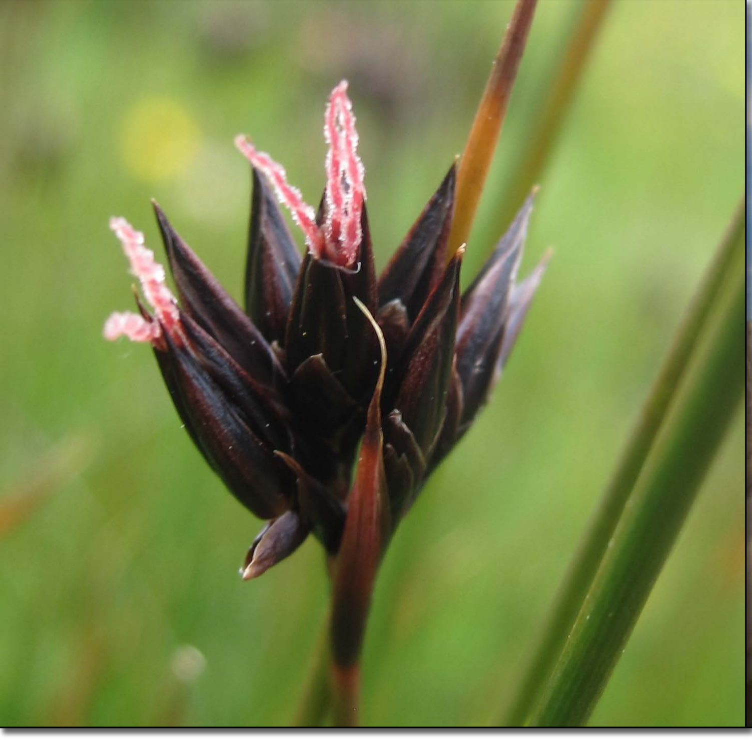

Changes in the spatial distribution of vascular plant species in the Swiss Alps

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SLF WSL

Over the course of the last century, environmental conditions have changed in the Swiss Alps. Depending on species` responses to such changes, biodiversity in vulnerable high mountain ecosystems may be impacted. Based on vascular plant species data on Swiss alpine summits over one century, we studied long-term changes in the distribution of alpine plant species at two spatial levels: (1) latitudinal and elevational range shifts of species, and (2) the spatial effect of abiotic factors on species richness and assemblages mountain summits.

This study is a resurvey of vascular plant species on the top 10 meters of 120 mountain summits in the southeastern Swiss Alps. Historical plant surveys from 1871 to 1947 are compared with plant surveys which were systematically resampled on the same mountains from 2010 to 2011.

Species Range Shifts

Species range shifts were studied to understand the geographical patterns of species distribution and changes in these patterns over the past century.

