



Ash DieBack in Europe

the Aim of this talk is ...

**TO SCARE ASH-OPTIMISTIC
AMERICAN
EAB COLLEAGUES**



**Dieback of Ash: early 1990s in
Eastern EU**

History

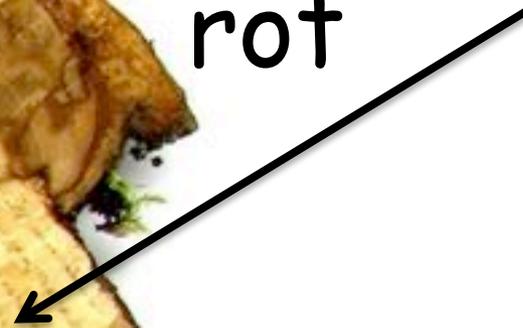
- o Lethal disease of *Fraxinus* spp.
- o No correlation with tree age, soil (moisture & fertility), environment (forest, urban, nursery, roadside ...)
- o First wild guess: *Armillaria* (honey fungus)? (but why?)





... but what's
ahead, killing
cambium ?

*Yes, Armillaria
rot*



Enderle R, Sander F,
Metzler B (2017)
i-Forest (in press)

Subsequent development of Ash DieBack in Europe

- o Stepwise geographic spread
- o Massive tree death
- o Currently, over larger part of Europe
- o Threat for species existence (in Sweden, since 2010 *Fraxinus excelsior* is Red-listed)

EUROPE



Mid-1990s

EUROPE



Late-1990s

EUROPE



Early-2000s

EUROPE



2011

EUROPE



2012
UK

EUROPE



2013
Ireland

EUROPE



2016
Serbia
(only areal
spread)



2017
Isle of Man
(only areal
spread)

... but *Armillaria* was present everywhere across European continent (and globally) for thousands of years, thus observed gradual stepwise disease expansion in a tidy frontline over large geographic range indicated that there must be something new coming ...

... but what?

...again, a closer look to the symptoms ...



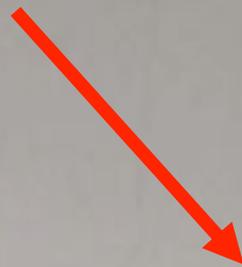
Enderle R, Sander F, Metzler B (2017), *i-Forest* (in press)

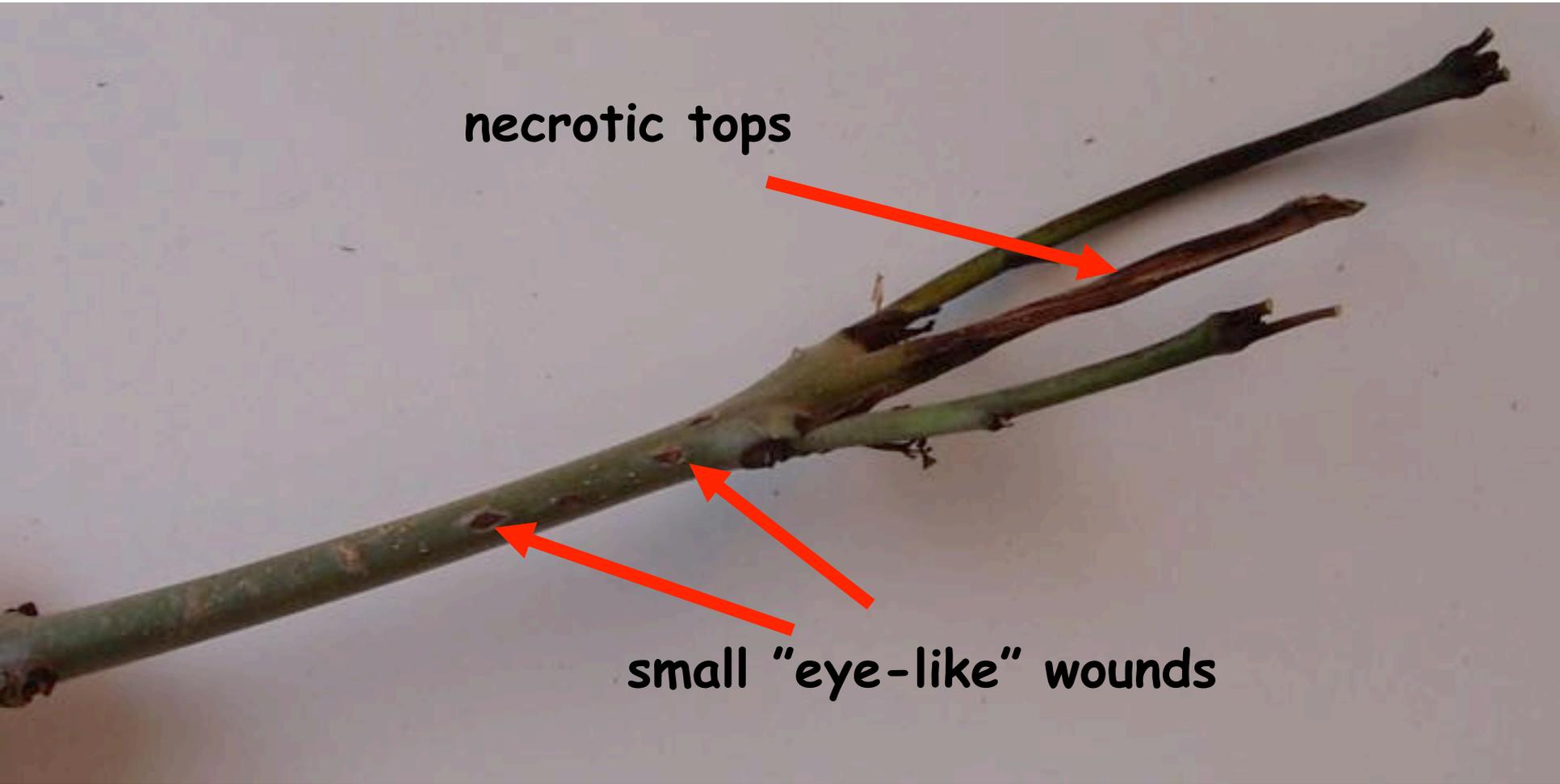
yet many more &
different external
symptoms:

on shoots ...



