

Predicting the effect of stakeholder variability in natural resource management: using the GMSE R package



Dr Jeroen Minderman
(jeroen.minderman2@stir.ac.uk)
Dr Brad Duthie
Prof Nils Bunnefeld

Introduction: *Increasing populations, increasing*

pressures...

Living Planet Index (2018)

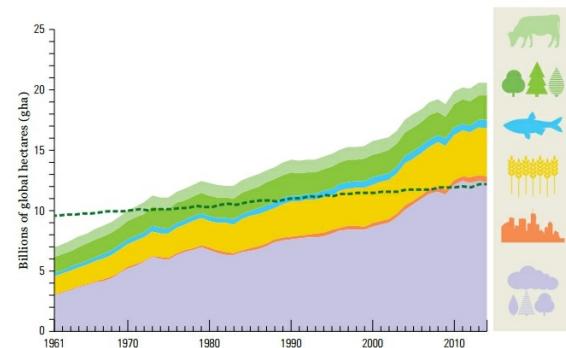
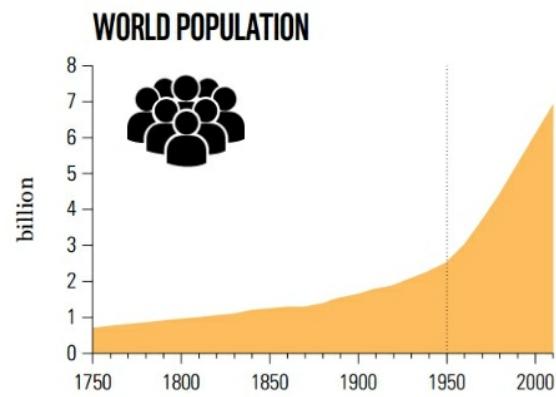
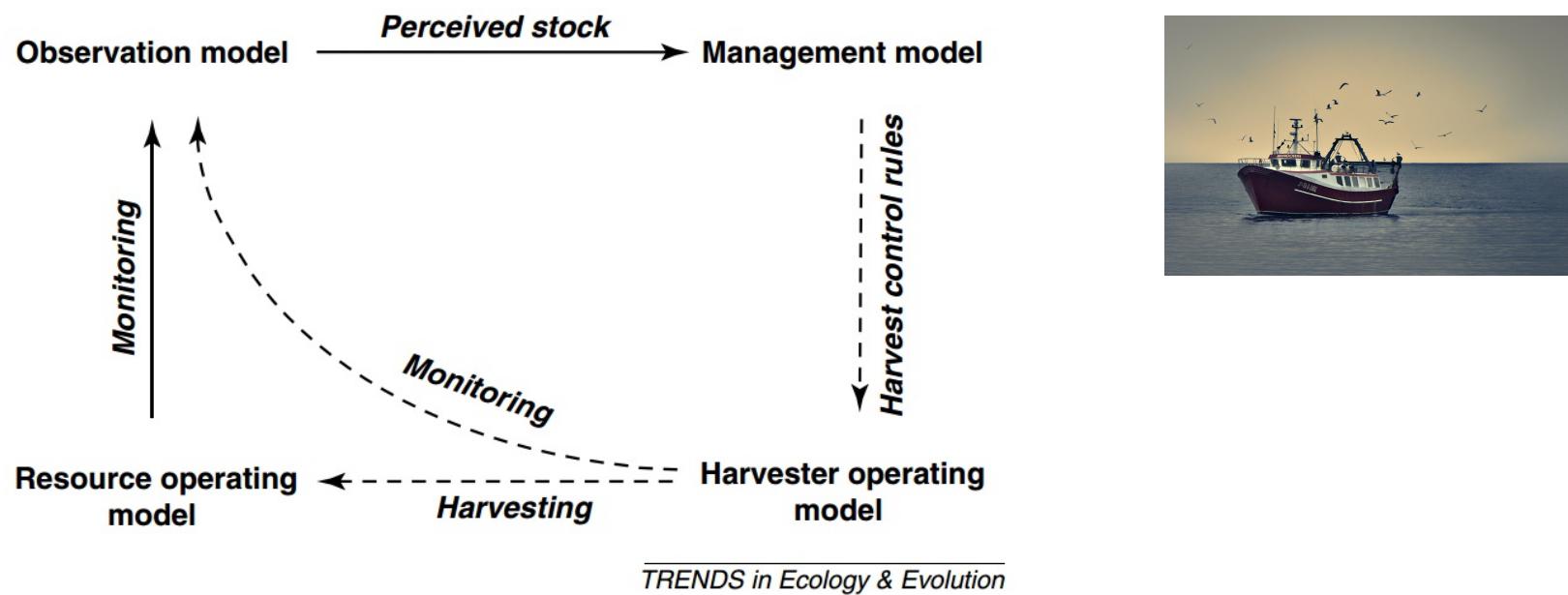


