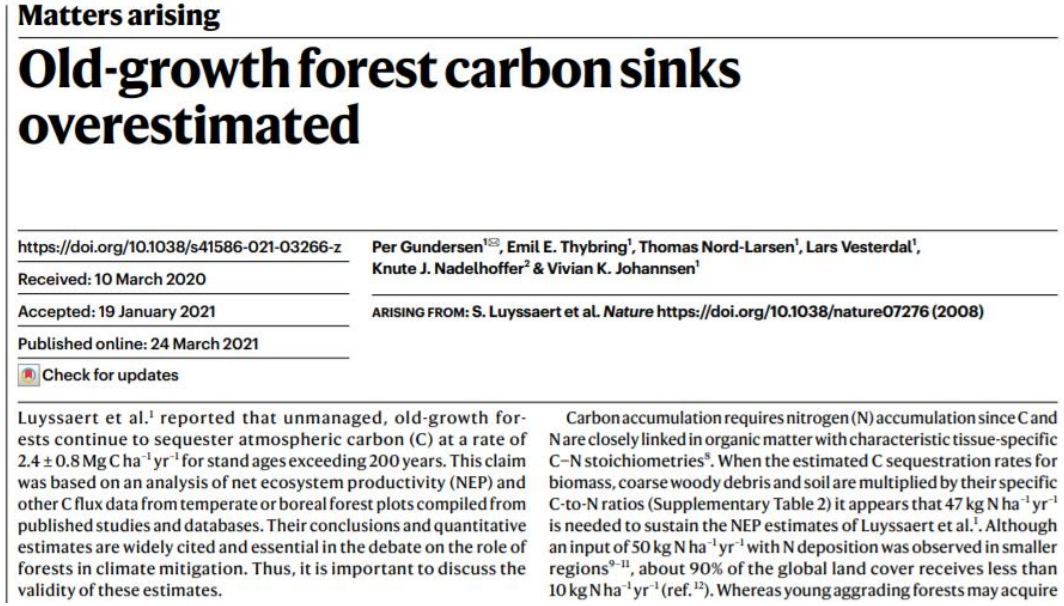
Many aspects of old-growth forests

D.Zute, A.Jansons**,** L.Kenina, V.Samariks
Forest tree breeding and climate change Unit
Latvian State Forest Research Institute Silava
Rigas iela 111, Salaspils, LV-2169,
daiga.zute@silava.lv

New Publications in Europe: Old-growth Forests



Matters arising

Old-growth forest carbon sinks overestimated

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Check for updates

Per Gundersen[1]✉, Emil E. Thybring[1], Thomas Nord-Larsen[1], Lars Vesterdal[1], Knute J. Nadelhoffer[2] & Vivian K. Johannsen[1]

ARISING FROM: S. Luyssaert et al. *Nature* https://doi.org/10.1038/nature07276 (2008)

Luyssaert et al.[1] reported that unmanaged, old-growth forests continue to sequester atmospheric carbon (C) at a rate of 2.4 ± 0.8 Mg C ha^{-1} yr^{-1} for stand ages exceeding 200 years. This claim was based on an analysis of net ecosystem productivity (NEP) and other C flux data from temperate or boreal forest plots compiled from published studies and databases. Their conclusions and quantitative estimates are widely cited and essential in the debate on the role of forests in climate mitigation. Thus, it is important to discuss the validity of these estimates.

Carbon accumulation requires nitrogen (N) accumulation since C and N are closely linked in organic matter with characteristic tissue-specific C–N stoichiometries[8]. When the estimated C sequestration rates for biomass, coarse woody debris and soil are multiplied by their specific C-to-N ratios (Supplementary Table 2) it appears that 47 kg N ha^{-1} yr^{-1} is needed to sustain the NEP estimates of Luyssaert et al.[1]. Although an input of 50 kg N ha^{-1} yr^{-1} with N deposition was observed in smaller regions[9–11], about 90% of the global land cover receives less than 10 kg N ha^{-1} yr^{-1} (ref. [12]). Whereas young aggrading forests may acquire

Barredo, J.I., Brailescu, C., Teller, A., Sabatini, F.M., Mauri, A. Janouskova, K, Mapping and assessment of primary and old-growth forests in Europe, EUR 30661 EN, Publications Office of the European Union, Luxembourg, 2021, ISBN 978-92-76-34230-4, doi:10.2760/797591, JRC124671.

***O'Brien, L.,** Schuck, A., Fraccaroli, C., Pötzelsberger, E., Winkel, G. and Lindner, M.,2021: Protecting old-growth forests in Europe - a review of scientific evidence to inform policy implementation. Final report. European Forest Institute. DOI: https://doi.org/10.36333/rs1*

***Gundersen P.,** Thybring E.E., Nord-Larsen T. et al. (2021) Old-growth forest carbon sinks overestimated. Nature, 591, E21–E23. https://doi.org/10.1038/s41586-021-03266-z*

Forest protection: for which stands?

- **The EU Biodiversity Strategy (2030) makes the preservation of Europe's old-growth forests one of its priorities.**
- Protected areas will make up 30% of the EU area, with 10% under strict protection. **Intended to include all primary and old forests in the EU**.
- Conclusion of the European Commission: good data is also needed for forest protection: what exactly to protect?

The identification of undocumented primary and old-growth forests in the field remains crucial (EK, 2021)

Which areas to protect?

What kind of forest management would be more appropriate?

