Response of low-elevation pine stands in the Central Alps to changes in land use in a warmer climate

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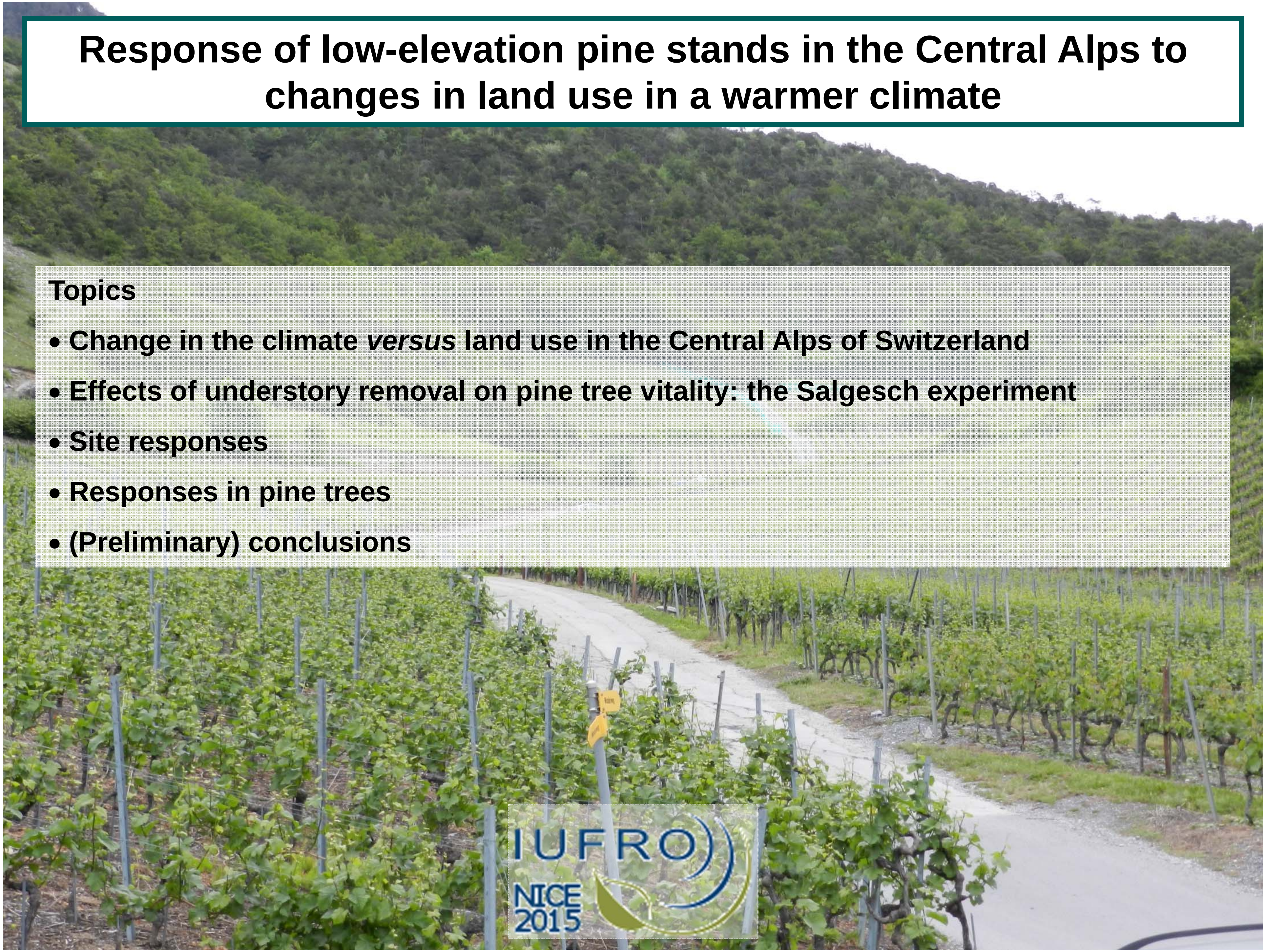
Topics

- **Change in the climate *versus* land use in the Central Alps of Switzerland**
- **Effects of understory removal on pine tree vitality: the Salgesch experiment**
- **Site responses**
- **Responses in pine trees**
- **(Preliminary) conclusions**



Change in the climate *versus* land use in the Central Alps of Switzerland (I)

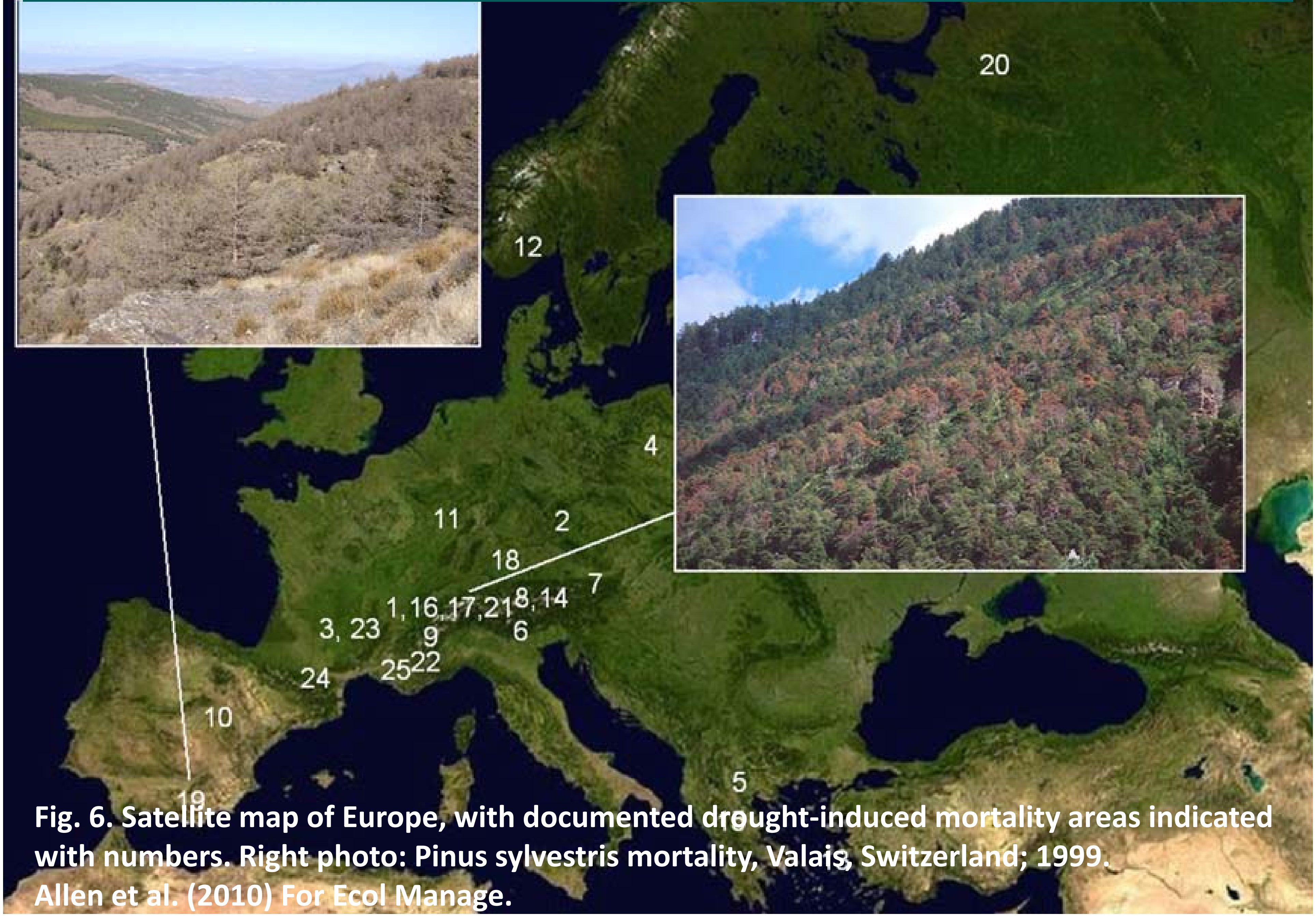


Fig. 6. Satellite map of Europe, with documented drought-induced mortality areas indicated with numbers. Right photo: Pinus sylvestris mortality, Valais, Switzerland; 1999.
Allen et al. (2010) For Ecol Manage.

