Invasive alien pests threaten the carbon stored in Europe's forests

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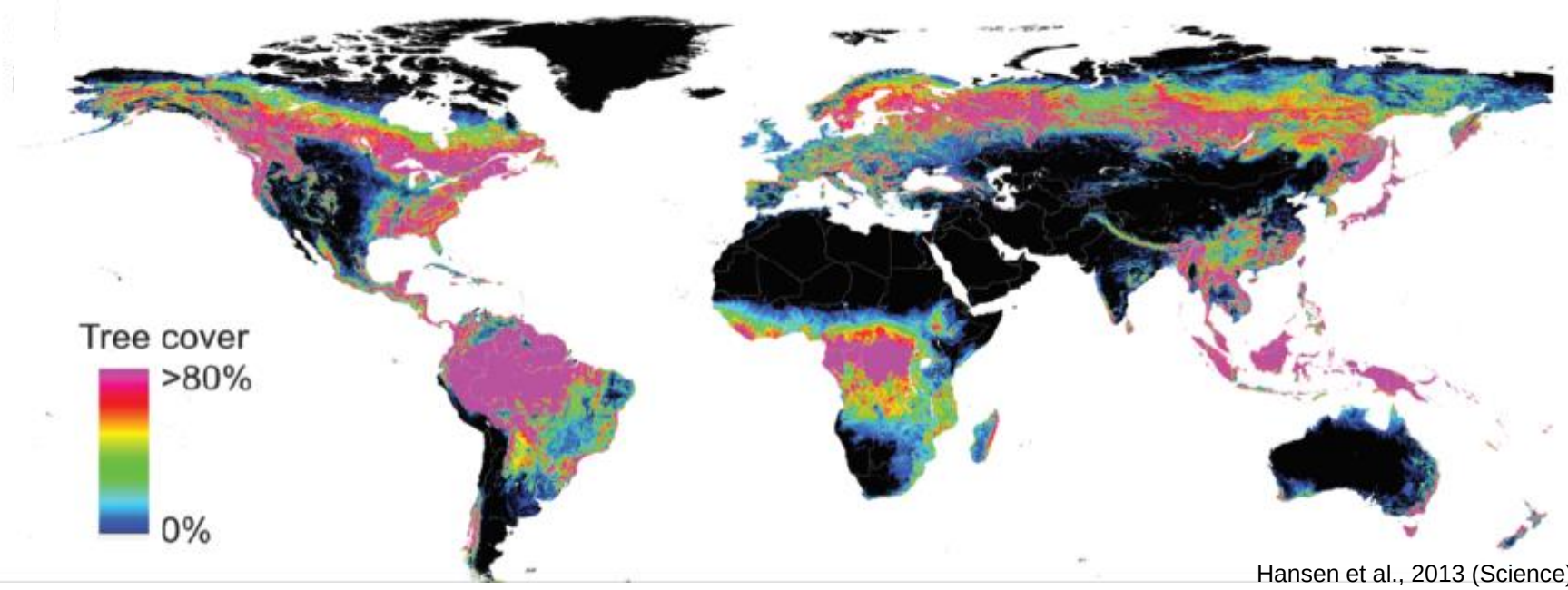


Hansen et al., 2013 (Science)

Forests and the global carbon cycle

861 Pg C

Carbon stored in forest ecosystems globally

-4.0 Pg C yr^{-1}

C uptake 2000 – 2007 of established forests

~800 Pg C

Carbon stored in the earth‘s atmosphere

+7.6 Pg C yr^{-1}

Emissions from fossil fuel (2000 – 2007)

Source: Pan et al. (2011, Science)