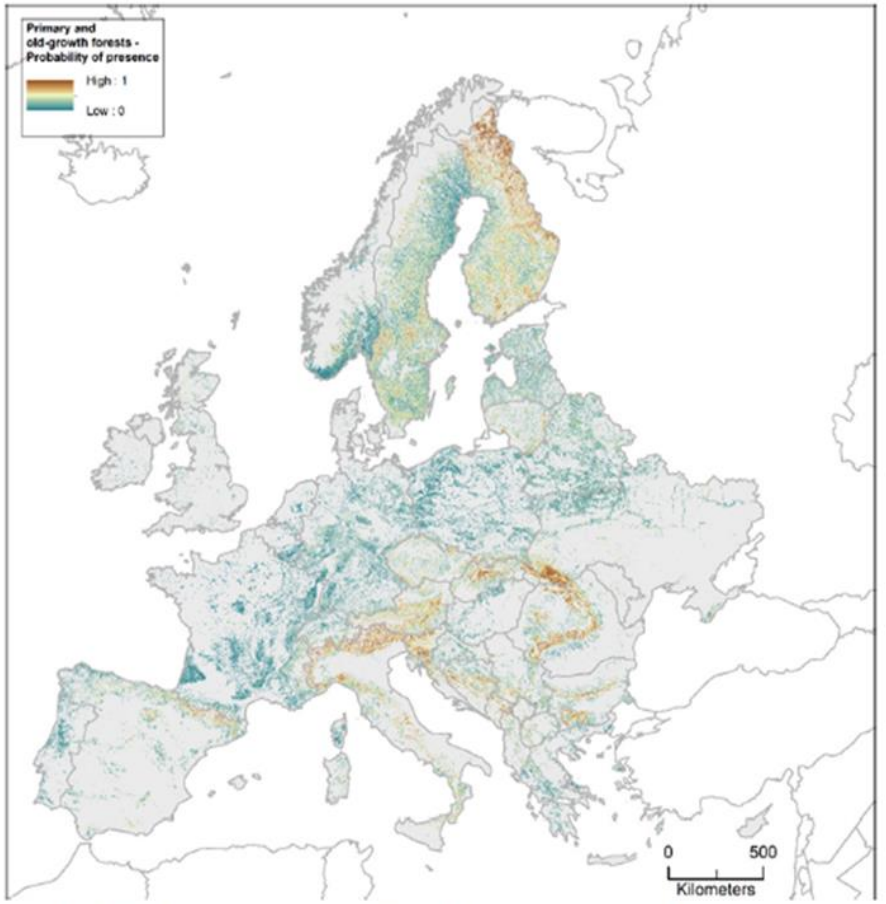
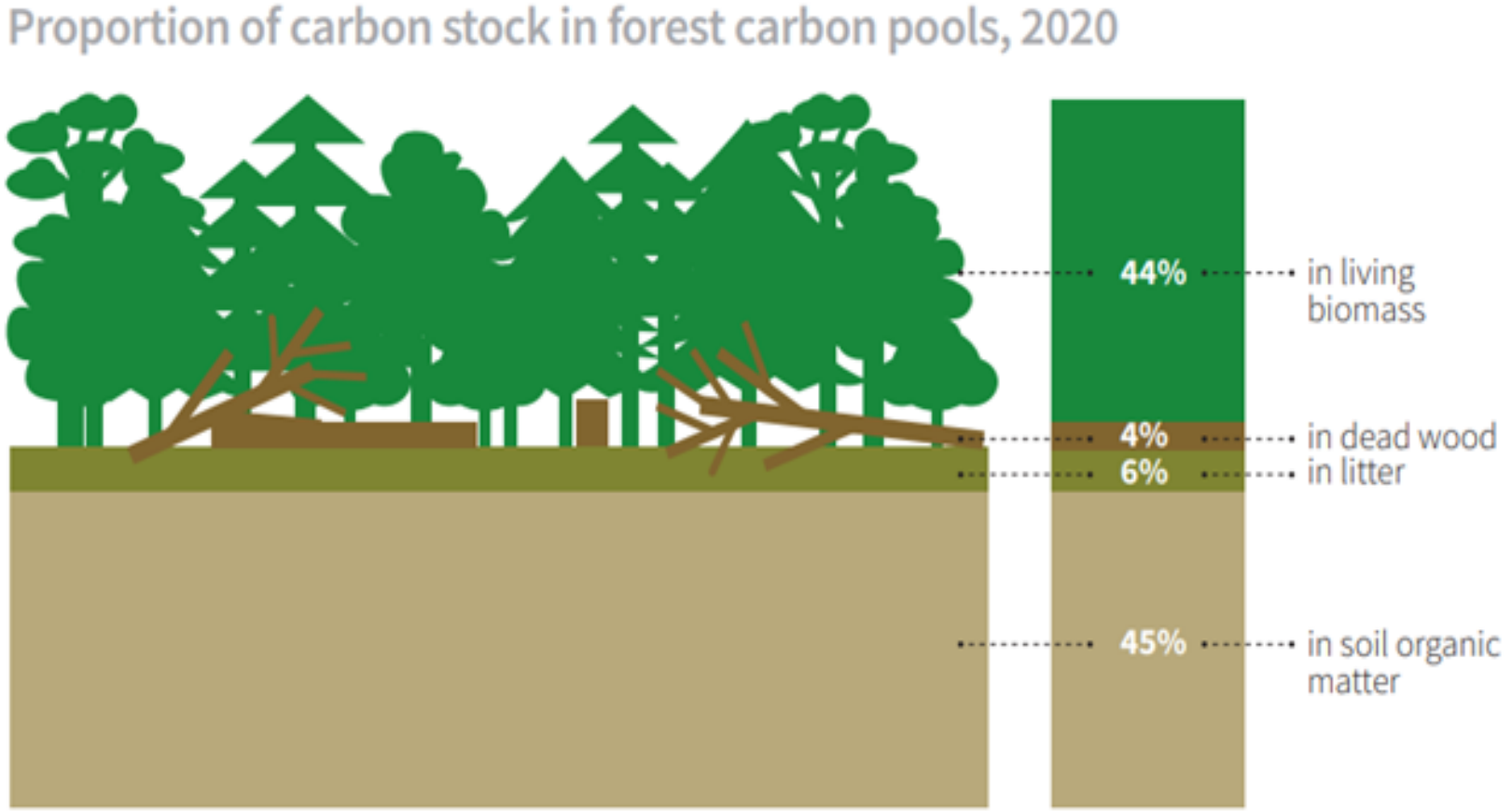


Figure 5. Likelihood of presence of primary and old-growth forests. Map at 250 m grid size implemented by Sabatini et al. (2020b) using a spatially explicit boosted regression trees model relating the presence of primary and old-growth forests and 15 biophysical, socio-economic and historical land use predictors. EU areas outside the domain of the map not included in the model.