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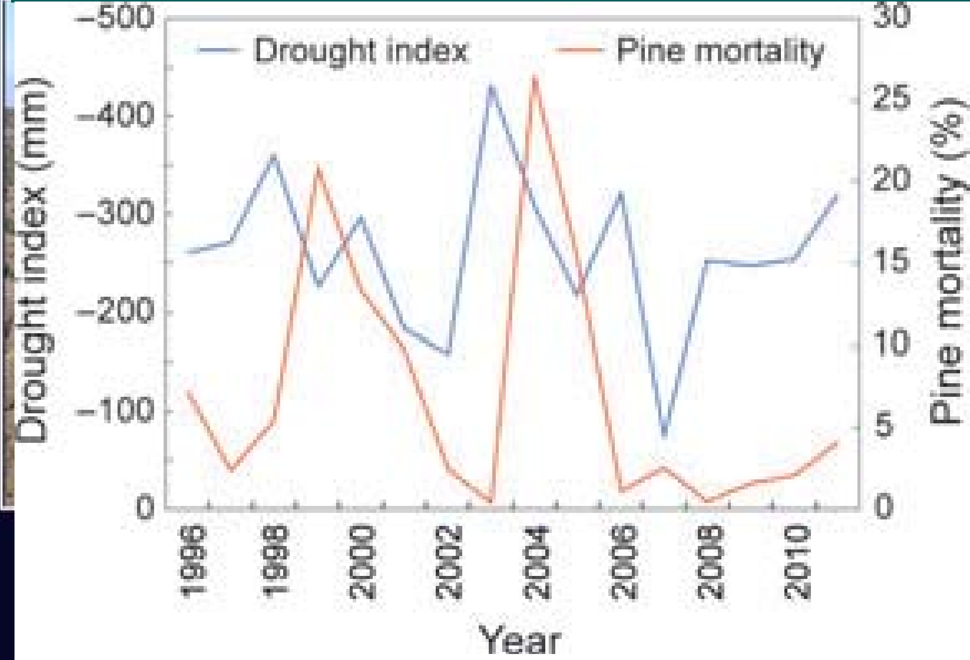
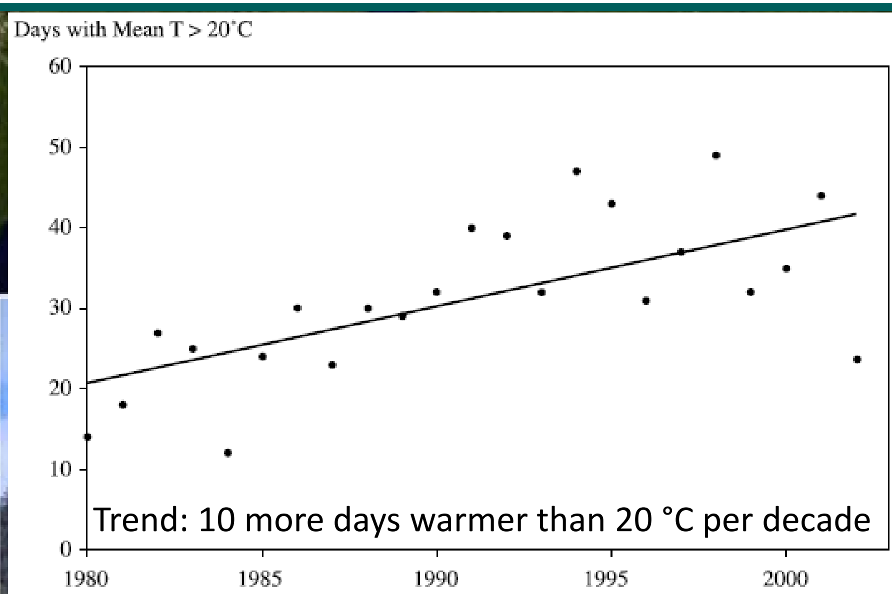
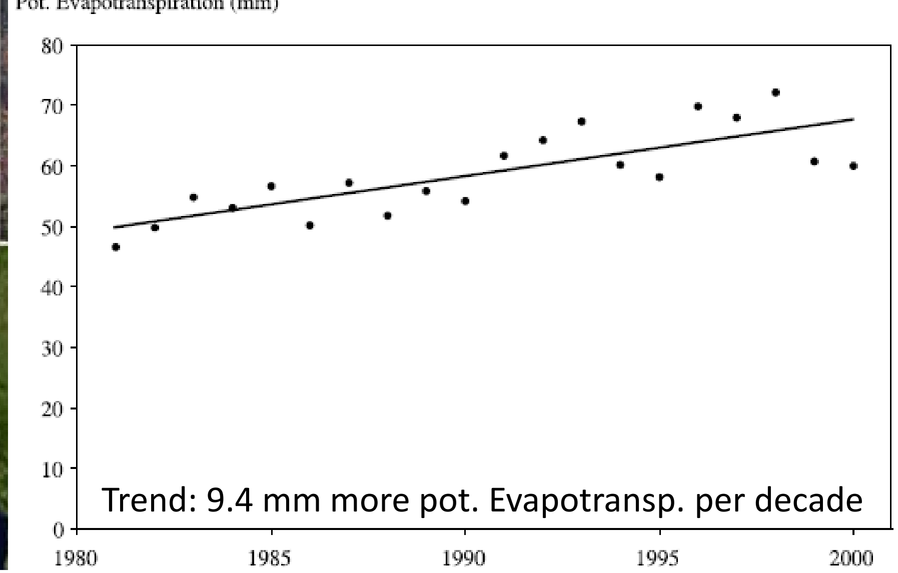


Temporal variability in drought and Scots pine mortality surveyed on the long-term monitoring plot of Visp, Valais, Switzerland. Rigling et al. (2013) Glob Chang Biol.





Increase in the number of warm days and potential evapotranspiration in Visp, Valais, from 1980 to 2000 (April to September mean monthly values). Rebetez and Dobbertin (2004) Theor Appl Climatol.

Fig. 6. Satellite map of Europe, wi… with numbers. Right photo: Pinus… Allen et al. (2010) For Ecol Manage.

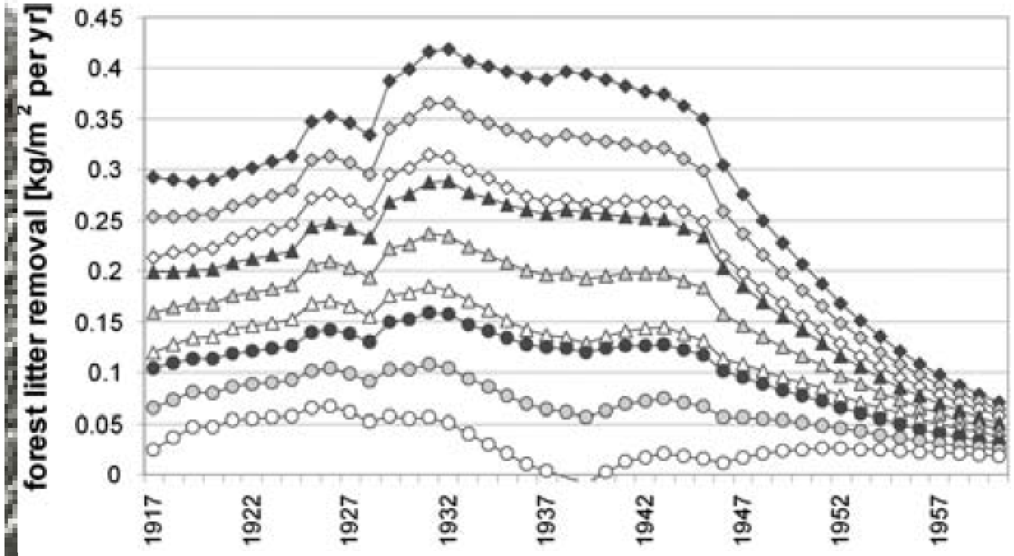
Change in the climate *versus* land use in the Central Alps of Switzerland (II)

Forest litter harvest, Valais 1965

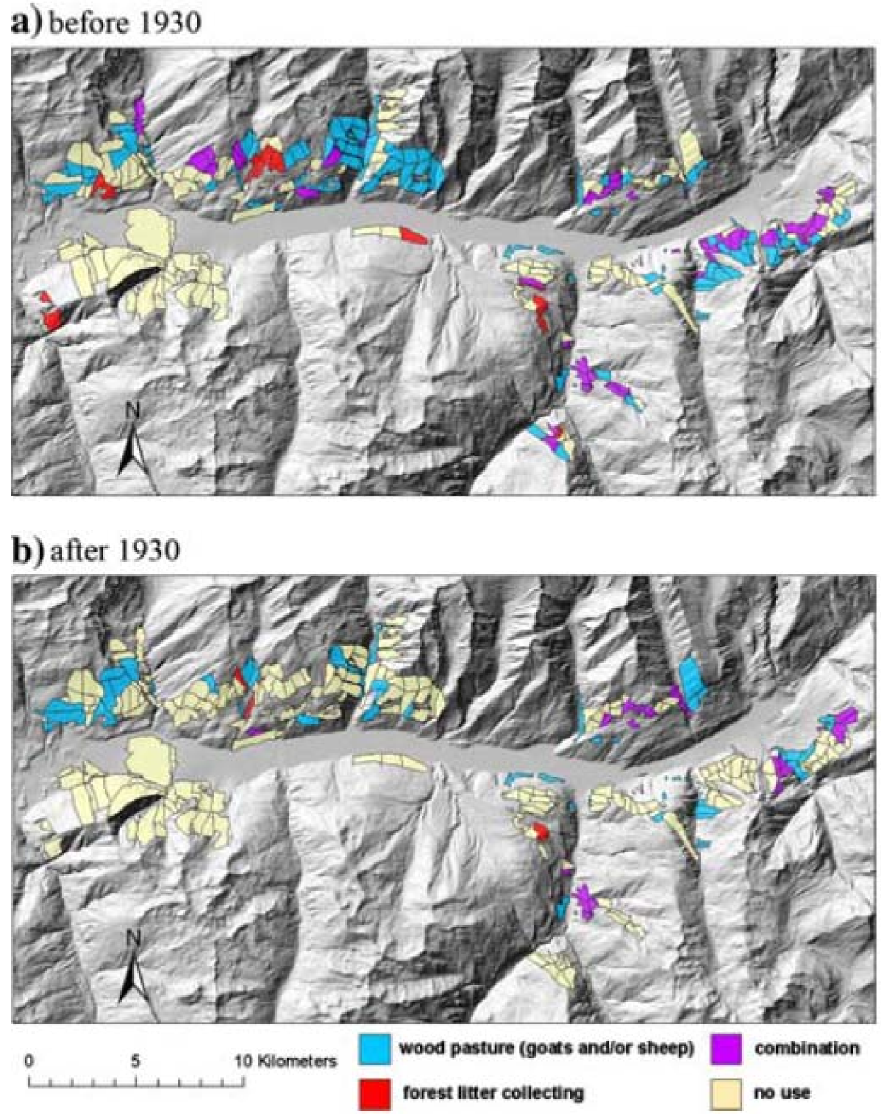
Goat cattle grazing in forest, Valais 1920

Change in the climate *versus* land use in the Central Alps of Switzerland (II)

Gimmli et al. (2008) Ecosystems

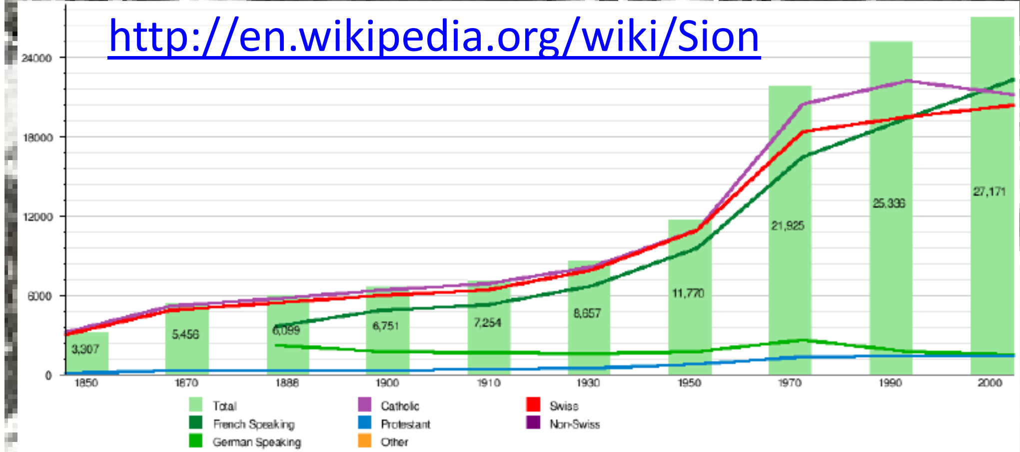


Reconstruction of biomass removal due to forest litter collecting for the period 1917–1960 for different estimates of litter demand per large animal unit and straw production rates.