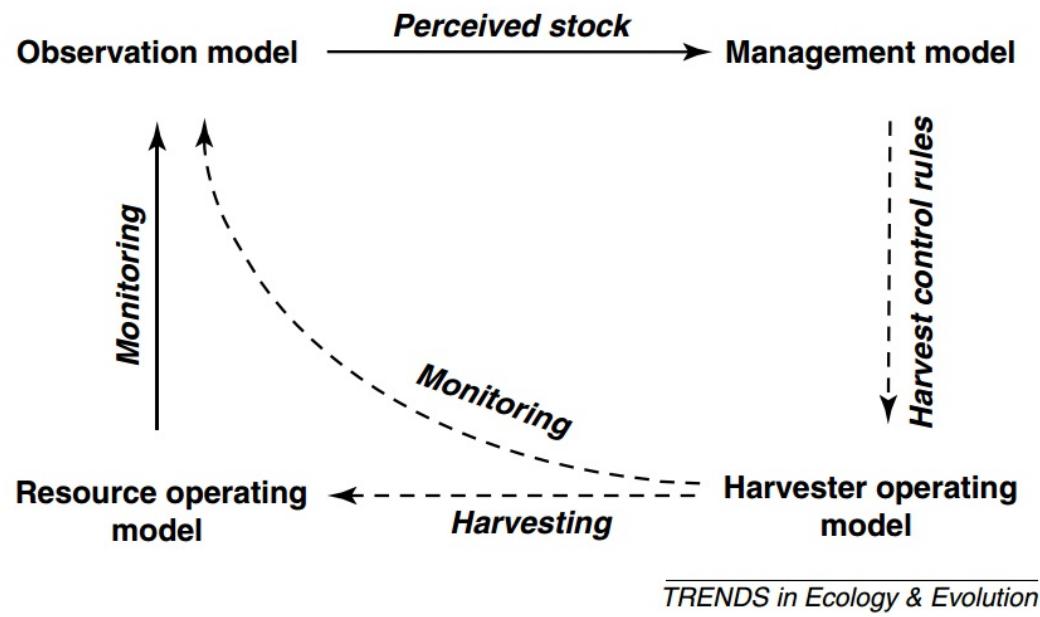
Photo: Ove Martin Gundersen

Introduction: Management Strategy Evaluation



From Bunnefeld *et al.* (2011)

Introduction: Management Strategy Evaluation



From Bunnefeld *et al.* (2011)

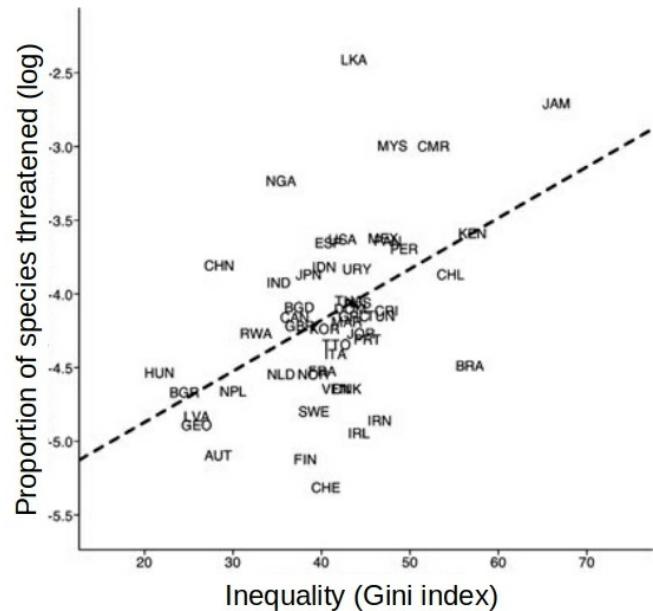
Introduction: .. *however, variation matters*