Natural disturbance regimes of Europe‘s forests

Wind, bark beetles, and wildfire are the most important disturbances

Wildfire

Native bark beetles

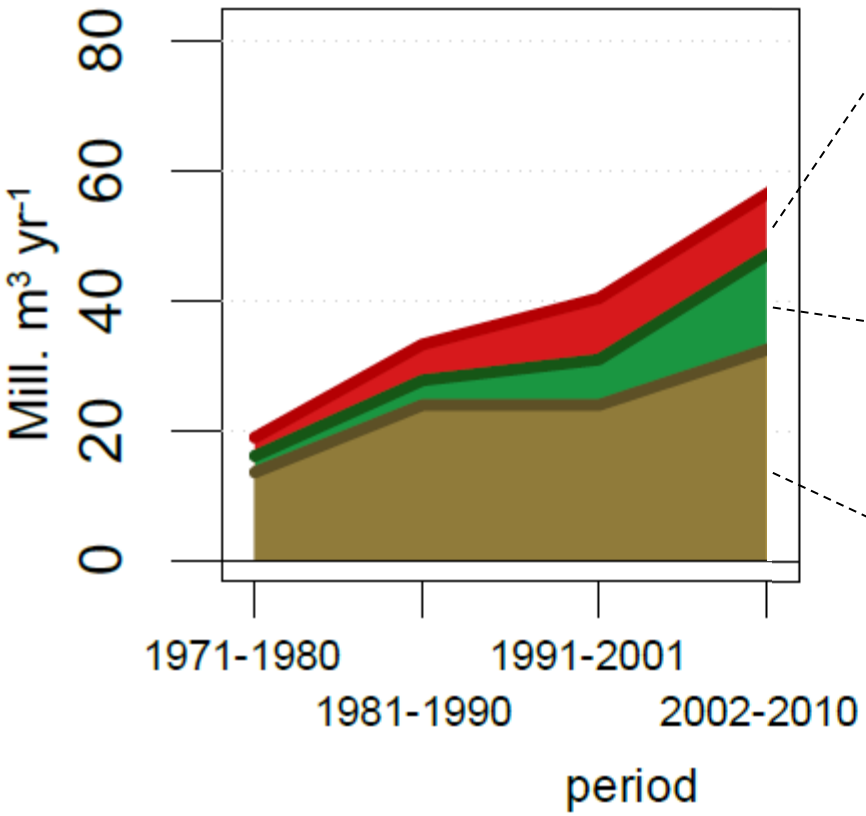
Wind

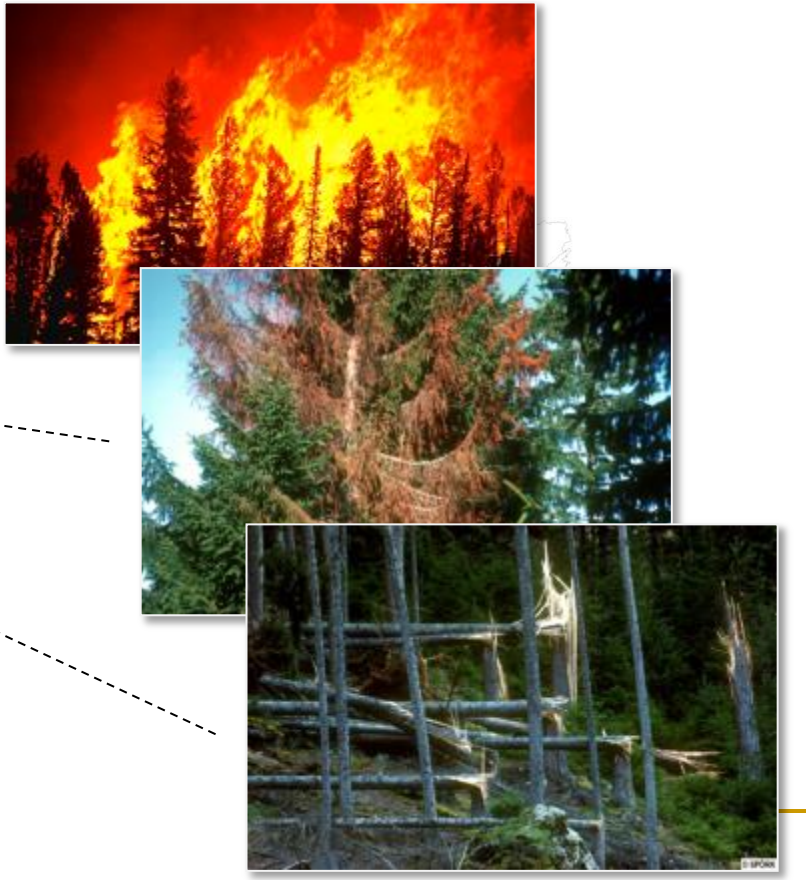
Seidl et al. (2014, Nature Clim. Change)

Natural disturbance regimes of Europe‘s forests

Wind, bark beetles, and wildfire are the most important disturbances

Natural disturbances have nearly trippled over the last 40 years in Europe‘s forests

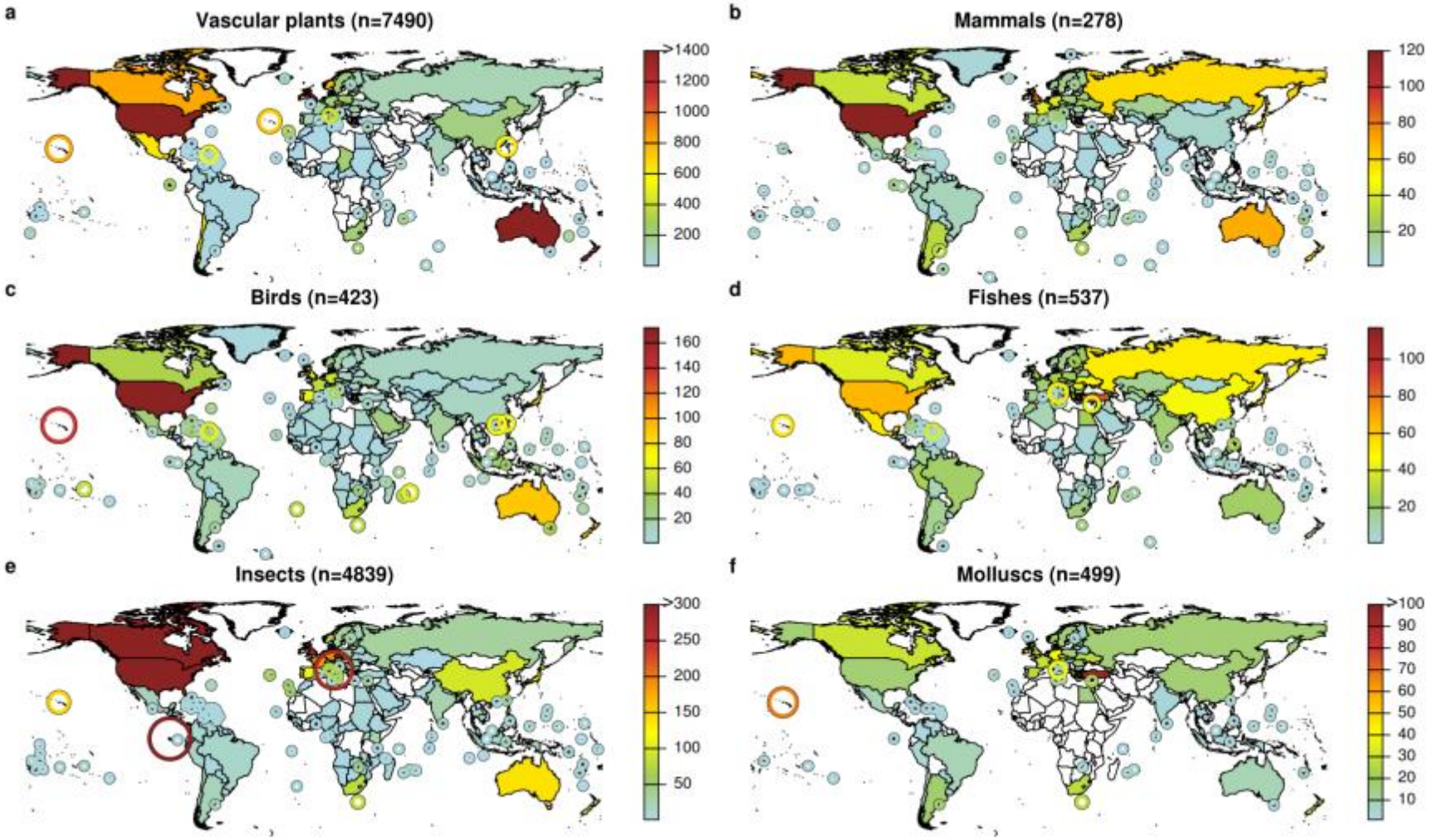




Seidl et al. (2014, Nature Clim. Change)

