Forest management and conservation of the threatened lichen *Lobaria pulmonaria* in Mediterranean oak forests

Working Group for Ecology of the Italian Lichen Society

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4th Mediterranean Plant Conservation Week

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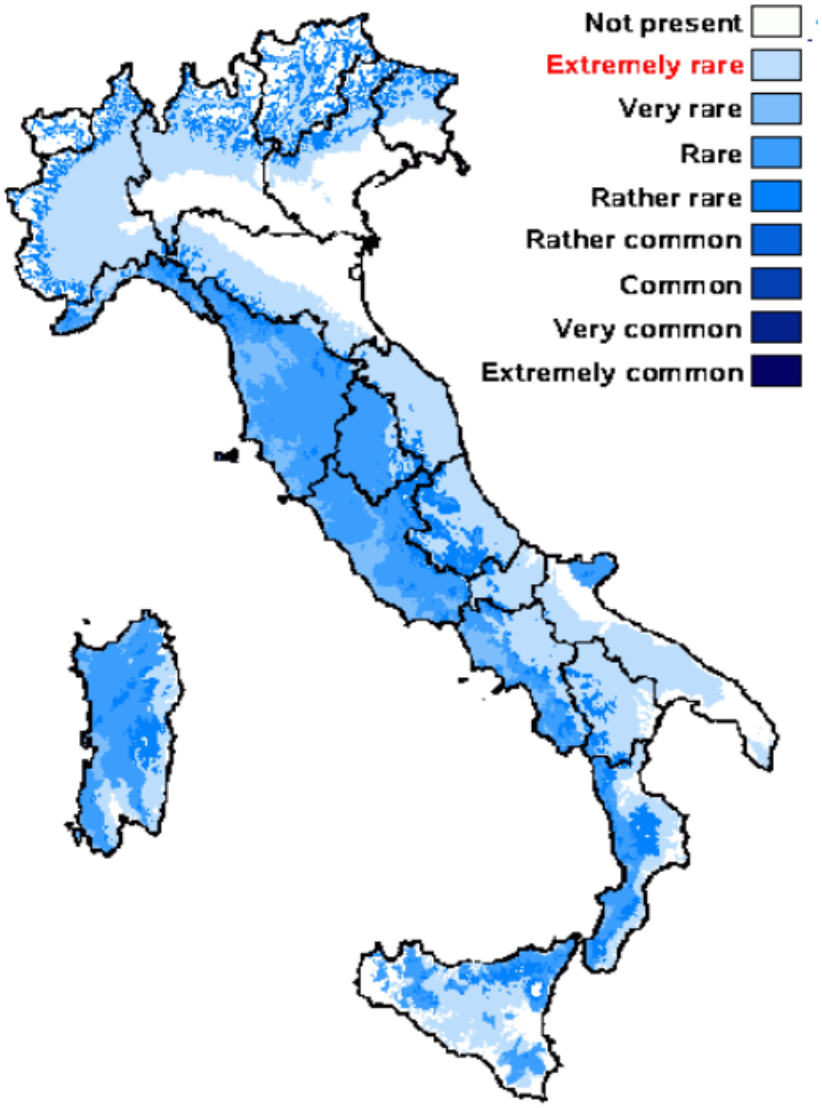
- Intensive forest management may threaten forest lichens, causing habitat fragmentation, degradation and loss.
- The epiphytic forest lichen ***Lobaria pulmonaria*** (L.) Hoffm. has suffered a general **decline** throughout Europe as a consequence of **air pollution** and **intensive forest management**, whose effects are expected to be further exacerbated by climate change (Nascimbene et al. 2016).
- Its occurrence and abundance are used as indicators of forest **ecological continuity** and for mapping **forest sites worthy of conservation**.
- Red-listed and legally protected in several European countries…