.. but most MSE approaches do not (cannot) account for this

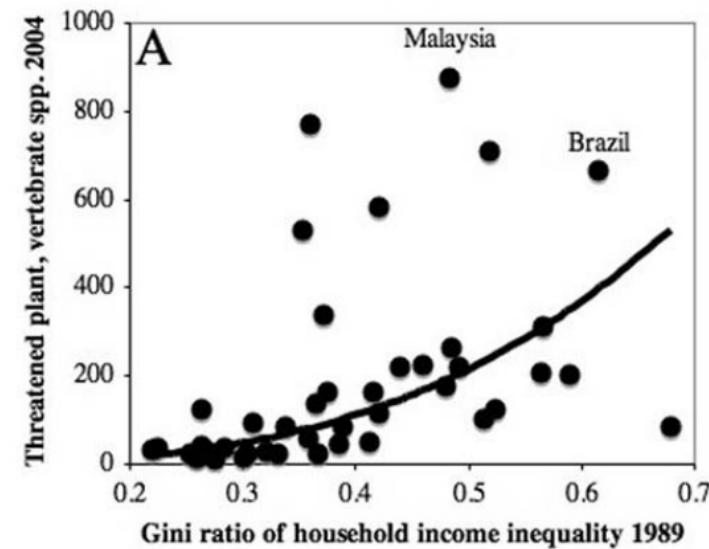
Introduction: .. and equity may be related to

biodiversity loss



Holland *et al.* (2009)

A Cross-National Analysis of How Economic Inequality Predicts Biodiversity Loss
Cons Biol 23(5)



Mikkelsen *et al.* (2007)

Economic Inequality Predicts Biodiversity Loss
PLoS ONE 2(5): e444

Aims



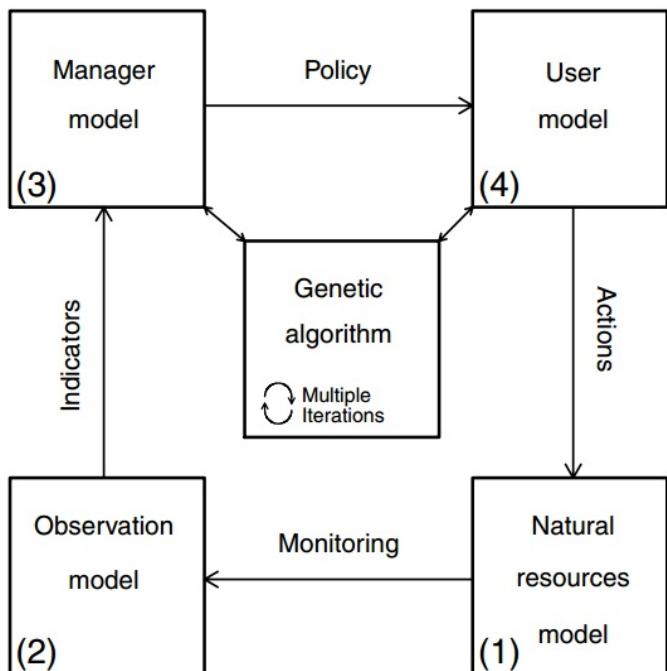
1. **Introduce GMSE** as flexible and extensible platform for simulating population management

Brief overview of methods, capabilities, etc...

2. Use GMSE to **test effect of stakeholder variation** on population management.

Does inequity in wealth and land ownership affect extinction risk?

