

Modelling socio-ecological processes across scales

Calum Brown



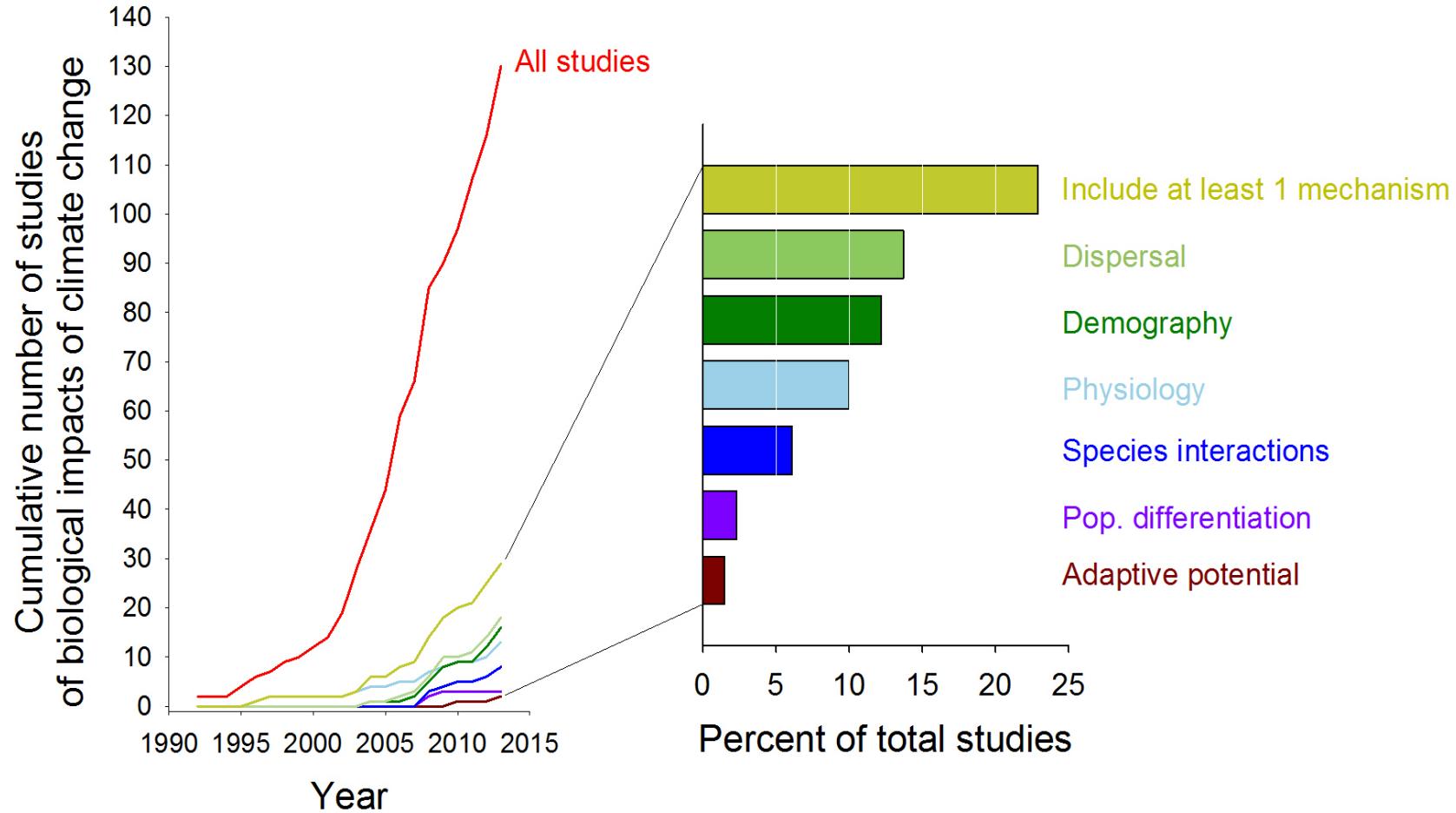
Institute Of Meteorology and Climate Research, Atmospheric Environmental Research, IMK-IFU
Land Use Change and Climate Research Group