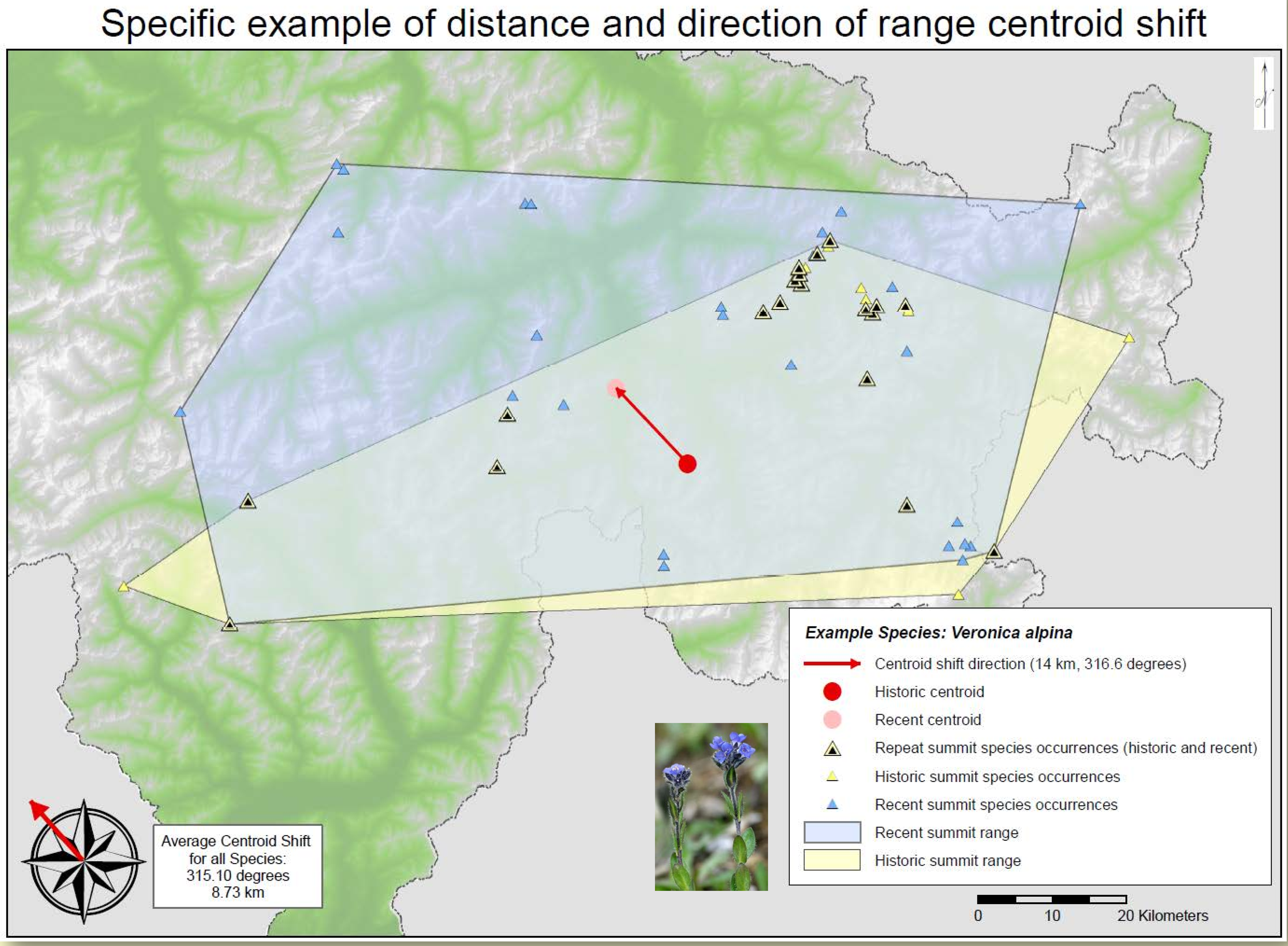
- Latitudinal range expansion has occurred within the alpine and nival elevational belts
- Ranges have shifted in a northern latitudinal trajectory
- Elevational ranges have shifted toward higher maximum elevations

Legend: historic range recent range

Latitudinal Parameter	Illustration	Mean (significant results)
Change in number of summit occurrences		9.39
Number of extinctions		5.06
Number of colonizations		14.46
Change in alpine range area		672.20 km²
Rate of range area change		65.40 km²/ decade
Area of overlap of alpine range areas		3695.62 km²
Percent overlap of alpine range areas		69.17 %
Distance of range centroid shift		8.73 km
Direction of range centroid shift		315.10°
Rate of distance shift		0.85 km/decade

Altitudinal Parameter	Illustration Per species for the entire lateral range at the top 10 meters of the summit	Mean (significant results)
Change in maximum alpine elevation		43.78 meters
Rate of change of the maximum elevation		4.30 m/decade

