

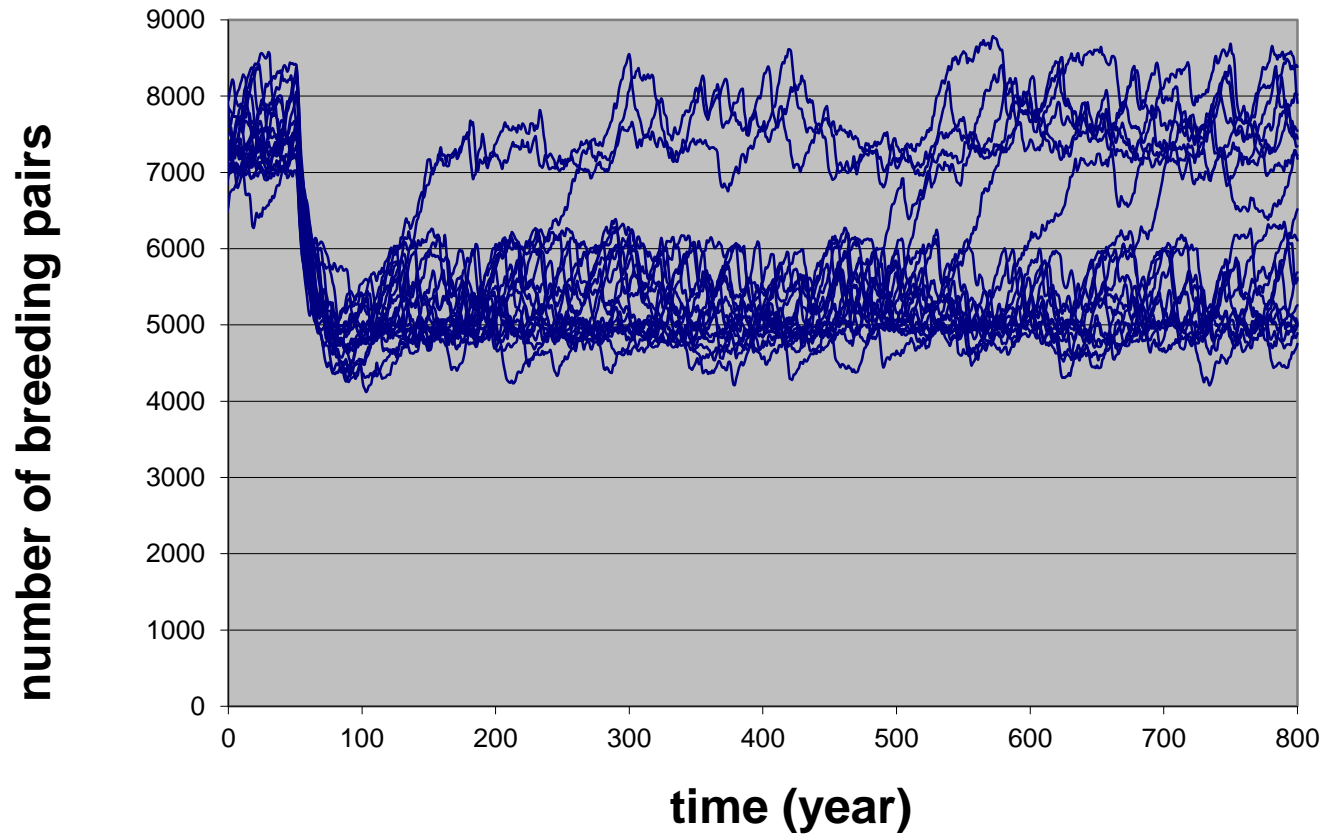
# RESILIENCE AND ALTERNATIVE STABLE STATES IN METAPOPOPULATIONS OF COLONIAL (SEA)BIRDS

Peter Schippers, Eric Stienen, Alex Schotman, Robert Snep, Pieter Slim  
(2011) Ecological modelling (in press)