Novel disturbances in forests: alien pests

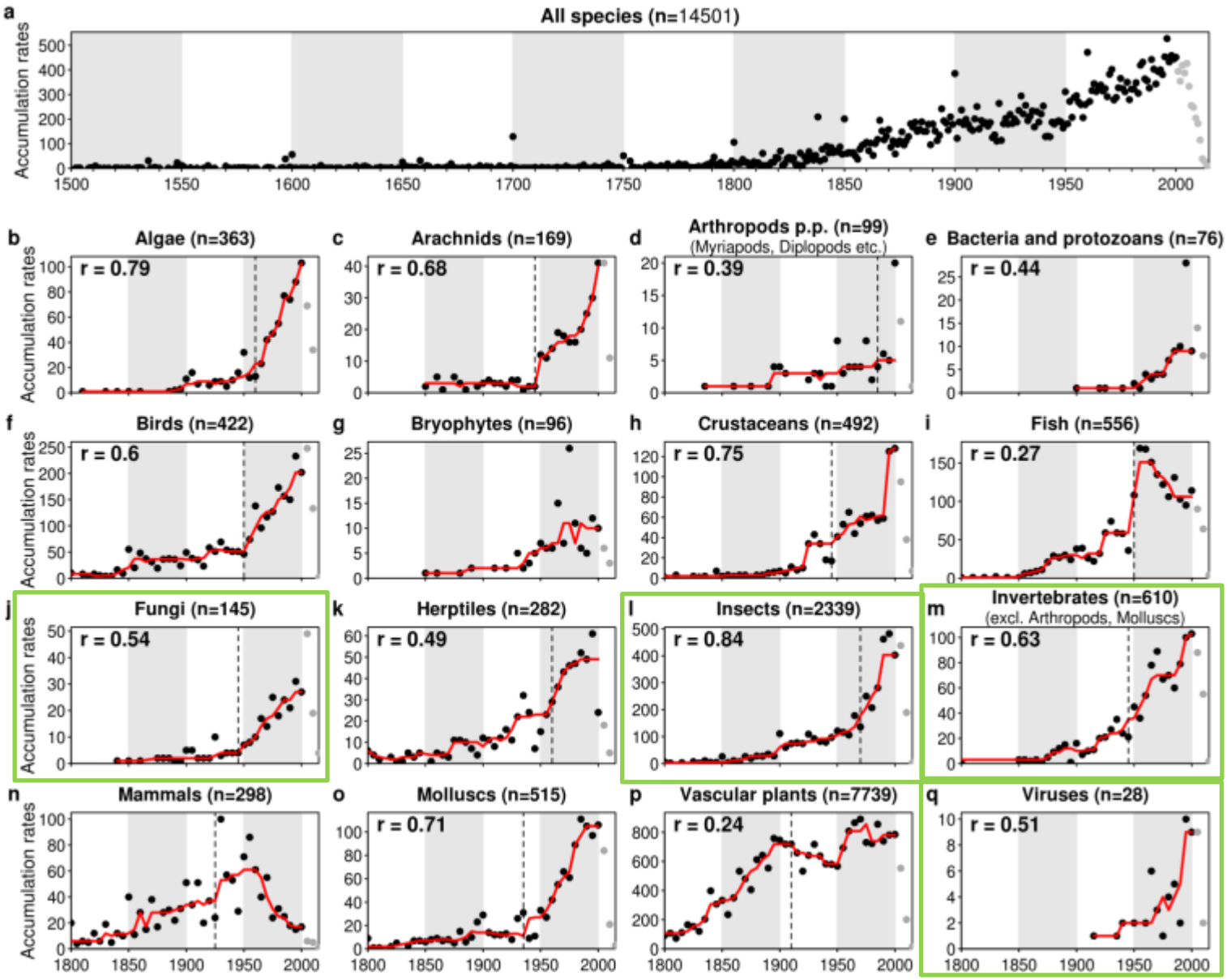
The temporal dynamics of the global accumulation of alien species



The Global Database of Alien Species First Records: > 50,000 entries of c. 15,000 species in countries or islands

Seebens, … & Essl 2017, *Nature Communications;* Seebens, … & Essl 2018, *PNAS*

No saturation of the global accumulation of alien species



Seebens, … & Essl 2017, *Nature Communications*

Novel disturbances

A global redistribution of species (including forest pests)

Transcontinental human trade has removed dispersal barriers for species

Extreme effects of novel disturbance agents possible

Naïve hosts, i.e. trees have not adapted to pests through co-evolution

ALB
Asian Long-horned Beetle (*Acer* spp.)
(*Anoplophora glabripennis*)

PWN
Pine Wood Nematode (*Pinus* sp.)
(*Bursaphelenchus xylophilus*)

SOD
Sudden Oak Death
(*Phytophthora ramorum*)

Alien to Europe
Initial Populations
Potentially Invasive

BBC
Beech Bleeding Canker
(*Phytophthora kernoviae*)

PPC
Pitch Pine Canker
(*Fusarium circinatum*)