necrotic bark & dead cambium

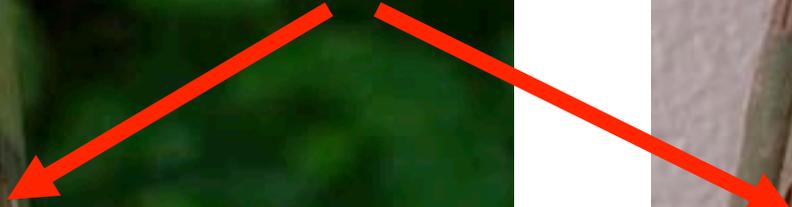




necrotic tops

small "eye-like" wounds

bigger bark wounds



canker wounds



symptoms on leaves

wilt 



necrotic leaves & petioles



Pathogenicity tests

- isolations of fungi into pure culture (> 1000 isolates)
- 45 most common mycelial morphotypes (species) from crowns, stems and roots of declining trees
- inserting their mycelia to 700 one-year-old *Fraxinus excelsior* seedlings
- bare root nursery and greenhouse



Pieces of pre-colonized wood
(1x1x5 mm) ...



... taped to a 1x5 mm wound.



Direct analyses (ITS), % of samples

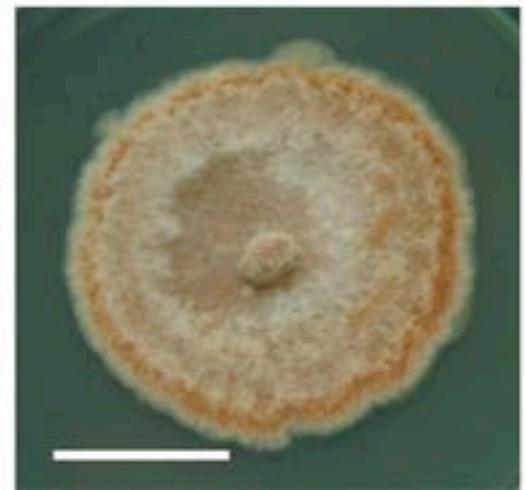
Fungi (in 34-70% of all 96 samples)	bark	petioles	leaves
<i>Cryptococcus foliicola</i> ?	48	63	100
<i>Cryptococcus</i> sp. ?	38	72	93
<i>Hymenoscyphus</i> sp.970	41	97	39
<i>Phoma glomerata</i>	76	13	71
<i>Phoma exigua</i>	66	13	68
<i>Cladosporium</i> sp.	38	28	79
<i>Dioszegia</i> sp.	31	28	54
<i>Bullera coprosmaensis</i>	17	34	54
<i>Chalara</i> sp. ?	28	56	14

The test with *Hymenoscyphus*
sp.970: the only one of 45
yielding symptoms





- Origin: Far East Asia
- Ecology: in native environment, (harmless) decomposer of shed ash leaves
- Identity: *Chalara fraxinea* / *Hymenoscyphus fraxineus* (to date called 4 names)
- Entrance to EU: imported plants for planting
- Spread: plant material & airborne spores (flying far)
- Genetic diversity in EU: not too high, indicating few entries



Kowalski &
Holdenrieder (2009)
Forest Pathology

Ascospores: sexual
spores implying
genetic diversity

Airborne spread



H. albidus_ascospore release.wmv

39 second long thriller by
Prof. Thomas Kirisits

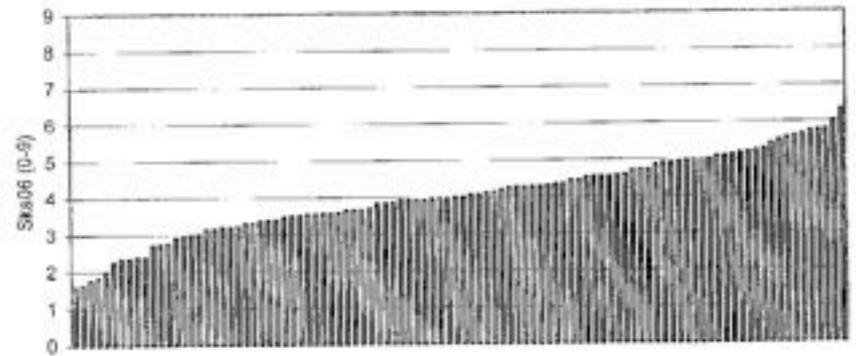
Perspectives: Breeding Ash

- In Europe, trials initiated about 10 yrs ago
- Inventory & mapping of healthy looking trees
- Following "durability" of resistance over time
- Progeny trials & propagation
- Establishment of seed orchards / banks of dieback-resistant ash

Different susceptibility of *F. excelsior* genotypes

Stener (2007):

- 15 yr-old clonal seed orchard
- 100 clones
- 6-29 (aver. 17) ramets per clone



Figur 1.
Genotypvärden för Skadegrad sorterad i stigande ordning (ju högre värde desto större skada). Varje stapel representerar en plussträdklon.

Preliminary hints

- strong evidence for genetic variation in resistance against Ash DieBack
- potential available for breeding for resistance
- yet, the proportion of genotypes initially deemed as ADB-resistant decrease with time
- the pathogen genetically recombines on yearly basis, while trees are to remain for 100s of yrs
- Emerald Ash Borer is closing from Russia
- should hybrids of European Ash with Asian be considered?