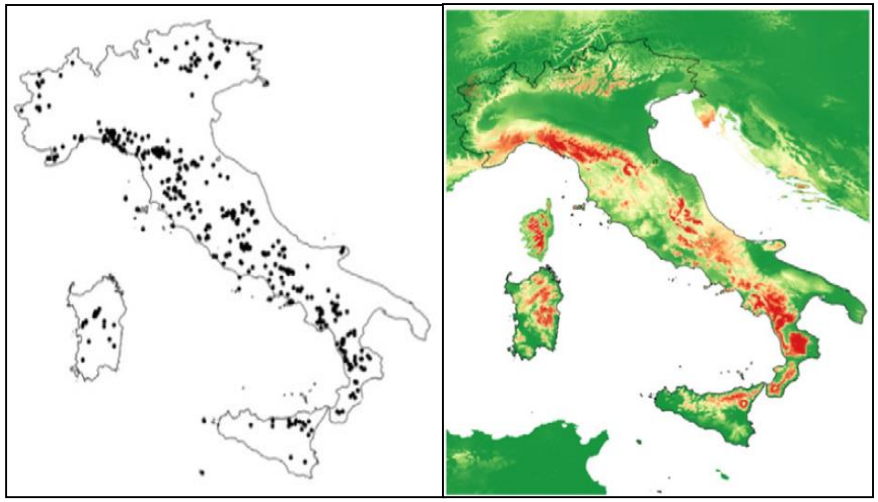


Distribution of *Lobaria pulmonaria* in Italy (Nimis 2016)

In **Italy**:

- locally spread, but **habitats with fertile populations rare** – confined to high quality environment

- the species is **not protected.**



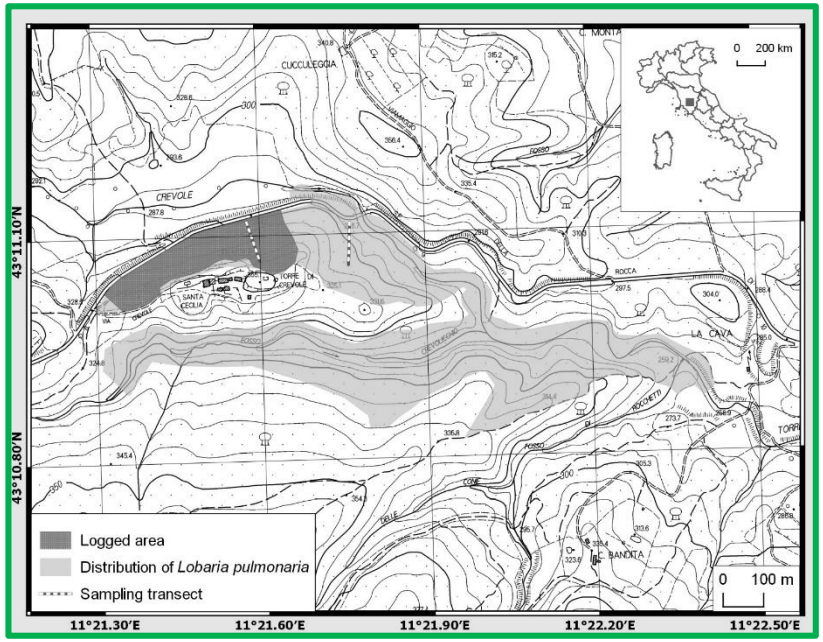
Current and predicted distribution of *Lobaria pulmonaria* in Italy (Nascimbene et al. 2016)

- **After logging**, lichens are exposed to a sudden microclimatic variation, consisting of an increase in solar radiation, temperature, wind and a reduction of humidity.

- **Prolonged dry conditions** may negatively affect photosynthetic activity, and hence the overall vitality of sensitive species, such as the forest lichen *Lobaria pulmonaria*.

- The **background** for this research was offered in 2016 by a logging for timber production which depleted a large population of *L. pulmonaria*, including hundreds of fertile thalli in Central Italy.

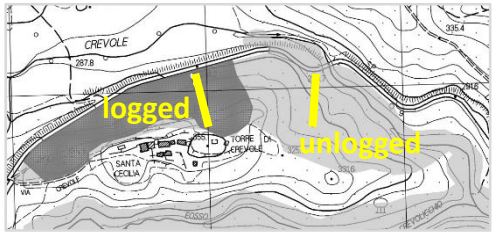
- Afterwards, *L. pulmonaria* from that area has been used as a model to investigate the stress induced by logging and to enhance **better conservation practices**, by means of a series of experiments carried out in Mediterranean mixed forests and beyond.



1) Impact of forest management on threatened lichens in Mediterranean oak forests
(Paoli et al., 2019 - iForest 12: 383-388)

- We estimated that about 40% of *L. pulmonaria* biomass has been lost due to logging operations, in particular large and fertile thalli (37–54 kg over the whole area).