# Introduction

- ⊙ *Seabirds are important species*
  - for humans (protected) & nature (role in ecosystem)
- ⊙ *Advances of being colonial*
  - *density dependent mechanisms like*
    - *Dilution, Defence, Foraging & Sex ratio*
  - *Allee effects*
- ⊙ *Dispersal of seabirds*
  - *surprisingly low*
- ⊙ *Strange dynamics in models*

# Common Tern population in Zeeland



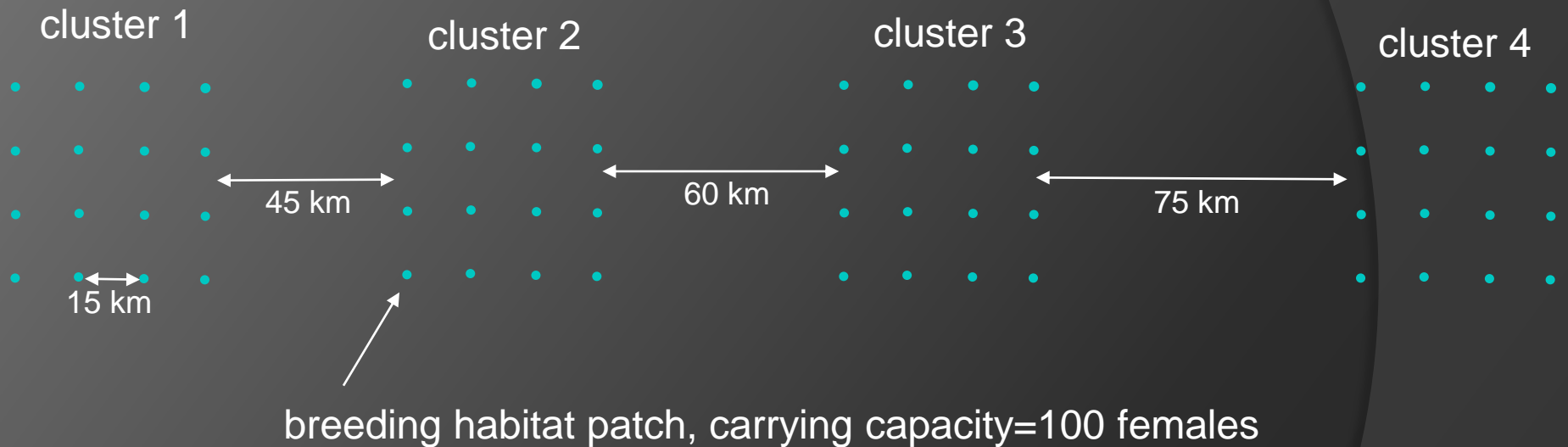
# Objective

- What are the consequences of low reproduction potential at low densities (Allee effects) on the dynamics and resilience of individual populations and at the metapopulation level.

# Method

- ① *METAPOP model parameterized for the Common Tern*
- ① *Life history events per year*
  - ② *Lesly matrix demography 5 age classe*
    - ③ *with density-dependent reproduction*
  - ② *Losses of recruits due to Allee effects*
    - ③ *Introducing loss rate  $L$*
  - ② *Dispersal: Probability to disperse*
    - ③ *Density dependent*
  - ② *Dispersal: Inter-patch relations*
    - ③ *Exponential with distance*