Searching for resistance: a case study

Differences in susceptibility to dieback clearly manifested on a long-term basis



Identification of dieback-resistant genotypes (screened by nature)



Some TASKS of EU LIFE+ project on Gotland Island, Sweden

i) identify and map at least 100 presumably dieback-resistant *F. excelsior* genotypes native to Gotland;

ii) collect seeds from those;

iii) establish seed bank as a sawn plantation;

iv) monitor health status both of mapped "mother" trees and eventually emerging sawn seedlings in the plantation

Gotland Island



Criteria for selection: just two

- 1) Good-looking (symptomless)
- 2) Adjacent to ash trees killed by dieback long time ago (10 years or so)

Mapping (GPS, Gotland island)



Implementation strategy

- 123 trees were selected, assigned a unique ID and labelled
- Trees were measured, photographed and GPS recorded
- All data is compiled into a database
- Selected trees are monitored for health status and vitality
- Latest news: plantation sown !!!

Establishment of seed bank of dieback-resistant *F. excelsior* in order to replant disease-damaged Natura 2000 sites



1. Seeds collected from selected & mapped trees resistant /tolerant to ADB



2. Selection of site (former barley field) & 3. Seeds sown in massive amounts (September 2014)



Forest owned by SLU

... just after a single season, by
September 2015, the results were just
beautiful!



... only no ash ... (authorities)

... but after the second year, by September 2016, the results were not so charming ...



... & no ash as well ... & rising certain tension at project stakeholder: deliverables (plantation) must be delivered

... consequently, it was decided to take the matter into our own hands

i) to plant on the site 2 - 3 year-old symptomless saplings excavated from forest stands of Gotland;

ii) ... from under canopy of diseased stands;

iii) in April 2017, plantation established composed of 1032 dug-out & planted saplings in 43 rows \times 24 trees, spacing 3 \times 3 m;

iv) "protection plates" against competing vegetation placed around each planted sapling.

...as susceptible saplings are to be killed by ADB already during the 1st season, thus planted 2-3 yr-old were somehow "pre-screened"



Inventory of the plantation accomplished in mid-August 2017, after 1st vegetation season

i) each planted sapling assigned individual number and its location & health status recorded;

ii) health status accounted in three categories

0 - dead;

1 - living with dieback symptoms;

2 - symptomless;

(ev. damage by rabbit noted)

0- dead:
killed by
ADB



0- dead: cut by a rabbit



The terrible animal



1- living
with
dieback



1- living
with
dieback



2- no symptoms





2-despite:
i)dug-out;
ii)planting
iii)drought
iv)rabbit
... stress ...



... and then, sudden
observation ...

a) *sawn?*

b) *planted*



Another angle:

a) 1st year seedling looking better than b) the one from planted 2- symptomless category



... a closer look ...



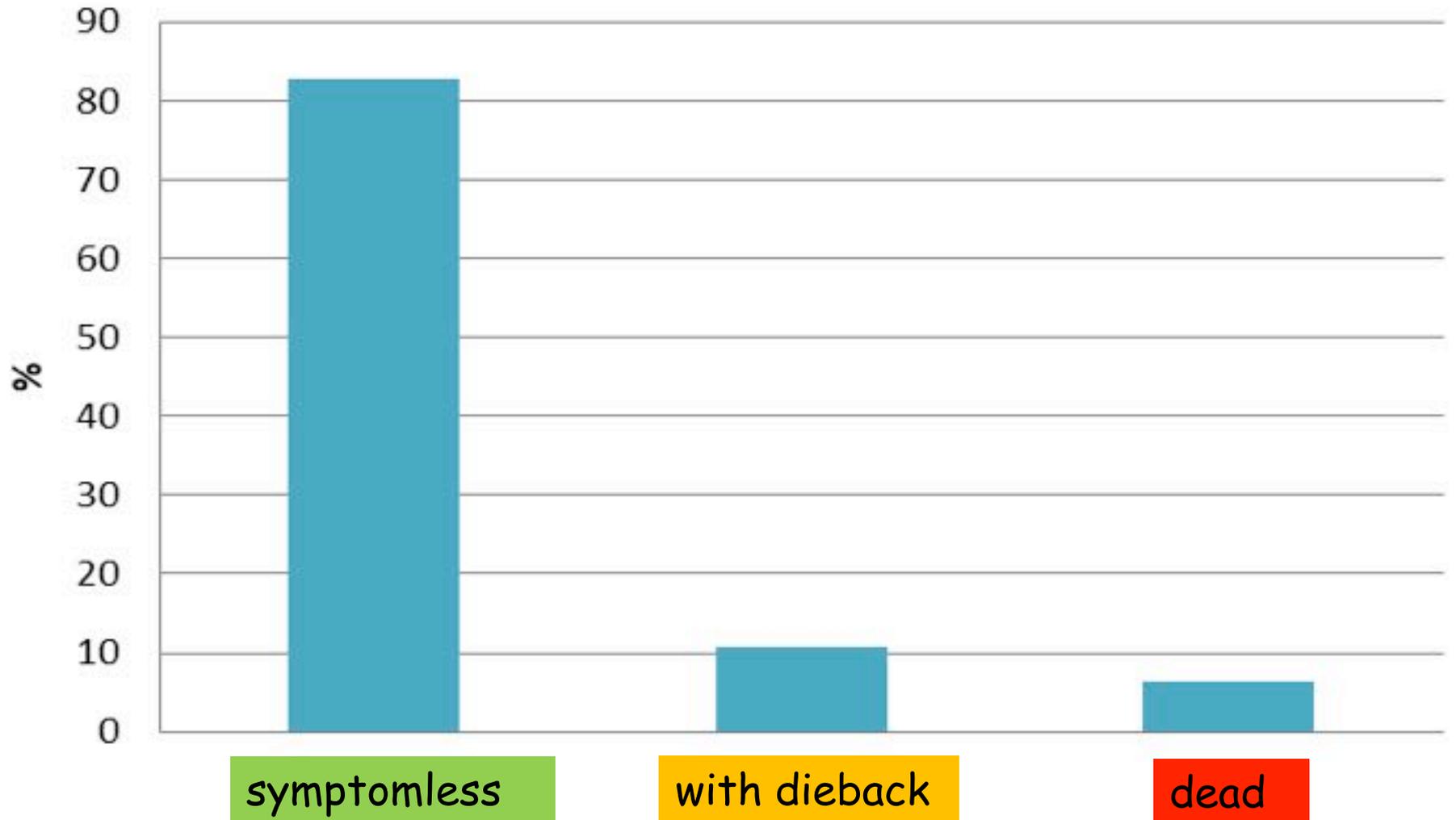
... then, numerous more closer looks ...



each (randomly) observed sawn ash:
category 2- symptomless



Results after 1st season (of planted 1032, sawn excluded)



Fencing in and out ...