- Changes in composition: after logging, most of the remaining *L. pulmonaria* thalli are small and sterile, while most of the largest ones (and fertile) disappeared.

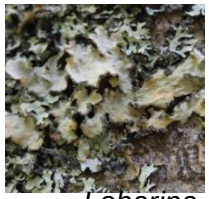


- Decrease of the density of potential host trees (from ~ 1050 stems ha^{-1} to ~ 165 ha^{-1}).

- Disappearing of other lichens of conservation concern.

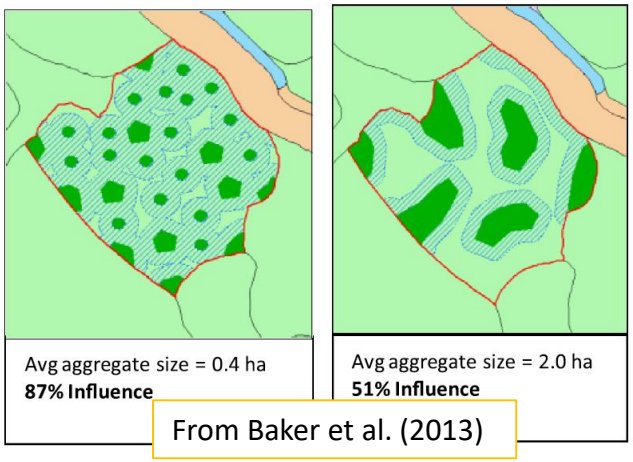

Pannaria conoplea


Degelia plumbea

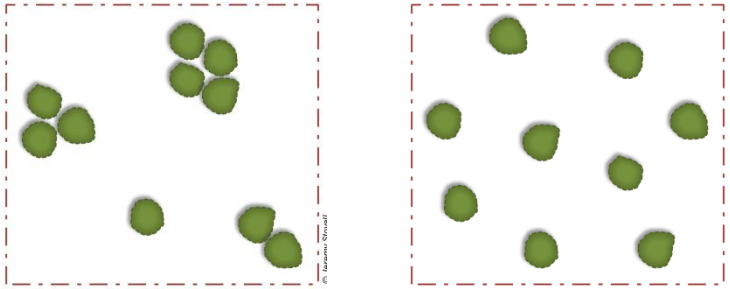

Lobarina scrobiculata

- 46 % of remaining thalli reflect lower vitality after 1 year (analysis of chlorophyll *a* fluorescence emission).

2) effectiveness of forestry retention



From Baker et al. (2013)