# Artificial landscape

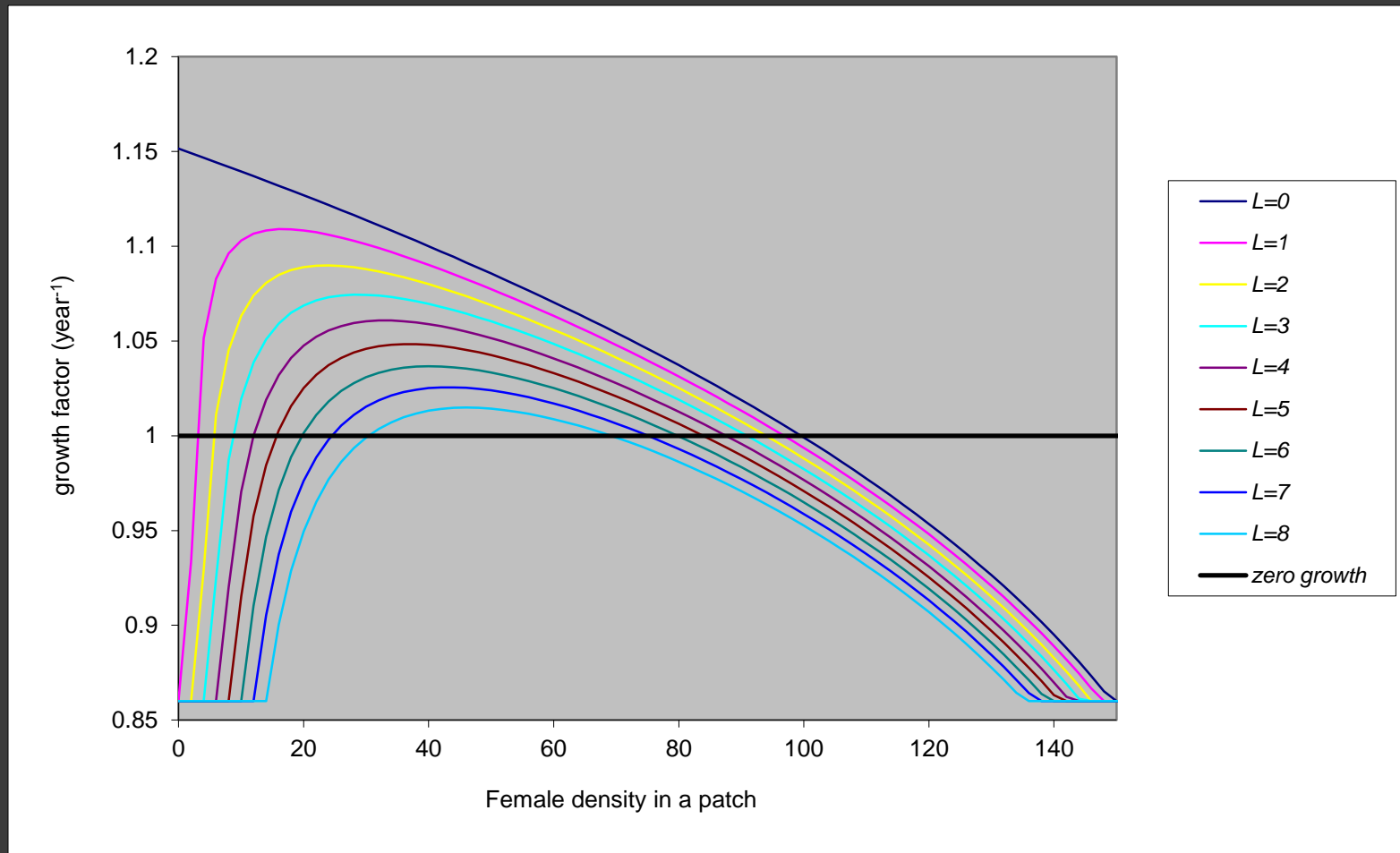


# Simulations (effects of $L$ on)

1. Single patch growth
2. Colonisation of a single cluster of 16 patches
3. Dynamics of multi-cluster metapopulation
4. Colonisation of an empty clusters from an other cluster
5. Metapopulation stability and resilience