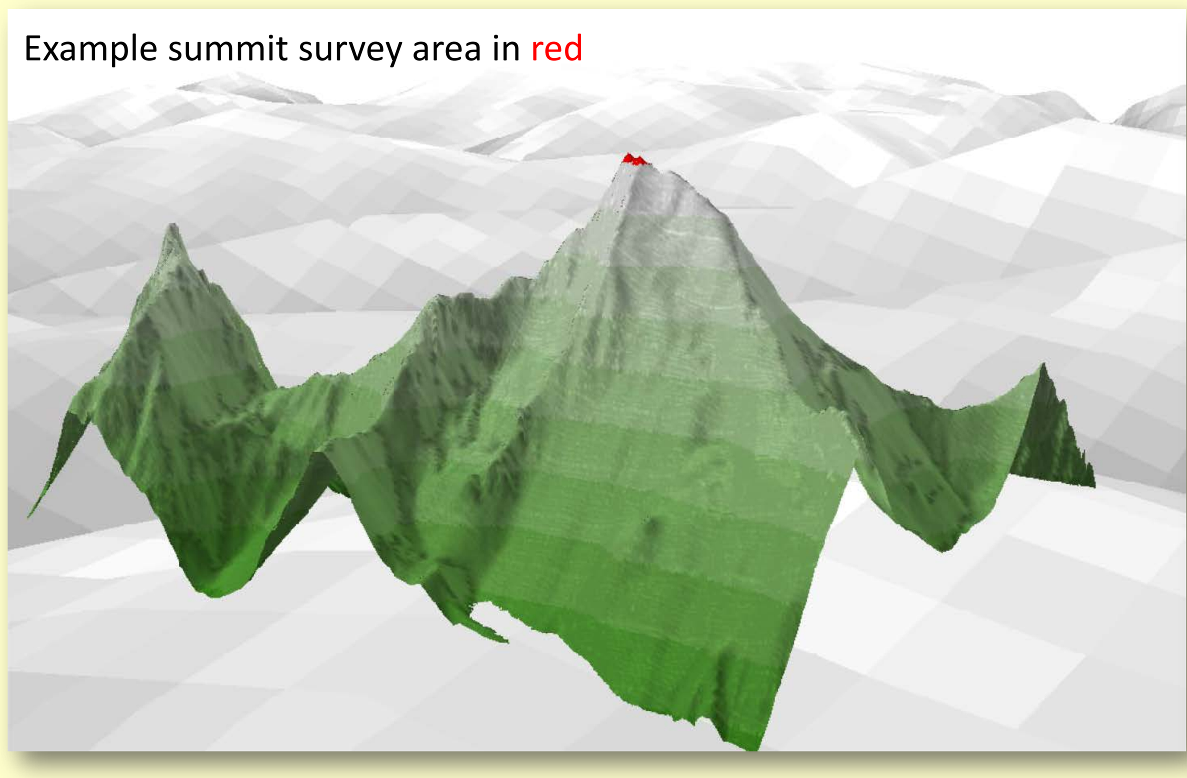
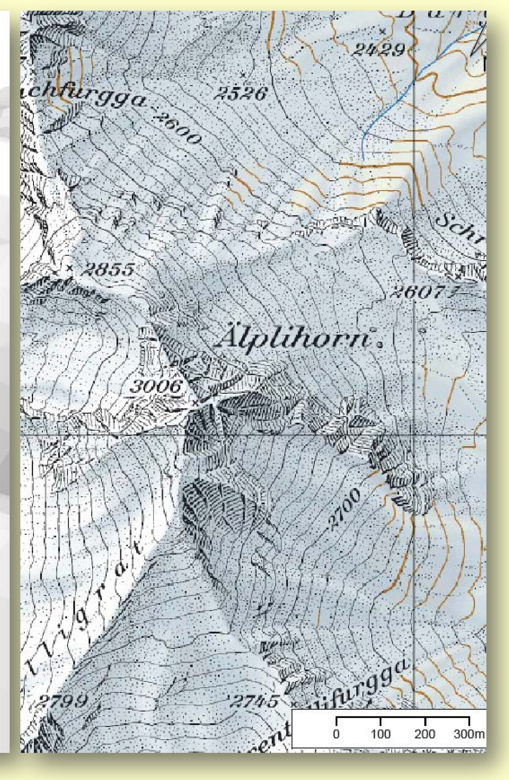
Specific example of distance and direction of range centroid shift