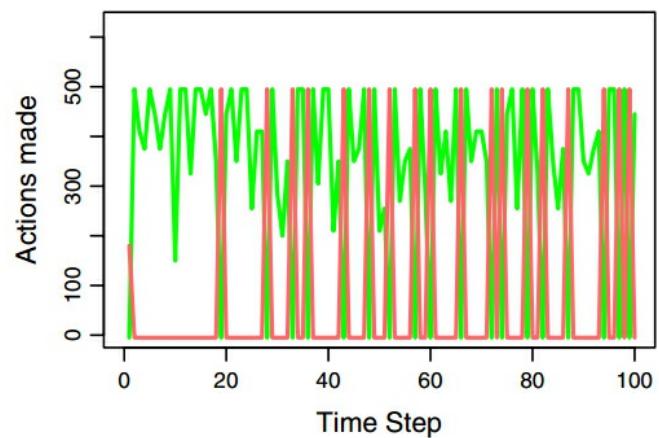
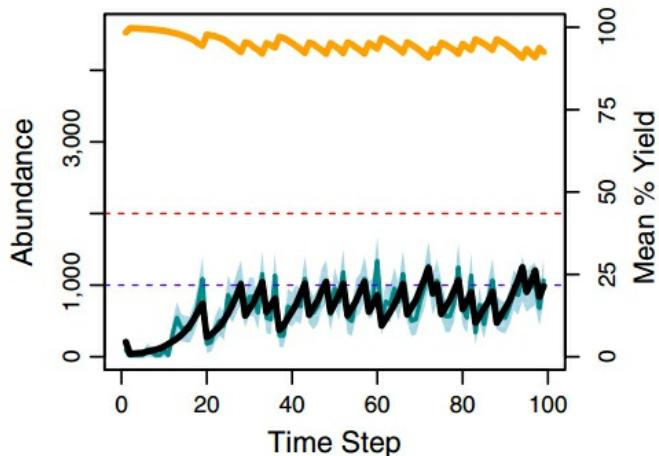
Generalised Management Strategy Evaluation (1)



Duthie et al. (2018) *Methods in Ecology & Evolution*. DOI:
[10.1111/2041-210X.13091](https://doi.org/10.1111/2041-210X.13091)

- Individual-based & spatially explicit
- **"Manager": maintain resource**
- **"Users": maximise yield**
("resource" may negatively affect yield)
- "Users" can choose to e.g. farm, kill resources, etc.
- Cost of each action set by manager

Generalised Management Strategy Evaluation (2)



Duthie et al. (2018) *Methods in Ecology & Evolution*. DOI:
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Simulation scenarios

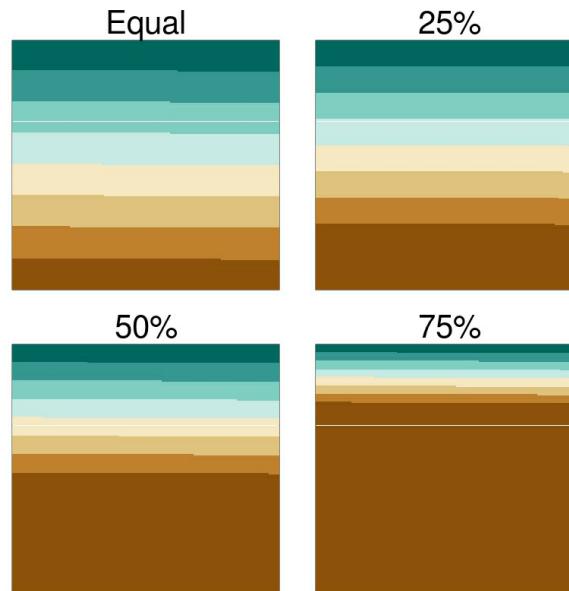
General set-up



- Resource population exploits crops (i.e. negatively affects users' yield)
- Users can farm, kill resources on their land, or "scare" resources off their land
- All land is "privately" owned; users can only kill on their own land