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Asian Long-horned Beetle (*Acer* spp.)
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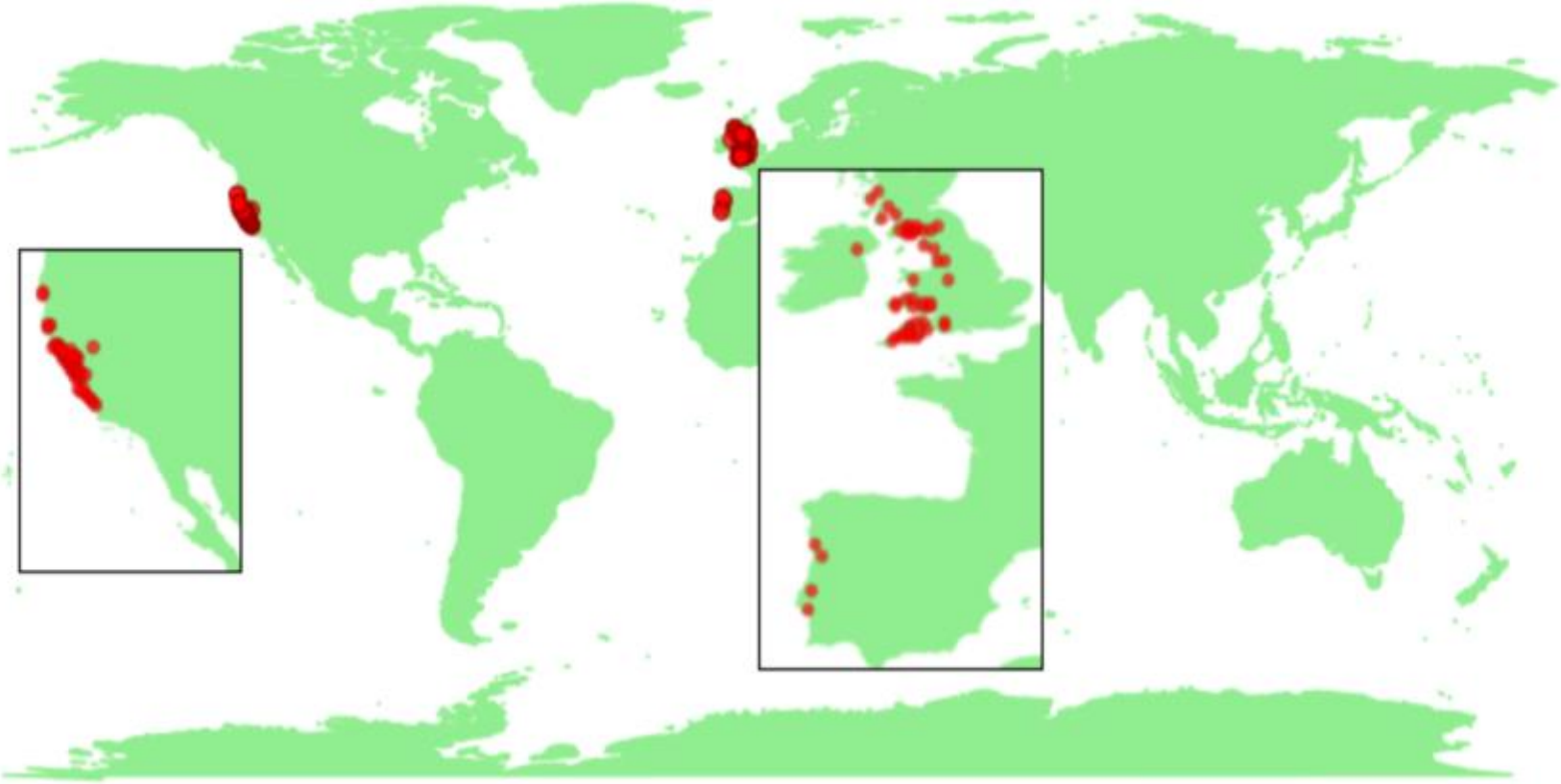

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Beech Bleeding Canker (*Fagus, Quercus*)
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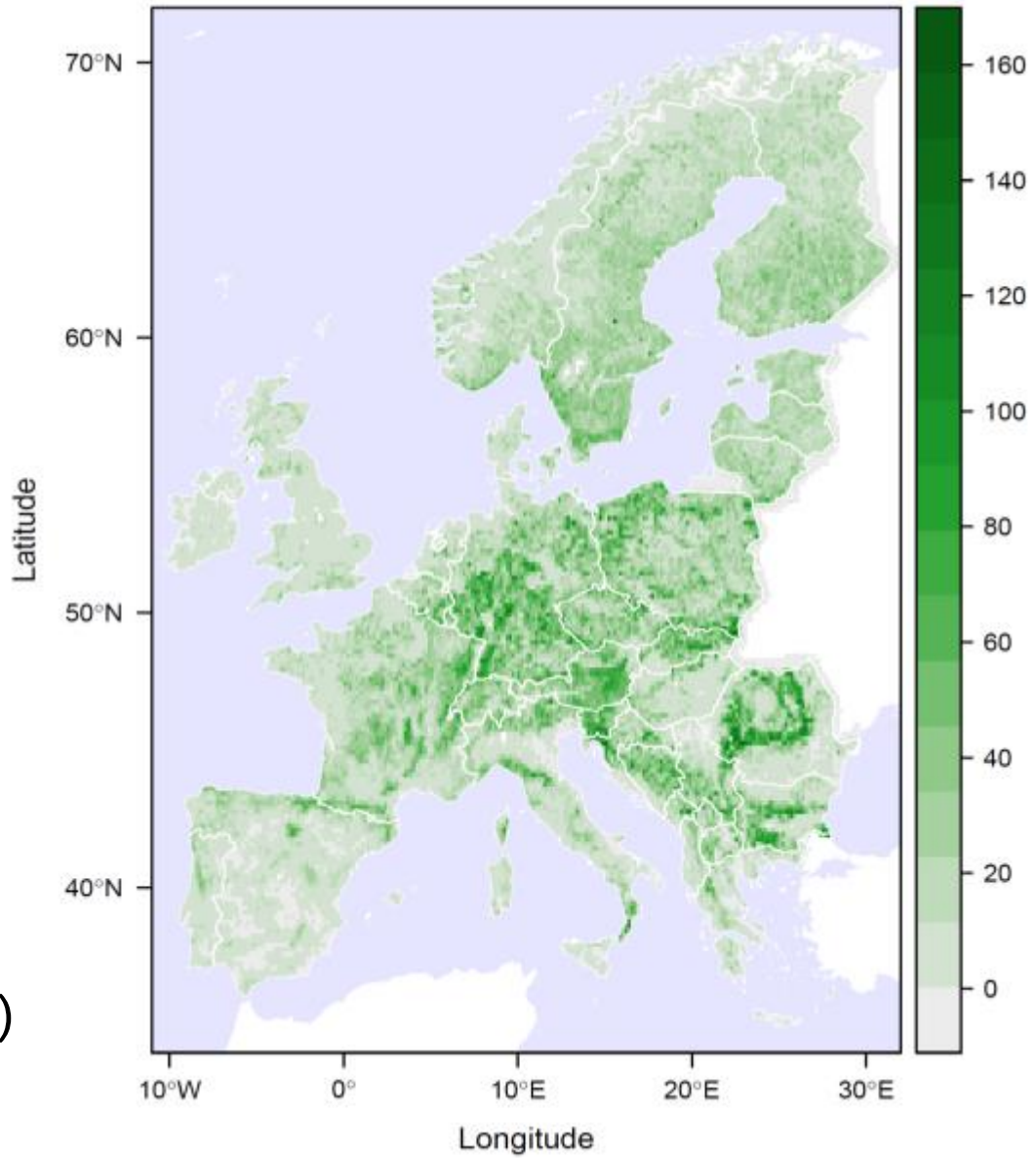
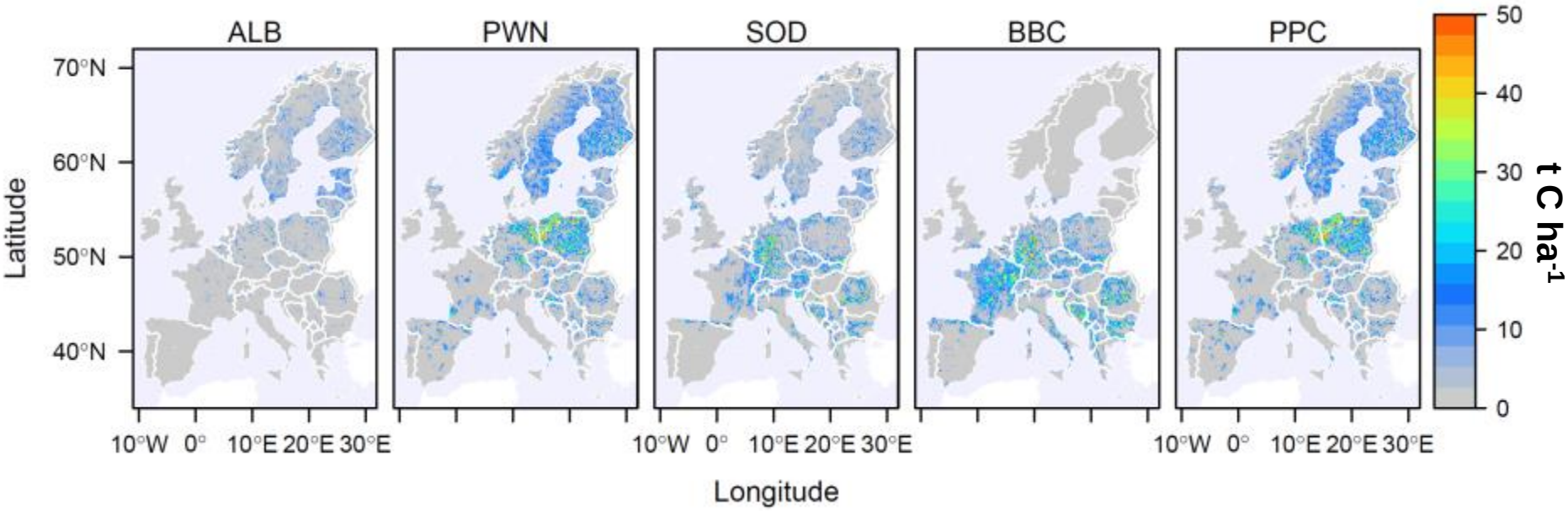
Current live carbon in Europe`s forests