Source: Sabatini et al. 2020

Different Biomes - Different Potential for Carbon

- Each biome has its specific carbon potential
- **Boreal forests hold its specific carbon potential**
- Forest store carbon not only in trees, but in all ecosystem carbon pools
- We have gained solid knowledge on forest ecosystems
- However, still some knowledge gaps remain, e.g. soil & old-growth forests less studied



Source: Global Forest Resource Assessment, 2020

PROFOR
Promoting sustainable forestry in a growing bioeconomy

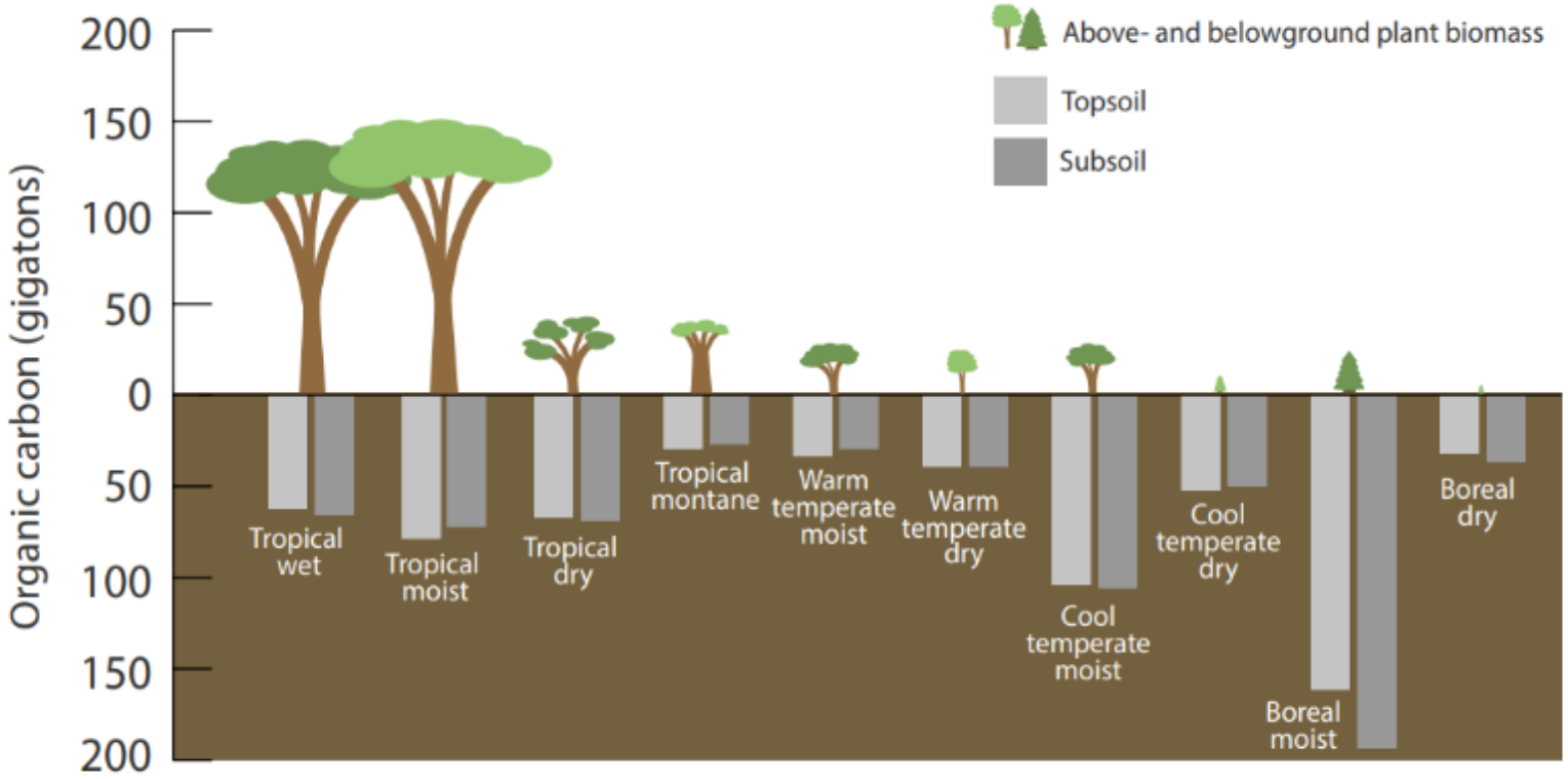
Forest Carbon: Ecosystems are Diverse

Global forest biomes:

- Tropical forests,
- Boreal forest,
- Temperate forests,

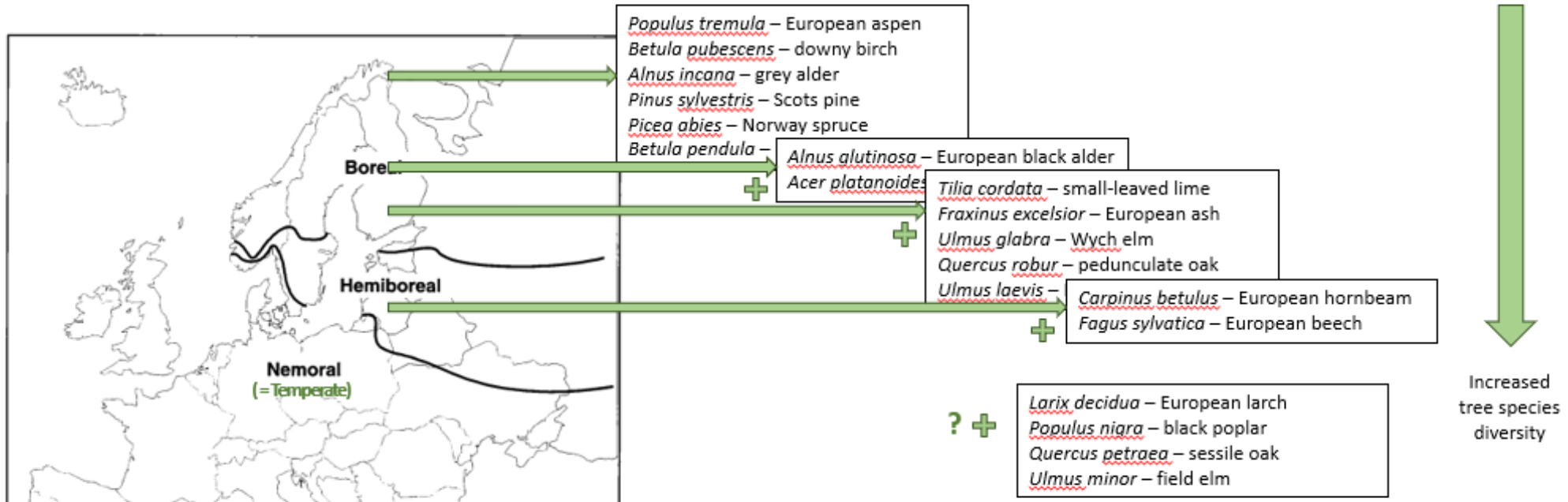
Different biomes means different potential for carbon.

