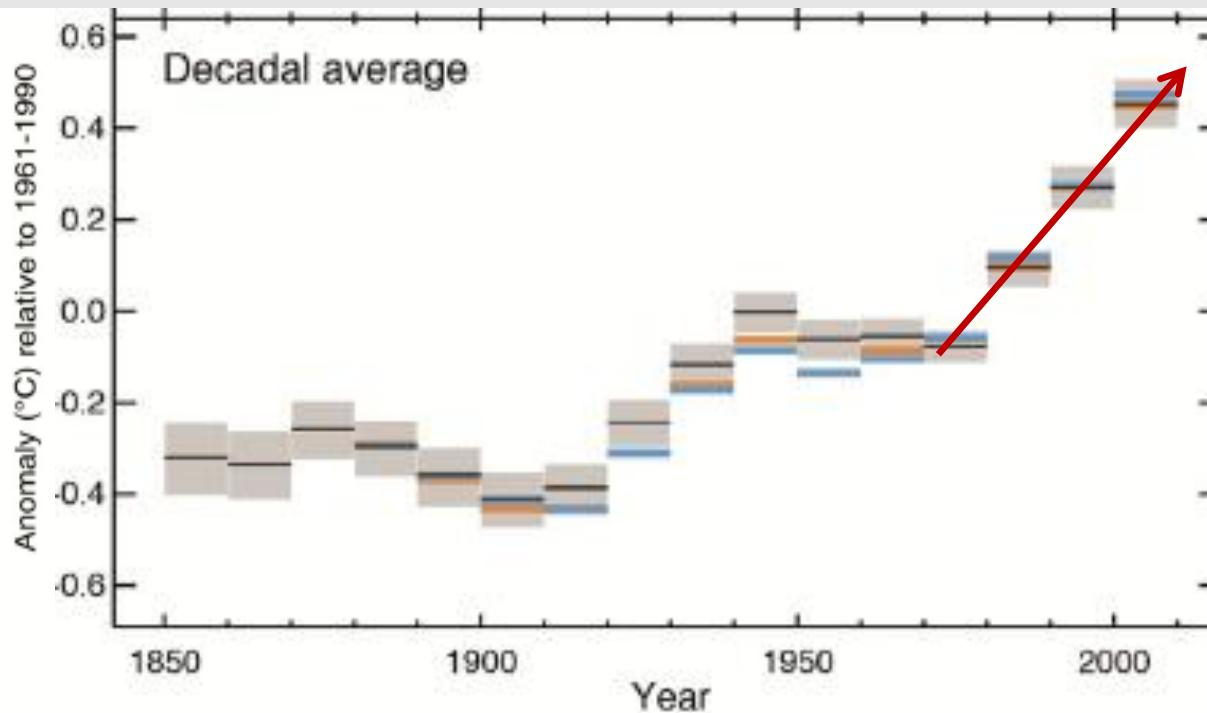




The limits of adaptation: climate change creates substantial risks for species survival which are irreducible by conservation strategies

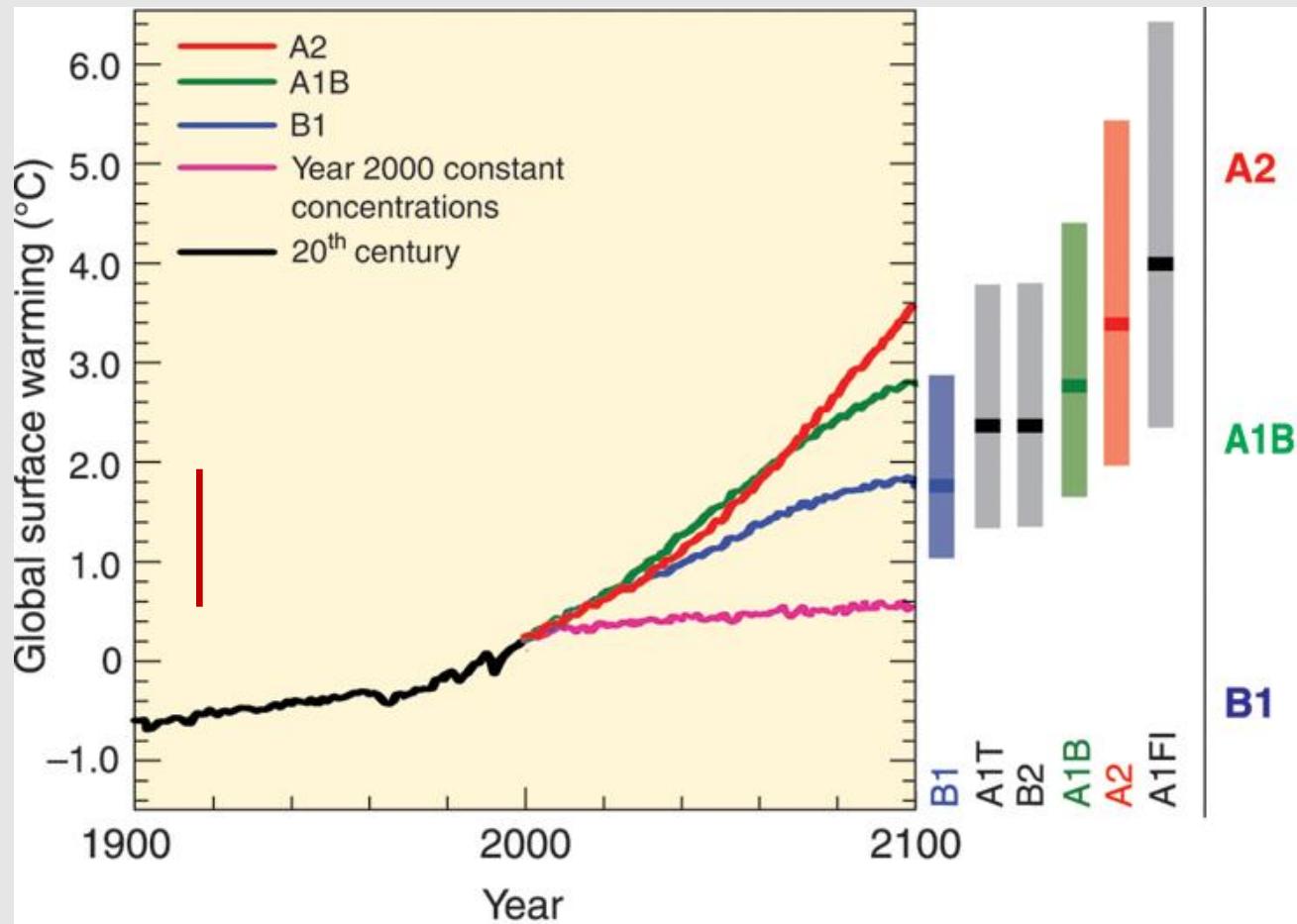
Franz Essl, Michael Kuttner, Karl Hülber, Andreas Gatteringer, Dietmar Moser, Wolfgang Rabitsch, Stefan Schindler, Johannes Wessely, Stefan Dullinger