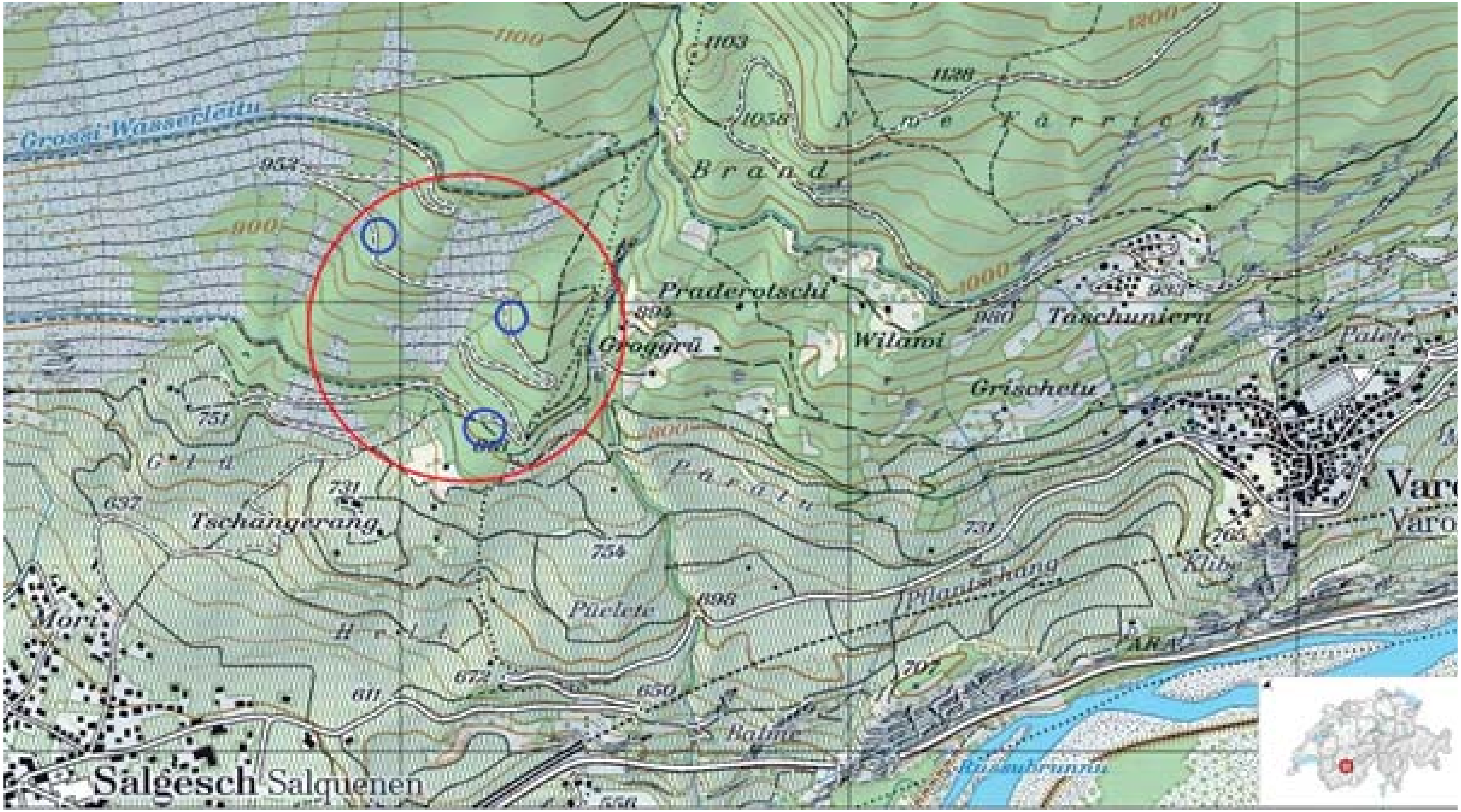
Spatiotemporal distribution of wood pasture and forest litter collecting in the upper central Valais before and after 1930.

http://en.wikipedia.org/wiki/Sion

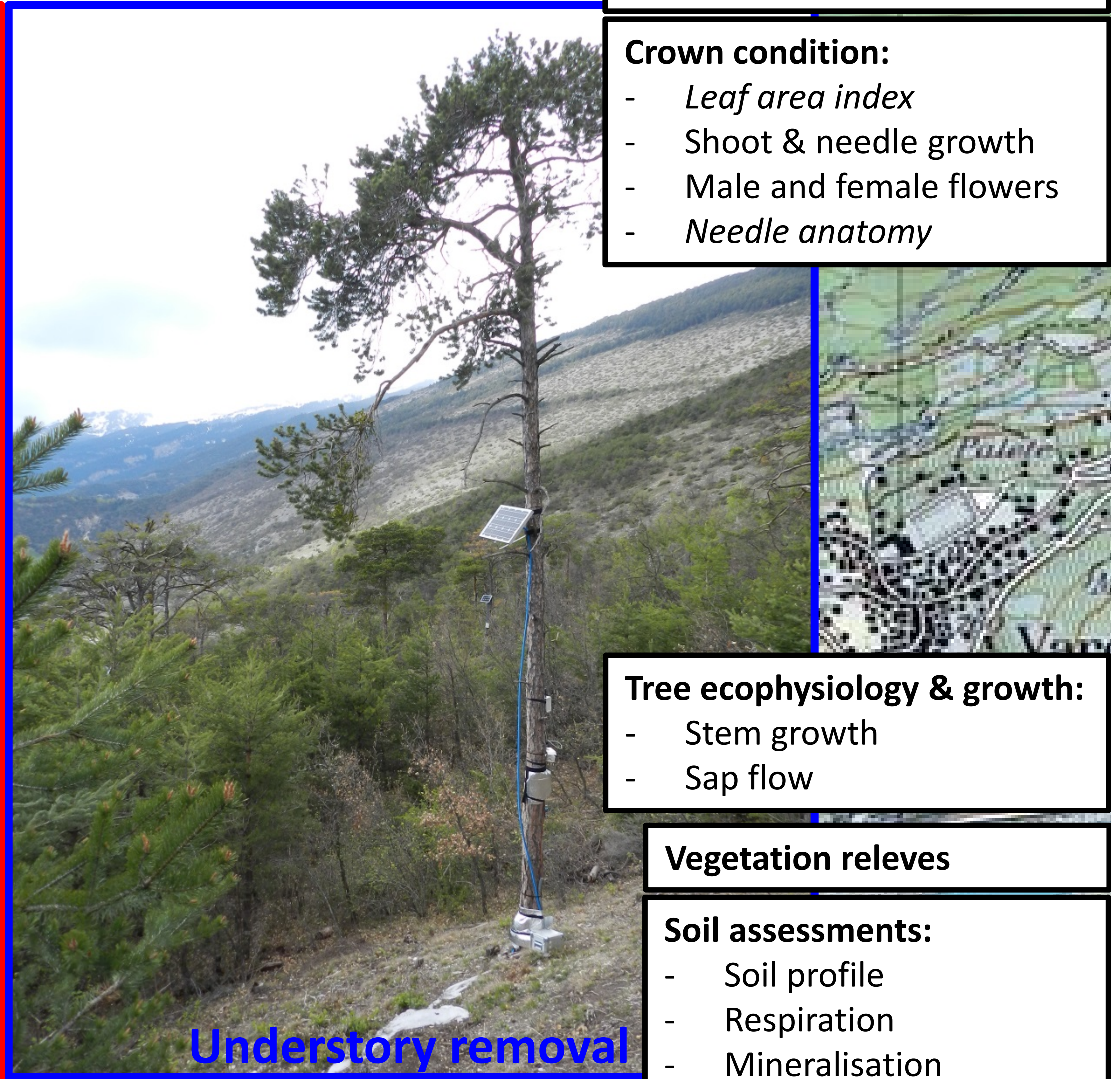


Population increase in the city of Sion, capital of Valais.

Effects of understory removal on pine tree vitality: the Salgesch experiment (I)



Effects of understory removal on pine tree vitality: the Salgesch experiment (I)



5 m circular plot arranged in pairs (N = 6), with or without understory removal
Plot centered on one dominant pine tree (*P. Sylvestris*) 120-160 year-old
Experiment started in 2010.

Assessments:

Crown condition:
- *Leaf area index*
- Shoot & needle growth
- Male and female flowers
- *Needle anatomy*

Tree ecophysiology & growth:
- Stem growth
- Sap flow

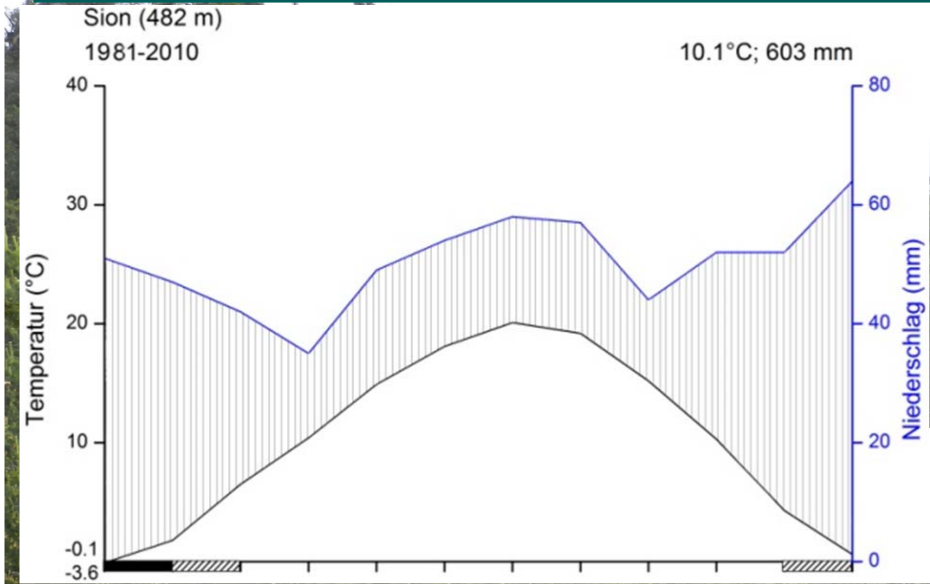
Vegetation releves

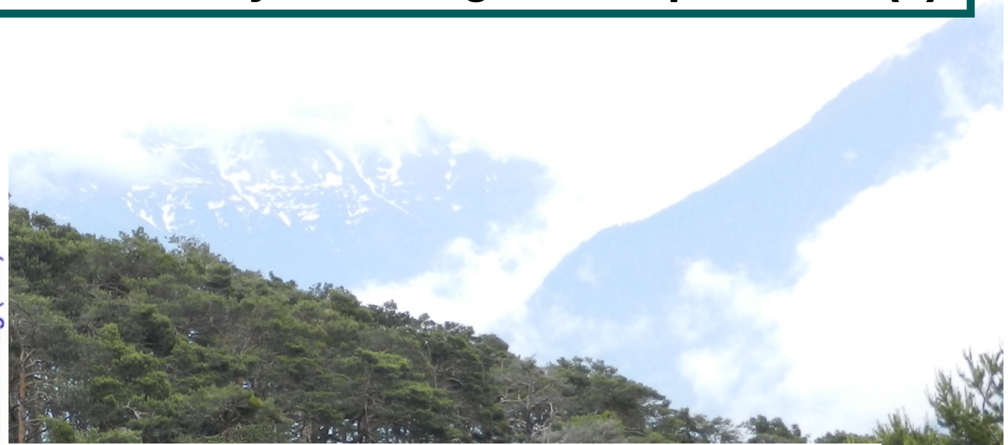
Soil assessments:
- Soil profile
- Respiration
- Mineralisation
- 3 depths: temperature, water content