Live carbon (t C / ha)

Live carbon in host tree species



Indicator of risk:

Overlap between the distribution of potential hosts and the climatic niche of the pests

What is the potential forest pests distribution in Europe?

Methods

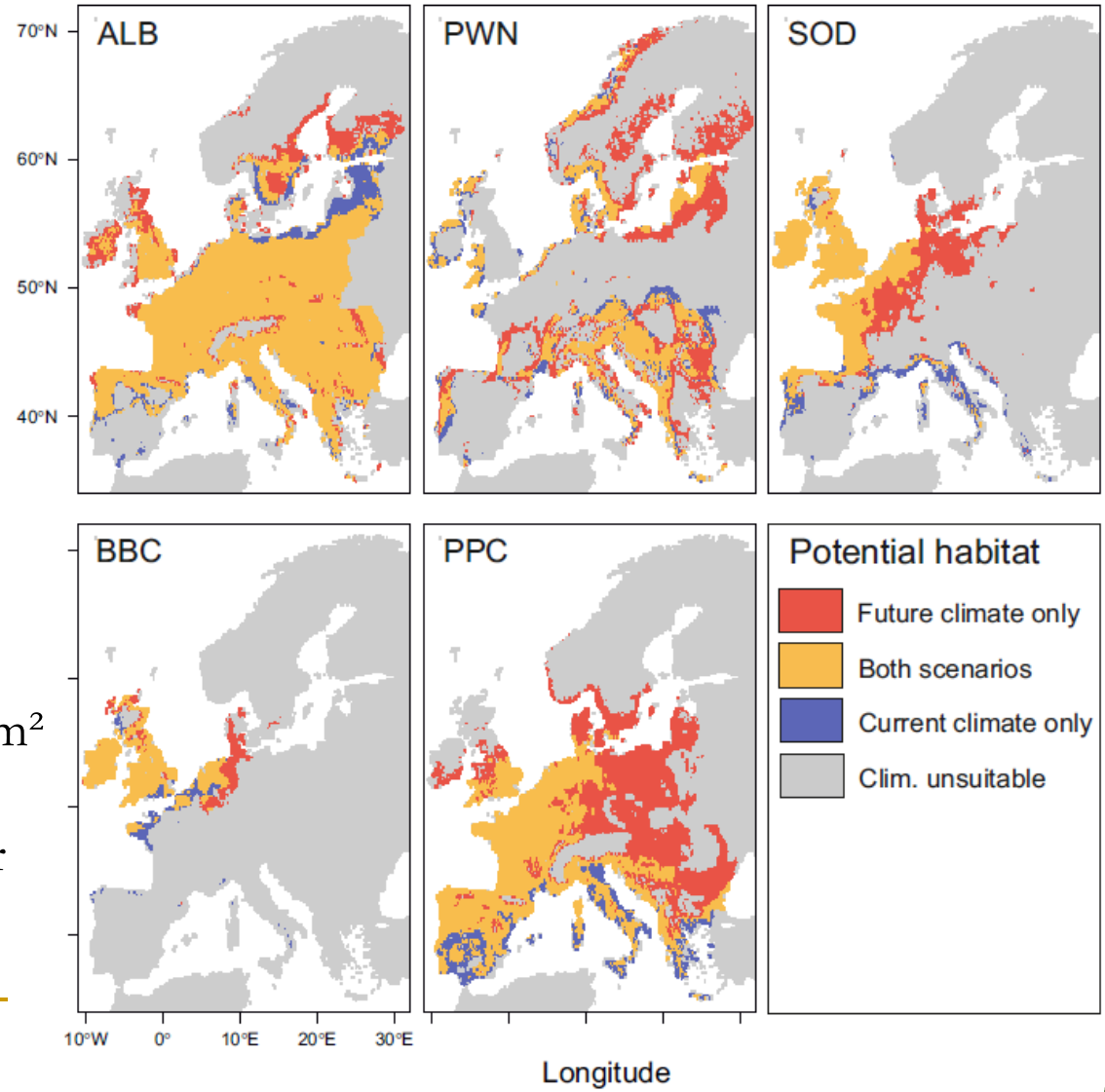
Correlative species distribution modelling