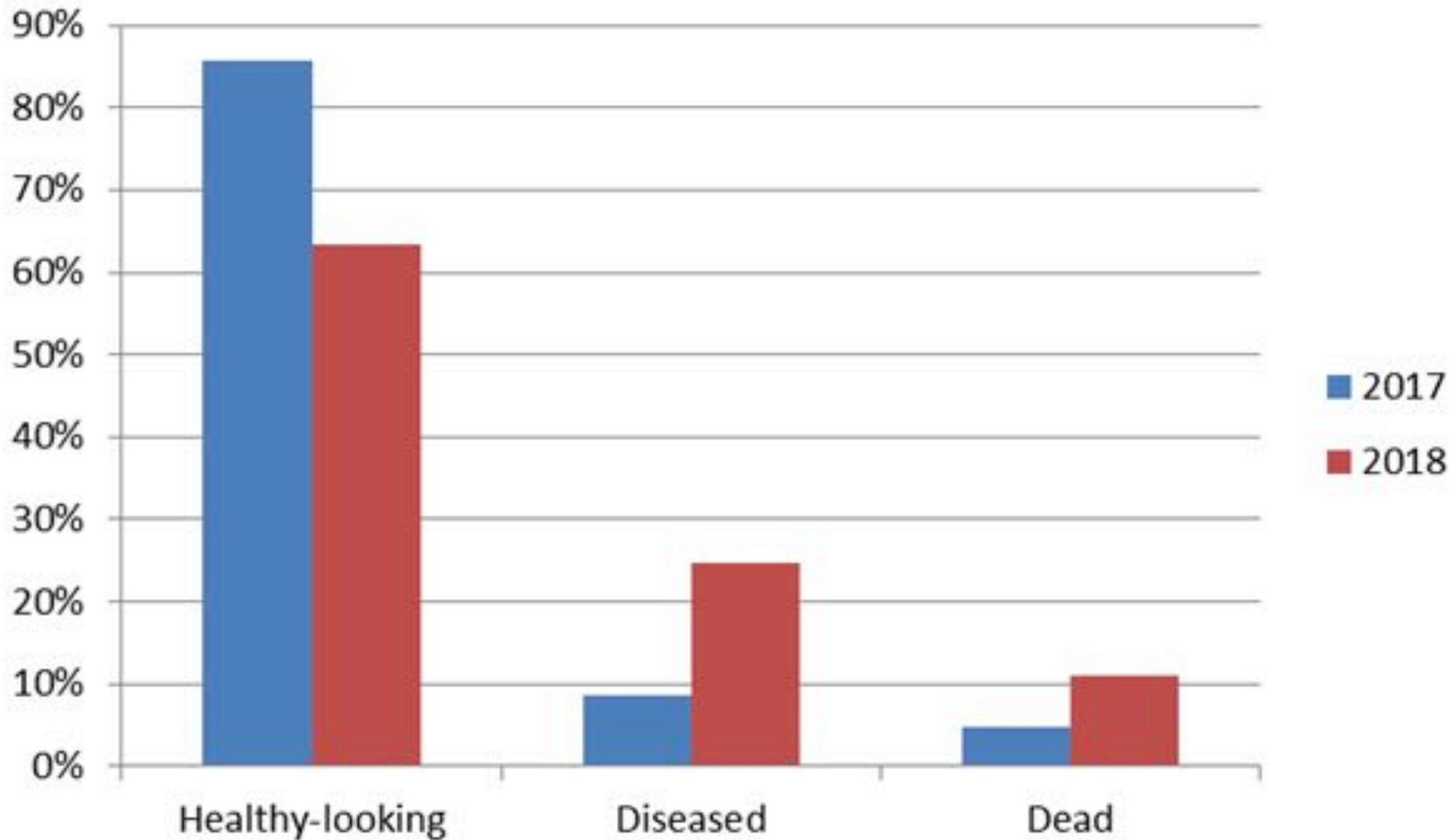




2nd season: record
drought of 2018 (view at
beginning of August from my
apartment window)



Results after 2nd season (of planted 1032)