retained-forest patches vs. retained-isolated trees

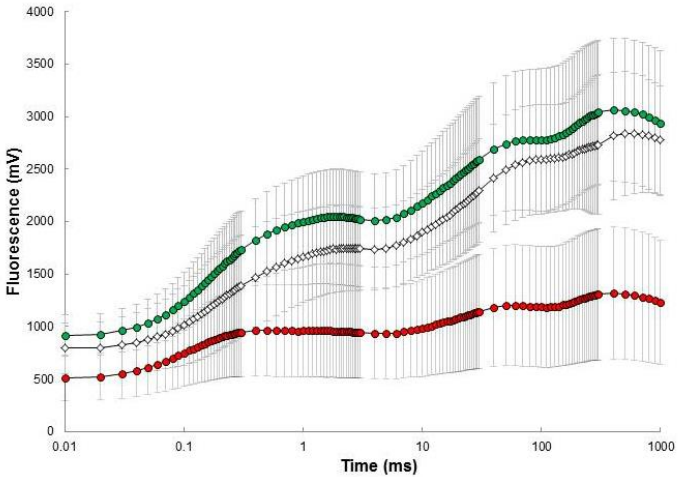
thalli from retained forest patches

thalli from isolated trees

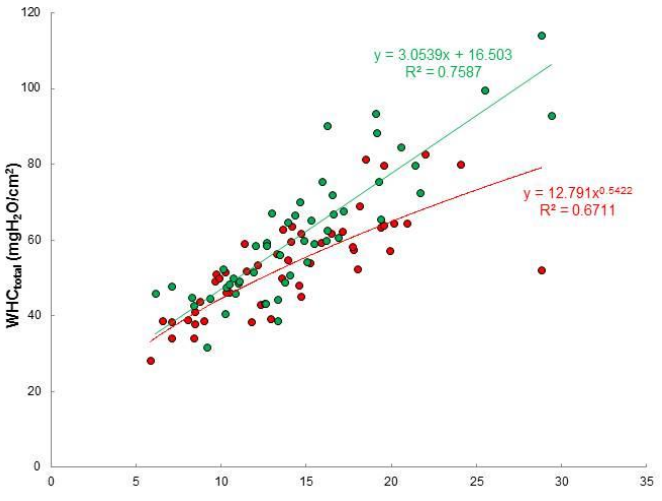
- 18 months after the conclusion of logging operations (February 2018).
- Assessment of the vitality of lichen thalli through the **measurements of photosynthetic performances** and **thallus anatomy**.
- Estimation of **water holding capacity** as one of the ecosystem services provided by the presence of healthy forest macrolichens.

2) effectiveness of forestry retention
(Fačkovcová et al., 2019 - iForest 12: 187-192)

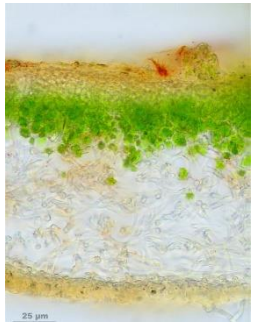
- Chlorophyll *a* fluorescence transients of *Lobaria pulmonaria* from isolated trees (red) and forest patches (green). For comparison, the average curve of individuals in the unlogged area is given (white).



- Thalli from forest patches had higher water holding capacity (WHC) than those from isolated trees.



- Thalli from isolated trees had a 35% reduction of the photobiont layer.



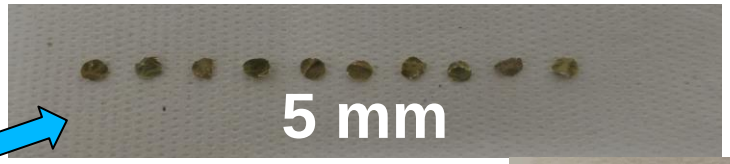
- Hence, thalli remained on isolated trees were overall thinner, with lower vitality and lower water holding capacity. They have lower capacity to provide ecosystem services.

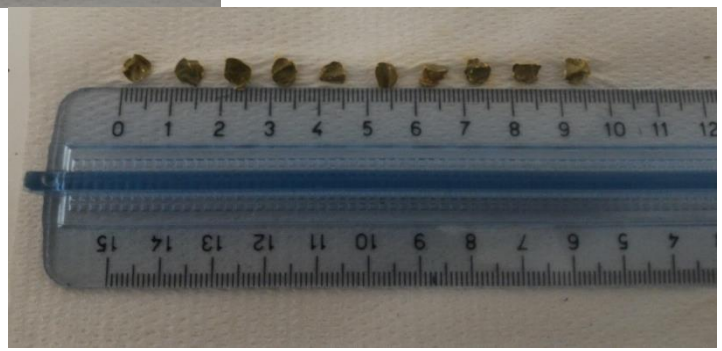
- On the other hand thalli from forest patches had performances comparable to those of healthy samples from unlogged forests.

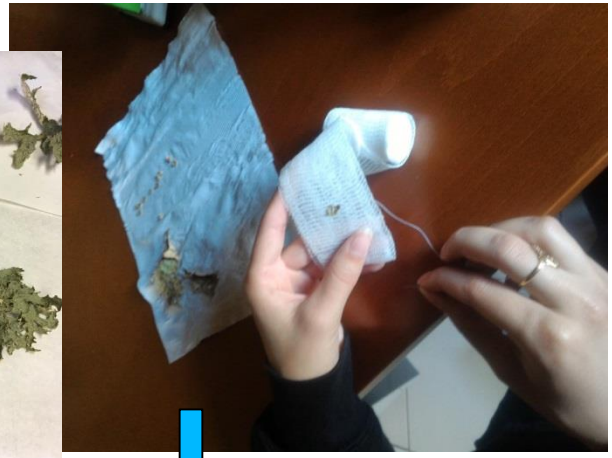
Retaining unlogged patches in Mediterranean oak forests may preserve threatened forest macrolichens

