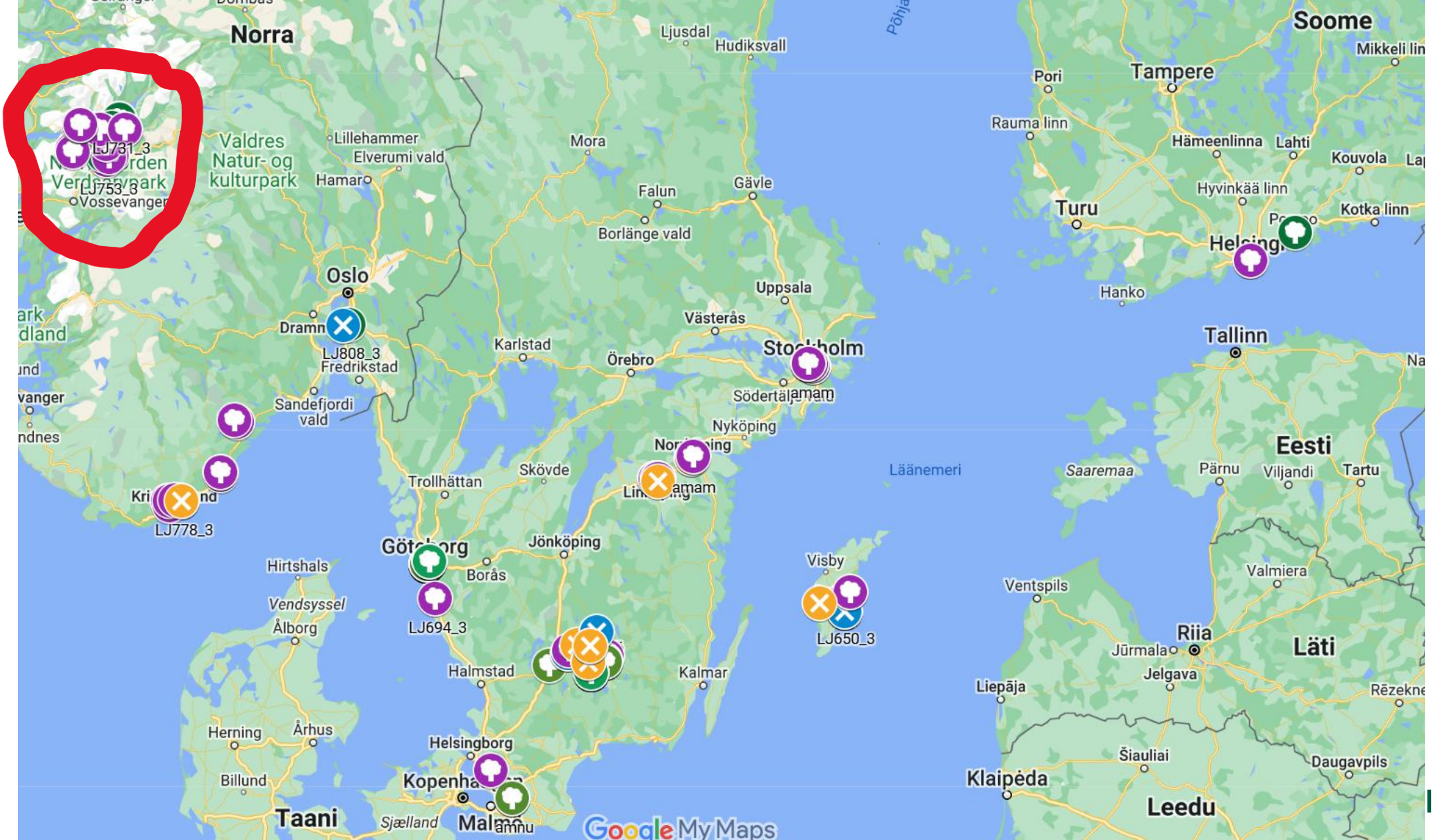
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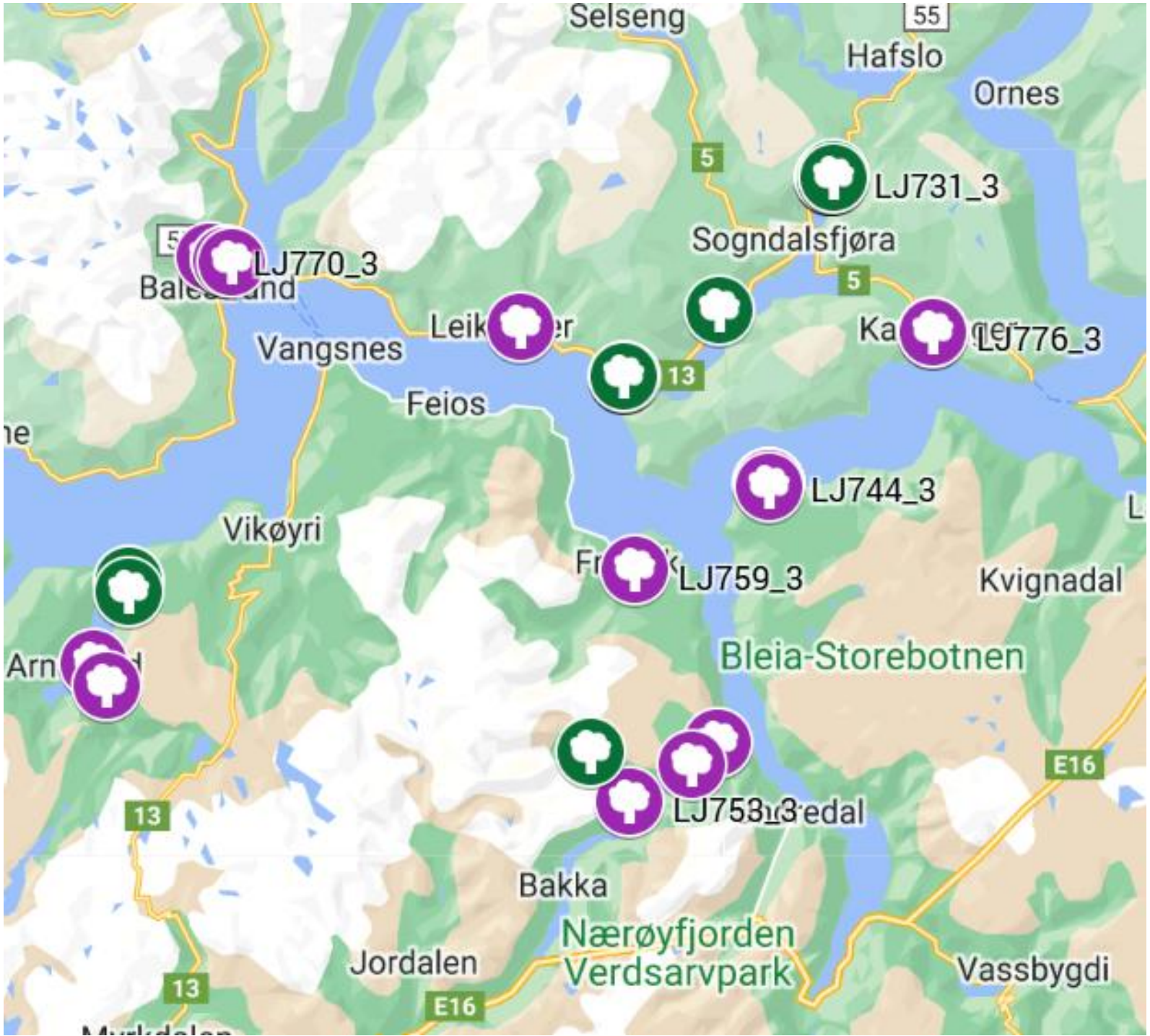

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New approaches for conservation of threatened elm trees through holobiont concept

The overall goal of this project is:

- to expand the current knowledge base for development of sustainable conservation strategies for elms (*Ulmus* spp.) under the threat of DED;

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Project

- the potential connections between the DED resistance and composition of associated fungal communities in elms.
- examine the consequences of vaccination treatment on the associated fungal and lichen biodiversity
- the resistance tests needed in future breeding efforts by characterizing the northern pathogen population.
- visits to expert collaborators' organizations

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‘Camperdownii’

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Ulmus laevis in St. Petersburg (2019)

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Is there any hope?

YES