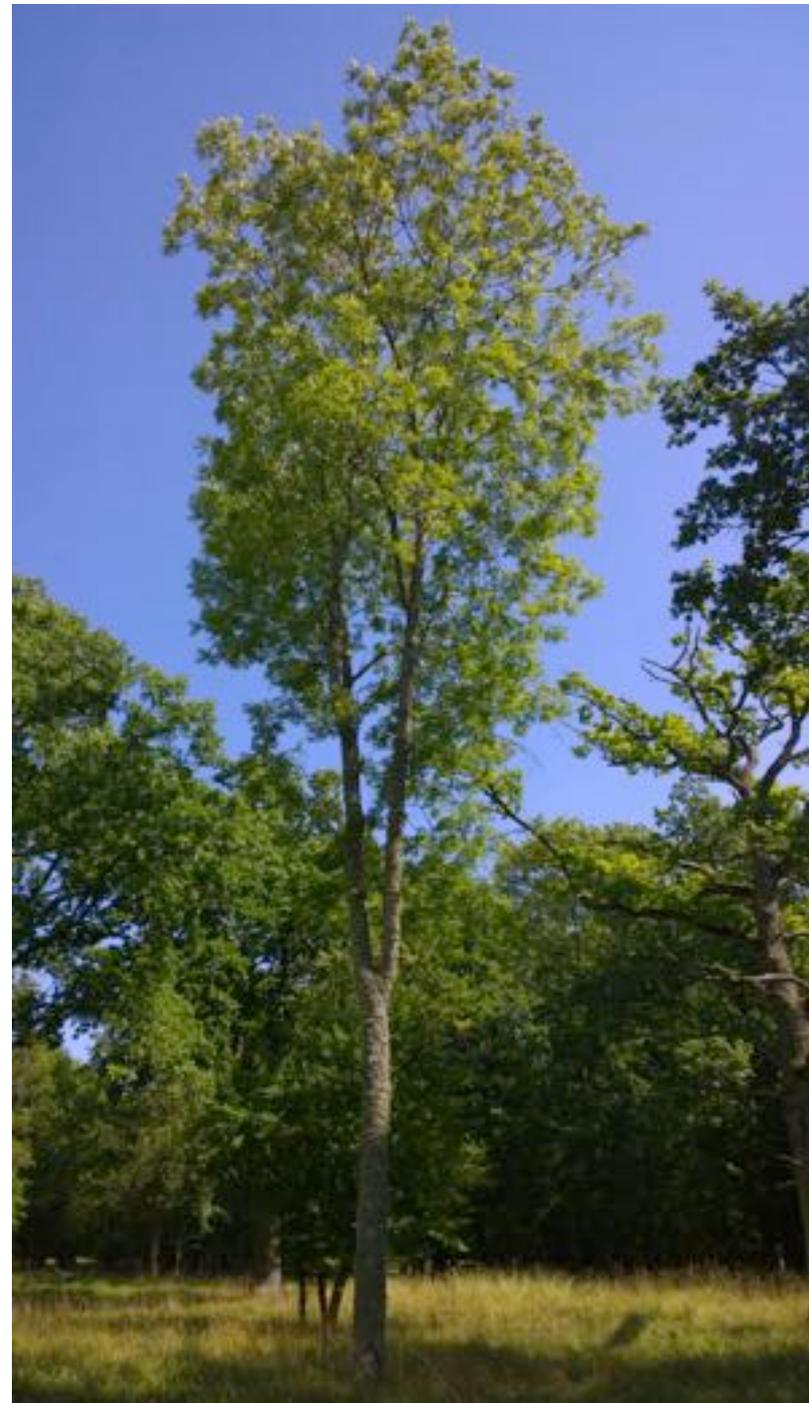


Two year-old sawn: no
ADB symptoms observed
on any of those seen



Monitoring health status of 123
"mother" trees:

over three vegetation seasons
mostly symptomless, and no one
with over 10% defoliation





The Team:

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Acknowledgements

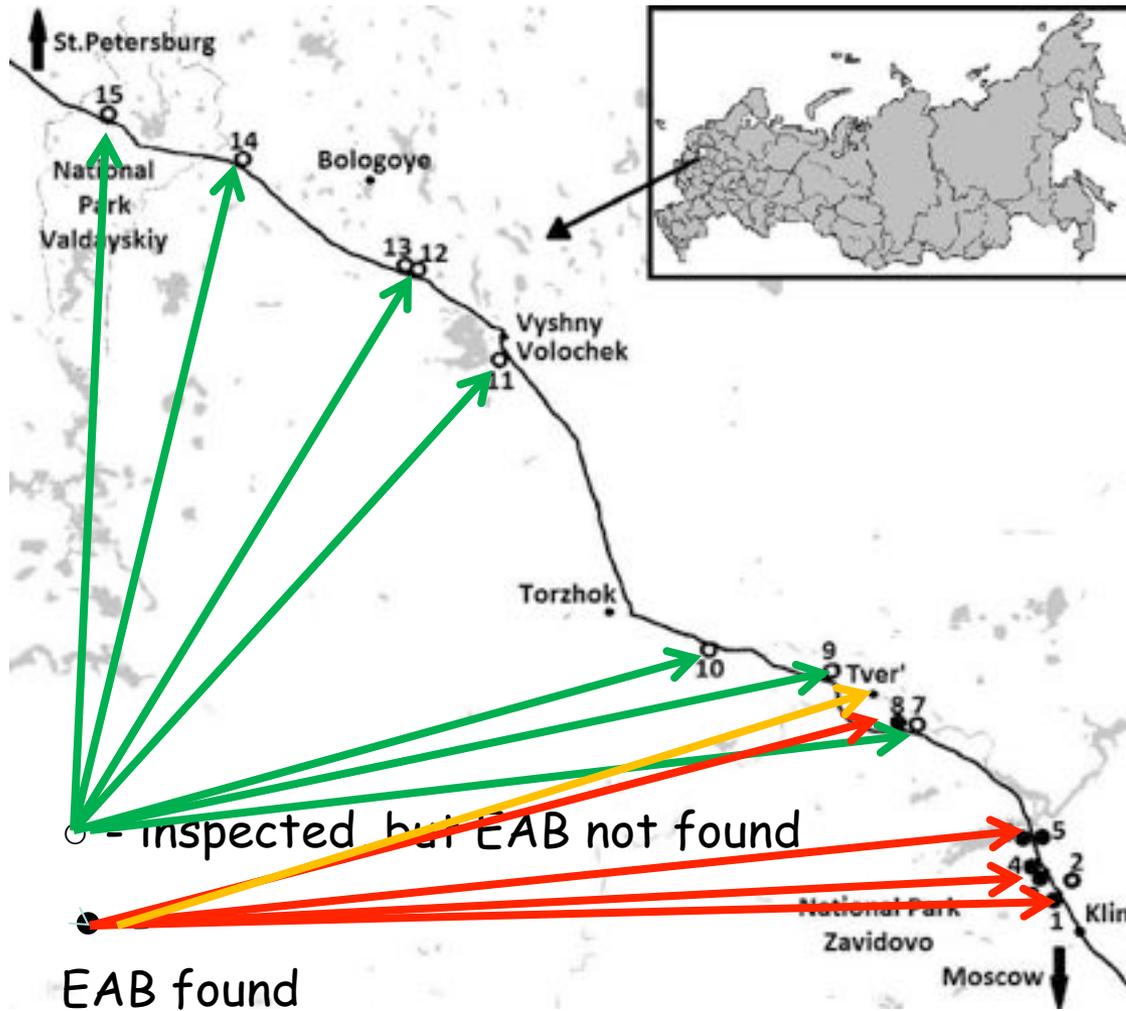
- *Gunilla Oleskog, Karin Wågström, Inga-Lena Östbrant*
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- COST Action FP1103 FRAXBACK
- Stiftelsen Oscar och Lili Lamms Minne
- Carl Tryggers Stiftelse för Vetenskaplig Forskning