- Current conditions
- RCP 4.5 (2050)

Results

Current conditions:
ALB, PPC, PWN >1 Mio.km²

RCP 4.5: ~50% increase for PPC and PWN



Live C at risk

Assumed complete invasion and species-specific mortality

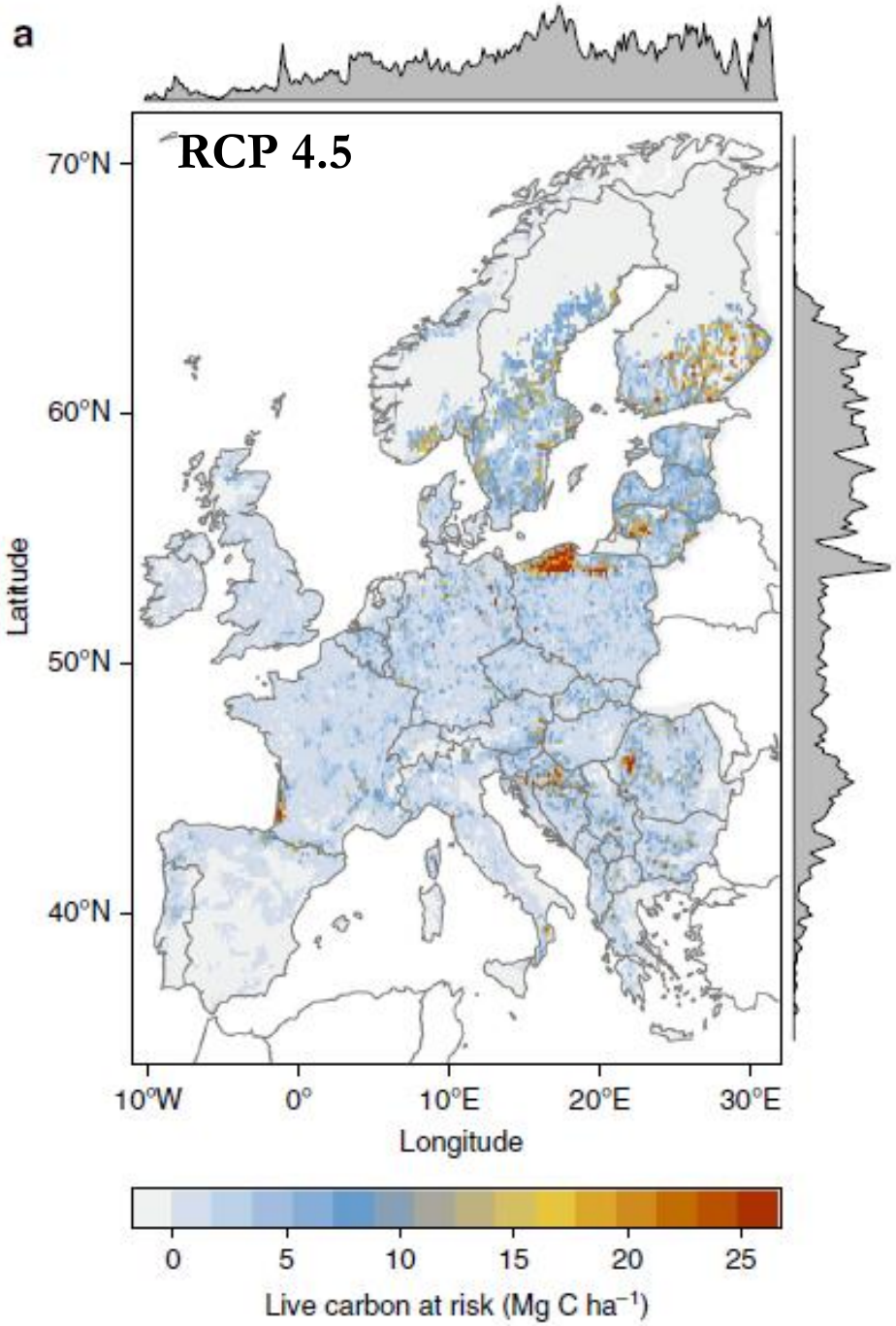
PWN: 596 Tg C

27% of the C currently stored in two-needle pines in Europe

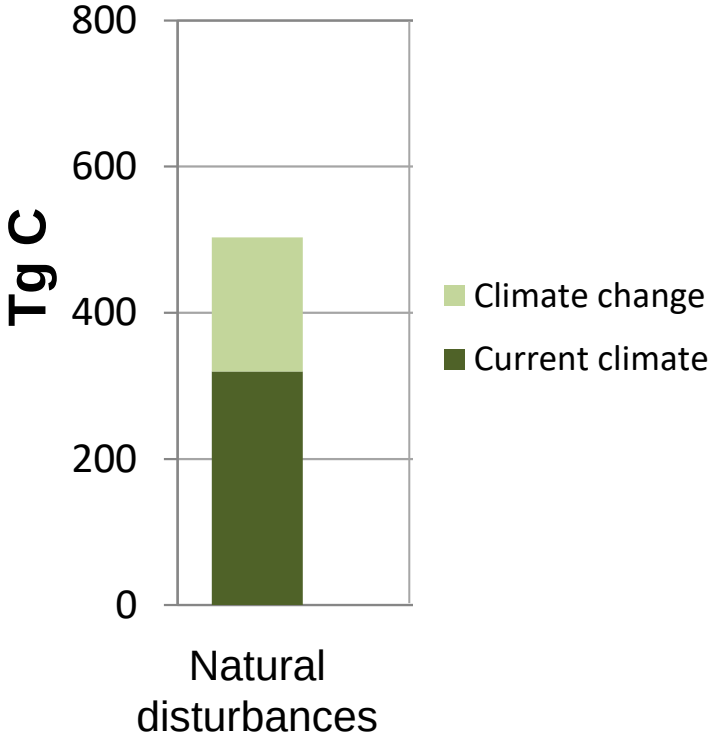
All 5 pests combined: 1,027 Tg C

10% of the live C in Europe's forest

Hotspots in Northern and Eastern Europe



How does the C cycle effect of alien pests compare to natural disturbances?