KIT-Campus Alpin

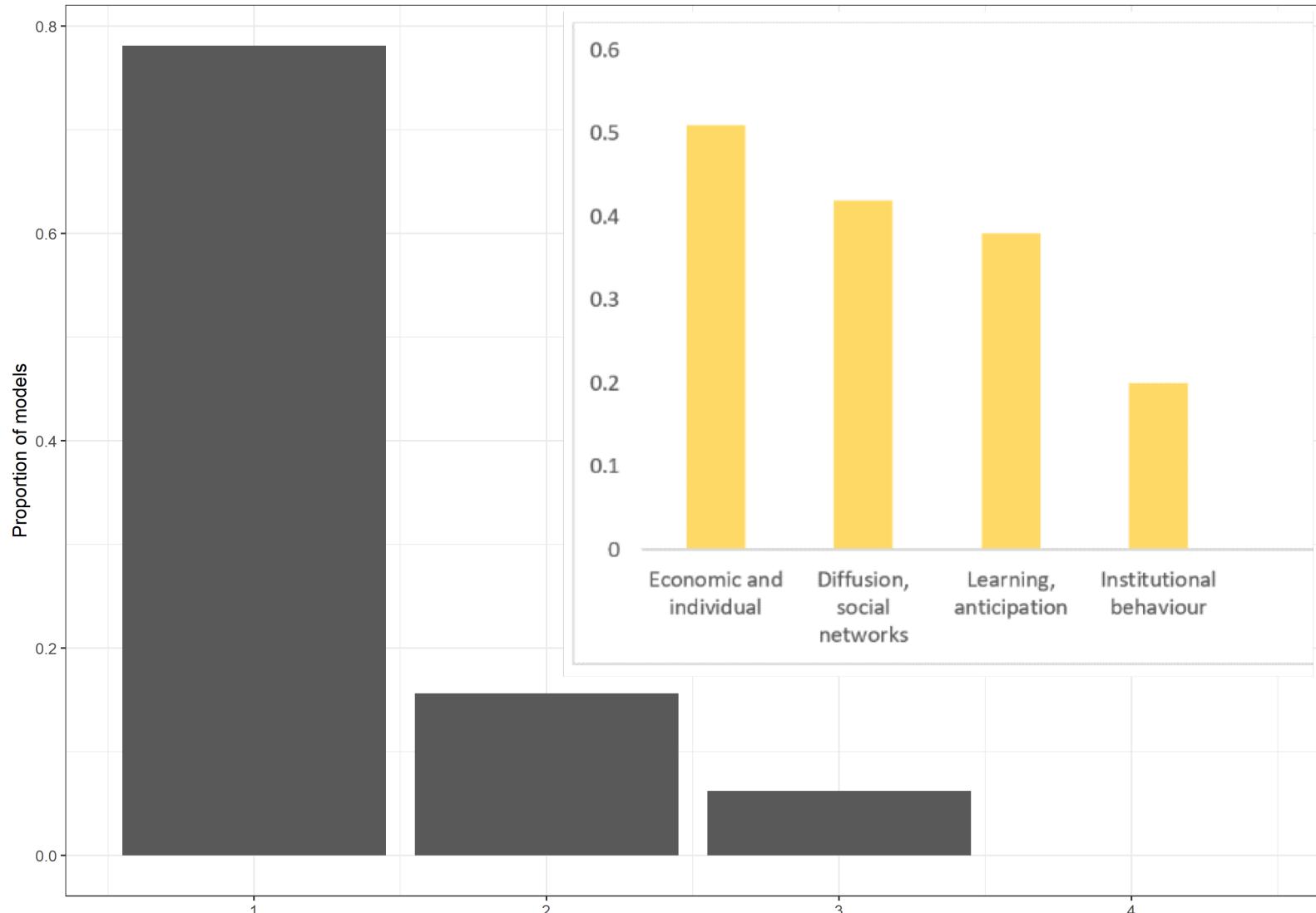
IMK-IFU: Atmospheric Environmental Research





The cumulative number of studies of biological impacts of climate change through time that include six biological mechanisms.