The climate is warming



IPCC 2013

But this is only a beginning



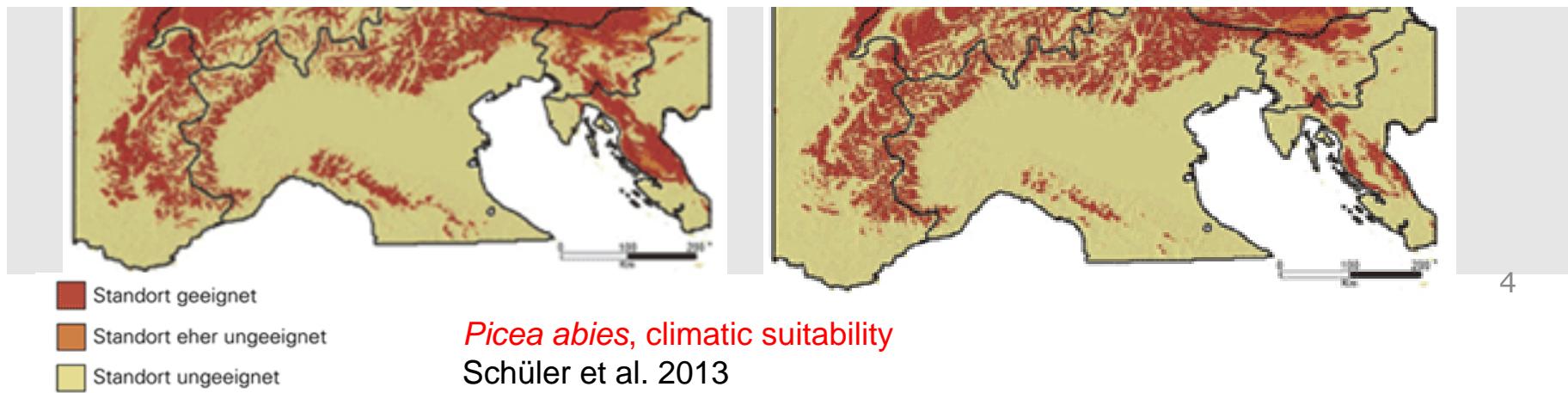
Spec Adapt: *Climate change driven species migration, conservation networks, and possible adaptation strategies*

- Environment Agency Austria & University Vienna

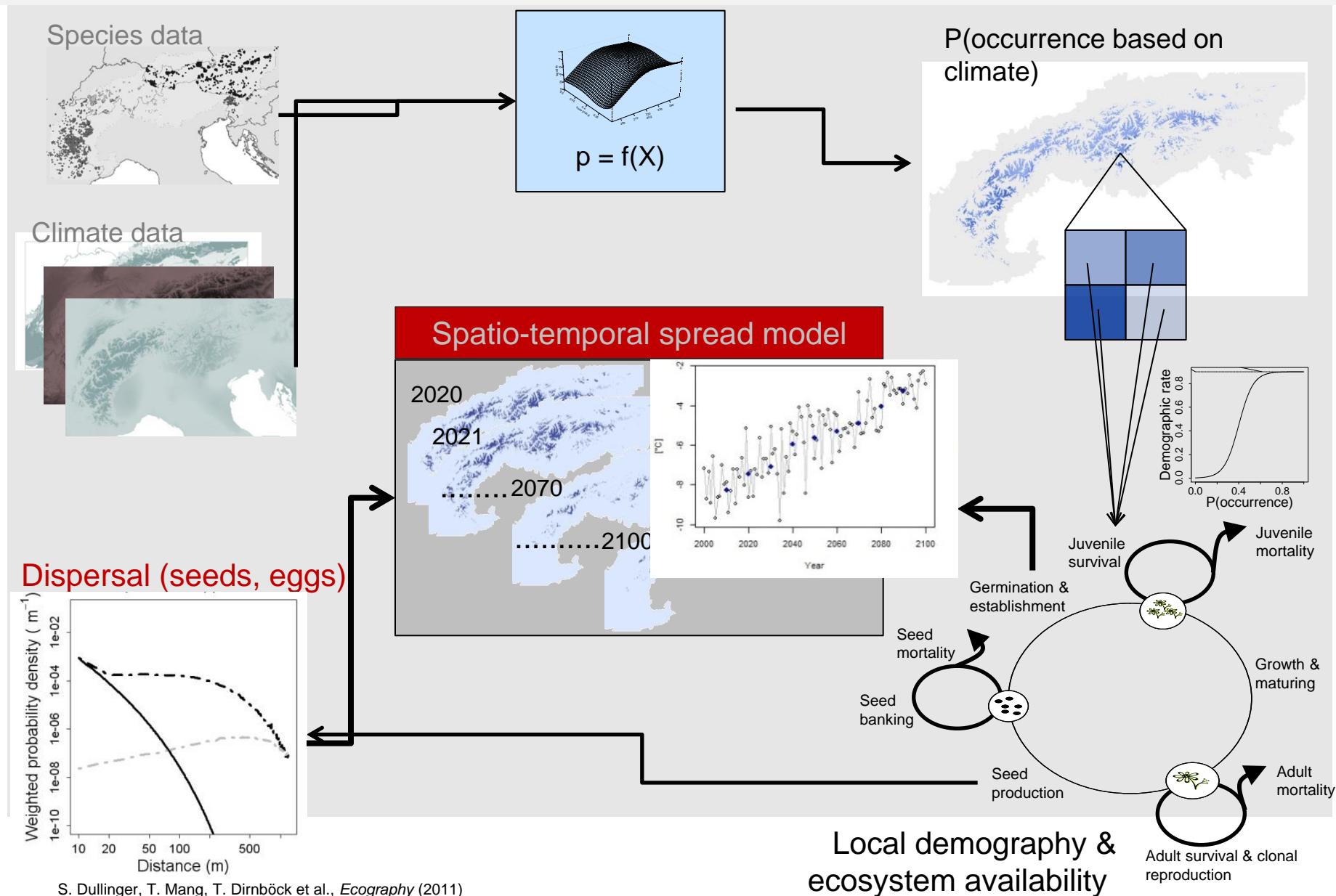
- I) Will species be able to track climate change?**
- II) Are conservation strategies able to compensate for climate change risks to biodiversity?**
- III) Which conservation strategies are most effective?**