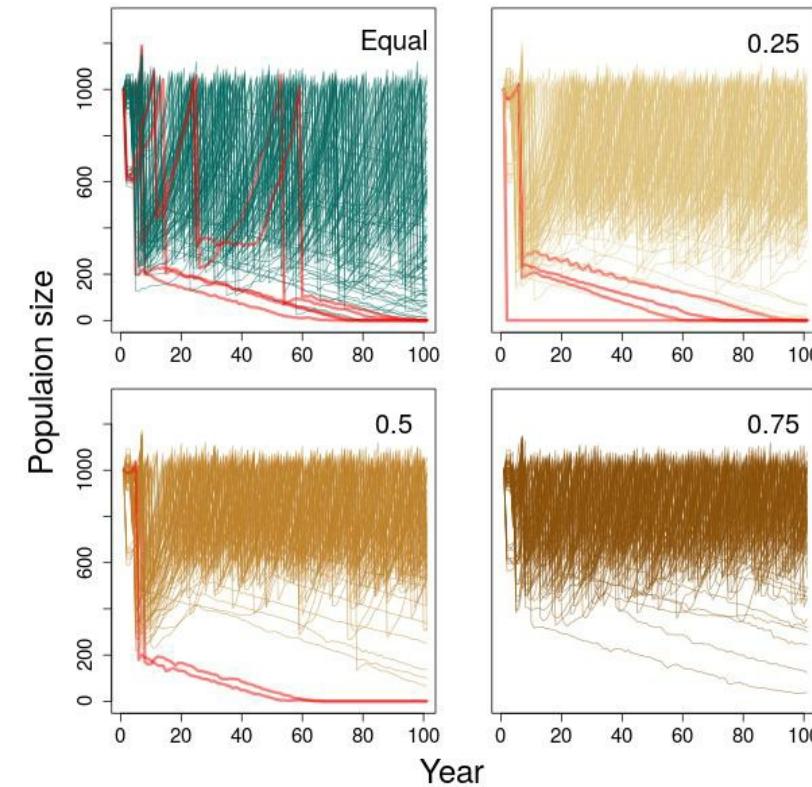
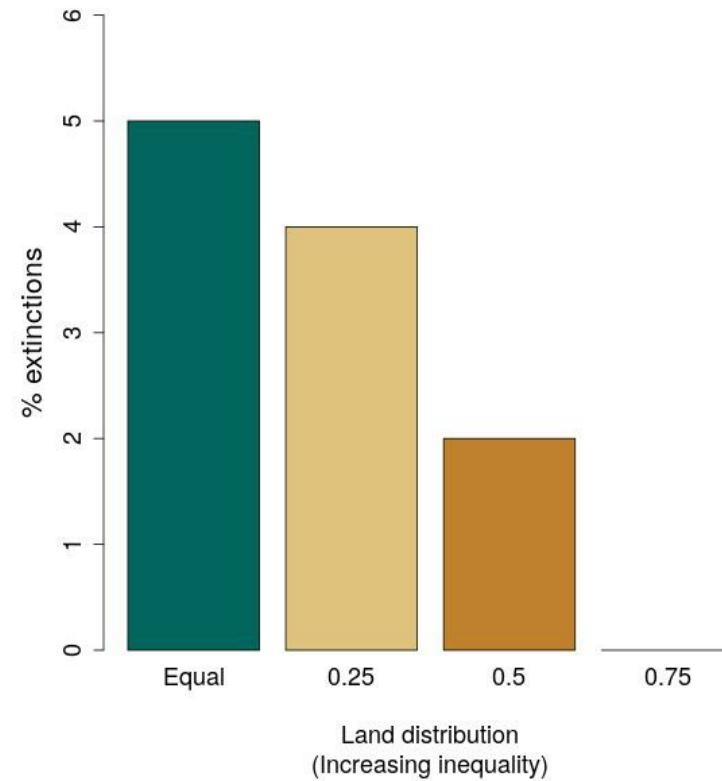
Stakeholder variation

- Budgets ~ yield
- Land distribution varied:



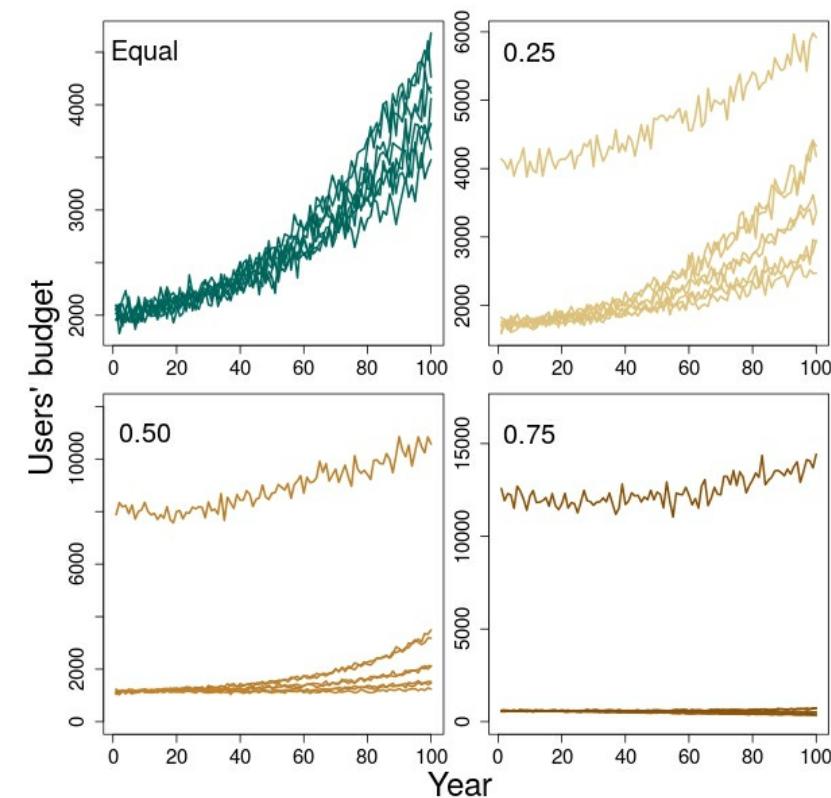
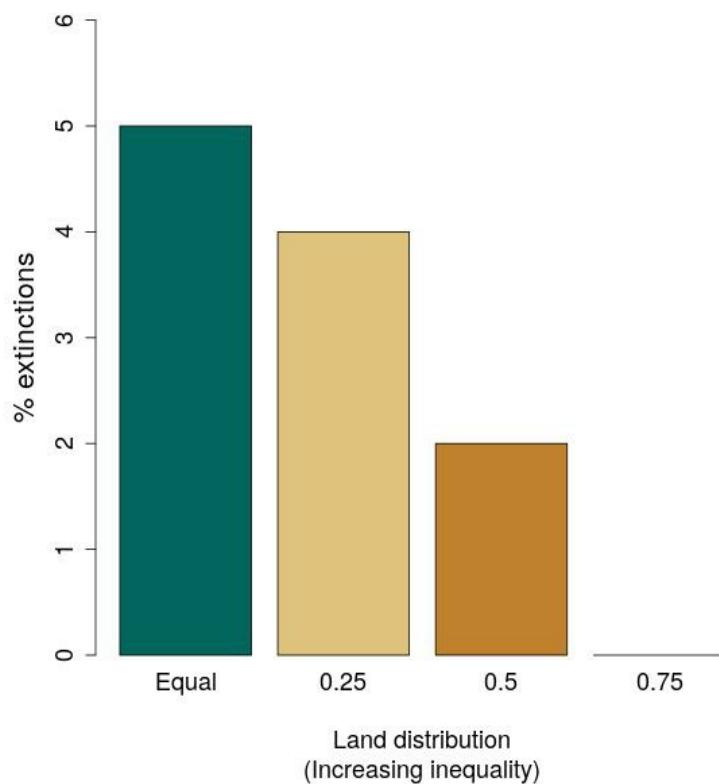
Results (1)

Increasing inequality = ***decreases*** extinction risk??



Results (2)

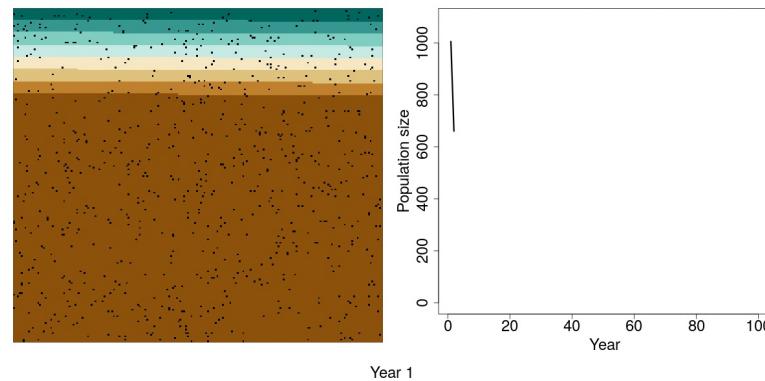
Increasing inequality = **budgets severely limited** for some..