Not shown

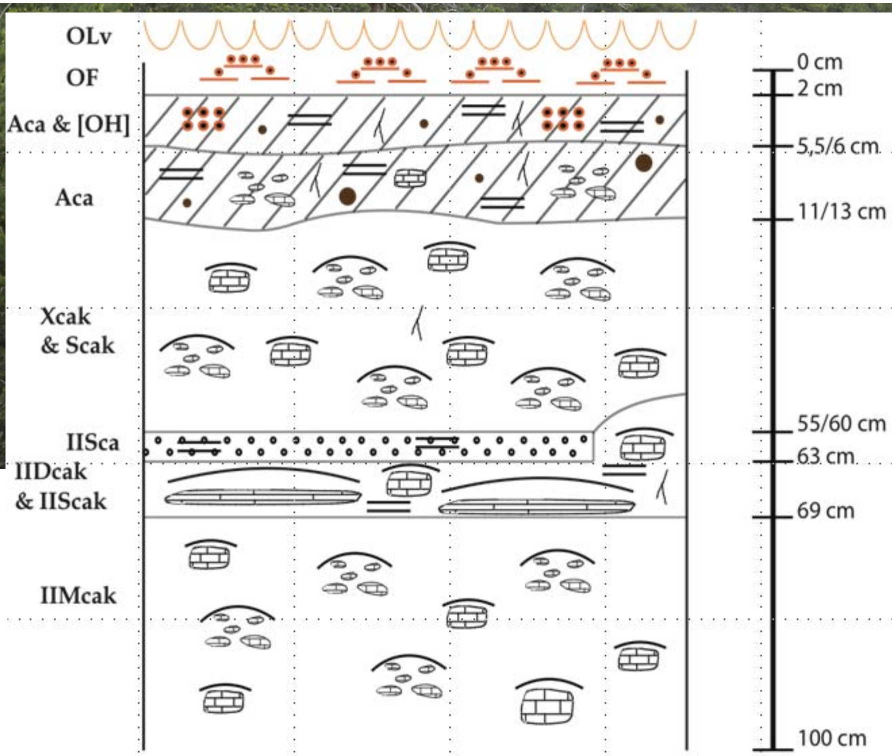
Effects of understory removal on pine tree vitality: the Salgesch experiment (II)

Effects of understory removal on pine tree vitality: the Salgesch experiment (II)



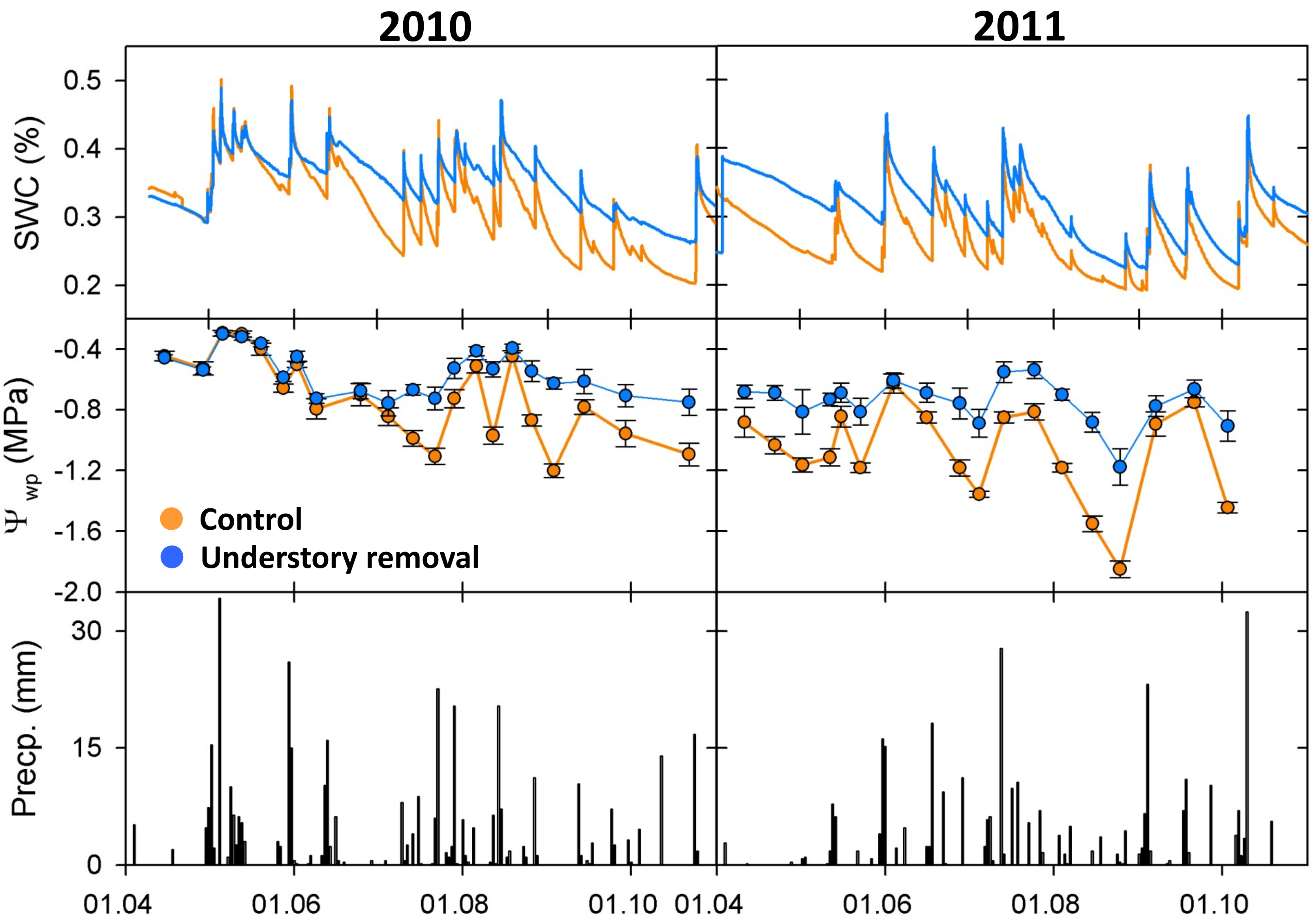


Climate diagram of Sion, Valais (about 15 km west of study site). Continental climate. Driest region of Switzerland.

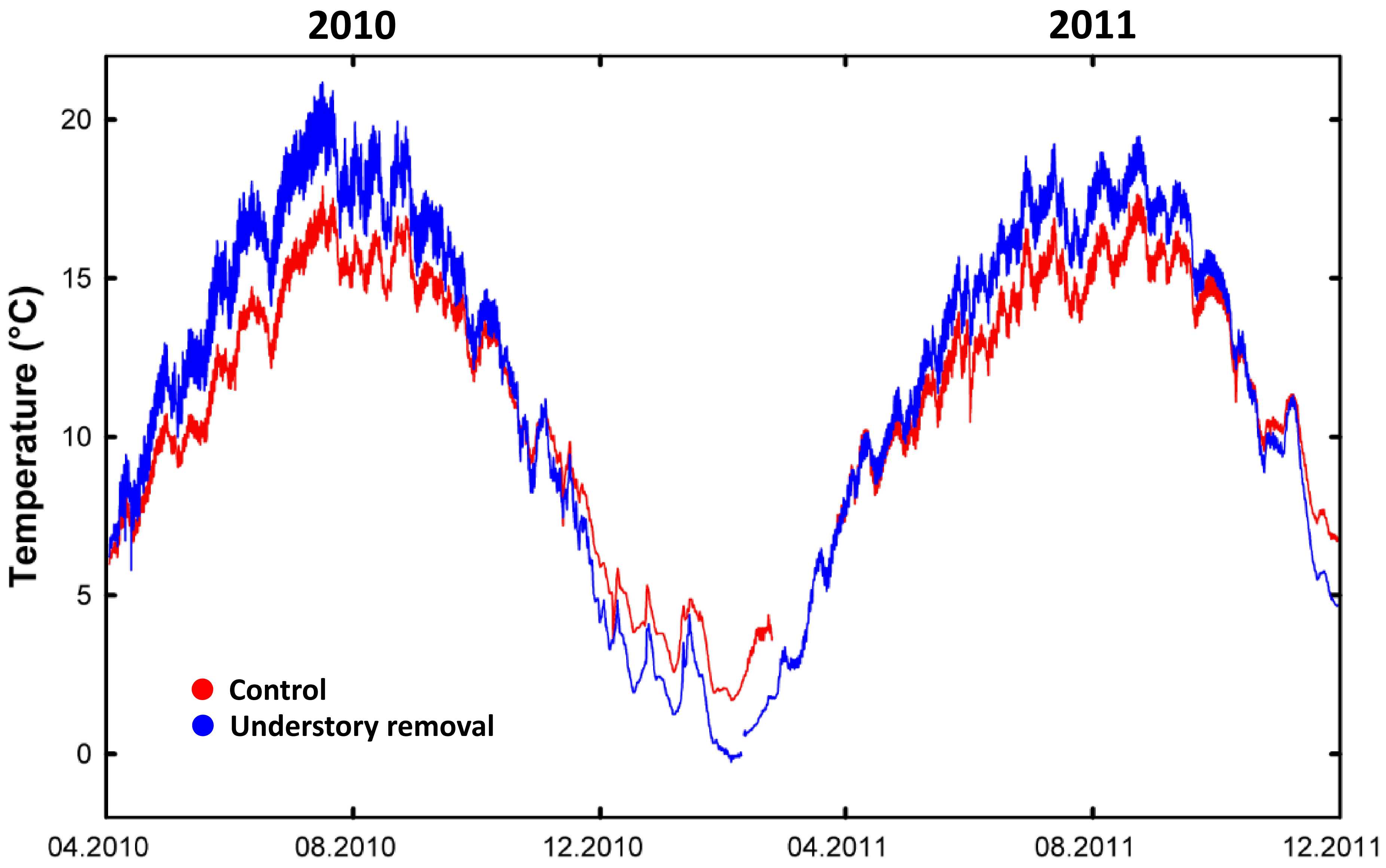


40 to 100 cm-deep dry, calcareous and polyphasic soils (Calcosols) derived from mostly colluvial material, with occasional occurrence of a 60-80 cm-deep loess horizon.