Using a dynamic modelling framework



Dynamic modelling frame work: CATS



Study region



Study species and distribution

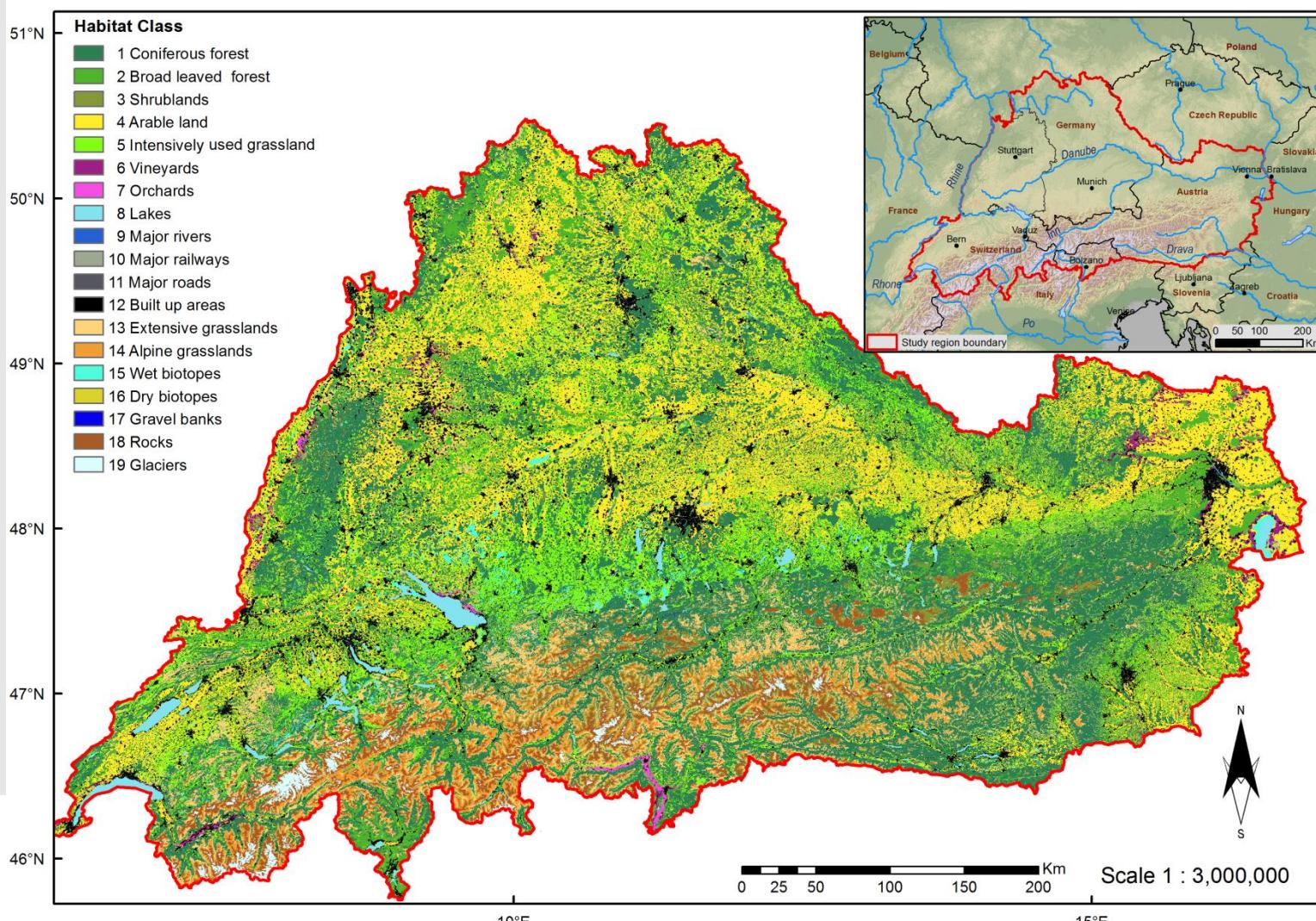
Species Name	Taxon	Trait	ALLUV	ALPGR	BLFO	CFO	DRY	EXT	SHRUB	WET
<i>Aeropedellus variegatus</i>	G	a		X						
<i>Alchemilla anisiaca</i>	P	a		X					X	X
<i>Arcyptera fusca</i>	G	a								
<i>Aster bellidiastrum</i>	P	a	X	X					X	X
<i>Bistorta officinalis</i>	P	n					X			X
<i>Bohemanella frigida</i>	G	a			X				X	
<i>Boloria eunomia</i>	B	n								X
<i>Boloria thore</i>	B	n								X
<i>Boloria titania</i>	B	a			X					X
<i>Brenthis daphne</i>	B	n								X
<i>Bryodemella tuberculatum</i>	G	n	X							
<i>Cerastium uniflorum</i>	P	a							X	
<i>Chorthippus pullus</i>	G	n	X							
<i>Colias palaeno</i>	B	a							X	X
<i>Colias phicomone</i>	B	a			X					
<i>Conocephalus dorsalis</i>	G	n								X
<i>Dianthus alpinus</i>	P			X					X	X
<i>Drosera rotundifolia</i>	P				X					X
<i>Erebia nivalis</i>	B			X					X	
<i>Euphydryas maturna</i>					X					
<i>Gentiana clusii</i>		a		X					X	X
<i>Gentianella bohemica</i>		n						X		
<i>Gymnadenia conopsea</i>		n		X			X	X	X	X
<i>Isophya brevicauda</i>	G	n				X	X			
<i>Jasione montana</i>	P	n				X	X			
<i>Leontopodium</i>	P	a	X						X	X