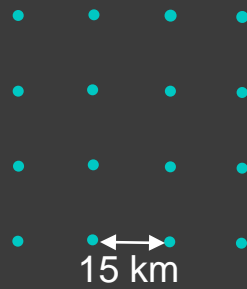
# *1) Single patch analysis*

# Growth-density relation



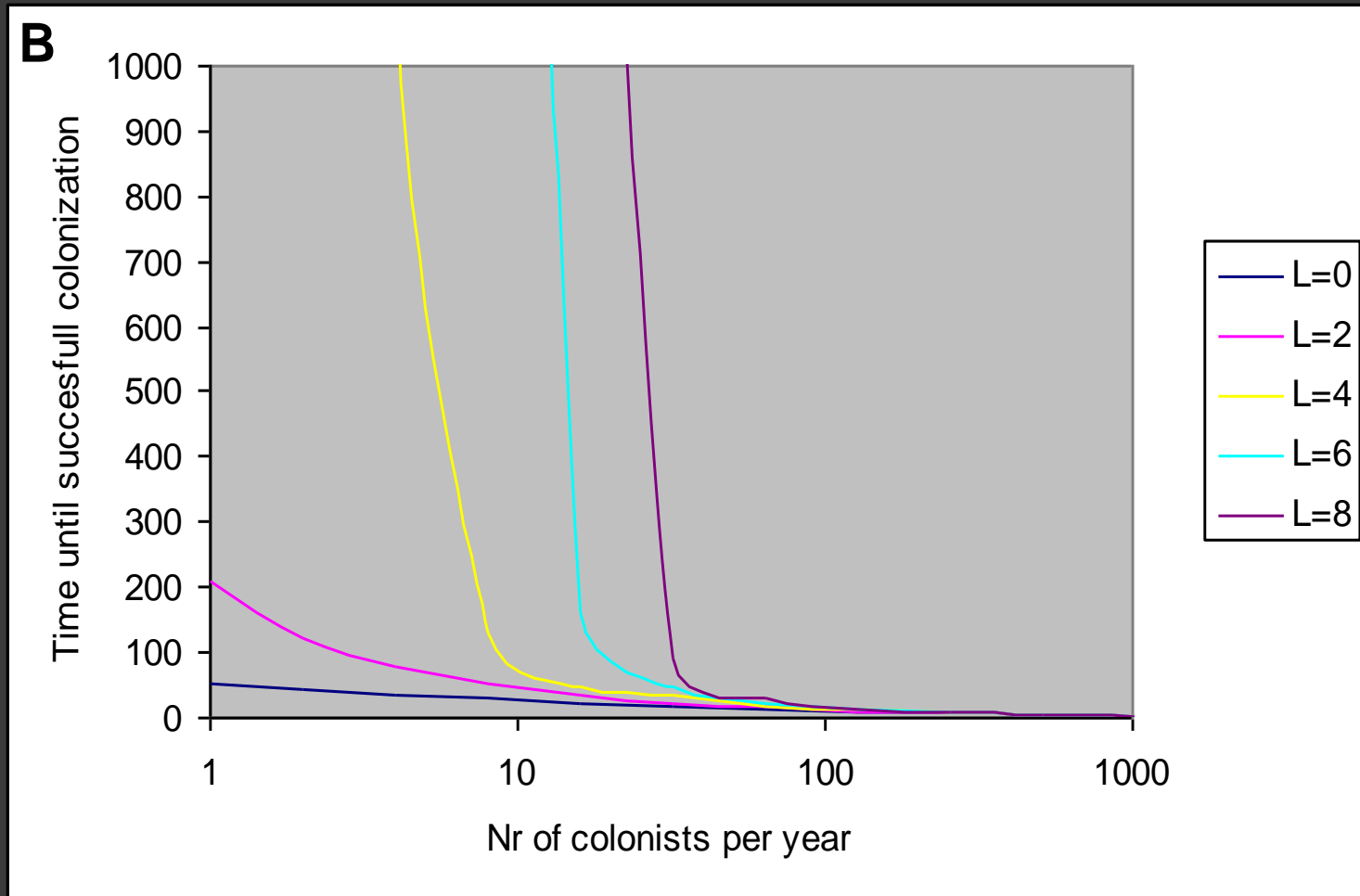
## 2) *Analysis of an empty single cluster*