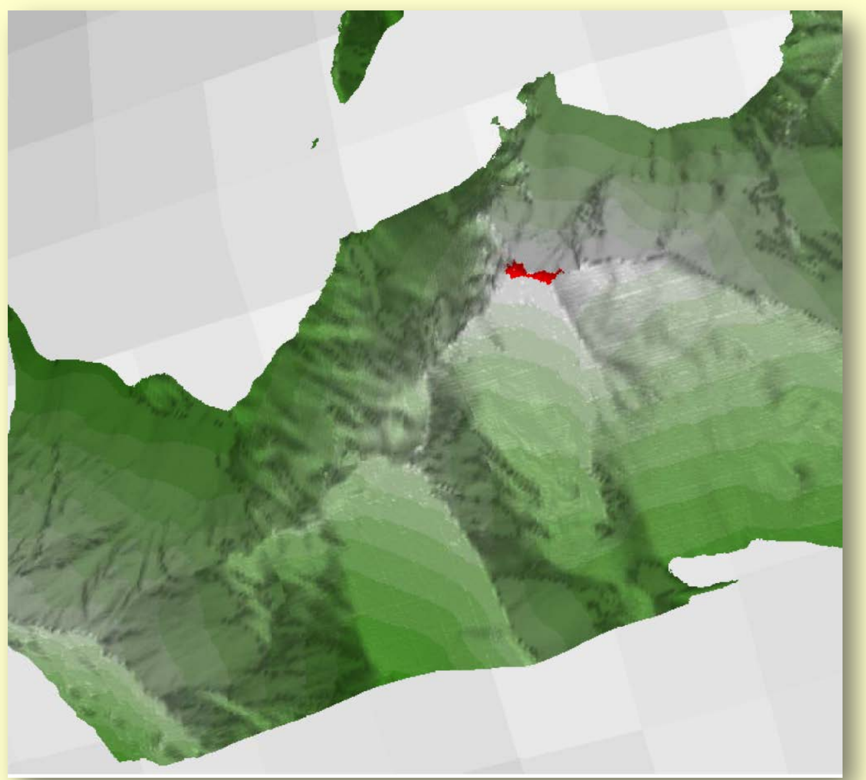
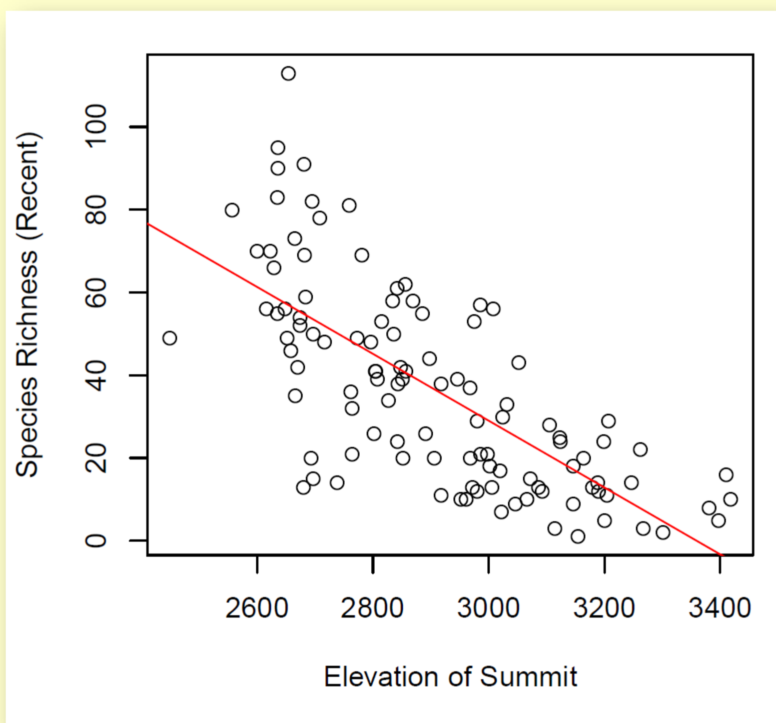
Species Richness and Surface Area

Abiotic landscape and spatial factors were investigated to understand relationships which may influence small-scale patterns of species richness and assemblages.

Example summit survey area in red

- Species richness decreases with increased elevation
- Species richness increases with surface area
- Mountain summits can be considered „islands“ and spatial relationships with species richness or species assembly support the Theory of Island Biogeography

These results show that over the past century, alpine plant distributions exhibited the fingerprint of climate change predictions of **poleward** and **upward migrations**, however predicted patterns of high altitude extinctions have not been shown empirically in this study. In light of anticipated future changes due to climate change, further complicated by other anthropogenic impacts, such empirical studies of spatial patterns of alpine plant responses can be important for conservation planning for the future of alpine flora in Switzerland.

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