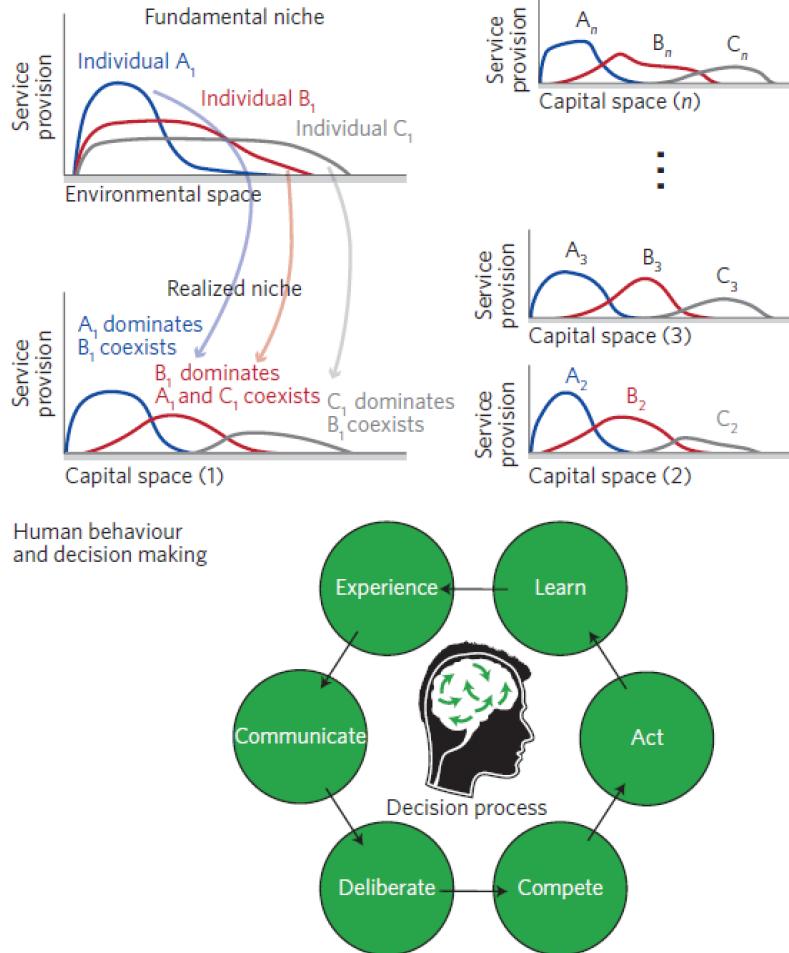
Urban 2019, WIREs Climate Change



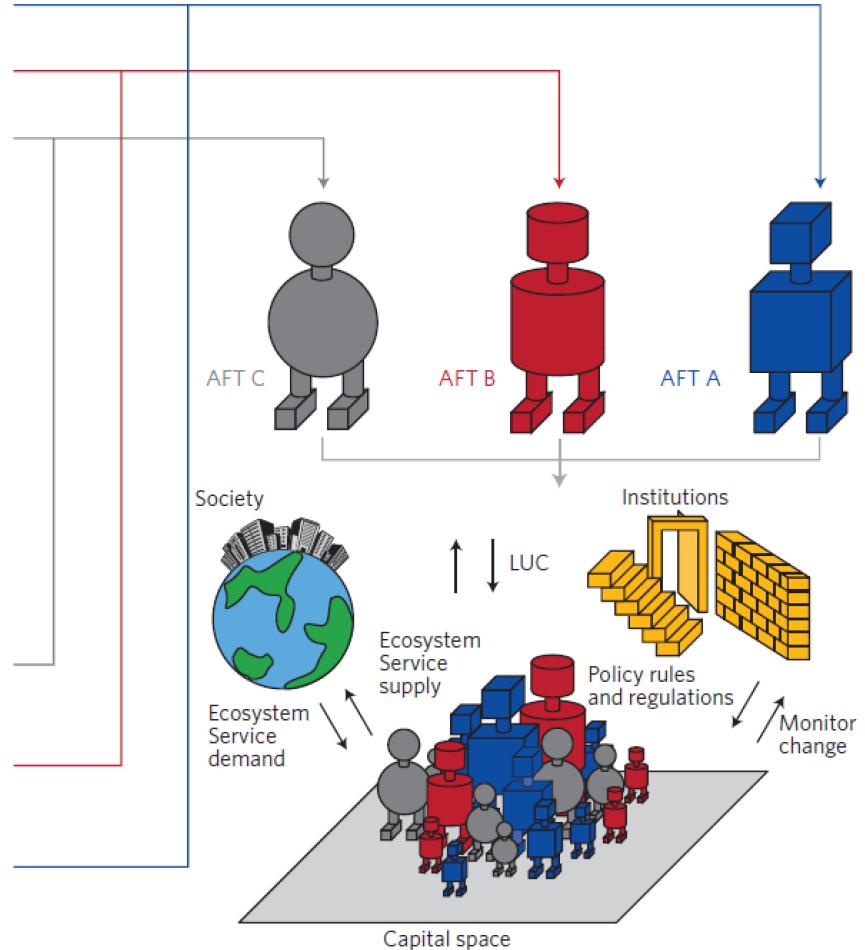
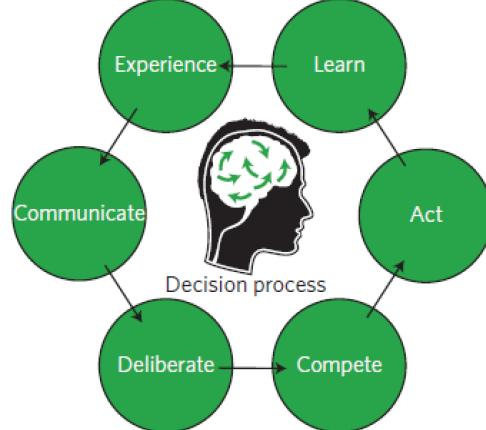
The proportion of studies predicting land use responses to climate change that include four behavioural mechanisms. Brown et al 2017, WIREs Climate Change

'Agent Functional Types'