cluster 1

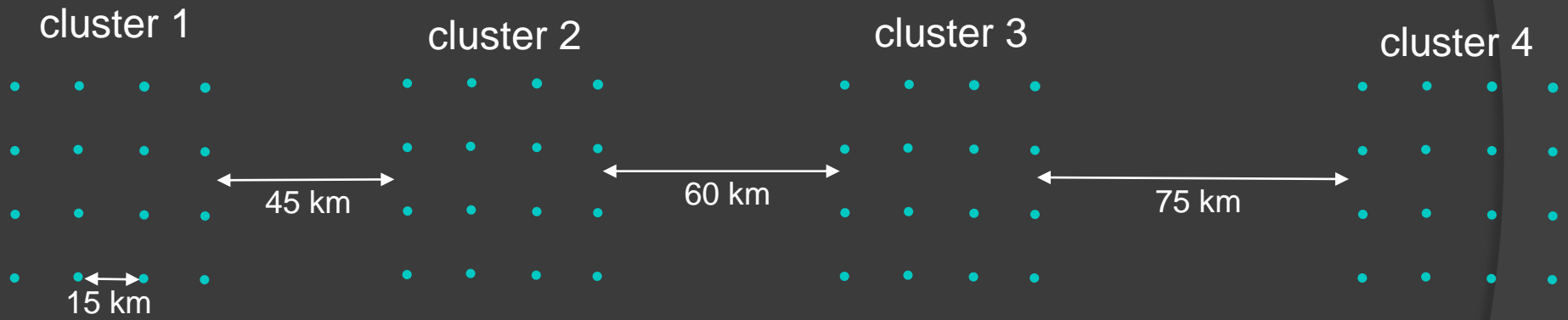


# Repeated colonization

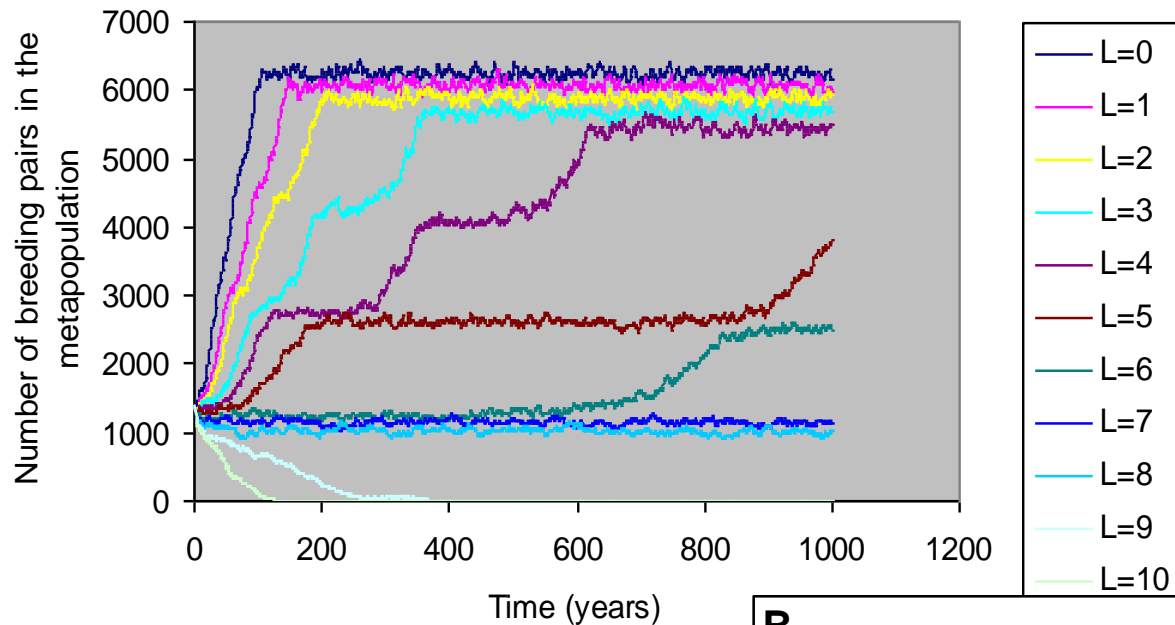
Fig 4b



### 3) *Dynamics of a multi cluster