The need of data for specific region, e.g. Latvia (hemiboreal forests).



Source: https://www.fs.usda.gov/ccrc/topics/global-carbon
Scharlemann et al., 2014

Biomes and tree species in the Nordic-Baltic region



.1 The forest zones of north-west Europe as defined by Ahti *et al.* (1968)

Graph: Bradshaw and Edenius 1998

Hemiboreal Forests

Hemiboreal forests are **comparatively rich in ecosystem diversity**.


Forestry Commission

Grazing as a Management Tool in European Forest Ecosystems

Edited by Jonat and

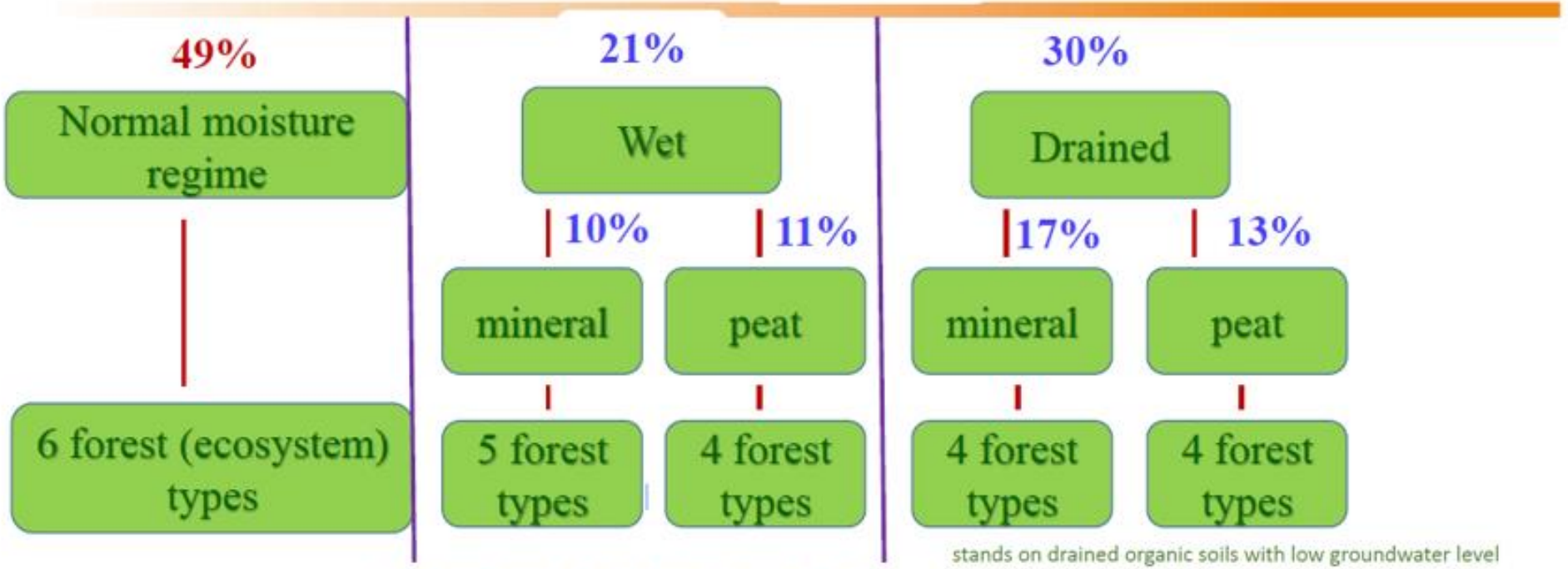
CONTENTS

Table 1.1 Main forest ecosystem types in Fennoscandia, and occurrence in forest zones

Forest type	Boreal	Hemiboreal	Nemoral
Coniferous forest			
Scots pine	✔	✔	
Norway spruce	✔	✔	
Mixed	✔	✔	
Swamp forest	✔	✔	
Plantations		✔	✔
Deciduous forest			
Mixed	✔	✔	✔
Birch	✔		
Spruce–beech		✔	✔
Pine–oak		✔	✔
Beech		✔	✔
Oak, elm, ash, lime		✔	✔
Alder		✔	✔
Abandoned meadows		✔	✔
Parkland with giant trees			✔

Source: /5a450a92aca272d2945d9796/Ungulates-and-forest-management-in-Great-Britain-and-Ireland.pdf#page=8