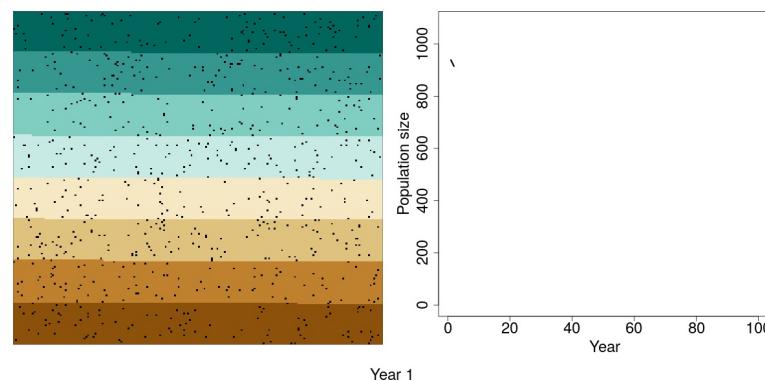
Results (3)

Limited budgets, **limited power = *de facto* population refuges**

Unequal
distribution
(75%)



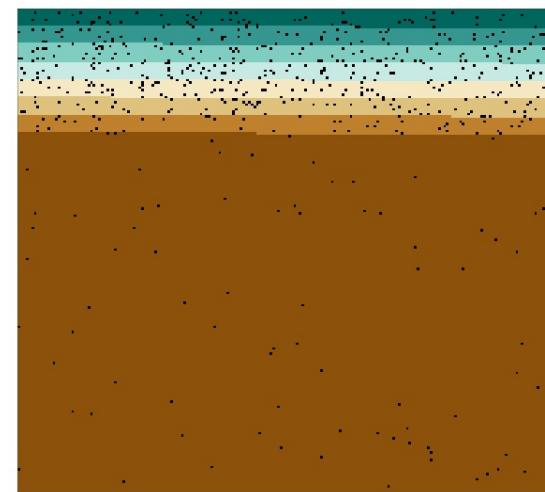
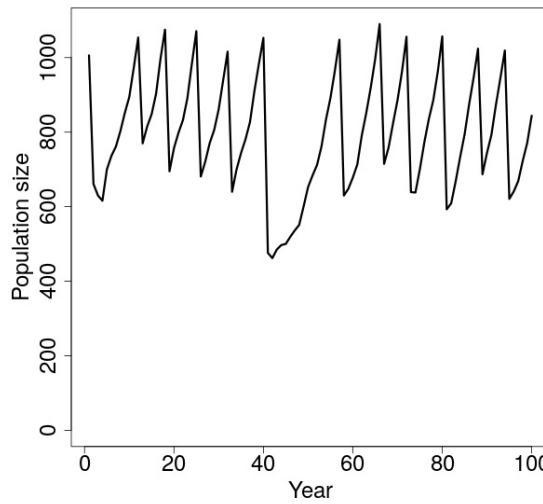
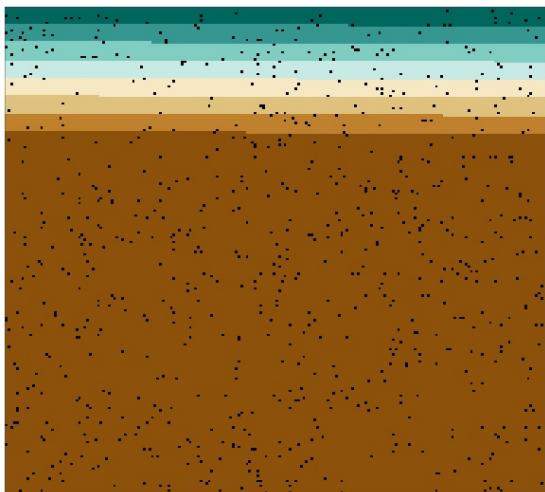
Equal
distribution



Results (3a)