60 species (plants, grasshoppers, butterflies)

Ecosystem layer

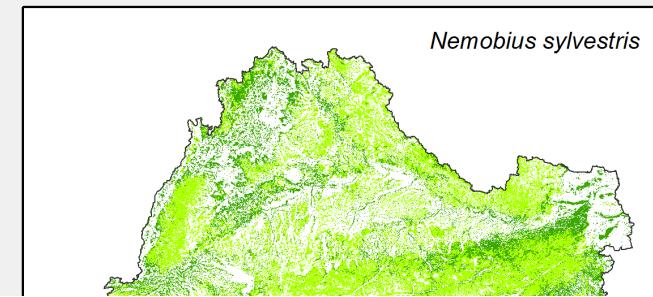
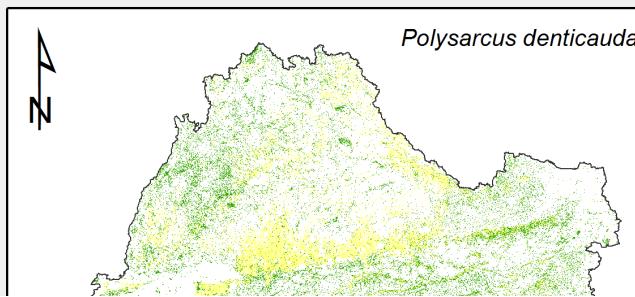
A new high-resolution habitat distribution map for Austria, Liechtenstein, southern Germany, South Tyrol and Switzerland

Michael Kuttner, Franz Essl, Johannes Peterseil, Stefan Dullinger, Wolfgang Rabitsch, Stefan Schindler, Karl Hülber, Andreas Gatterer & Dietmar Moser

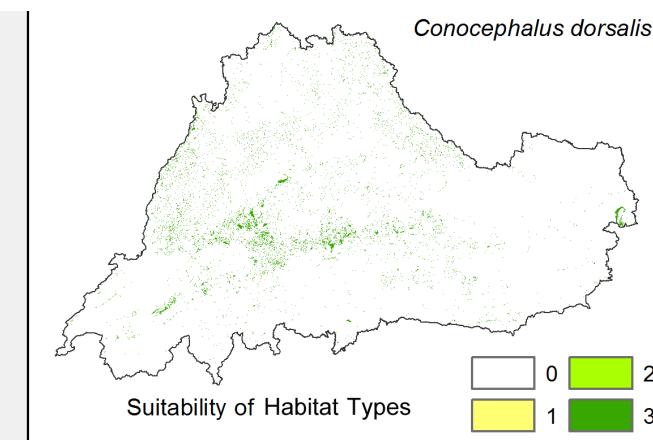
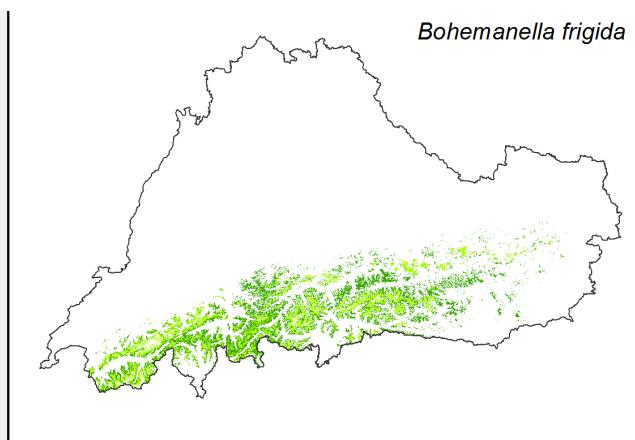


Assessing suitability of ecosystems for species

	BLFO	CFO	DRY	EXTGR	INTGR	ROCKS	SHRUBS	WETLANDS	ALPINE GRASSLAND
<i>Bohemanella frigida</i> (Boheman, 1846)	0	0	0	0	0	2	0	0	3
<i>Conocephalus dorsalis</i> (Latrelle, 1804)	0	0	0	0	0	0	0	3	0
<i>Nemobius sylvestris</i> (Bosc, 1792)	3	2	0	0	0	0	2	0	0
<i>Polysarcus denticauda</i> (Charpentier, 1825)	0	0	3	3	1	0	0	0	0