Part 2

Emerald Ash Borer in North West Russia

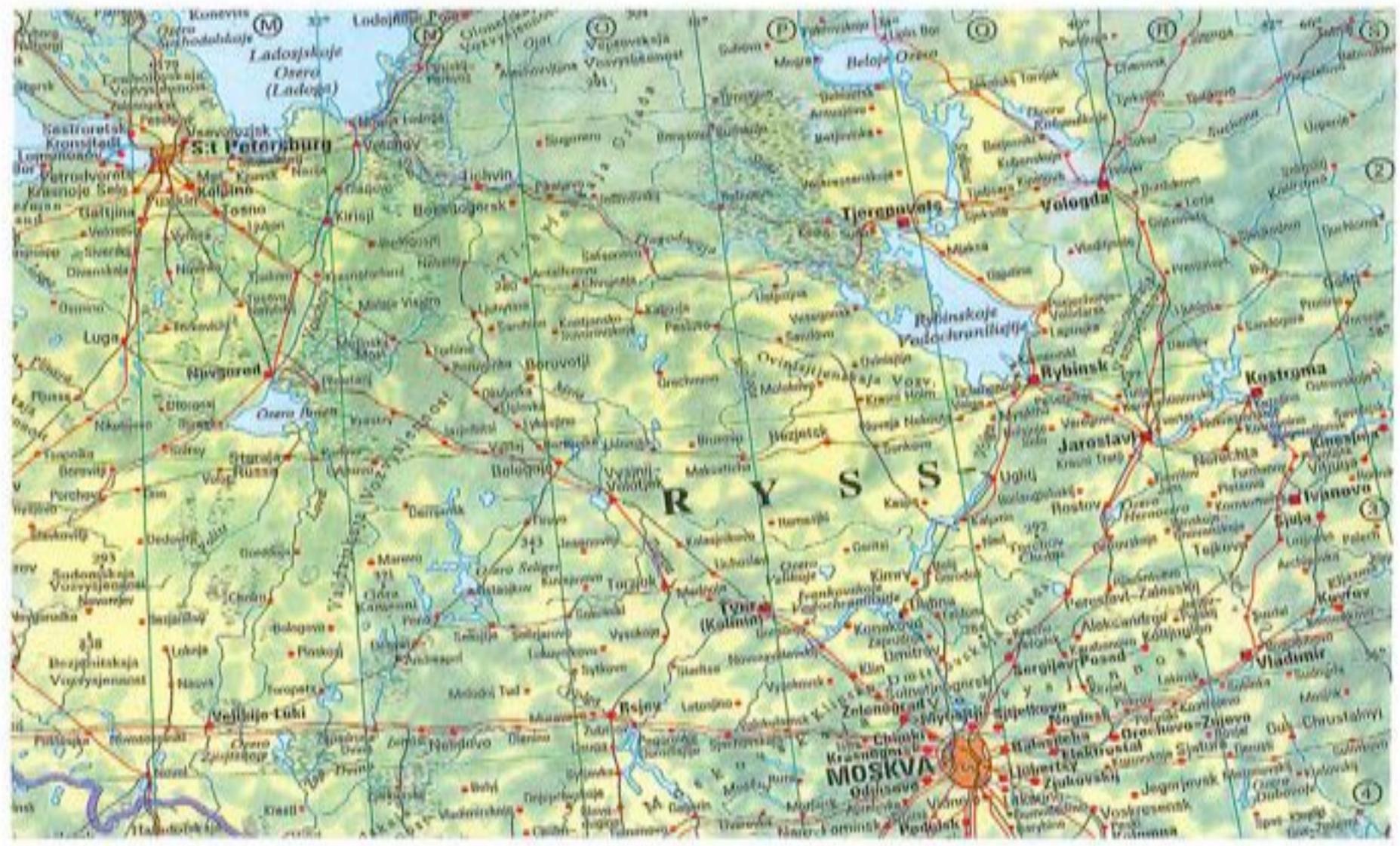
Focusing towards north-west: Moscow - Sankt Petersburg direction

- Aim: to estimate status quo with EAB spread towards north-west, from Moscow to Sankt Petersburg as for year 2016
- St.Petersburg and its suburbs would be very vulnerable to EAB: contain numerous historical parks and alleys with monumental ash trees
- ... but in later decades, ash was commonly planted along federal highway Moscow - St.Petersburg
- As natural occurrence of ash in surrounding forests is scarce, inspecting roadside trees provided excellent opportunity for monitoring EAB spread