metapopulation at various initial conditions*

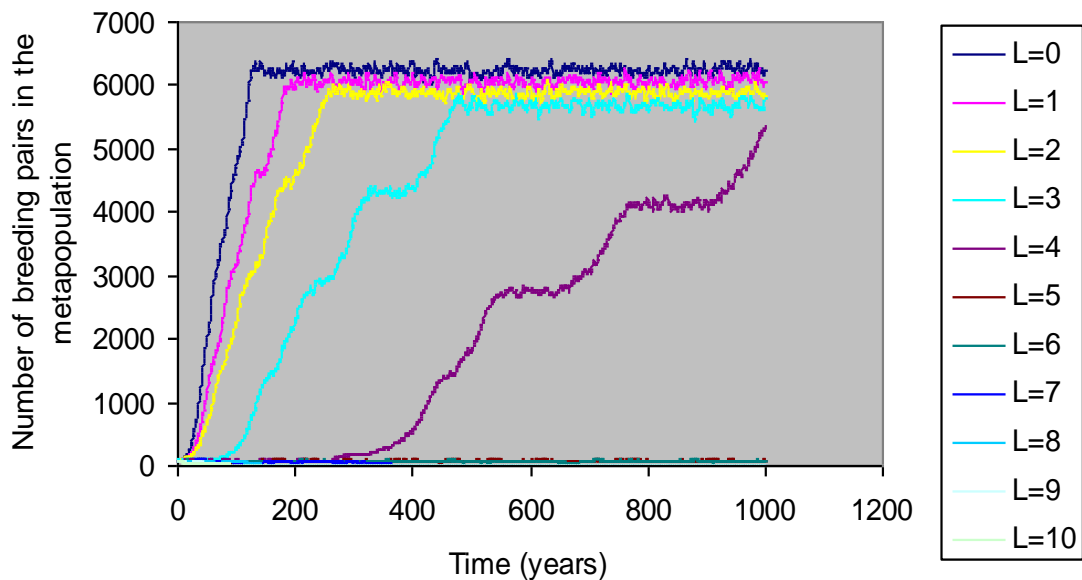


Initial condition: cluster 1 at carrying capacity

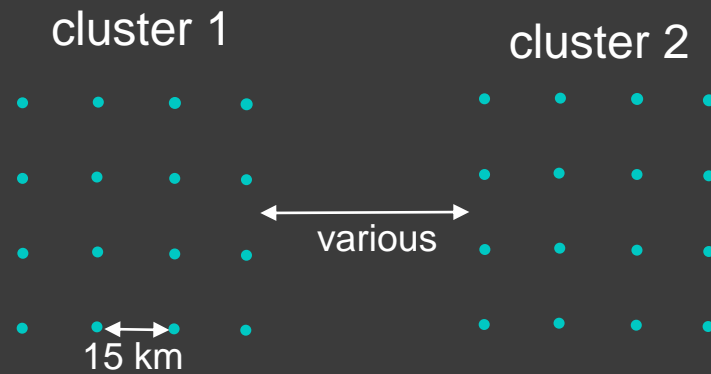