Different forest growing conditions in Latvia



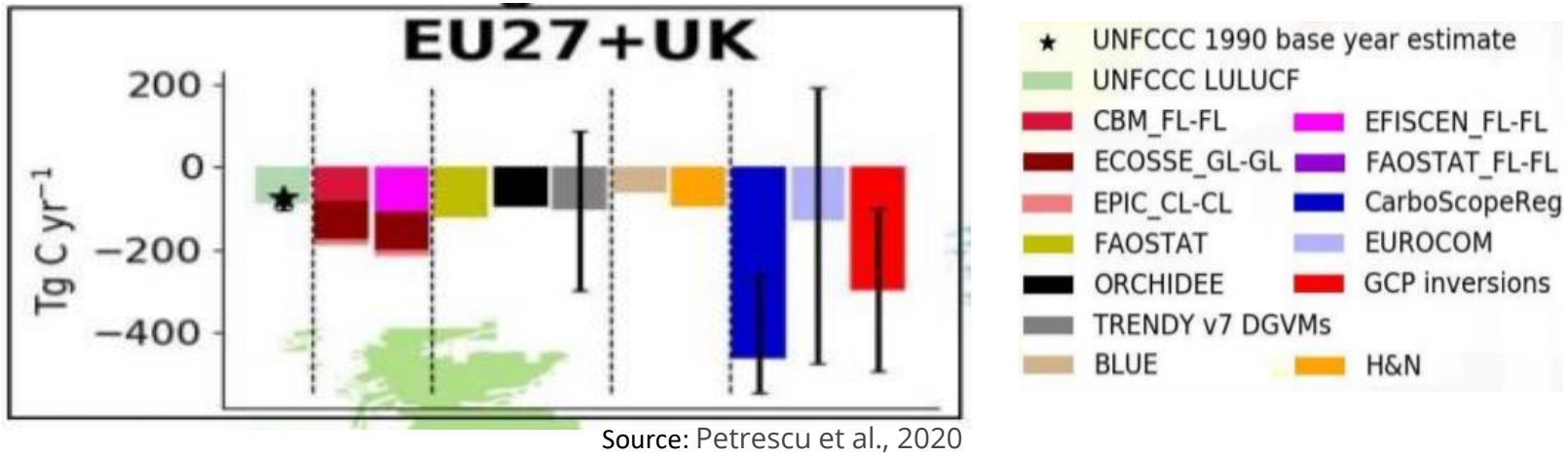
The System Boundaries

Forest carbon balance modelling. Considering the potential of capturing CO_2 and storing carbon **the system boundaries matter**, e.g. if soils is not included, if substitution effect is not included can much impact the total carbon balance.

How much carbon?

- Is **soil pool** included?
- Is **HWP pool** included?
- Is **fossil resource substitution** effect included?
- All models are valid, **the system boundaries differs.**

Different Land Sector Carbon Modelling Tools av. 2011-2015



Source: Petrescu et al., 2020

Sector-specific BU models for FL-FL (CBM, EFISCEN), CL-CL (EPIC-IIASA), and GL-GL (ECOSSE); Ecosystem models (ORCHIDEE and TRENDY v7 DGVMs); FAOSTAT, Bookkeeping models (BLUE and H&N); TD inversion ensembles (GCP2018, EUROCOM); and one regional European by CarboScopeReg; UNFCCC NGHGI (2019) submissions (grey) and base year 1990 (black star).

Old growth forests: how to define?

EUROPEAN COMMISSION

Brussels, 20.3.2023
SWD(2023) 62 final

COMMISSION STAFF WORKING DOCUMENT

Commission Guidelines for Defining, Mapping, Monitoring and Strictly Protecting EU Primary and Old-Growth Forests

Old growth forests: how to define?

Old-growth forest: 'A forest stand or area consisting of native tree species that have developed, predominantly through natural processes, structures and dynamics normally associated with late-seral developmental phases in primary or undisturbed forests of the same type. Signs of former human activities may be visible, but they are gradually disappearing or too limited to significantly disturb natural processes.'

Primary forest: 'Naturally regenerated forest of native tree species, where there are no clearly visible indications of human activities and the ecological processes are not significantly disturbed.'[10]

10 FAO definition

Old growth forests: indicators

Indicators by EU
Guidelines dated of March, 2023

All the main indicators and at least two complementary indicators need to be met.

Main indicators

1. Native species

   Old-growth forests are composed of native species. However, the presence of a small number of non-native trees should not disqualify a forest from being designated as old-growth, if they do not significantly disturb ecological processes.

2. Deadwood

   Old-growth forests are characterised by a high proportion and diversity of standing and lying deadwood. The amount and type of deadwood can vary greatly between old-growth forests (depending on the forest type, the local environmental conditions, and the area's recent disturbance history).

3. Old or large trees

   Old-growth forests are often characterised by a high volume of standing trees relative to earlier development stages for the given forest type and local growing conditions, and by the presence of old or large trees, some of which may reach the maximum age known for the species under the local site conditions.

Complementary indicators

4. Stand origin

   Most old-growth forest stands originate from natural regeneration, but some sown or planted forests can meet the definition, if given enough time to develop the characteristics of old growth forests.

5. Structural complexity

   Old-growth forests are generally characterised by structural complexity. This can include a multi-layer canopy structure, horizontal structural diversity, and soil microrelief structures such as mounds caused by uprooting.

6. Habitat trees

   Old-growth forests are often characterised by the high density and high diversity of tree-related microhabitats. These are defined as a 'distinct, well-delineated structure occurring on living or standing dead trees, that constitutes a particular and essential substrate or life site for species or species communities during at least a part of their life cycle to develop, feed, shelter or breed' [14].

7. Indicator species

Main indicators

- Native species: yes, 100%
- Deadwood: yes
- Old or large trees: possibly…

Which indicators relevant for hemiboreal forests ?

All the main indicators and at least two complementary indicators need to be met.

Main indicators

1. Native species

   Old-growth forests are composed of native species. However, the presence of a small number of non-native trees should not disqualify a forest from being designated as old-growth, if they do not significantly disturb ecological processes.

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   Old-growth forests are characterised by a high proportion and diversity of standing and lying deadwood. The amount and type of deadwood can vary greatly between old-growth forests (depending on the forest type, the local environmental conditions, and the area's recent disturbance history).

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Complementary indicators

Which complementary indicators relevant for hemiboreal forests ?

- Stand origin?
- Structural complexity?
- Habitat trees?
- Indicator species?

Do we have **data** on each indicator? How does **that impact** the area of OGF?

Complementary indicators

4. Stand origin

   Most old-growth forest stands originate from natural regeneration, but some sown or planted forests can meet the definition, if given enough time to develop the characteristics of old growth forests.