Ecosystem distribution severely constrains species occurrence





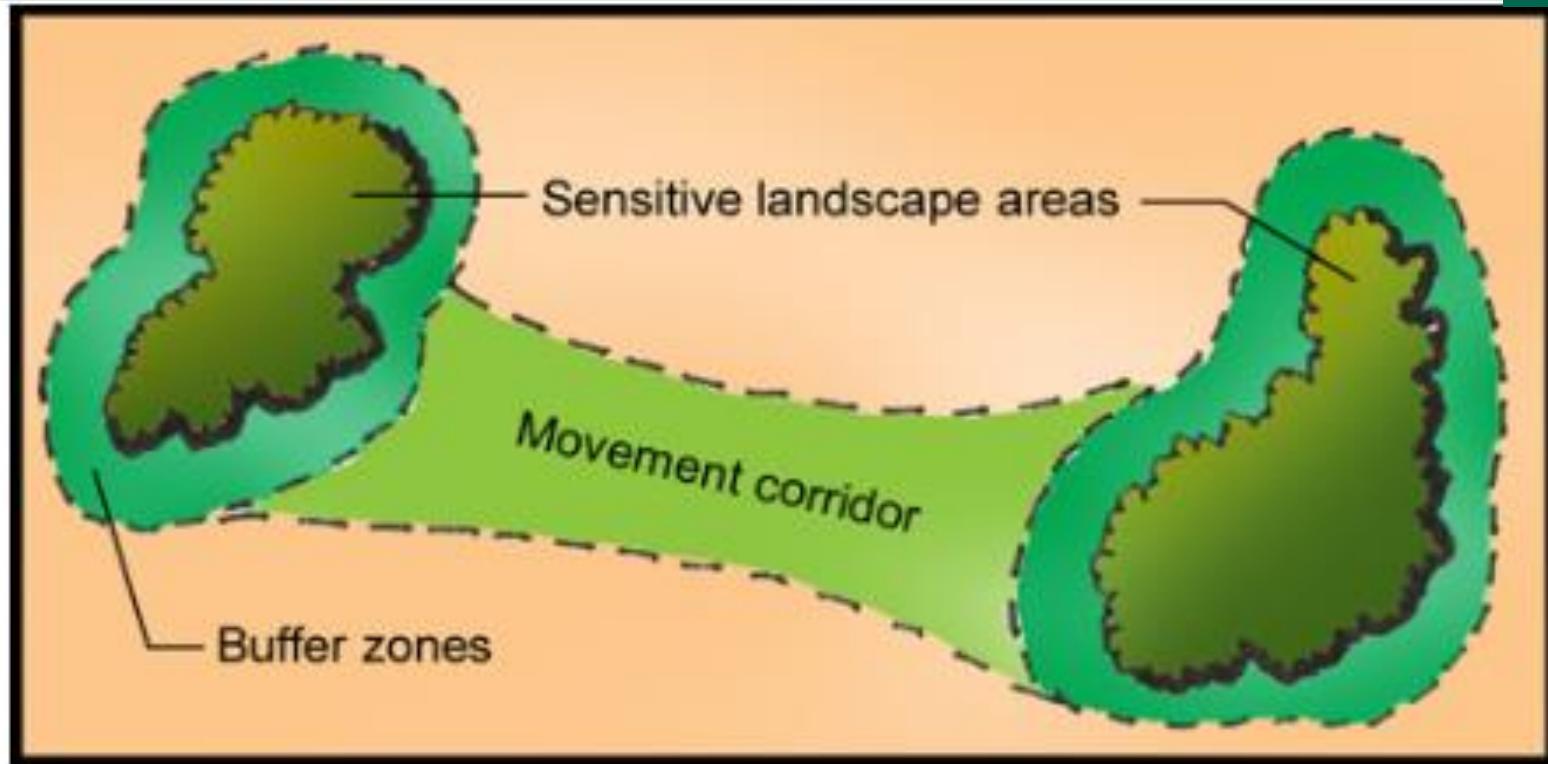
Franz Essl · Wolfgang Rabitsch Hrsg.

Biodiversität und Klimawandel

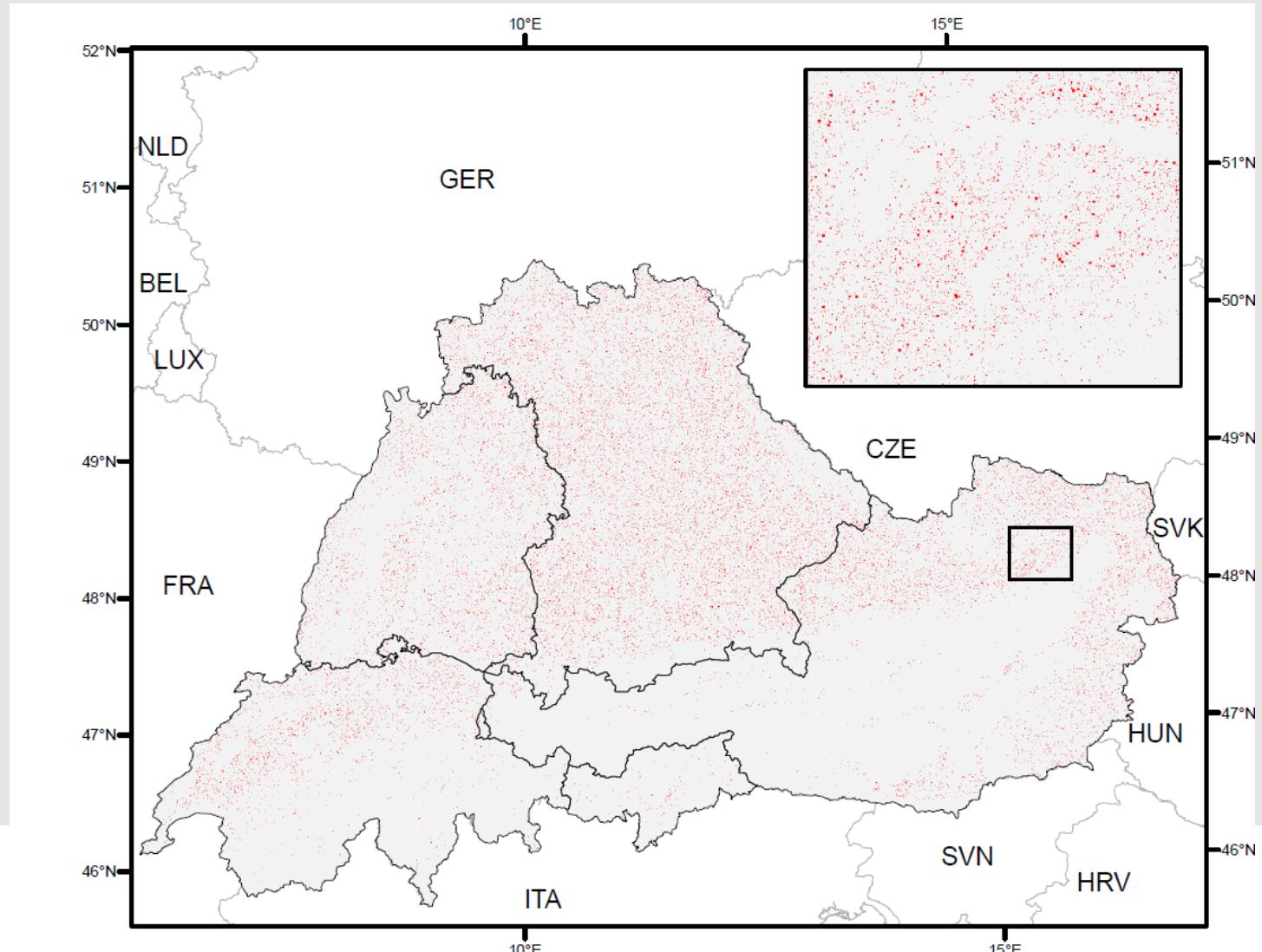
Auswirkungen und Handlungsoptionen
für den Naturschutz in Mitteleuropa