Agent competition for the use of capital resources

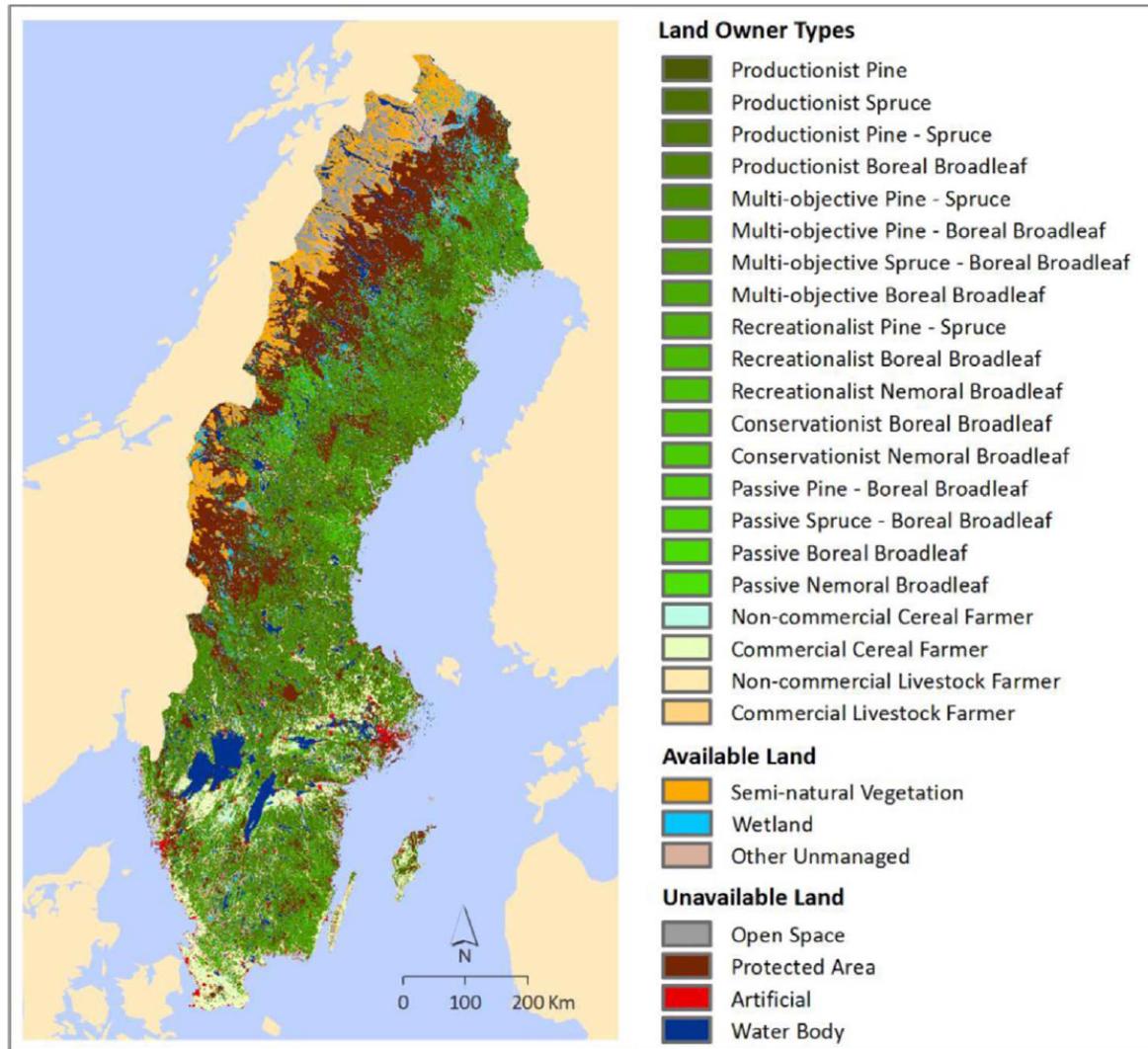


Human behaviour and decision making



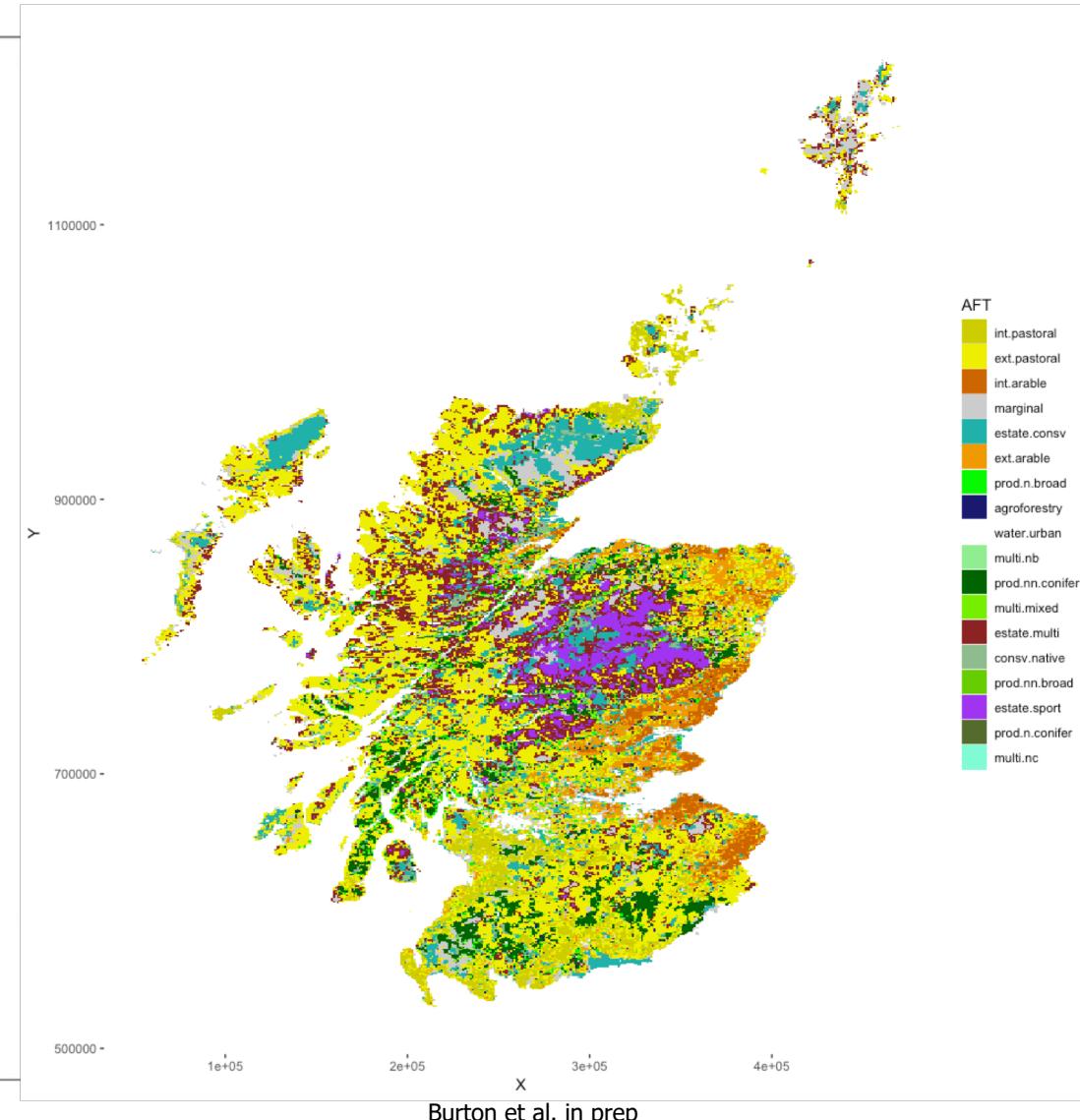
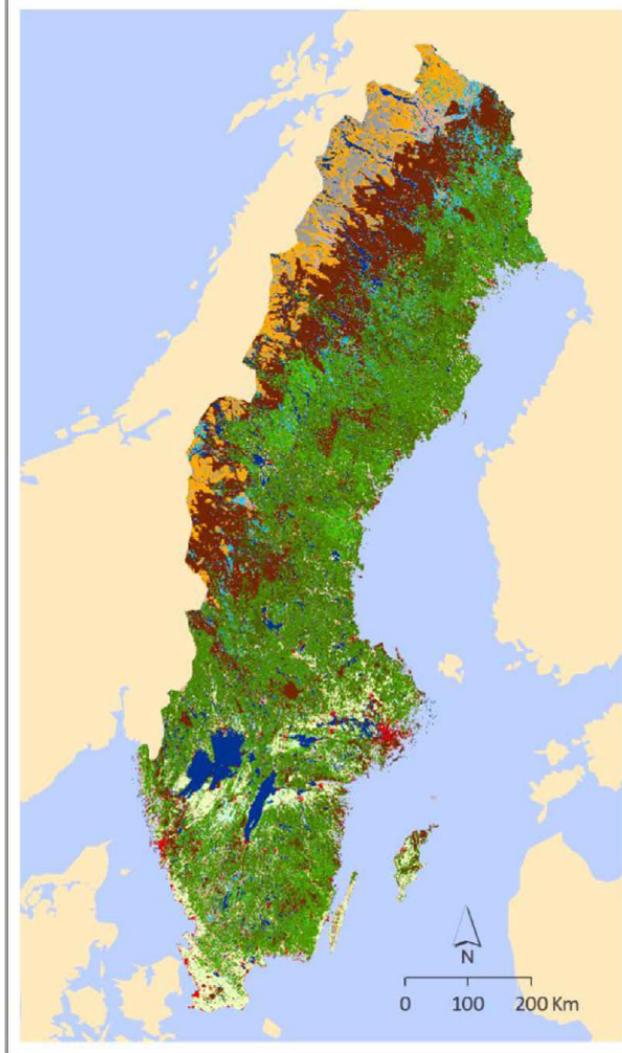
Arneth, A., Brown, C., Rounsevell, M. (2014). *Global models of human decision-making for land-based mitigation and adaptation assessment*. Nature Climate Change 4 (7), 550-557.