Simulating logging impact…

Investigation tools: micro-transplants



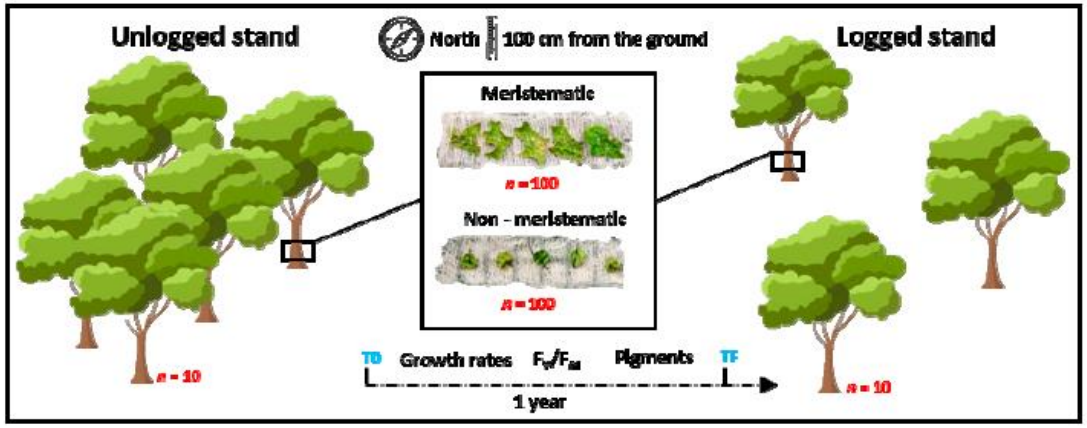




adult lobes

meristematic lobes

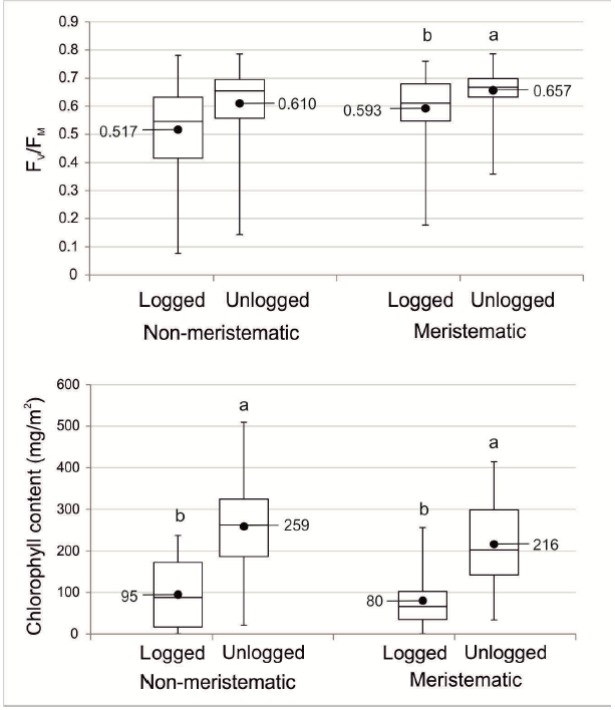
3) alterations in vitality and growth due to logging…focus on N oriented samples (Bianchi et al. 2020 - Forests, 11, 995)



- Transplants in the **unlogged stand** (both non-meristematic and meristematic) were characterized by **larger surfaces** and increase in the thallus area.

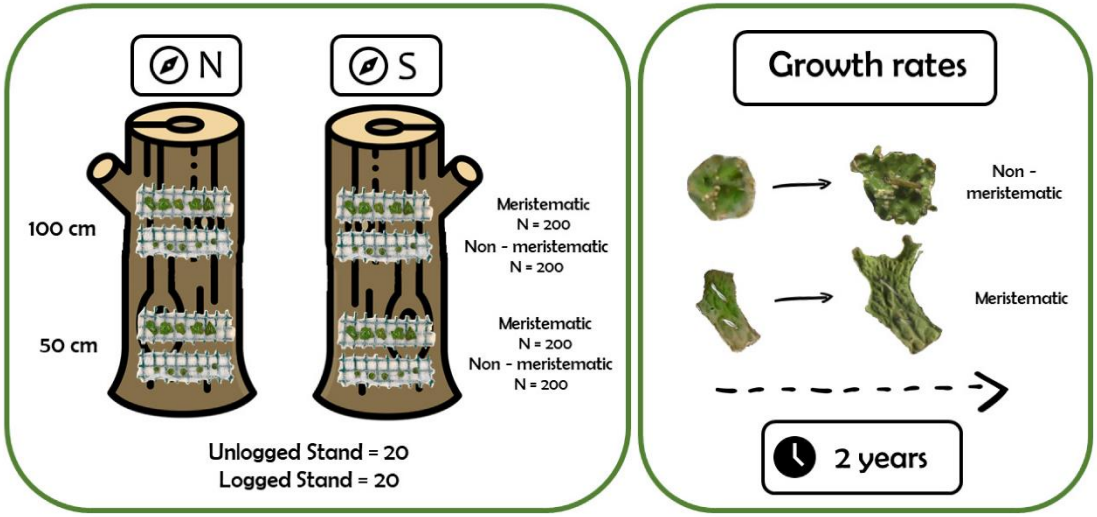
- Irrespective of forest management, **meristematic fragments** showed **higher performances and growth rates** (surface increase 0.16–0.18 cm^2 $year^{-1}$) as compared with non-meristematic fragments (0.02–0.06 cm^2 $year^{-1}$).