Based on C cycle modeling – amount indicates the reduction of the continental equilibrium C stock as a result of disturbances

Seidl et al. (2014, Nature Clim. Change)

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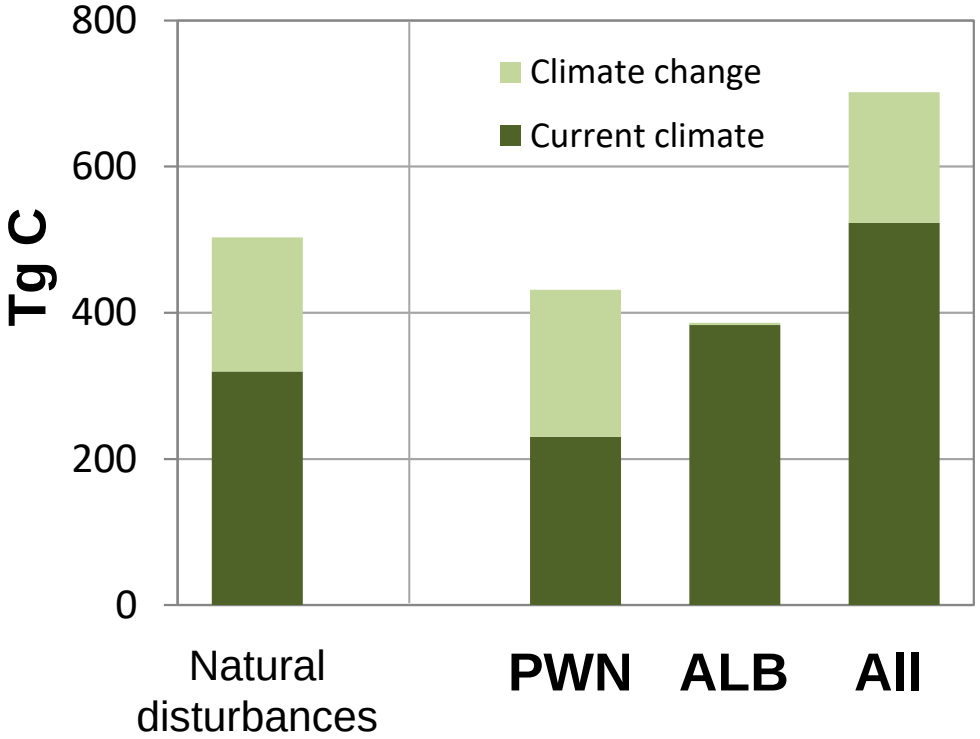
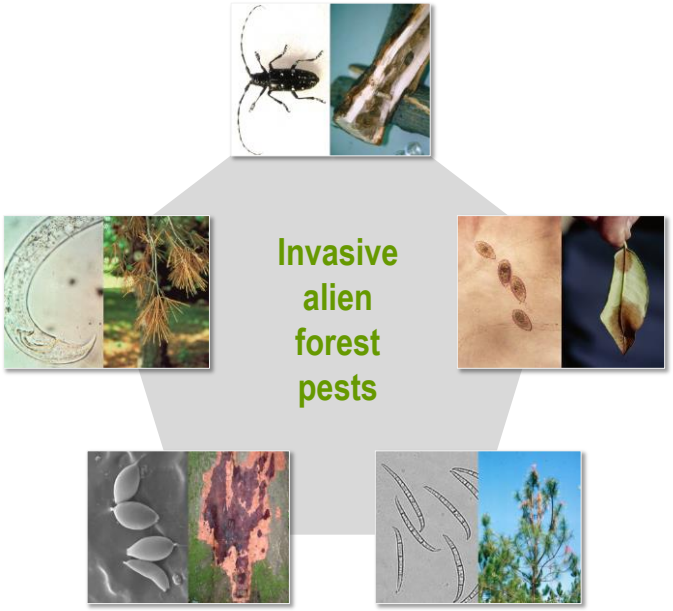