'Agent Functional Types'

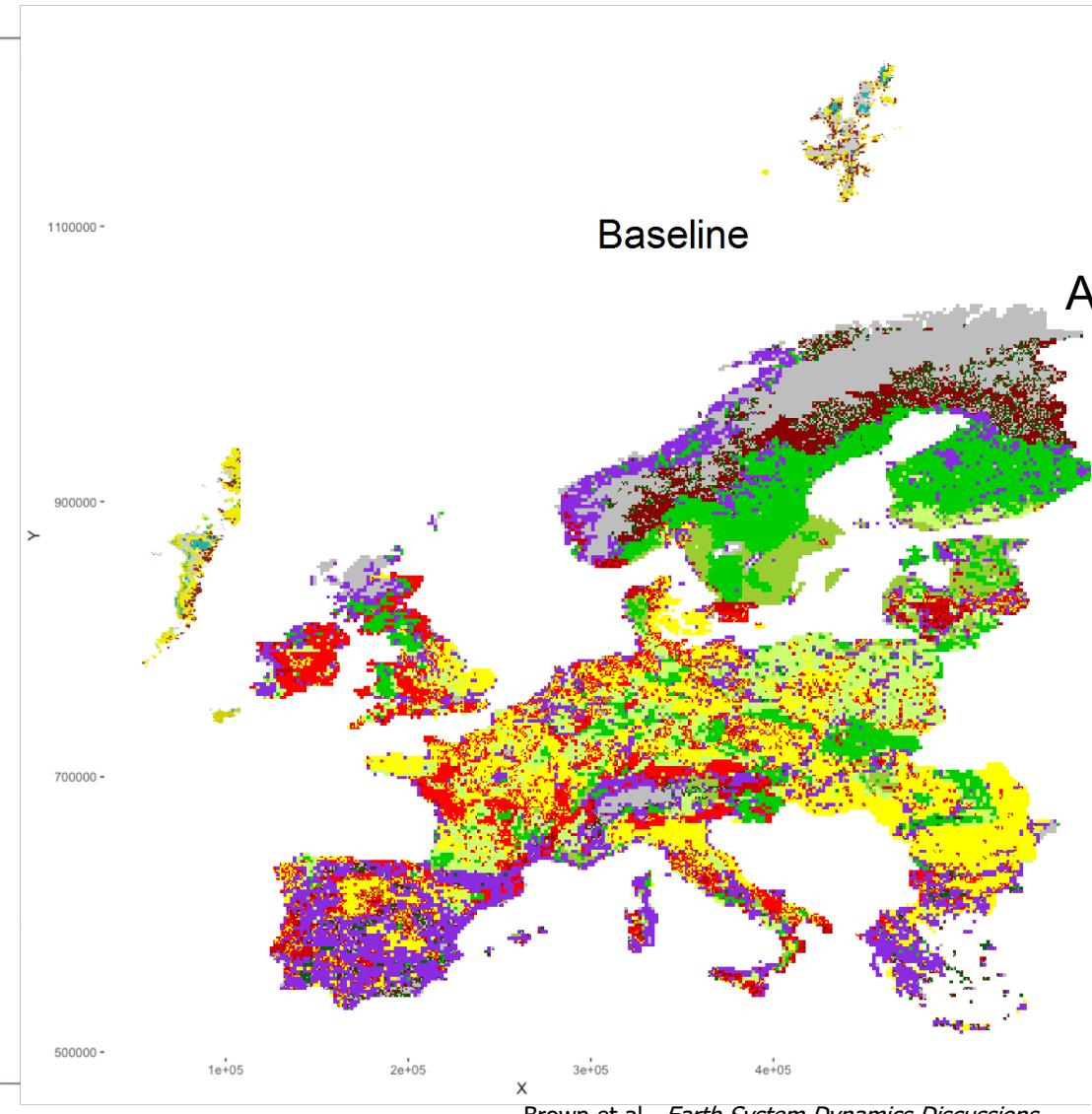
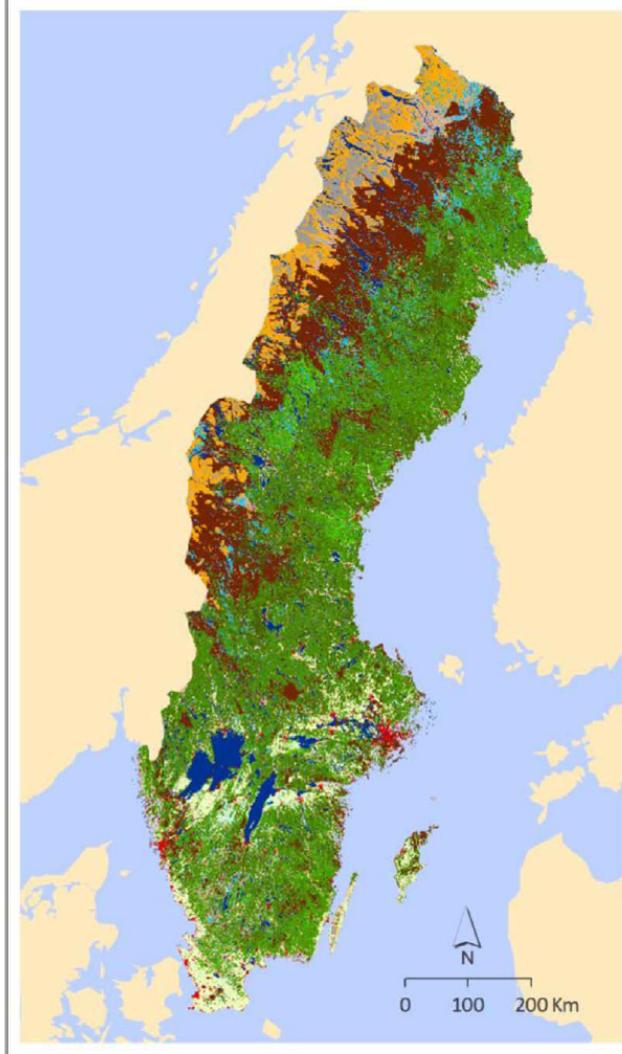