- For appropriate conservation strategies, it is necessary to **consider** the **life cycle** of the lichen: meristematic fragments have more chance to survive after logging.



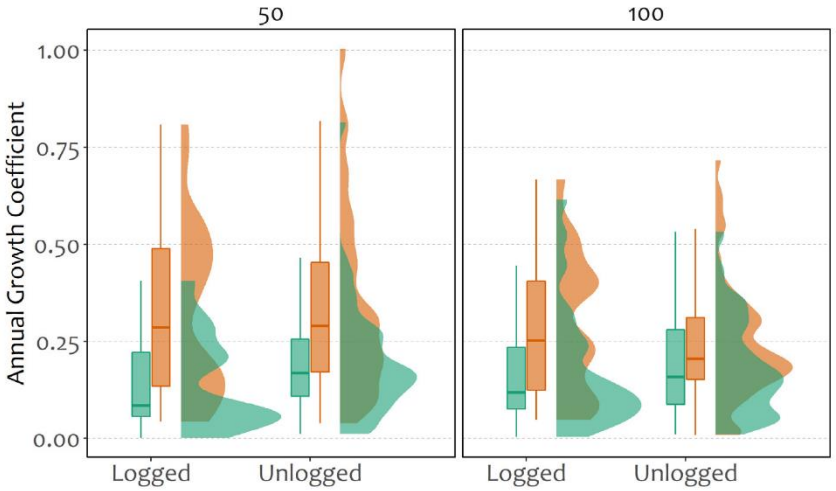
4) influence of local microclimate modifications introduced after logging

(Di Nuzzo et al. 2022 - Plants, 11, 295)

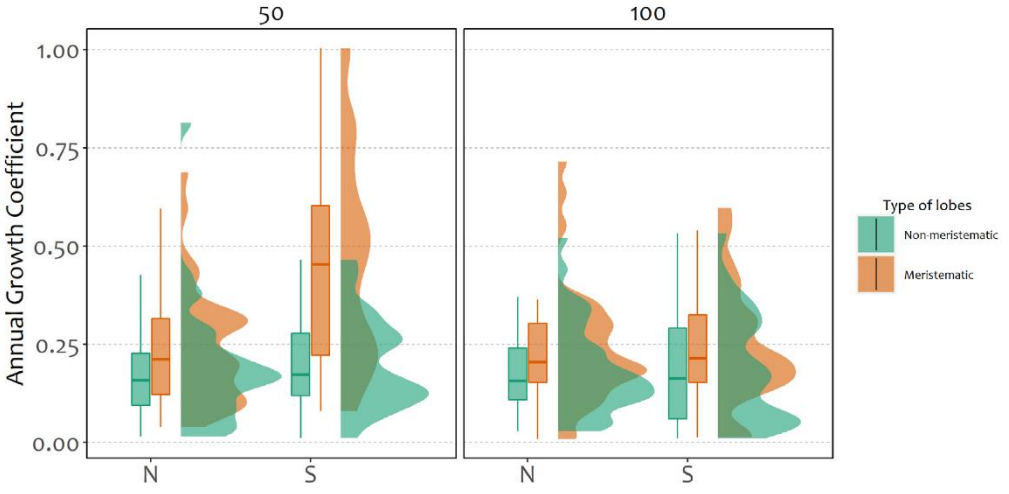


- Combined effect of forest logging and microclimatic conditions.
- The translocation as a method for the *in situ* conservation of threatened lichen populations.
- Microclimatic alteration at the tree level after logging affects transplants growth: young thalli have a higher chance of survival.