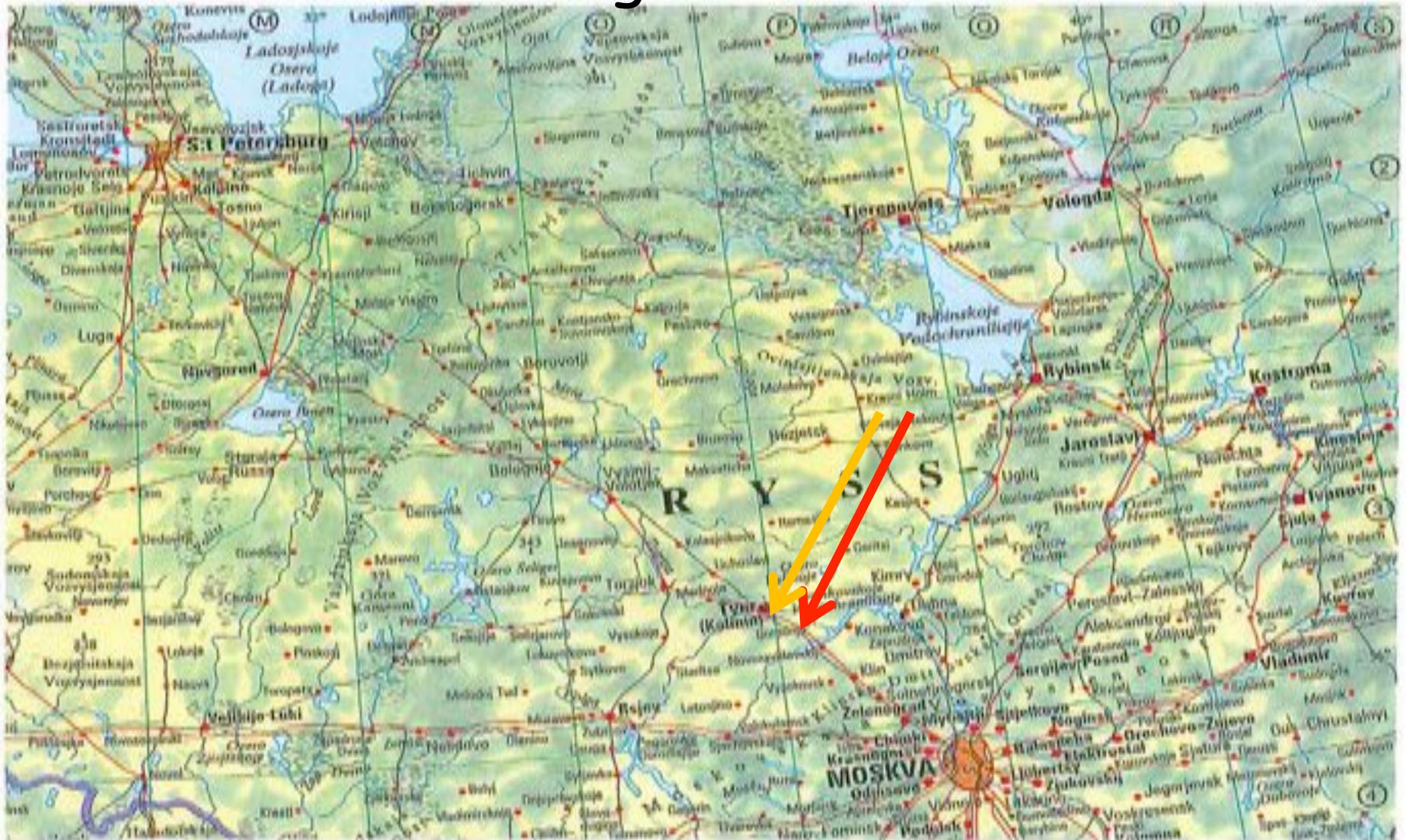


Selikhovkin AV, Popovichev BG, Mandelshtam MY, Vasaitis R, Musolin DL (2017)
 The Frontline of Invasion: the Current Northern Limit of the Invasive Range of Emerald Ash Borer, in European Russia. *Baltic Forestry* 23: 309-315. (modified)

Where are we with EAB in north-west Russia?



... here: approx. 140 km from Moscow & 480 km to St. Petersburg



The frontline of invasion: highway Moscow - St. Petersburg



Selikhovkin AV, Popovichev BG, Mandelshtam MY, Vasaitis R, Musolin DL (2017)
The Frontline of Invasion: the Current Northern Limit of the Invasive Range of
Emerald Ash Borer, in European Russia. *Baltic Forestry* 23: 309-315.

... and a closer look ...



Selikhovkin AV, Popovichev BG, Mandelshtam MY, Vasaitis R, Musolin DL (2017) The Frontline of Invasion: the Current Northern Limit of the Invasive Range of Emerald Ash Borer, in European Russia. *Baltic Forestry* 23: 309-315.

The worst EAB scenario

- in case if EAB would expand further west: the fate of ash in St. Petersburg and EU countries at risk
- need for measures to be taken to prevent or mitigate eventual impact of such scenario

Prospects?

- studies on EAB in Moscow region: in certain infested areas about half of *F. excelsior* were in a good condition and showed no signs of EAB, whereas the other half were in rapid decline
- this suggests that different individuals of *F. excelsior* exhibit different levels of resistance (or attractiveness) to EAB attacks
- there are certain indications that *F. excelsior* is less prone to EAB than North American species of ash

Straw NA, Williams DT, Kulinich O, Gninenko YI (2013)
Distribution, impact and rate of spread of emerald ash borer
Agrilus planipennis (Coleoptera: Buprestidae) in the Moscow region
of Russia. *Forestry (Lond.)* 86:515-522.

Recent Moscow example

During last 4 years EAB nearly disappeared from the city and from Moscow suburbs and many of damaged ash are still alive and are regenerating successfully

Seraya L, Yatsenko I, Demidko D, Baranchikov Y (2018)
Susceptibility of different ash species to Emerald Ash Borer in ash collection of the Main Botanical Garden in Moscow. In: *Proceedings of LIFE+ ELMIAS Ash and Elm Conference, 26 August - 1 September, Uppsala - Visby, Sweden* (ed. R.Vasaitis). Swedish University of Agricultural Sciences, Uppsala p. 75.

The network "Emerald Ash Borer (*Agrilus planipennis*), invasive deadly pest approaching eastern EU border: preparing for the worst case scenario (EMERALD)" has been recently initiated, and currently in action ...