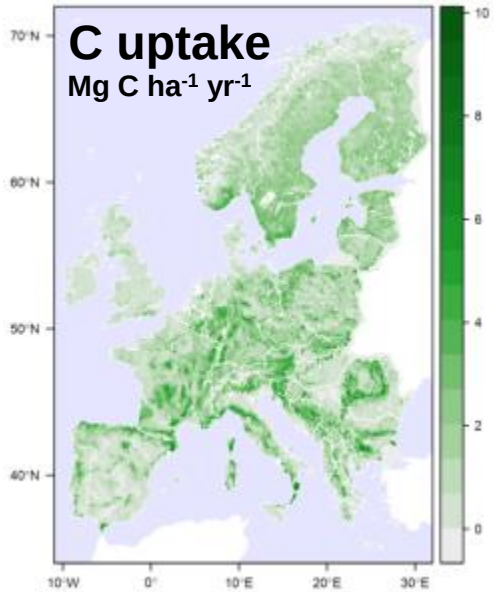


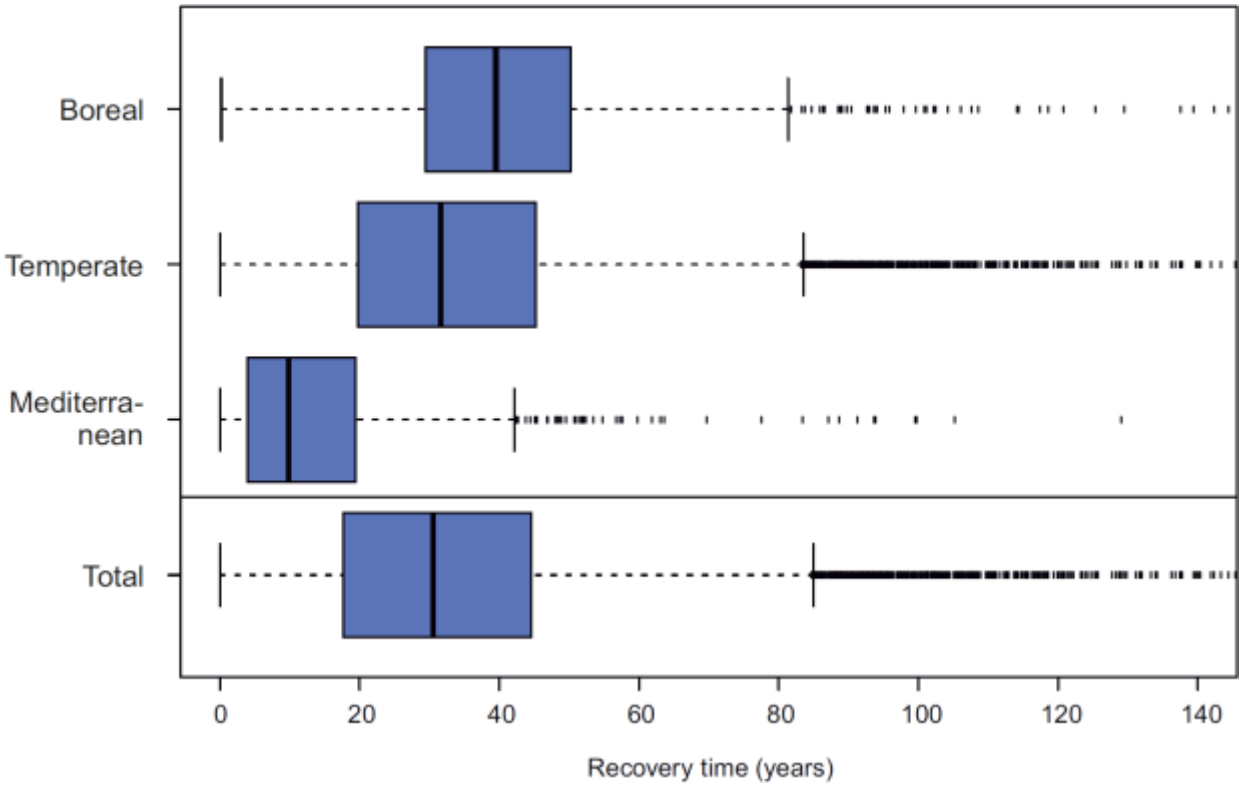
Based on C cycle modeling – amount indicates the reduction of the continental equilibrium C stock as a result of disturbances

Forests are slow in…

…rapid out systems

How long would it take C-pools to recover?



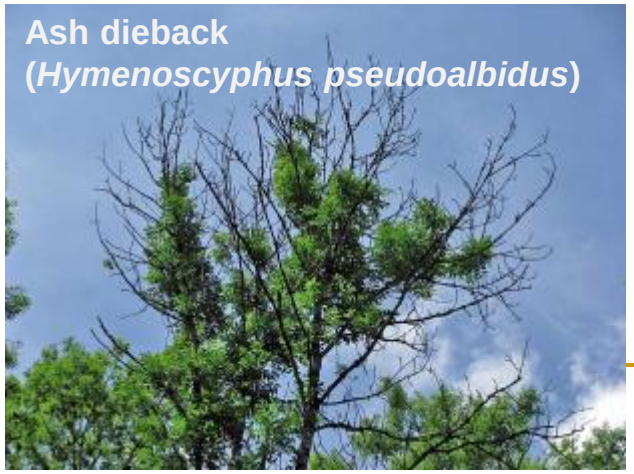


Time needed to recover the C potentially lost from a complete invasion of all five pests through primary productivity under RCP 4.5. Based on C-cycle modelling and maps of estimated NPP.

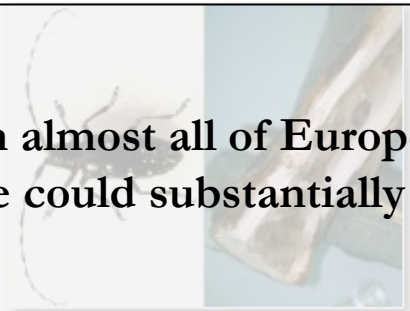
Alien forest pathogens: an emerging threat

More than half of the threatened *Fraxinus* species in this Red List report are native to eastern North America. These are common trees – found in native woodlands and planted widely as urban street trees – that many took for granted until now. This report shows that even widespread, presumably secure species are potential victims of invasive pests and diseases.

Emerald Ash Borer (*Agrilus planipennis*)

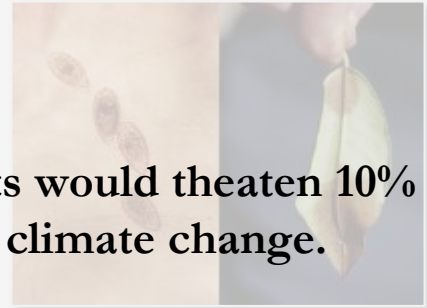


Potential impact of invasive pests on European forest carbon storage



Large scale

Alien pests may affect forests in almost all of Europe in the upcoming decades. Future climate change could substantially expand the range affected by these pests

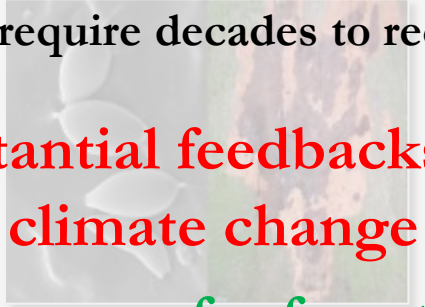


Substantial amount of C at risk

A simultaneous and complete invasion of the five pests would theaten 10% of the live C in Europe‘s forests, with negative feedbacks on climate change.

Long recovery

Ecosystems would require decades to recover the live C



Potential substantial feedbacks on greenhouse gas emissions and climate change

Severe consequences for forest biodiversity

Photo: Rupert Seidl