Springer Spektrum

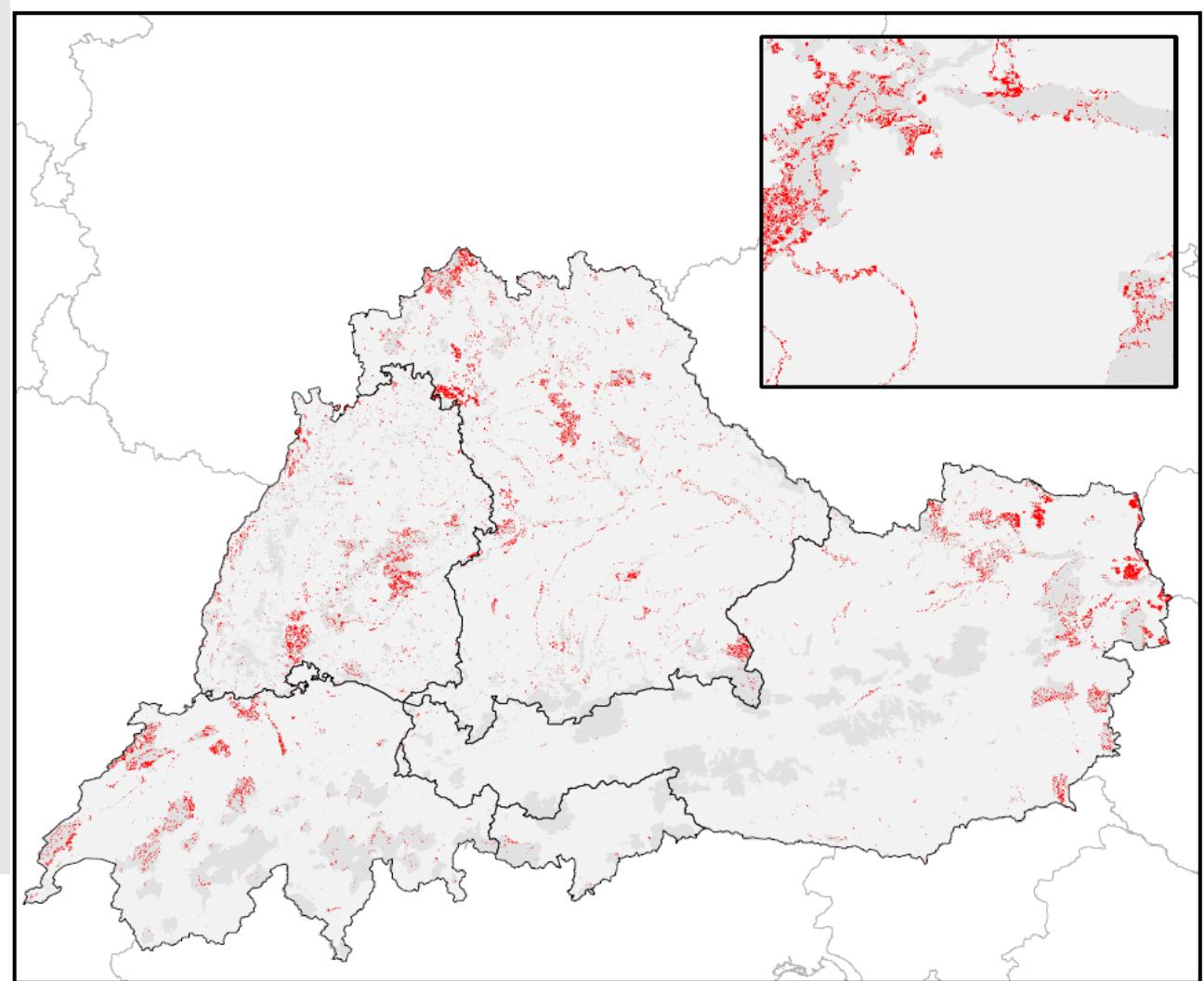
Conservation options under climate change: three broad strategies for improving habitat suitability and landscape permeability



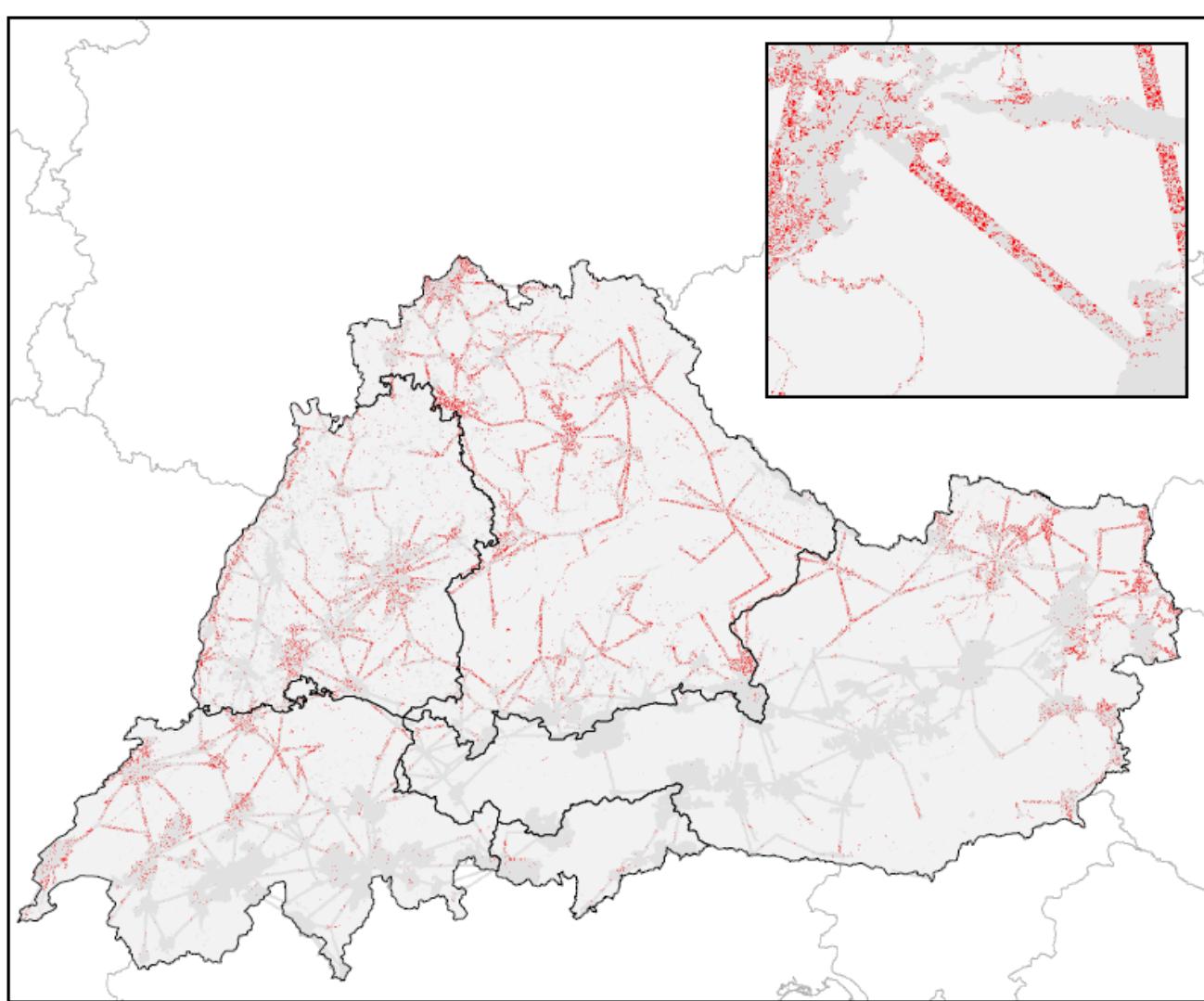
MATRIX SCENARIO: increasing permeability