Funded by [Nordic Forest Research \(SNS\)](#)

Main Aim:

to initiate related EU H2020 project proposal, elaborating the basis for the future work to mitigate the effects of eventual invasion of EAB to European Union

The Progress so far:

- i) mini-symposium on EAB situation in NW Russia as been conducted for worldwide scientific audience during international conference in Sweden, August 2018
- ii) excursion/workshop accomplished just last week to the North-Western border of expansion of EAB in Russia (representatives from Russia, Nordic - Baltic countries & Scotland)
- iii) currently, the consortium is established targeting eventual invasion of EAB, aiming at recent EU2020 call "SFS-05-2018-2019-2020: New and emerging risks to plant health"

Scope: Proposals will target one or more new or emerging plant pests and/or diseases (regulated or non-regulated, introduced or native) that are causing, or likely to cause, significant (socio-)economic and/or environmental losses to EU agriculture and / or forestry.

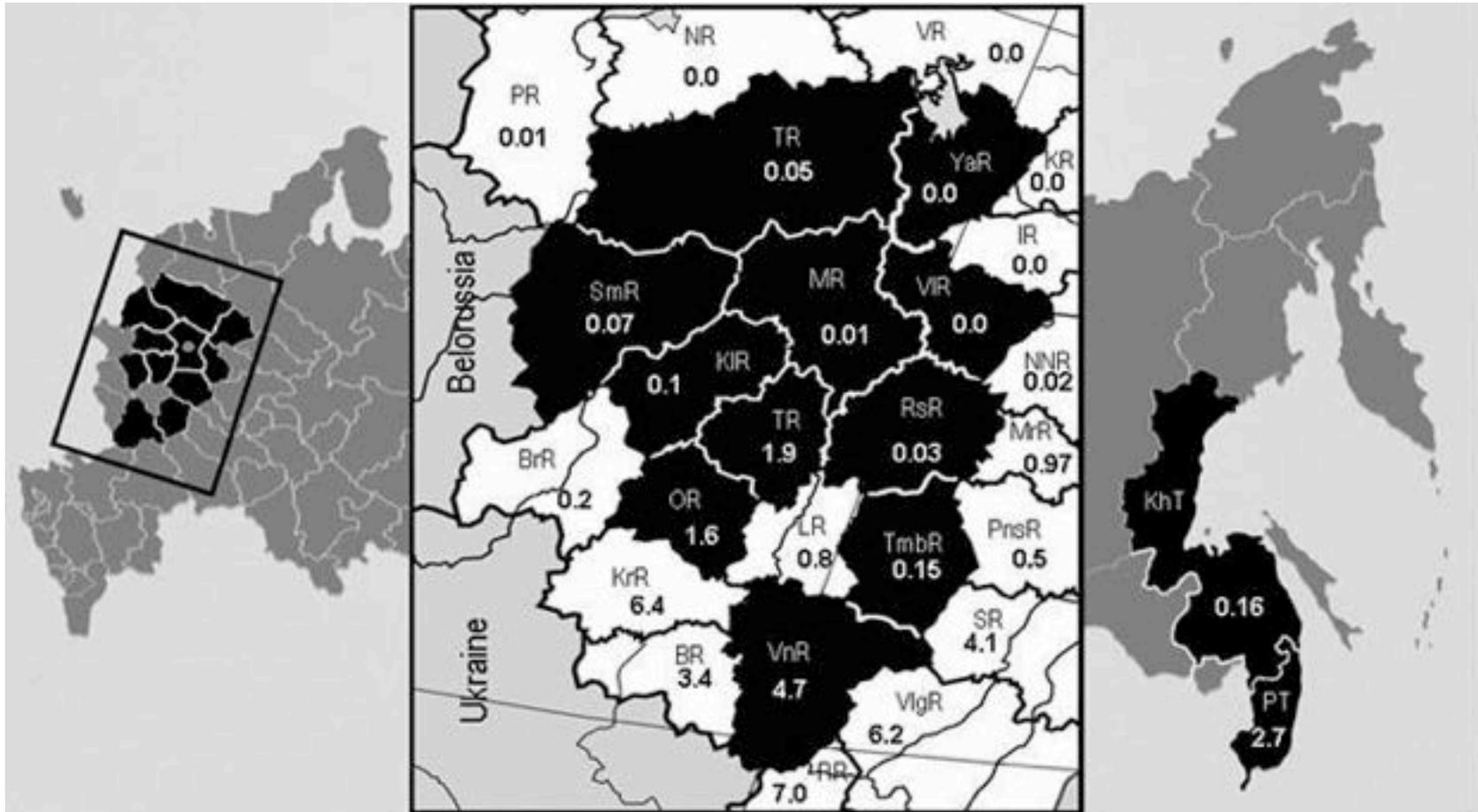
Initiated Consortium now includes: Sweden, Finland, Russia, Estonia, Latvia, Lithuania, Austria, Hungary, Scotland, Ireland, England;

Associated countries: Russia, Belarus, Ukraine;

Presumably topics to be addressed:

- i) EAB monitoring, detection and containment (on both sides of the border RU / EU);
- ii) selection and GPS-mapping databases of apparently vigorous ash in otherwise attacked areas in WE-RU;
- iii) study interactions between ADB & EAB;
- iv) analyses of biochemical traits of affected vs. non-symptomatic ash;
- v) sampling ash plant material in European populations of ash, checking for those hypothetical traits, creating databases;
- vi) eventually including those latter in future hypothetical breeding & propagation programs;
- vii) establishing "sentinel" plantations;
- viii) establishing facility for search and ev. propagation of EAB biological control agent native to Europe; etc., etc. ...

Administrative regions invaded by EAB in Russia in year 2018



Musolin, D.L., Selikhovkin, A.V., Shabunin, D.A., Zviagintsev, V.B. and Baranchikov, Y.N. 2017. Between Ash Dieback and Emerald Ash Borer: Two Asian Invaders in Russia and the Future of Ash in Europe. Baltic Forestry 23: 316-333.

Gotland Island



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Thank you!