Site responses (I): increase in the soil water content (30 cm depth)

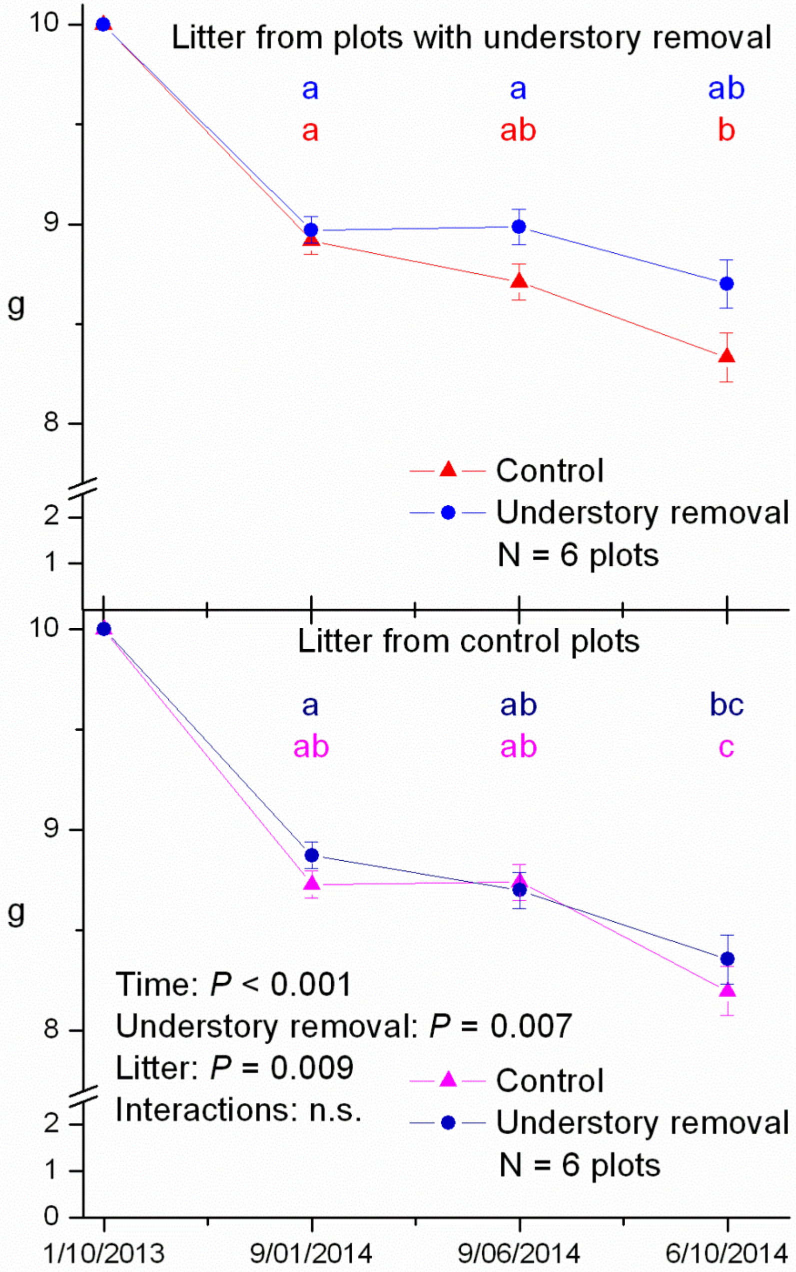


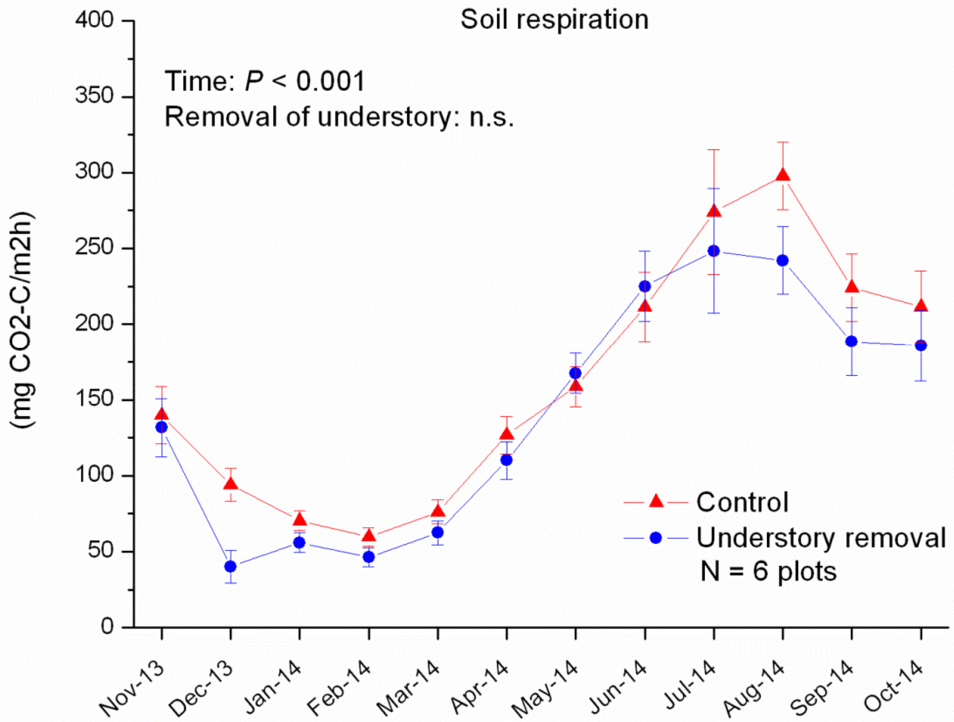
Site responses (II): increase in the soil temperature (30 cm depth)



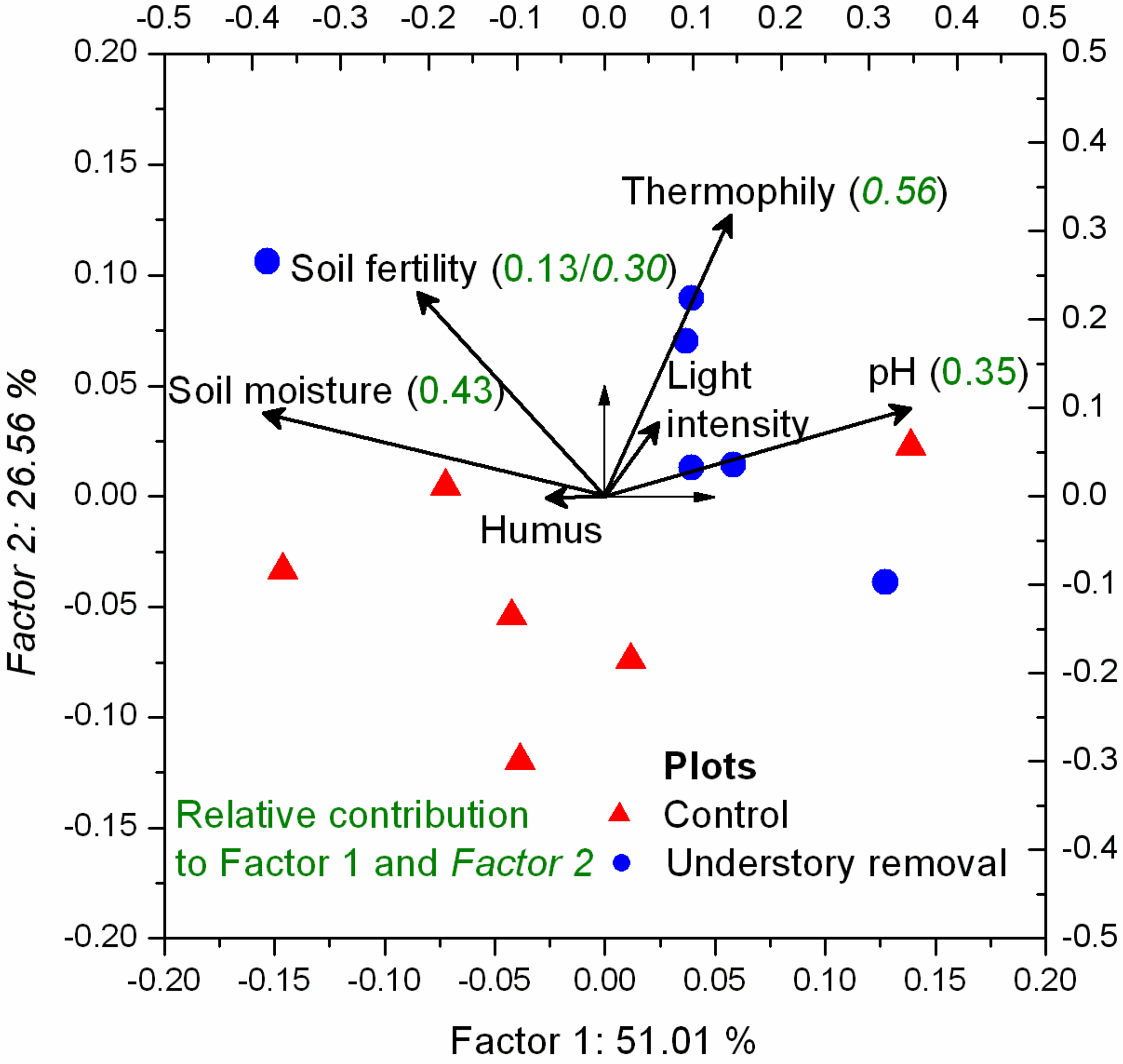
Site responses (III): lower biological activity in the soil