PROTECTED AREAS SCENARIO: improving the protected area network



CORRIDORS SCENARIO: establishing migration corridors



Three effort levels

- **Moderate:** conversion of **1%** of all grid cells of intensively used grasslands, arable lands and conifer plantations to **extensively used ecosystems**
- **Medium:** conversion of **3%** of all such grid cells
- **Maximum:** conversion of **5%** of all such grid cells

→ reflects European policy goals:
Common Agricultural Policy, Restoration
Goals, Green Infrastructure



Species life history and dispersal traits

Species name	Reproduction		Reproduction number of generations per year	Reproduction Sterblichkeitsraten/Mortalität bzw. wieviele Adulte (Weibchen) gelangen zur neuerlichen Eiablage		Dispersal	
	egg number per female	min max		min	max	flight distance min (m)	max
<i>Aeropedellus variegatus</i> (Fischer de Waldheim, 1846)	50	150	1	0,20	0,90	200	1500
<i>Anonconotus italoaustriacus</i> (Nadig, 1987)	50	150	1	0,20	0,90	200	1500
<i>Arcyptera fusca</i> (Pallas, 1773)	50	150	1	0,20	0,90	200	3000
<i>Barbitistes constrictus</i> (Brunner von Wattenwyl, 1878)	30	100	1	0,20	0,90	100	500
<i>Bohemarella frigida</i> (Bohemani, 1846)	50	150	1	0,20	0,90	200	1000
<i>Bryodemella tuberculatum</i> (Fabricius, 1775)	100	312	1	0,20	0,95	500	3000
<i>Chorthippus pullus</i> (Philippi, 1830)	50	100	1	0,20	0,95	200	1000
<i>Conocephalus dorsalis</i> (Latreille, 1804)	50	150	1	0,20	0,90	200	2000
<i>Isophya brevicauda</i> (Ramme, 1931)	50	150	1	0,20	0,90	200	1500
<i>Metrioptera saussuriana</i> (Frey-Gessner, 1872)	50	150	1	0,20	0,90	200	1500

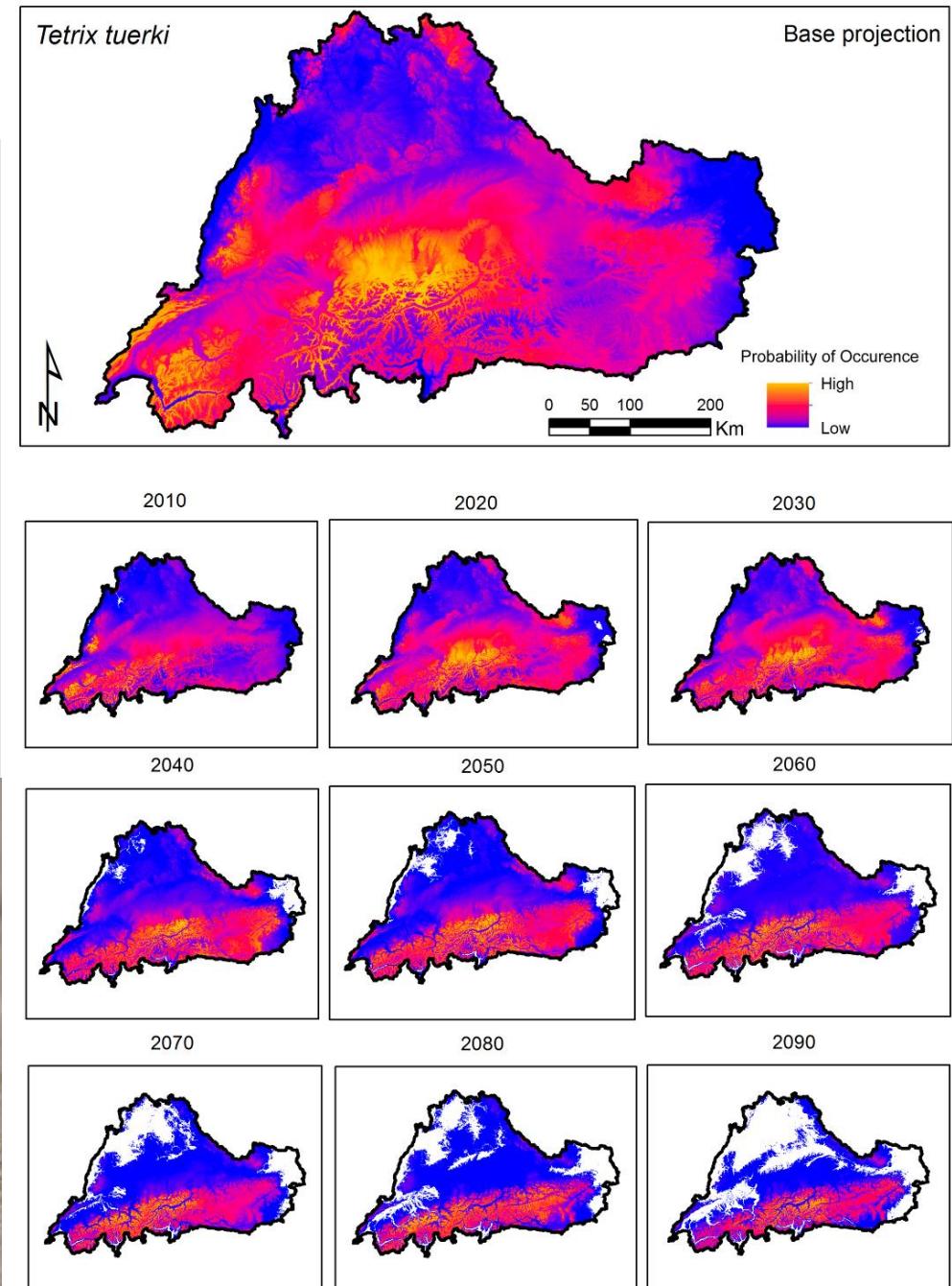
→ input for modelling demography and dispersal kernels