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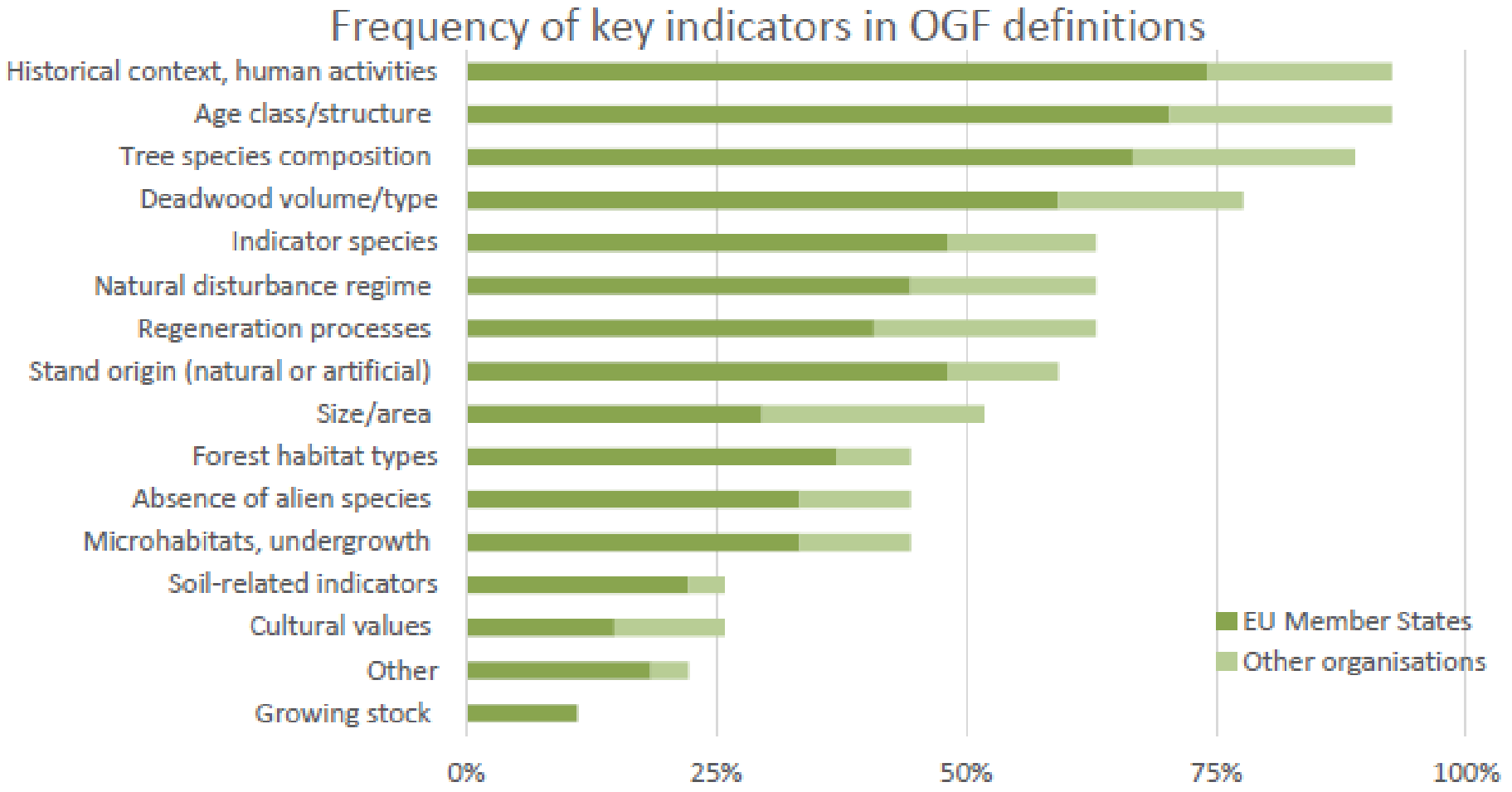
7. Indicator species

