



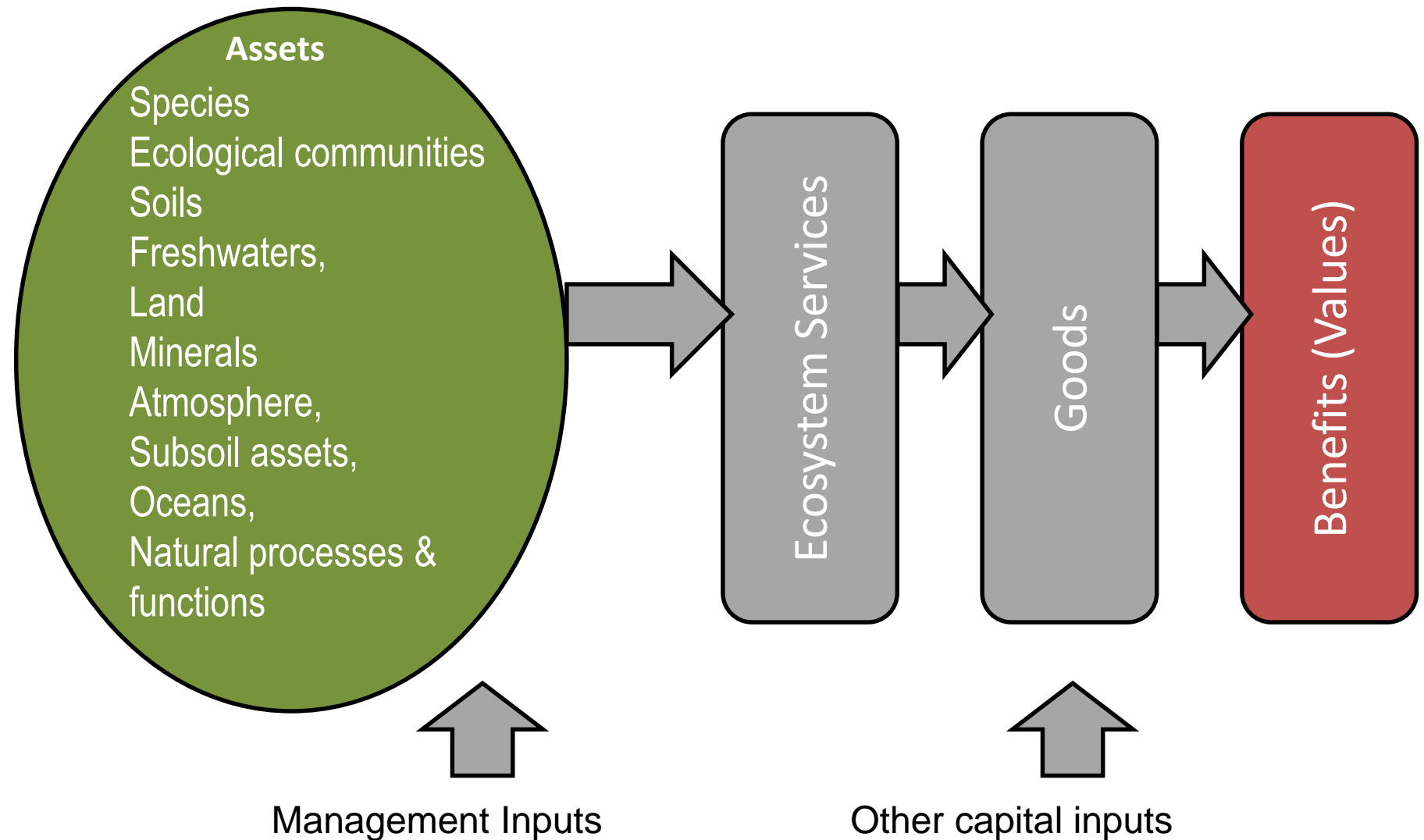
VALUING NATURE

Rosie Hails

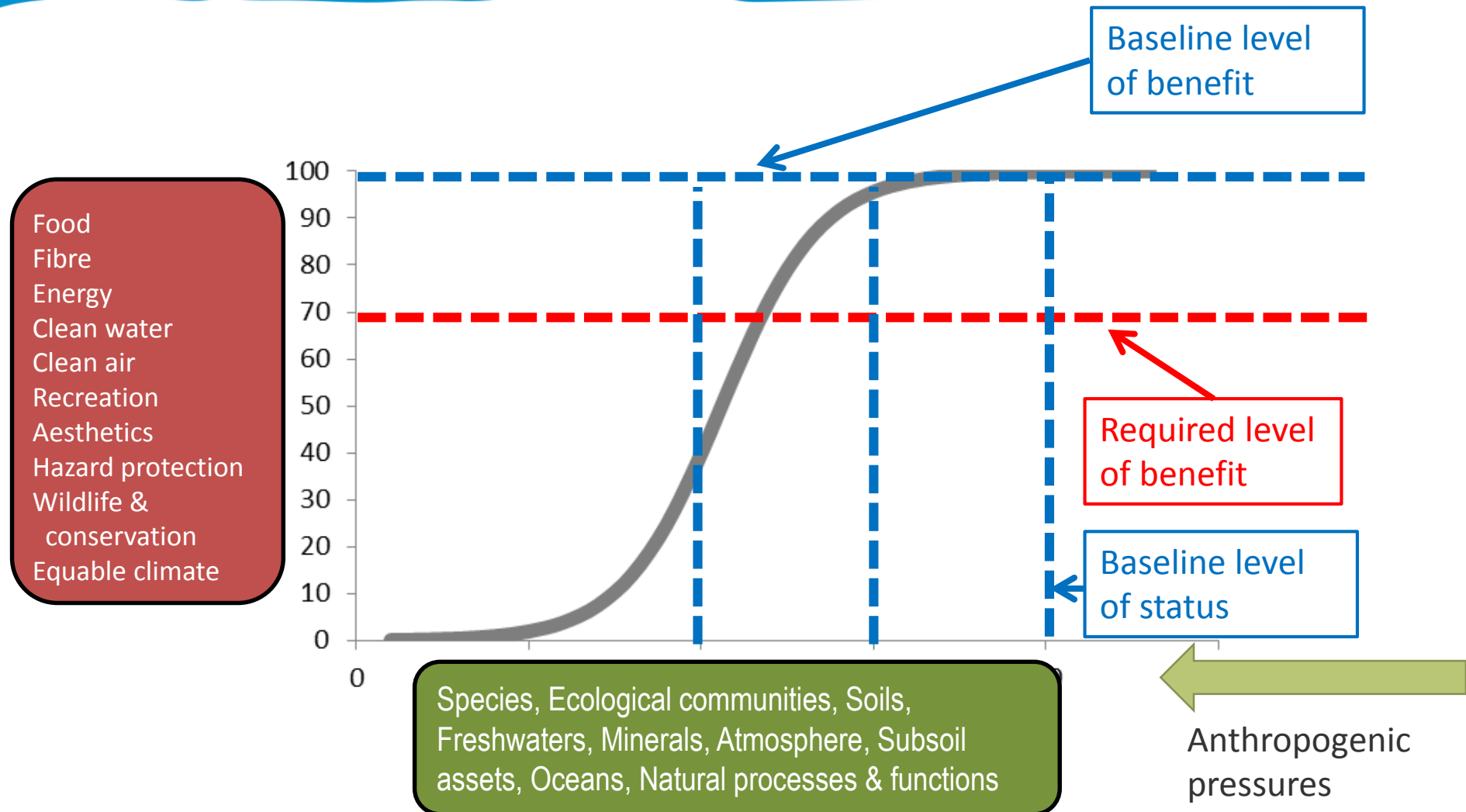
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How often do tipping points exist?



2. How often do tipping points exist?



How do we usefully apply the theory and methods of tipping points to ecosystem services?