**B**

Initial condition: one patch at carrying capacity



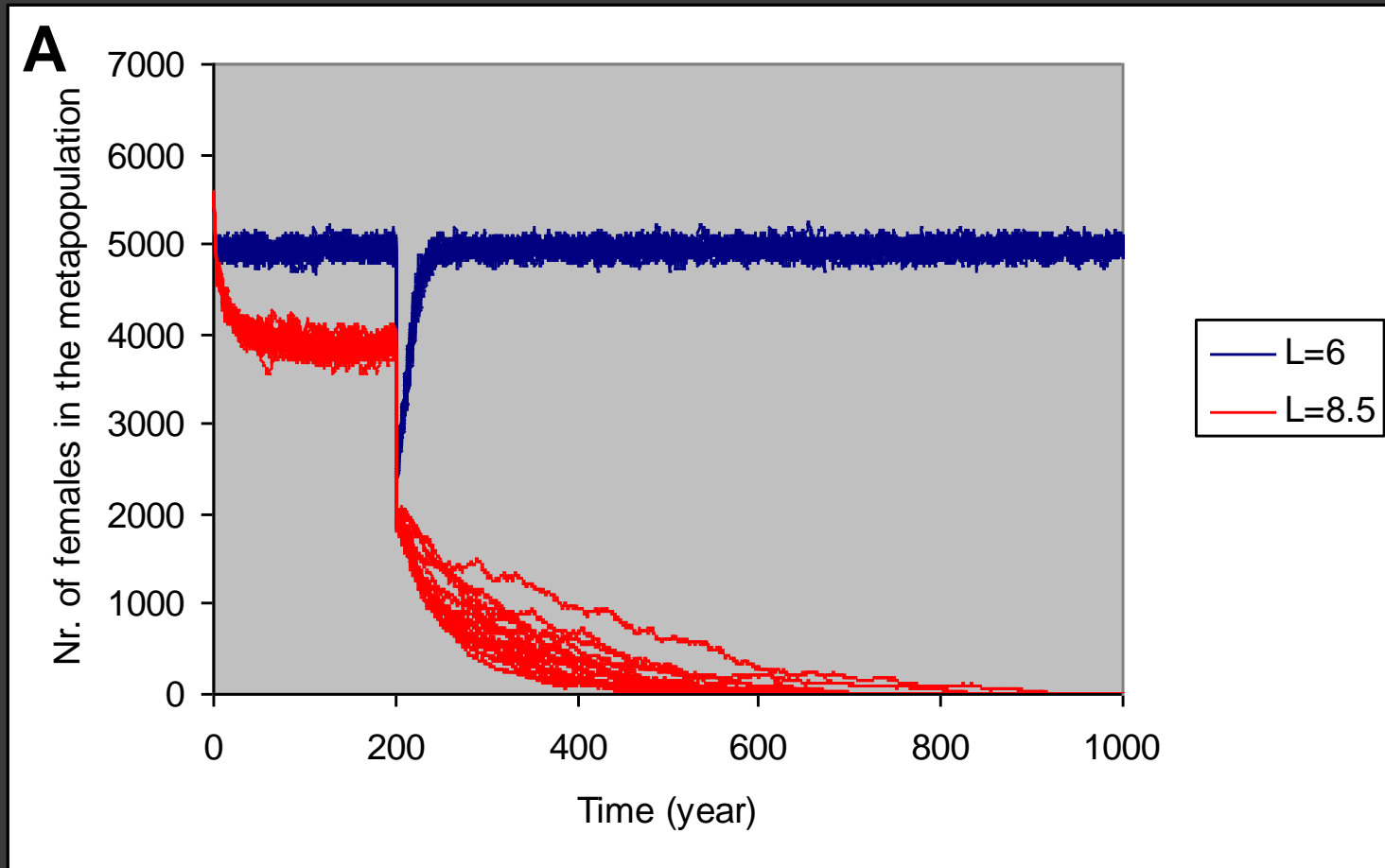
# 4) Colonization time and distance between 2 clusters