Limited budgets, **limited power = *de facto* population refuges**

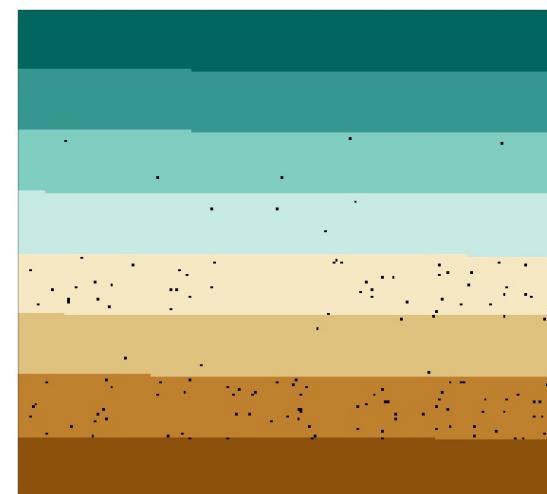
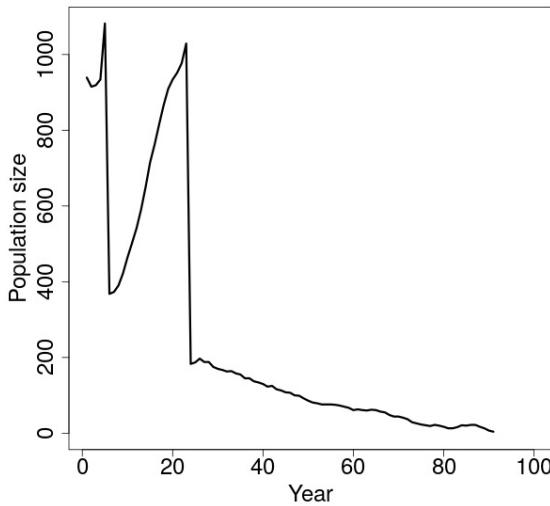
Unequal land distribution (75% to 1)



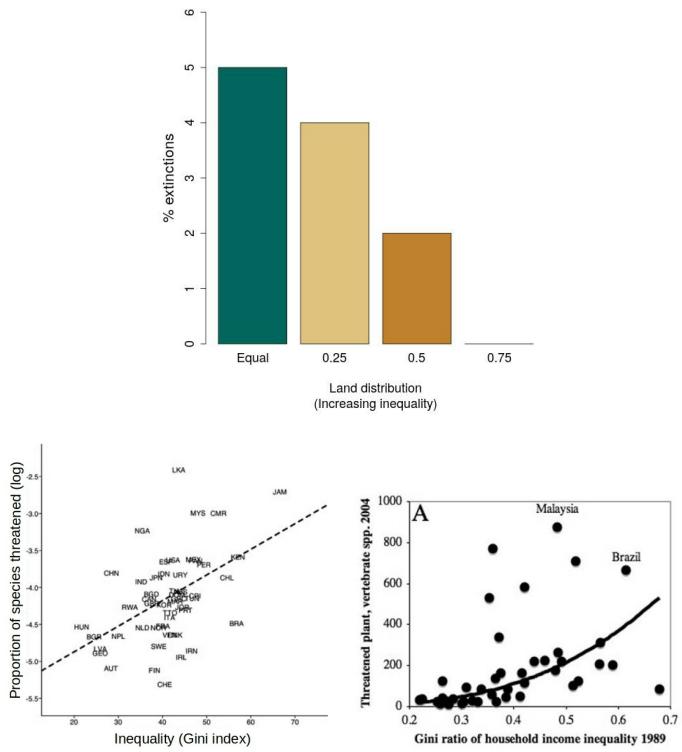
Results (3b)

Equal land = equal power = all users can affect resource

Equal land distribution



Conclusions & discussion



Contradiction?

- Current model clearly "toy" example...
- But does highlight need for accounting for complexity:
- .. many factors affect equality - biodiversity relationship.
- GMSE highly flexible;
- .. current model can (will!) be developed further
 - More realistic yield function (e.g. diminishing returns)
 - Societal change
 - ...

Thank you!



Nils Bunnefeld



Brad Duthie



ConFooBio

Jeremy Cusack
Lynsey Bunnefeld
Sarobidy Rakotonarivo
Isabel Jones
Isla Hodgson



European Research Council
Established by the European Commission

Rocio Pozo
Lovisa Nilsson
UNIVERSITY of STIRLING The University of Stirling logo, which is a crest featuring a castle and a river.



Conclusions & Discussion?

.pull-left[

**Scotland has the most inequitable
land ownership in the west. Why?**

As the grouse season opens, reforms are gathering which would allow tenant farmers to buy their land and end centuries of privilege that have made the rich ever richer

(The Observer, August 2013)