The term “tipping point” commonly refers to a critical threshold at which a tiny perturbation can qualitatively alter the state or development of a system. Lenton et al 2005. PNAS 105, 1786



A Bifurcation tipping point



- Rate dependent tipping point: rate at which processes occur change at a tipping point
- Compost gets hotter & hotter in the centre until it combusts

‘The compost bomb instability’



- Noise induced tipping point: an external random perturbation being large enough to push the system over a threshold.

‘The wine glass instability’



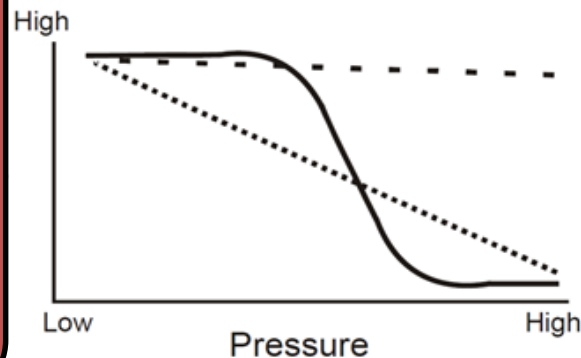
Abrupt changes

True tipping points

Bifurcation, rate & noise induced

Does it matter?

Food
Fibre
Energy
Clean water
Clean air
Recreation
Aesthetics
Hazard protection
Wildlife & conservation



Species, Ecological communities, Soils, Freshwaters, Minerals, Atmosphere, Subsoil assets, Oceans, Natural processes & functions

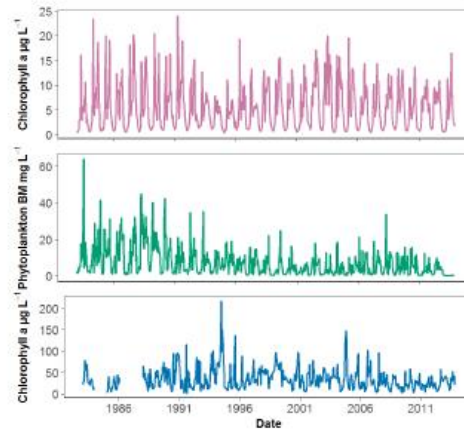
- The concern is abrupt change in the delivery of benefits.
- How do we detect early warnings?
- Can we detect lack of resilience, reversibility?

Early warnings of ecological change

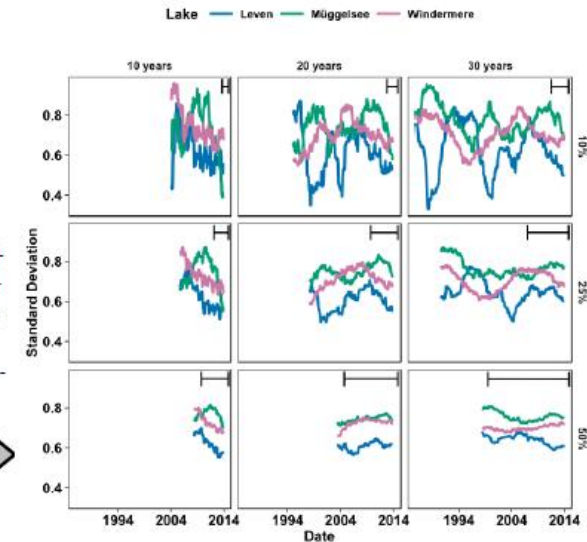
- **Theory:** statistical early warnings (EWs) precede “tipping points”
- **Practice:** EWs vary greatly over time in stable systems, and when calculated over different time periods (right graph)
- **Conclusion:** prediction is difficult



Long term environmental monitoring of phytoplankton biomass over 30 years



Changes in antecedent variance of phytoplankton biomass and the effects of window size and observation period



Thoughts

- Theoretical understanding is far in advance of empirical evidence
- Different triggering mechanisms have been identified
- True tipping points are a subset of abrupt change
- Concern is around all forms of abrupt change
- As yet early warning indicators have to prove their practical use – work in progress
- What does this mean for the management of natural capital and ecosystem services?