Blanco et al 2017a,b: *Journal of Environmental Management & Ecosystem Services*

'Agent Functional Types'



'Agent Functional Types'

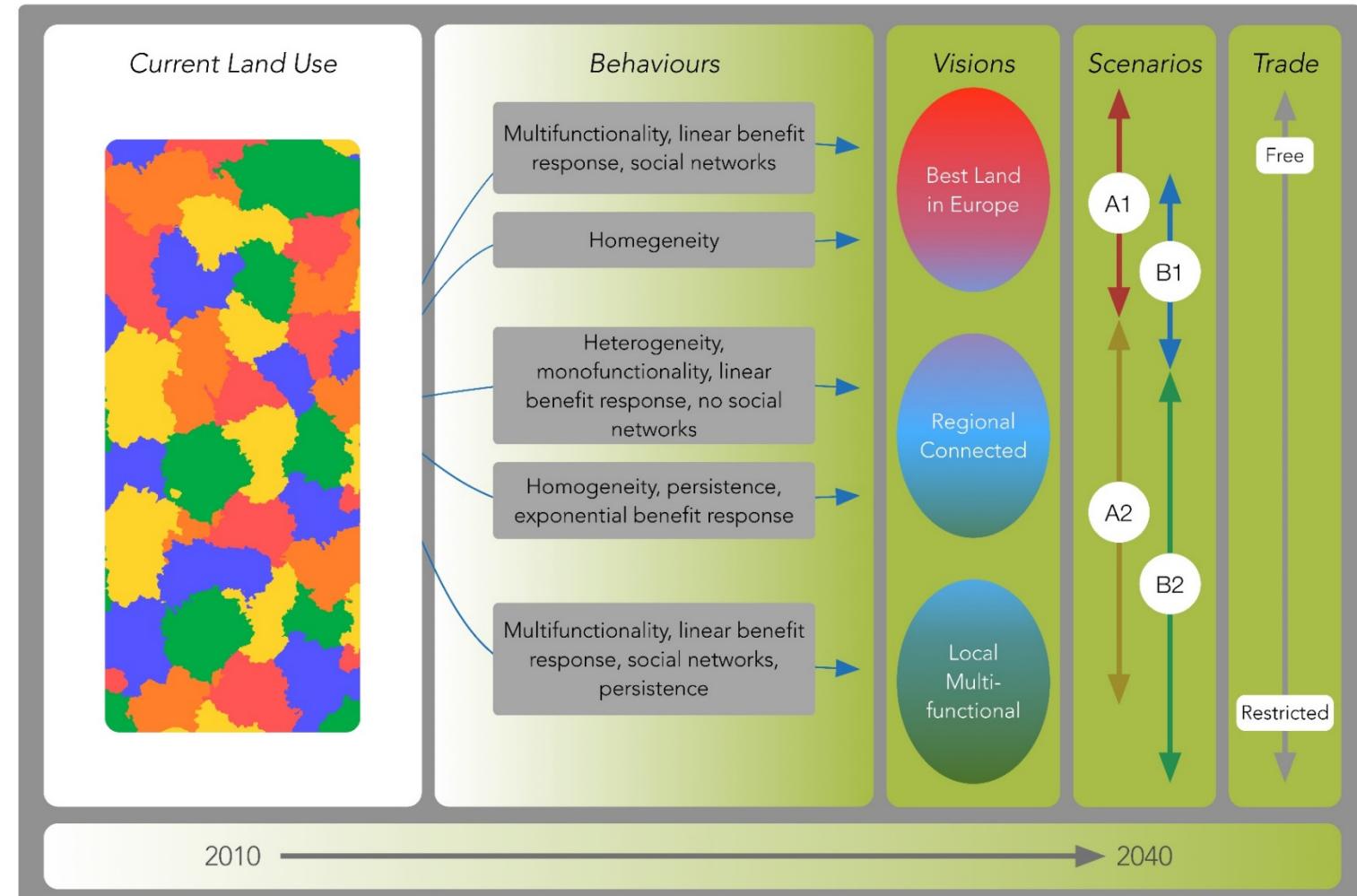


- Agent type
- Yellow: Intensive arable
 - Brown: Extensive arable
 - Red: Intensive pasture
 - Dark red: Extensive pasture
 - Maroon: Very extensive pasture
 - Light green: Intensive agro-forestry mosaic
 - Medium green: Extensive agro-forestry mosaic
 - Dark green: Managed forest
 - Black: Unmanaged forest
 - Purple: Marginal multifunctional
 - Grey: Unmanaged land

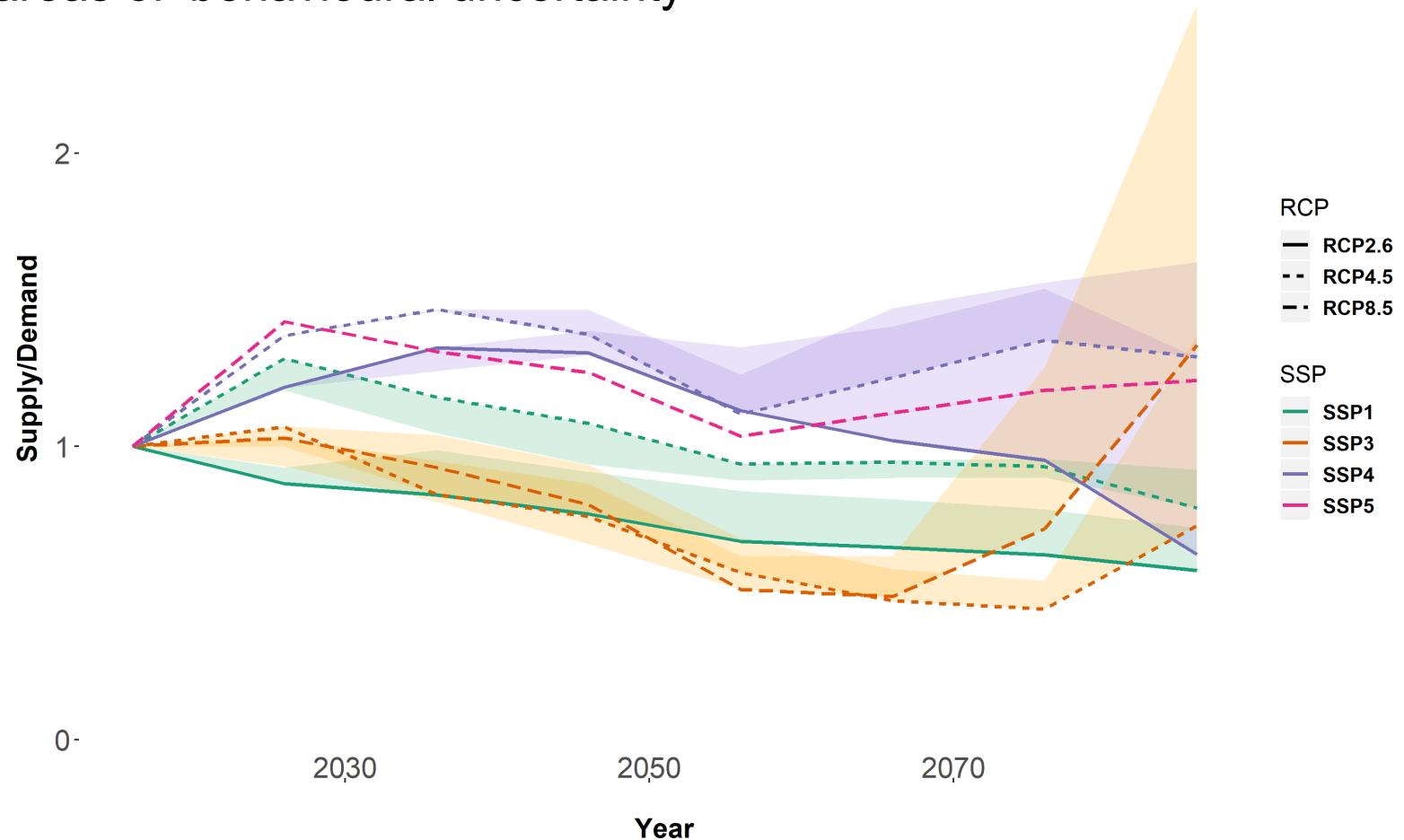
Brown et al., *Earth System Dynamics Discussions*

'Agent Functional Types'

- Range of ecosystem services
- Non-economic motivations
- Social networks & diffusion
- Institutional behaviours