Mineralisation of forest litter

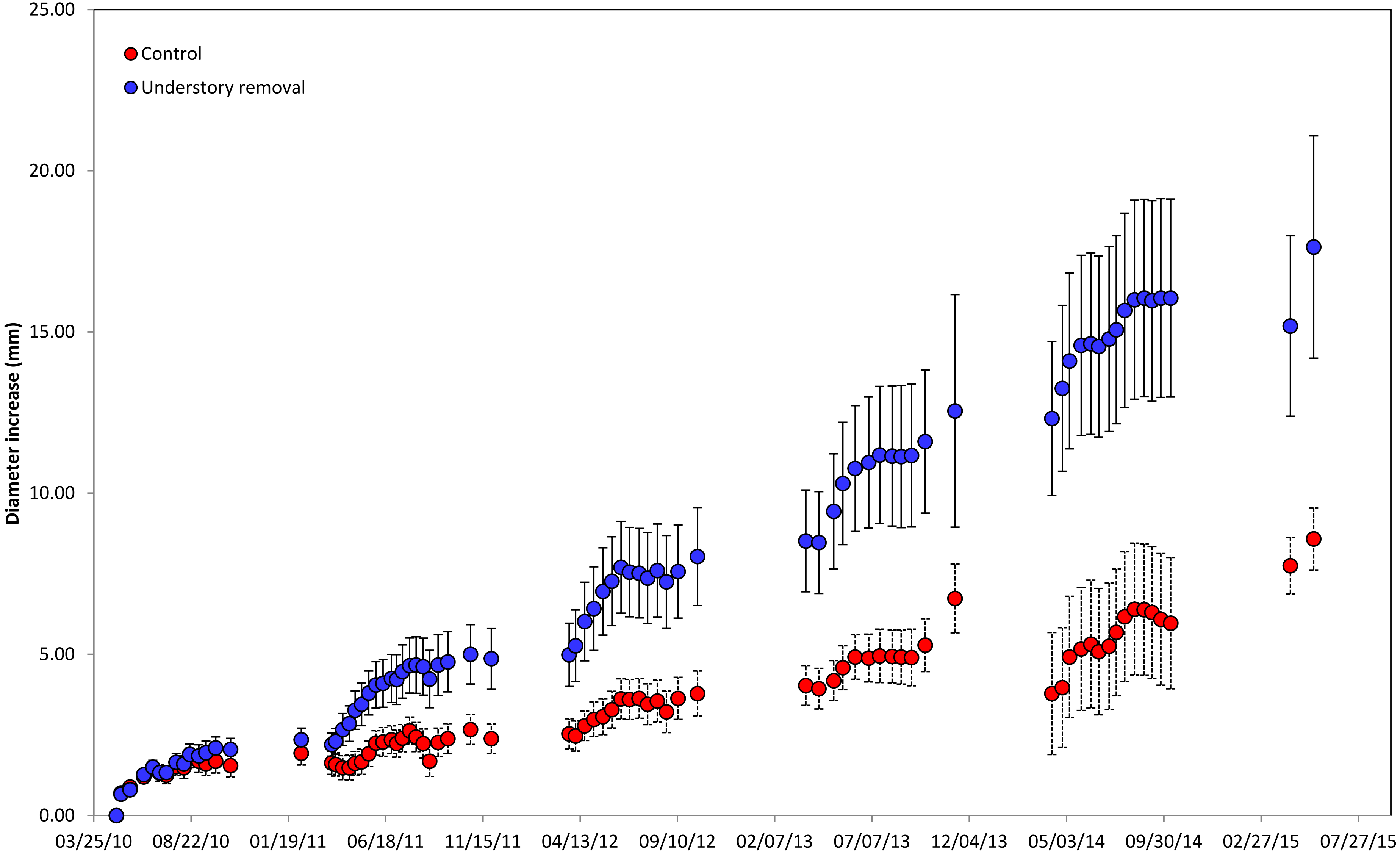




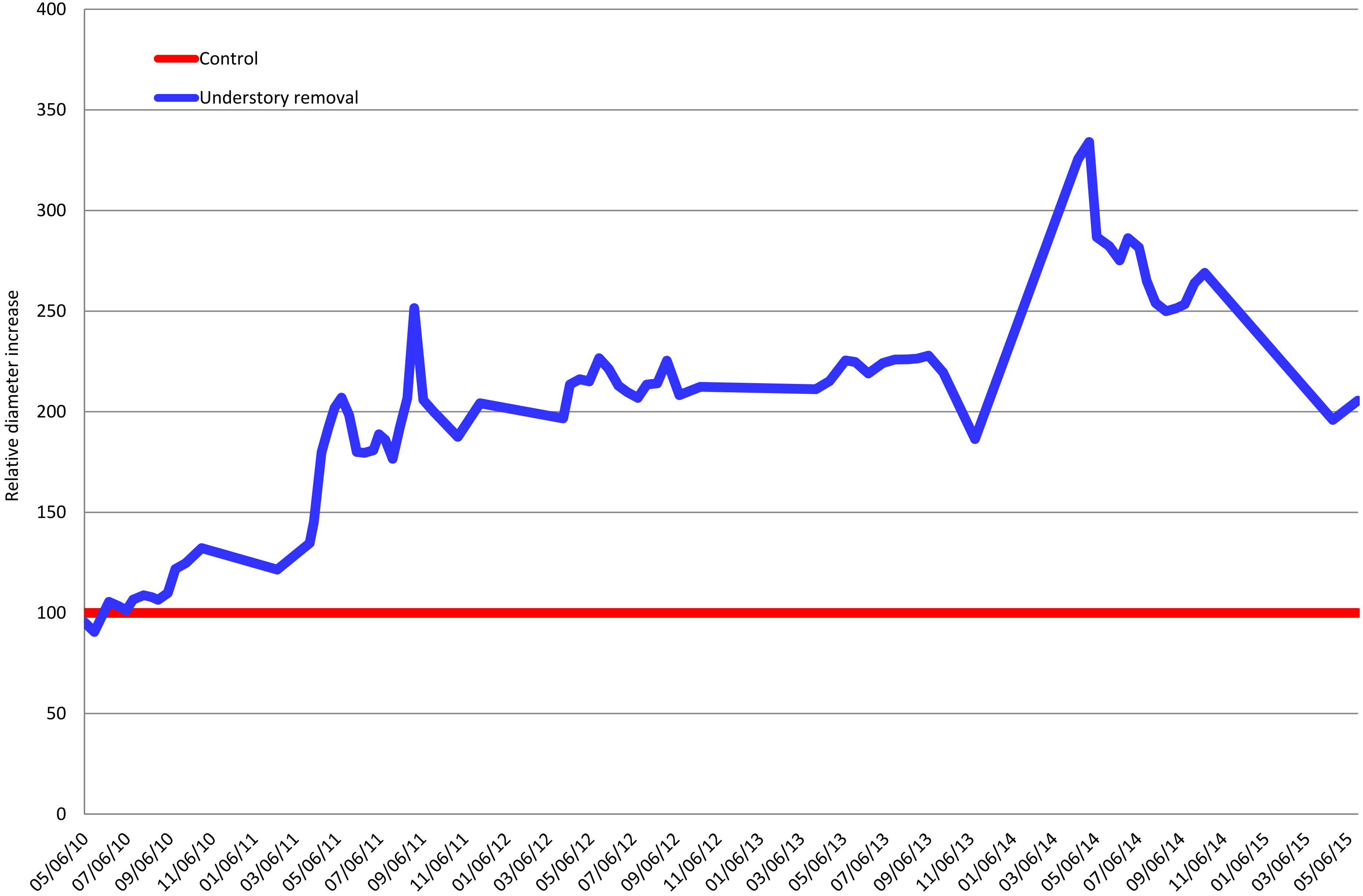
Site responses (IV): increase in the frequency of the more xero-thermophilous herbaceous species