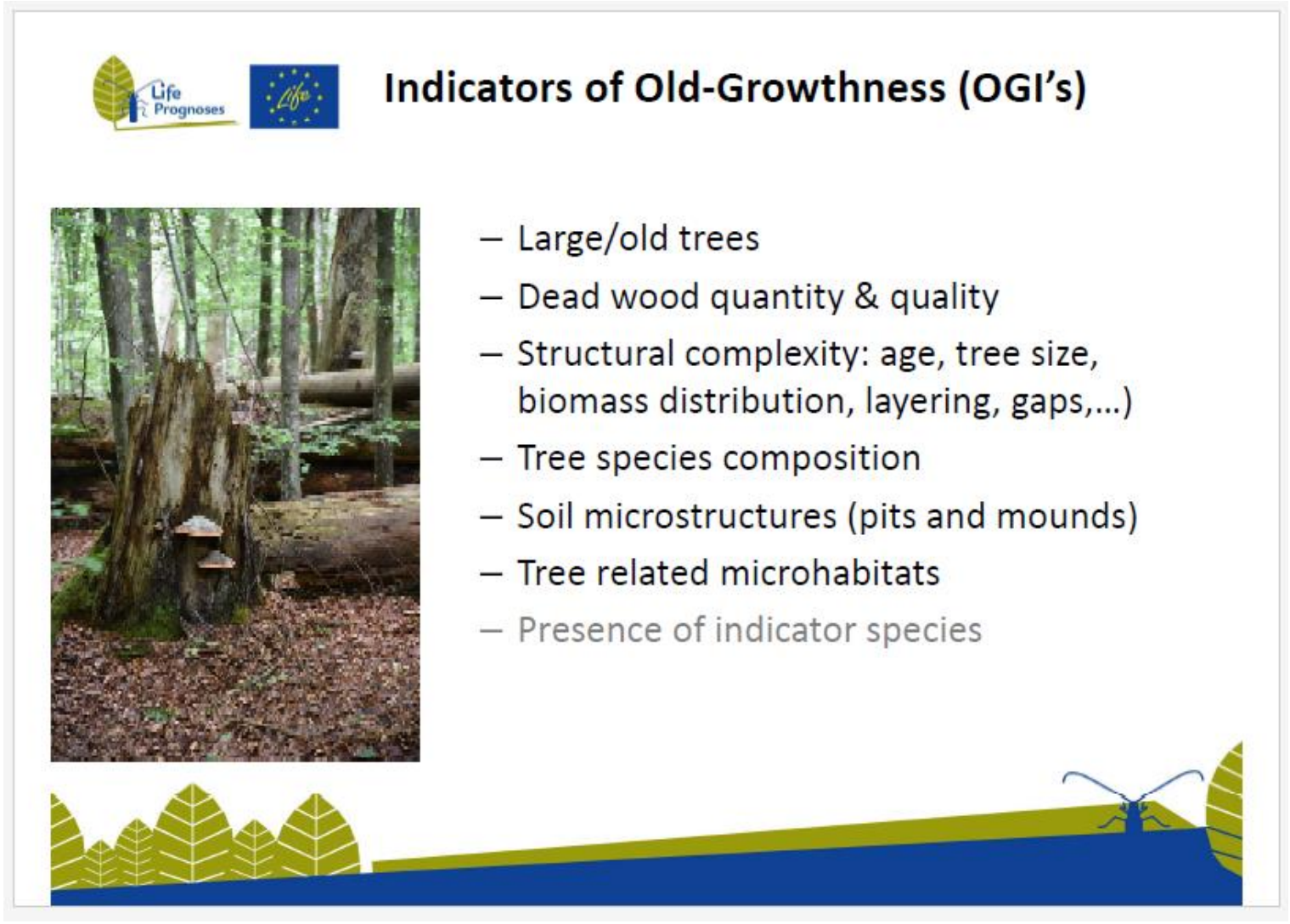
Old growth forests indicators used



EC, 2023

Old growth forests indicators used

LIFE-PROGNOSES project



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

Europe: Forest Age Structure

Reconstructed forest age structure in Europe 1950–2010

T. Vilén [a,*], K. Gunia [a], P.J. Verkerk [a], R. Seidl [b], M.-J. Schelhaas [c], M. Lindner [a], V. Bellassen [d]

[a] European Forest Institute (EFI), Torikatu 34, 80100 Joensuu, Finland
[b] Institute of Silviculture, Department of Forest and Soil Sciences, University of Natural Resources and Life Sciences (BOKU) Vienna, Peter Jordan Straße 82, 1190 Wien, Austria
[c] Alterra, Wageningen University and Research Centre, PO Box 47, NL-6700 AA Wageningen, The Netherlands
[d] Laboratoire des Sciences du Climat et de l'Environnement (LSCE), CEA-CNRS-UVSQ, CEA Orme des Merisiers, 94114 Gif-sur-Yvette, France

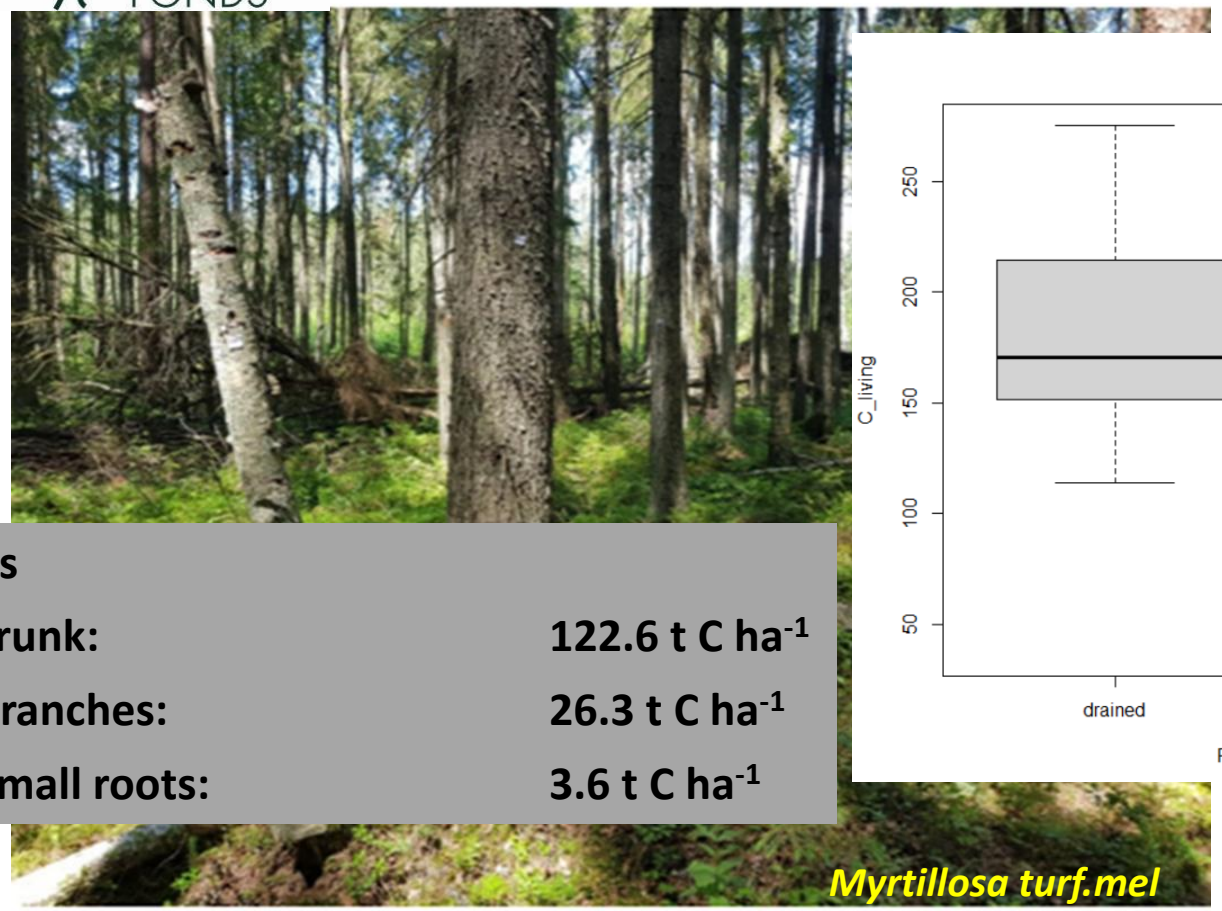
Old-growth forest oldest age class in the EU countries:

- plus 141 (Finland)
- plus 101 (Denmark)
- plus 61 (Portugal)
- plus 41 (Ireland)

Since only some countries provide separate information on the oldest age class 141+ (Austria, Finland, France, Germany, Netherlands, Switzerland; also Sweden for most of the inventories), we decided to use 121+ as highest age class for the mapping. However, for several countries the highest reported age class includes also forests younger than 120 years. This was the case for Belgium, Bulgaria, Denmark, Hungary, Romania, United Kingdom and also Sweden for some inventories (oldest class 101+), Portugal (oldest class 61+) and Ireland (oldest class 41+). In the maps of higher age classes these countries were grouped into an extra category. In the case of Norway, data was backcasted in 40-year intervals instead of 20-year steps. For the mapping exercise the backcasted values were equally divided between the applied 20-year intervals.