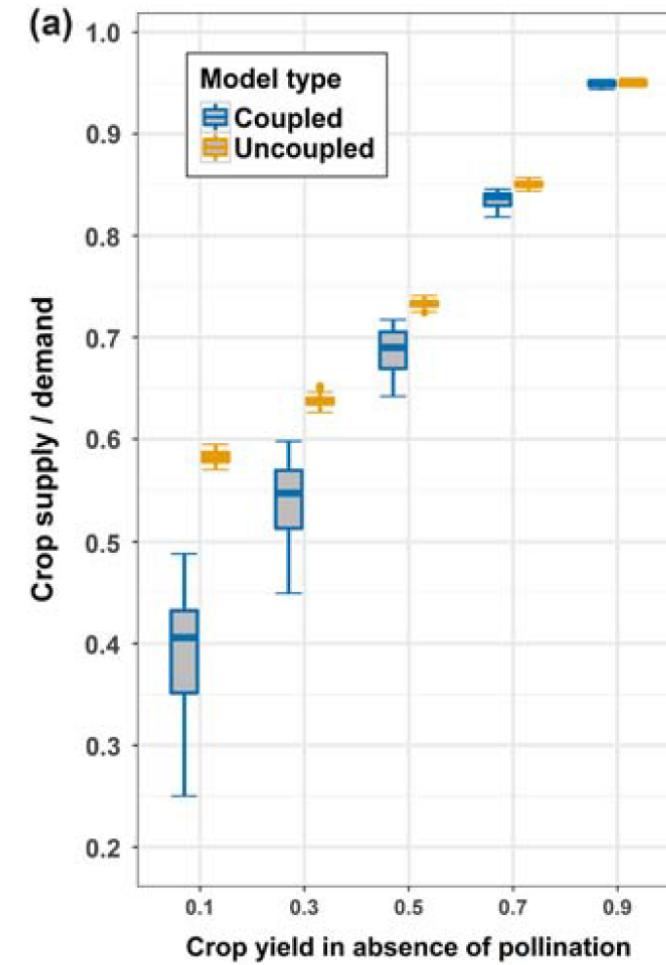


Agent-based models open up whole new areas of ‘behavioural uncertainty’



Socio-ecological feedbacks

- CRAFTY-Rangeshifter model coupling: pollinator population dynamics in agricultural landscape
- Coupled models show more variations, feedbacks produce 'tipping points' in socio-ecological system



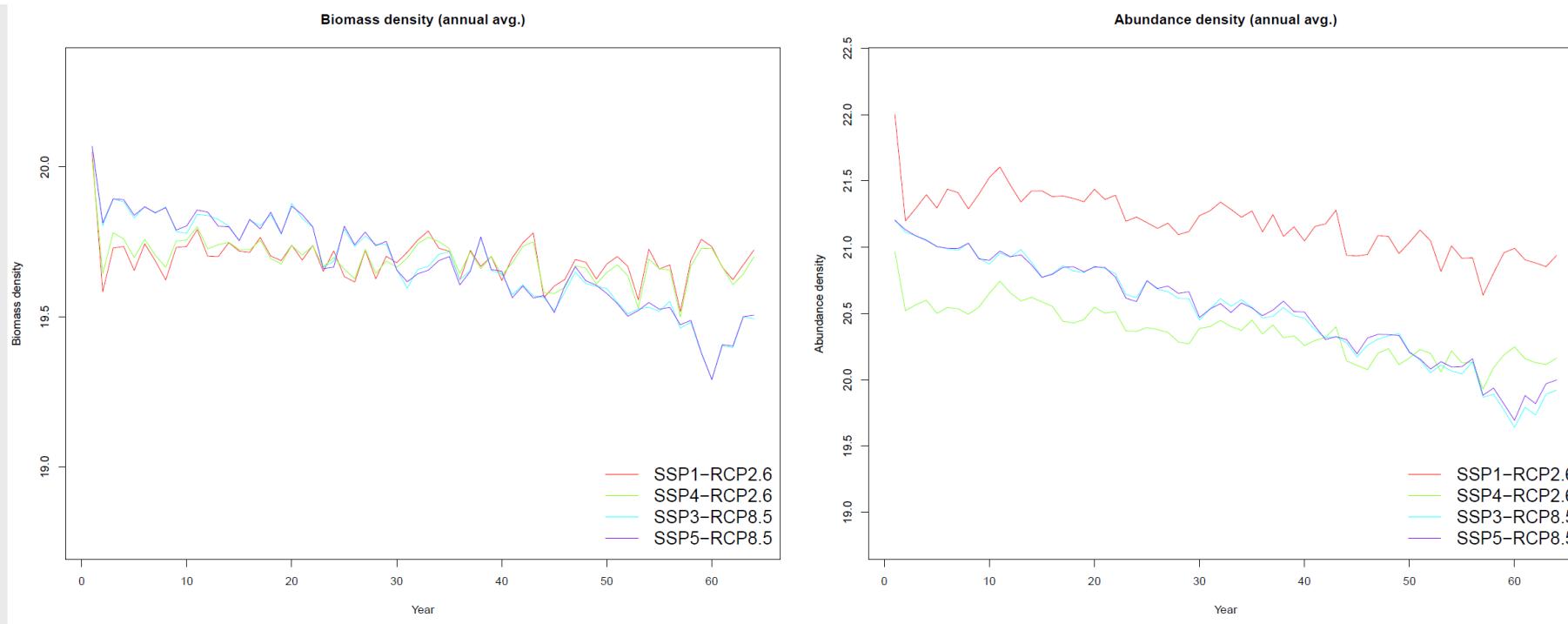
Synes et al. 2018, Ecography

Madingley

'next-generation' model of ecosystems and biodiversity

Cohort-based ecological dynamics within terrestrial and marine environments

Modelled ecosystems respond to Human Appropriation of Net Primary Productivity (HANPP)



Conclusions

- Scaling-up of behavioural models allows impacts of some key behaviours to be explored
- Well-constrained computational costs and uncertainties
- Links well to some existing up-scaled ecological models
- Coupled socio-ecological dynamics are different from uncoupled
- Many social & ecological behaviours – and feedbacks – still to explore

Questions?