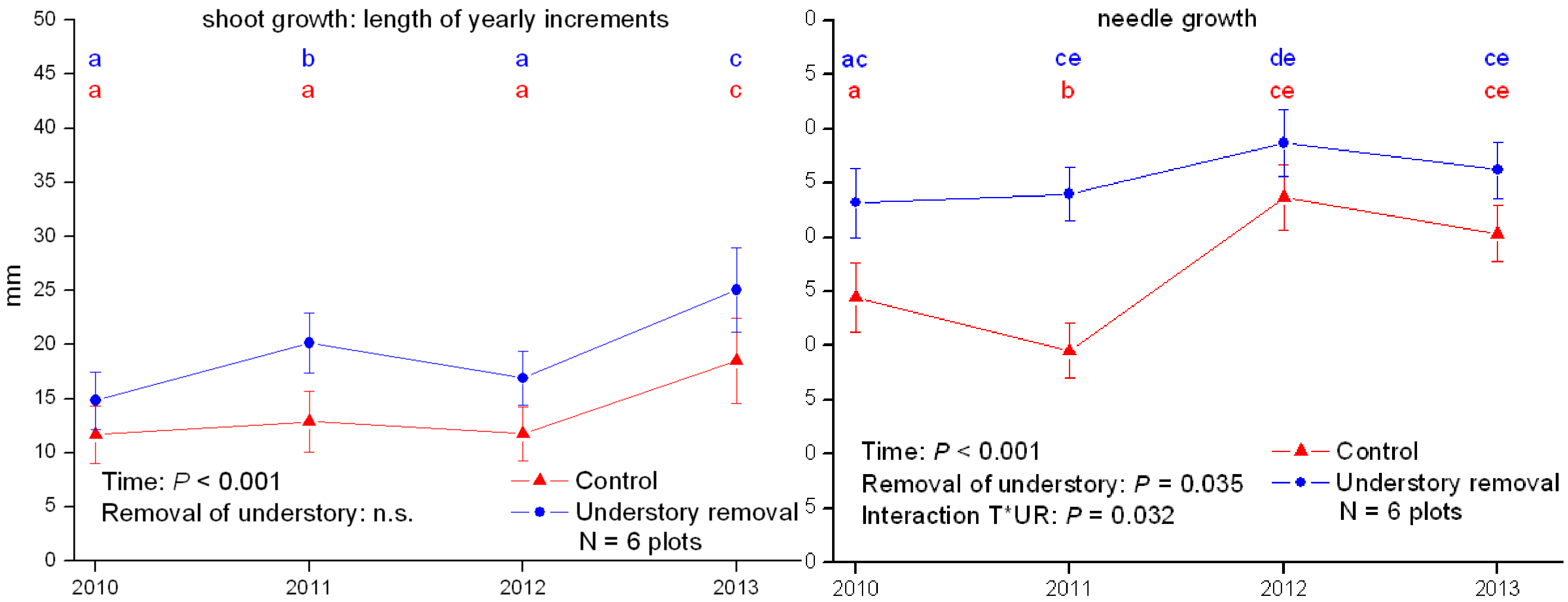
Response in pine trees (I): stem growth



Response in pine trees (I): stem growth



Response in pine trees (II): shoot and needle growth



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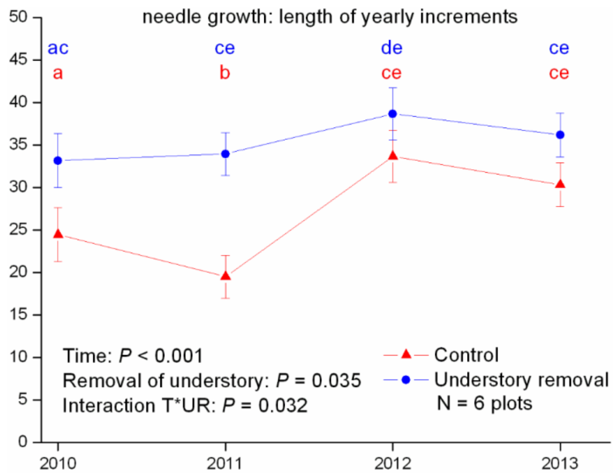
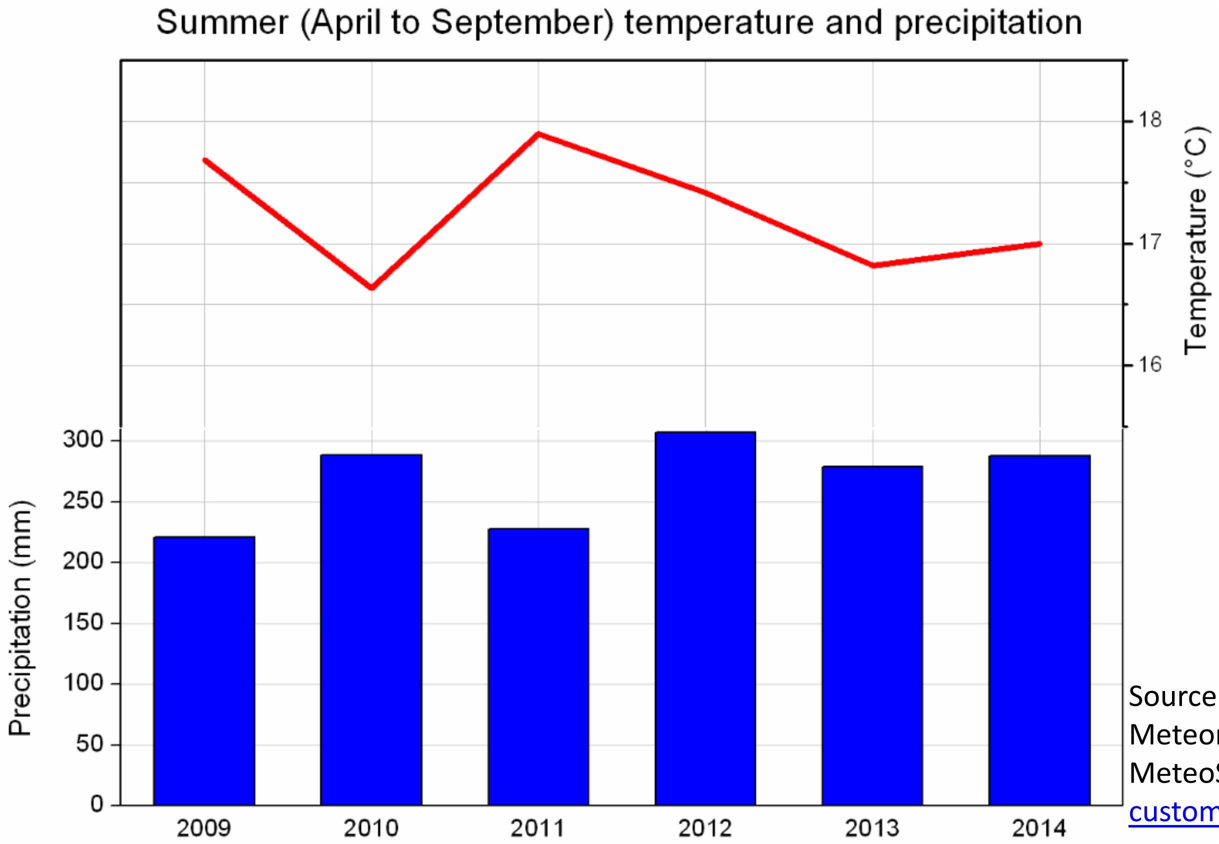
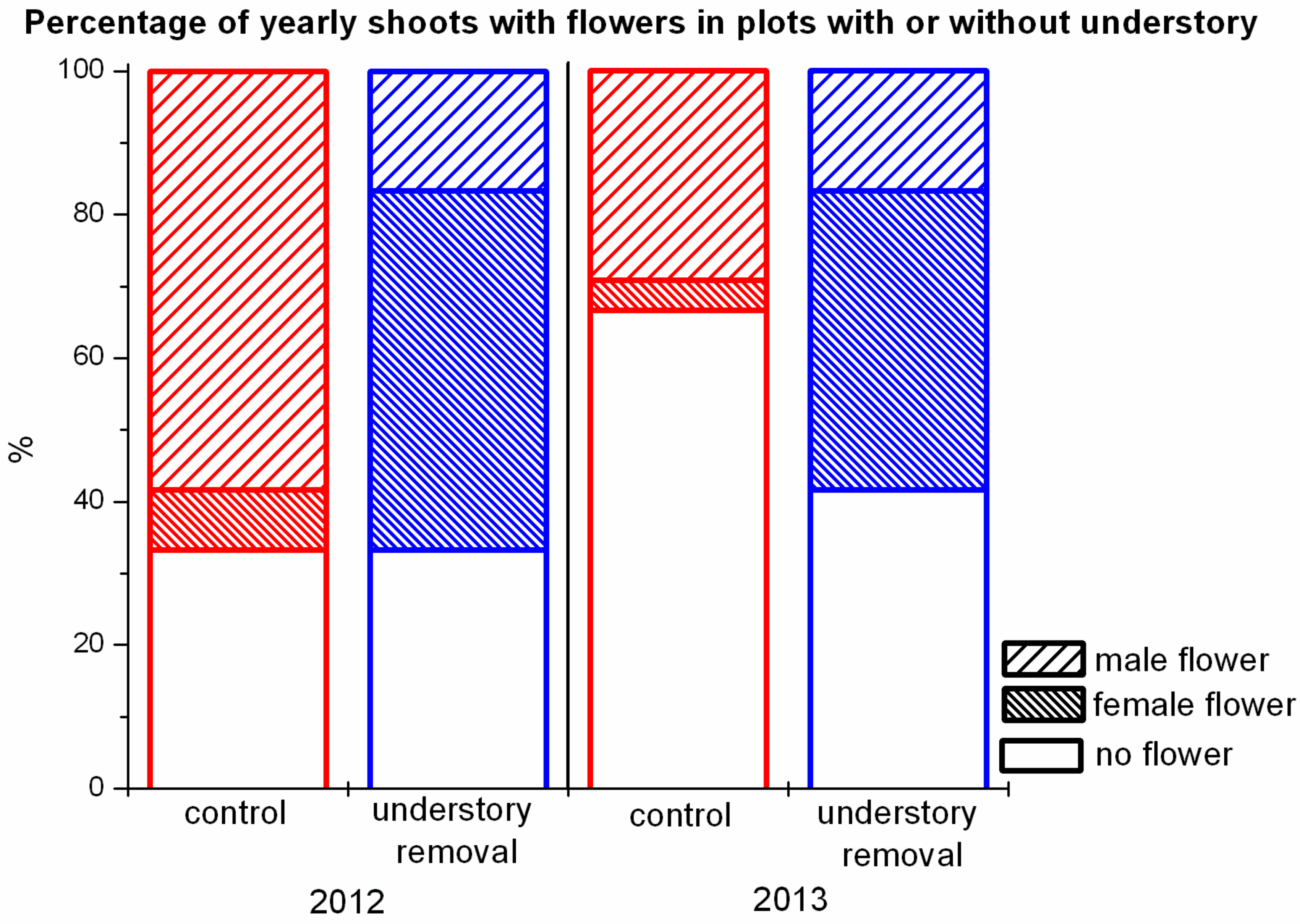




Source: Federal Office of Meteorology and Climatology MeteoSwiss. customerservice@meteoswiss.ch