Climatic suitability

Modelled on a decadal basis, using Species Distributions Models



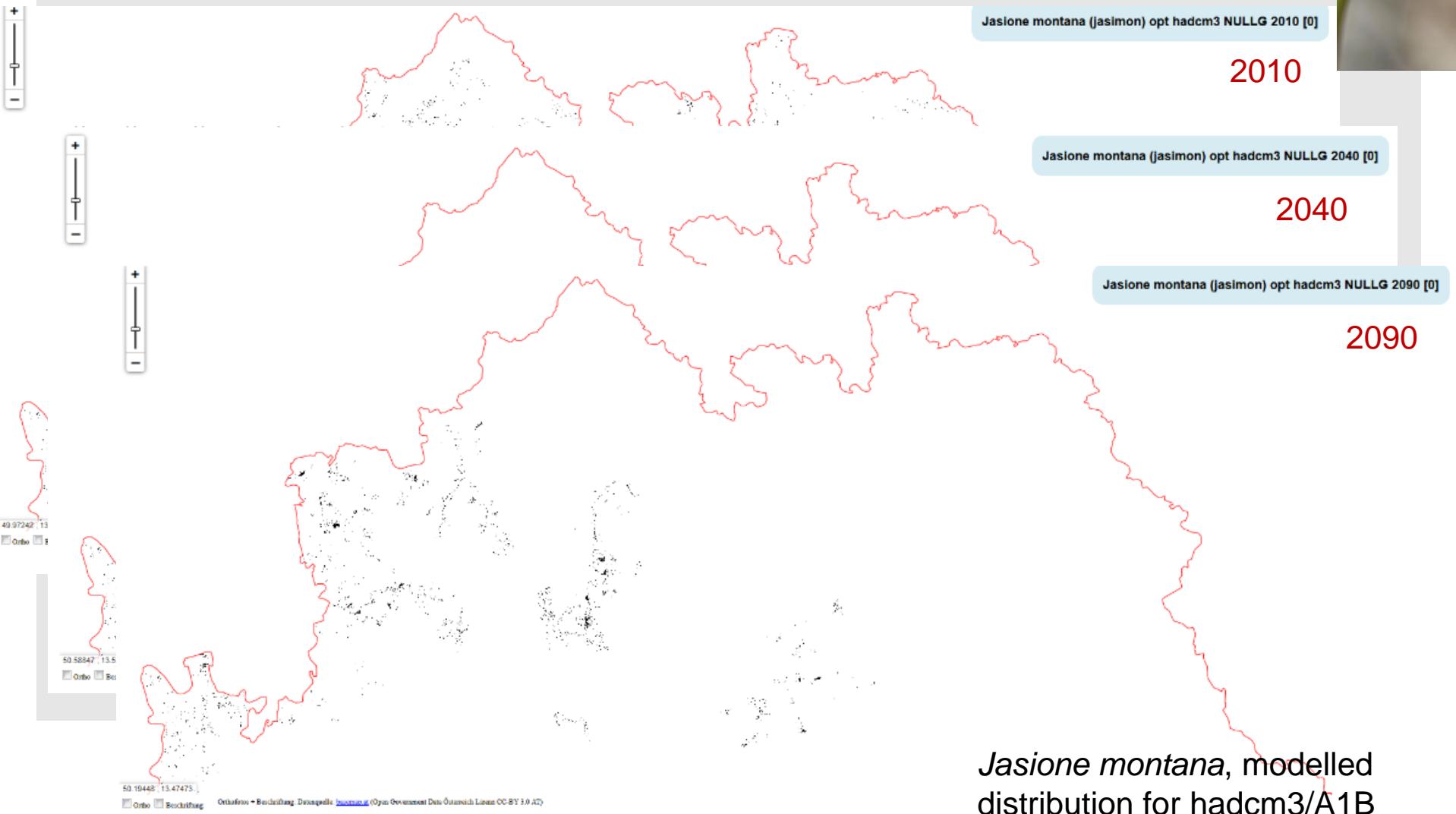
Orthoptera.ch
© - Christian Roesti



Tetrix tuerki



Dynamic modelling output: species occurrence based on climate, ecosystems, initial species distribution



Dynamic modelling shows that...

- ...species will respond dramatically to climate change: **severe range losses, high extinction risks**
- ...ecosystem availability and **species ecology** strongly interact with climate pressures
- ...conservation strategies have little effect for **high altitude species**
- ...conservation strategies can **reduce** – but **not compensate!** – climate change risks for lowland species

„As winner of the Eurovision contest, I can tell: there are *strong limits* to species conservation under rapid climate change“



Conchita Wurst, testimonial & personal communication

Publications

- 1) Kuttner et al. (in review) Habitat availability disproportionately amplifies climate change risks for lowland compared to alpine species. *Diversity and Distributions*.
- 2) Kuttner et al. (2015) A new high-resolution habitat distribution map for Austria, Liechtenstein, southern Germany, South Tyrol and Switzerland. *Eco.Mont* 7:18-29.
- 3) Wessely et al. (in prep.) The limits of conservation strategies to mitigate climate change-induced range losses.



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