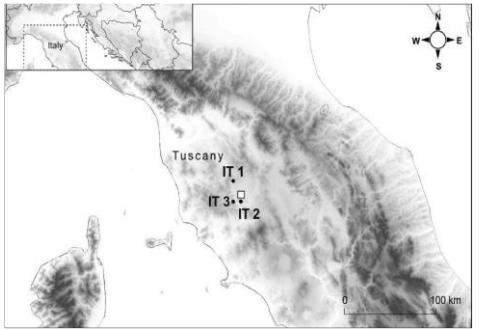
Annual growth coefficient for **forest type** (logged and unlogged), type of lobes (non-meristematic and meristematic) and different heights from the ground (50 and 100 cm).



Annual growth coefficient in the **unlogged stand** according to type of lobes (meristematic and non-meristematic), aspect and different heights from the ground (50 and 100 cm).



5) the efficacy of translocation for conservation purposes
(Paoli et al., 2020 – Ecological Indicators 117, 106666)

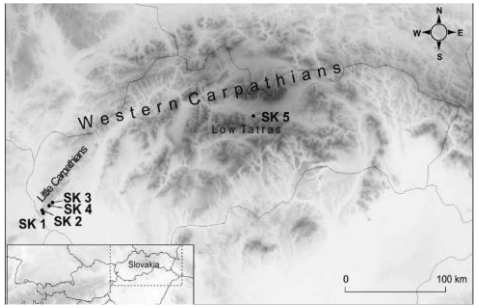


Does air pollution influence the success of species translocation?

About 500 thalli of *L. pulmonaria* have been translocated to:
- oak forests (protected areas) in Tuscany that already host native populations;
- beech forests in the Western Carpathian Mts., that hosted native populations in the past.

- Air pollution influences the success of lichen translocation for conservation purposes.

- The translocation of *L. pulmonaria* is effective only in unpolluted environments.



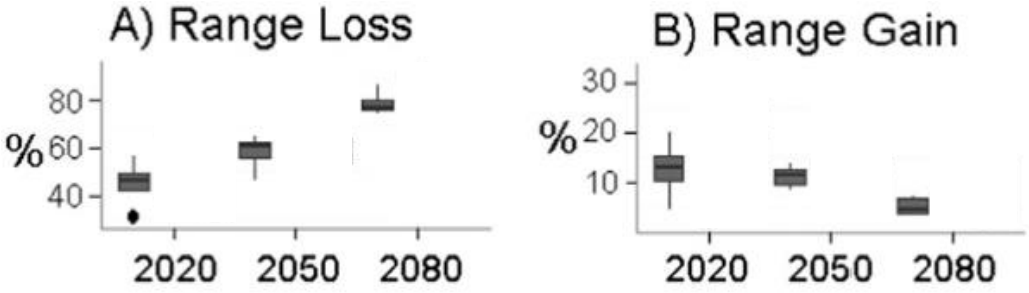
- Higher contents of heavy metals in translocated thalli reflect their lower survival.

- Current air quality in Central Europe limits recolonization by sensitive lichens.

Habitat loss and global change

Current distribution of *Lobaria pulmonaria* in Italy (Nascimbene et al. 2016)

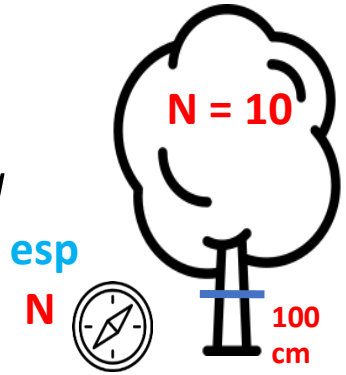
Predicted changes in distribution across the time (Nascimbene et al. 2016):



- steep gradient of increasing range loss across time
- the species is facing a high extinction risk associated with reduction of their range

The responses of lichens to habitat changes caused by invasive trees are poorly understood.

The main question:
Can forests composed of invasive *Robinia pseudoacacia* represent future habitats for *L. pulmonaria*?



5 lobes for a tree

Lobaria exposed on:
10 trees *Robinia*
10 trees *Castanea*

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