Response in pine trees (III): fructification



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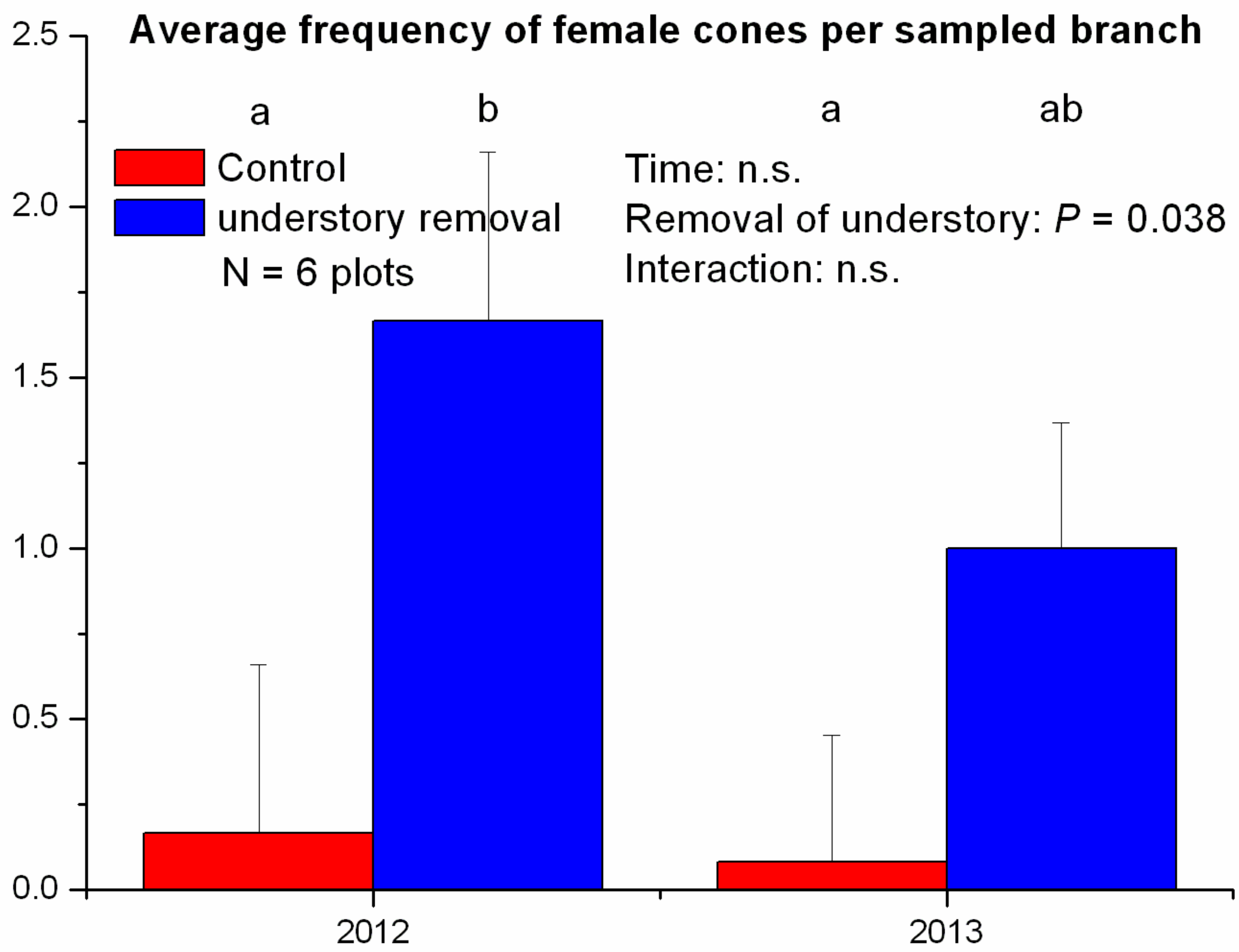


A few (preliminary) conclusions

- **In response to understory removal, the water availability, primarily in deeper soil horizons, was increased**
- **The understory removal caused an increase in site temperature and xericity**
- **The understory removal caused a stem growth release in dominant pines, fueled by higher water availability**
- **Within foliage, the pines from plots where the understory was removed have primarily responded with more fructifications**
- **Our findings suggest that changes in land use are an indirect cause for declining vitality in dominant pine stands at low elevation. Competition with thriving understory has been especially detrimental during dry years, in the context of a steadily warmer climate**

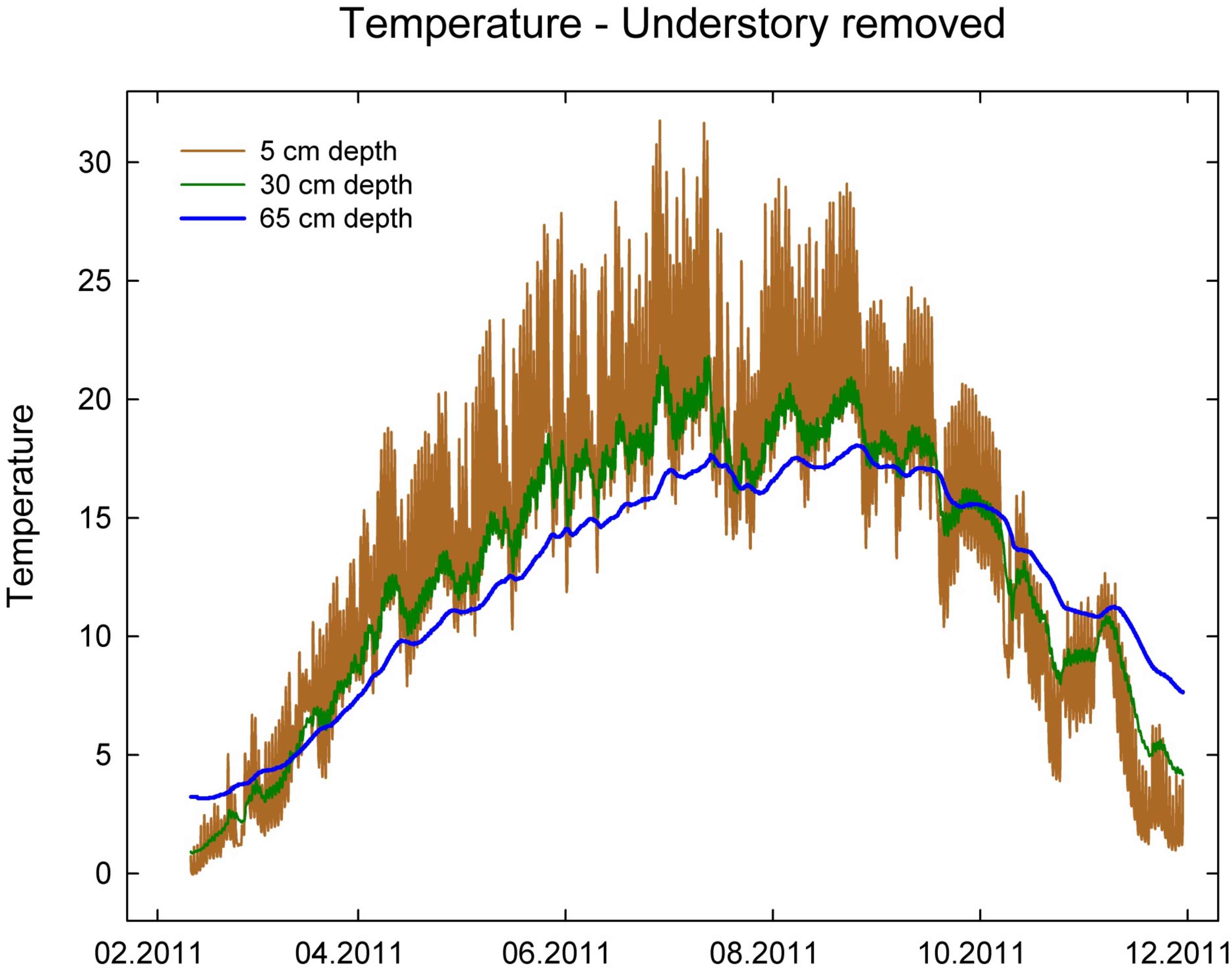
Next steps:

- **Assess the longer term responses**
- **Further document the interactions between drought and competition**

Past land-use within pine stands close to WSL, Canton of Zurich, 1814

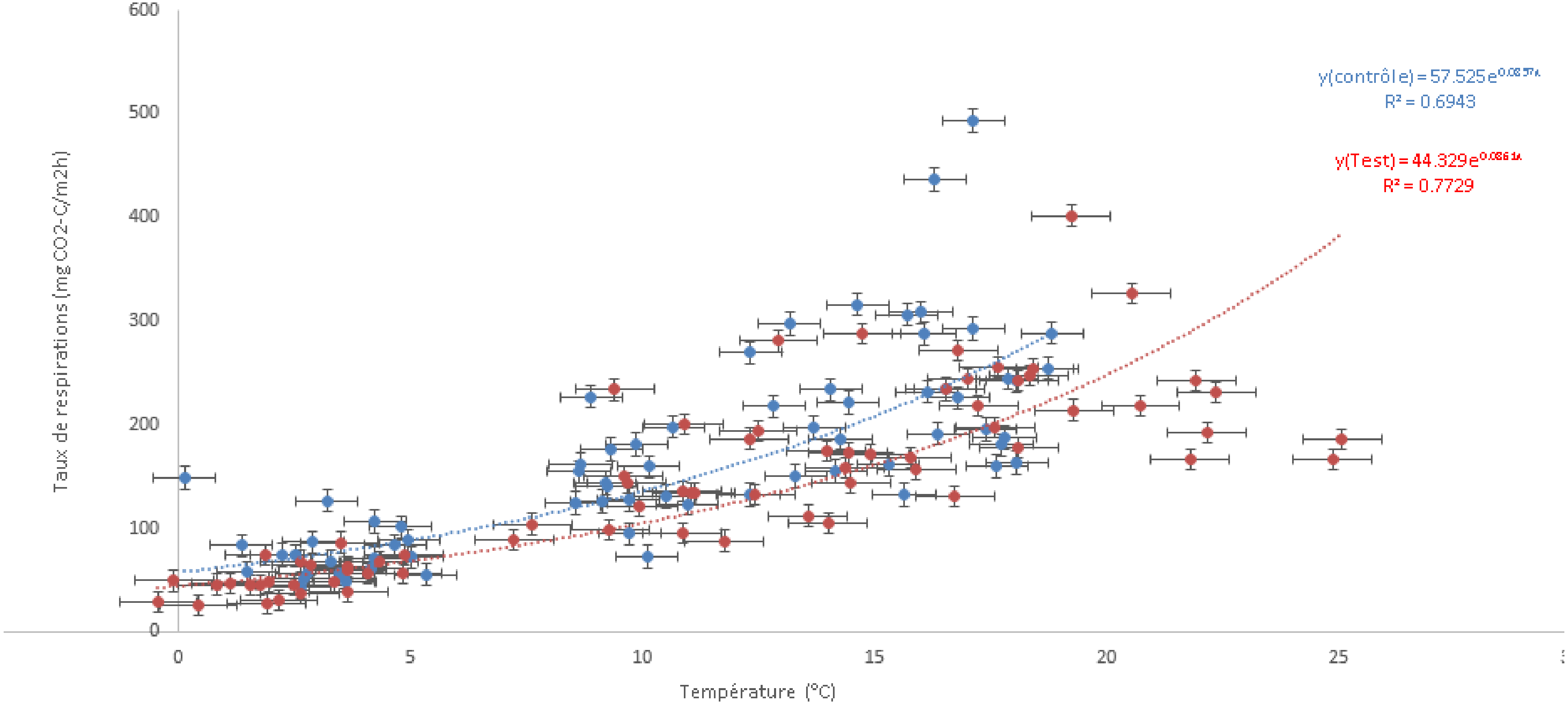

Thank you for your attention!

Site responses (II): increase in the soil temperature (30 cm depth)



Site responses (III): lower biological activity in the soil

Soil respiration as a function of the soil temperature



Response in pine trees: increase in the sap flow