Avots: https://sci-hub.se/https://doi.org/10.1016/j.foreco.2012.08.048

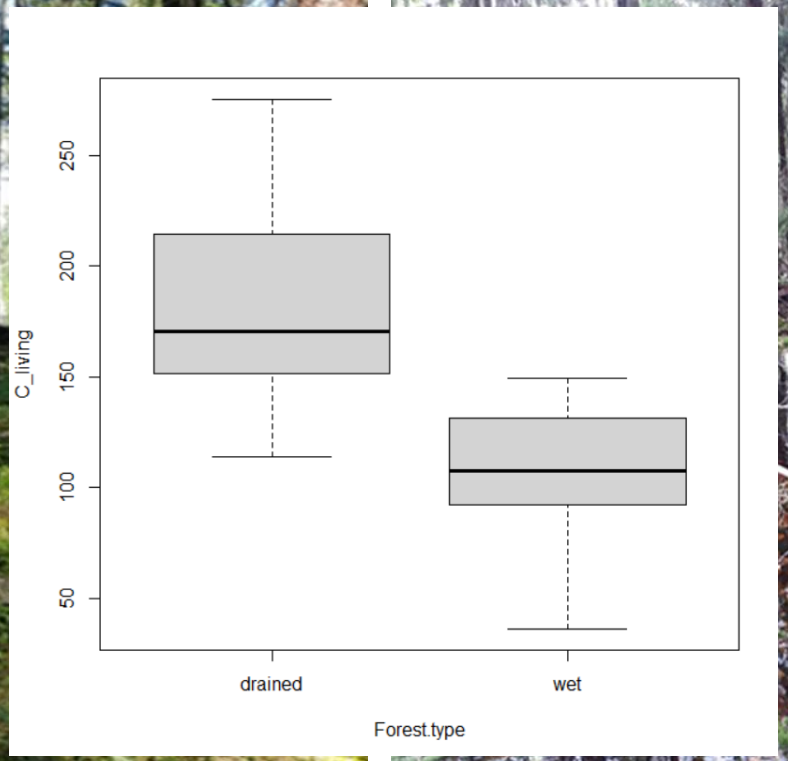
Results: C pools in living biomass



Ks

Trunk:	**122.6 t C ha^{-1}**
Branches:	**26.3 t C ha^{-1}**
Small roots:	**3.6 t C ha^{-1}**

Myrtillosa turf.mel



Nd

Trunk:	**62.9 t C ha^{-1}**
branches:	**20.3 t C ha^{-1}**
Small roots:	**2.9 t C ha^{-1}**

Caricoso-phragmitosa

- C in living biomass on wet soils stored 105.6 t C ha^{-1} and on drained 186.6 t C ha^{-1}
- **C storage by growing conditions differs significantly (p=0,0001)**
- Most prominent differences in stem C pool, respectively on drained and wet organic soils 122.6 vs 62.9 t C ha^{-1}

Old-growth Stands and Carbon

- Carbon accumulation in old-growth forest stands is gaining increasing attention due to the role of **forest sector in the global climate policy.**
- Currently much discussed, with different, even contrasting conclusions.

is neutral (sink and source balance out) (Odum, 1969; Seedre et al., 2015),

a significant sink (Carey et al., 2001; Zhou et al., 2006; Luyssaert et al., 2008);

a weak sink (Pukkala, 2017)

a weak source (Uri et al., 2017)

- **Carbon in managed vs unmanaged forests.** Carbon benefits from managed forests (Pukkala, 2017) vs unmanaged forest benefits to carbon (Stupak et al. 2007; Schwenk et al. 2012; Felton et al. 2016) thus forest management should be limited for the sake of carbon.
- **Empirical, direct measurement** is important in order to base conclusions not on modelling, but on sound, preferably national data.

Conclusions

- **With new forest science publications**, during the recent years the knowledge on old-growth forests has improved. However, on the EU level still large uncertainty remains due to the wide variety of old-growth forests' characteristics, lack of data, different definitions, and due to differences in oldest age class on thresholds on national level (NFI).

- **Old-growth forests and old forest stands are not the same.** Within old-growth forests can grow not only old forest stands as dominating element, but it is also possible that e.g. due to natural disturbances old stands are lost and with regeneration replaced by young stands as the dominated element.

- In Europe are used **several definitions of old-growth forests**, therefore it is possible that different sources refer to different old-growth area, that in some cases differ significantly.

- Natural disturbances and gradual vitality decrease with aging reduces carbon stock of old-growth forests.

- **Old-growth stands can be very different by carbon amount stored**, highly impacted by both the dominated tree species and stand growing conditions. Therefore, it is essential to obtain empiric data for each region in Europe separately. Latvia' s empiric data from forest sample plots characterizes most precisely carbon pools in our hemiboreal forests.

Conclusions

- Old-growth forests holds an important carbon stock, **but with aging annual CO2 sequestration (primary productivity) decreases** with decrease in annual increment. Thus, if we set a goal to compensate annual GHG emissions by forest carbon stock, taking out forest areas from management is not an effective way to reach this goal.
- Living trees forms the largest and most dynamic carbon stock, followed by carbon stock in mineral soil (in long term is stabile to different impacts), and small, but dynamic carbon pools are deadwood and litter. Thus, old stands represent a large carbon stock until old living trees are dominated.
- Thus old-growth forests are very important for biodiversity, however, **in the climate change context** we see both strong and weak aspects. **Strong aspects** include large carbon stocks, but **weak aspects** include: decrease in productivity, gradual decrease in forest stand vitality, decrease in annual CO2 sequestration, and A risk to lose a large carbon stock due to natural disturbances.
- Managed forests ensure not only carbon accumulation in living trees, **but also store carbon in harvested wood products (HWP) and replace fossil emissions** in products and energy. In Latvia country level estimations show, the decrease in forest management intensity would slightly increase carbon stock in living trees, however, this approach would lead to significant decrease in carbon stock in harvested wood products (HWP) and replacement effect, consequently reduction of harvesting level would result also in decreased climate change mitigation effect in forest sector.

Thank you!