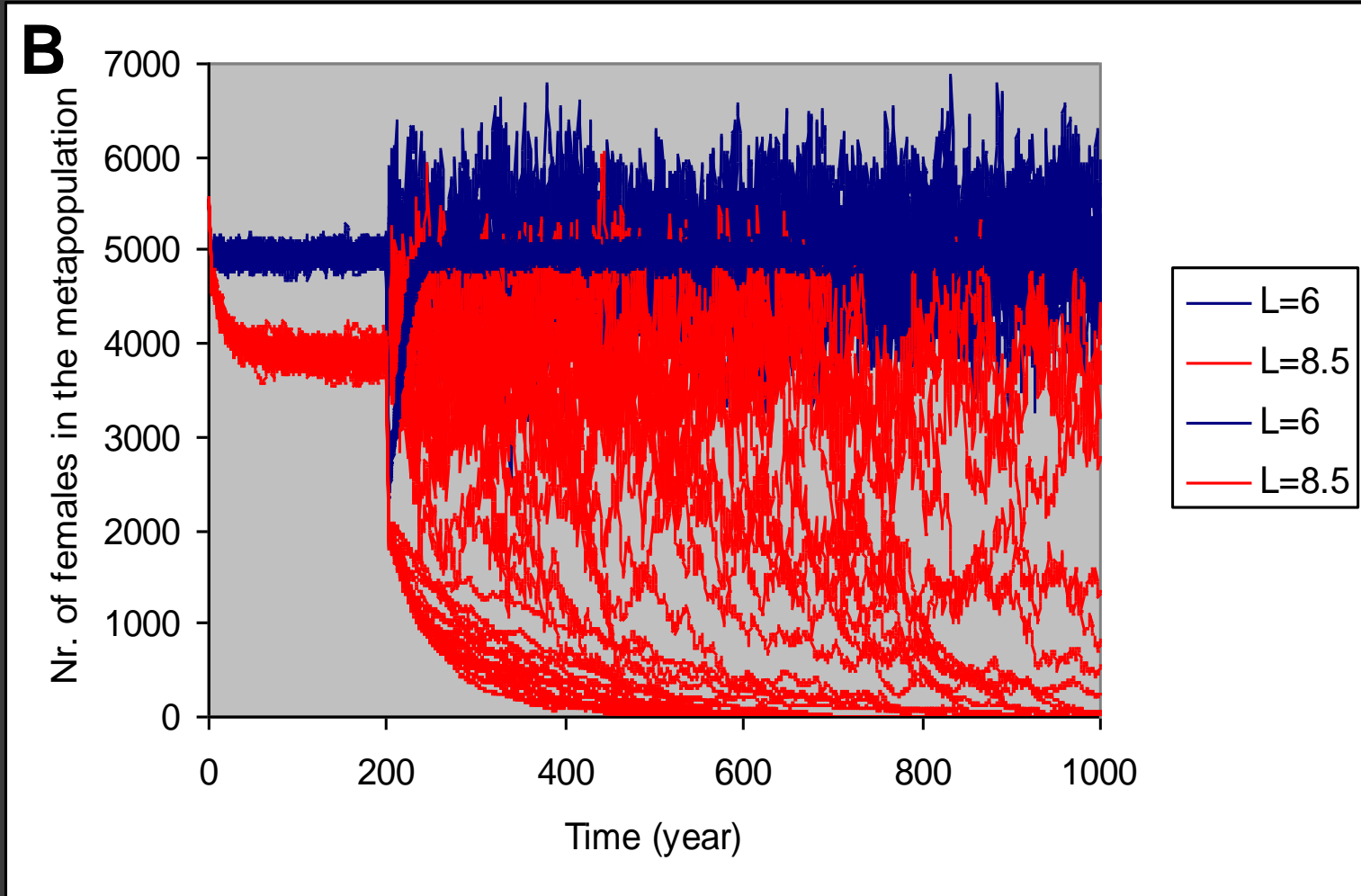


# 5) Metapopulation stability and resilience

# Response to single disturbance event



# Response to increased environmental stochasticity



# Conclusions

Allee effects have large effect on:

- ⦿ Colonisation of empty patches and clusters
- ⦿ Undermine the stability and resilience of:
  - Individual populations
  - Metapopulation fragments
  - Metapopulation

# Conclusion 2

- Also other animals that live in groups might have the same properties