Lecture 11

Population Cycles and Fluctuations

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Outline

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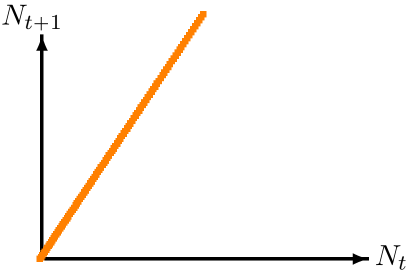
Level of compensation in density-dependence

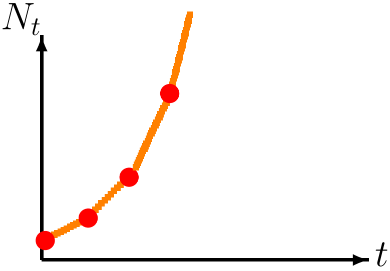
Density-independent growth: linear recursion relation

$$N_{t+1} = \lambda N_t \qquad \text{or} \qquad \frac{N_{t+1}}{N_t} = \lambda = const.$$

Recursion relation

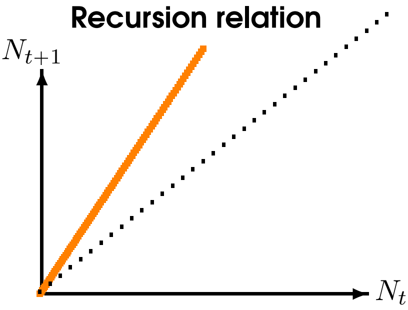


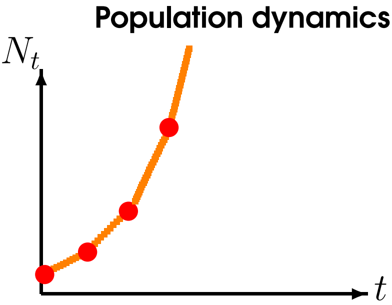
Population dynamics



Level of compensation in density-dependence

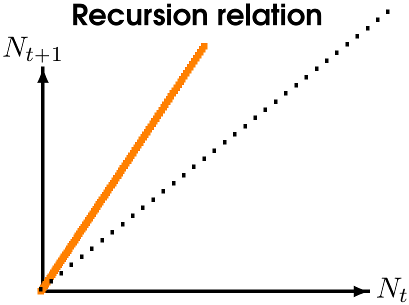
The long-term equilibrium population size can be obtained by intersection of the N_{t+1} curve with the unity line: $N_{t+1} = N_t$ (i.e., when finite rate of increase, $\frac{N_{t+1}}{N_t}$, is equal to 1).

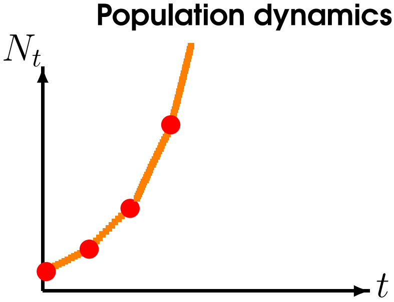




Level of compensation in density-dependence

For density-independent growth there is no such intersection, and therefore, no equilibrium population size.

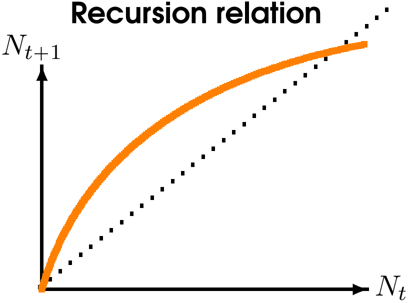




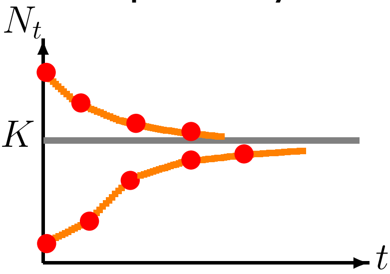
Level of compensation in density-dependence

Undercompensating density-dependence:
slope of recursion relation decreases over time, but it never reaches an asymptote.

Recursion relation

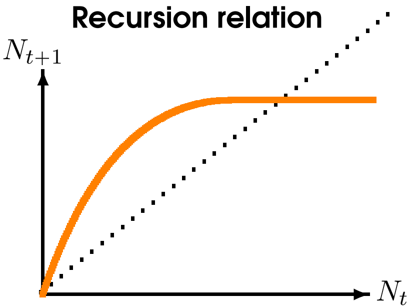


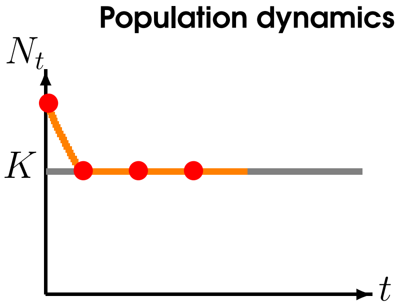
Population dynamics



Level of compensation in density-dependence

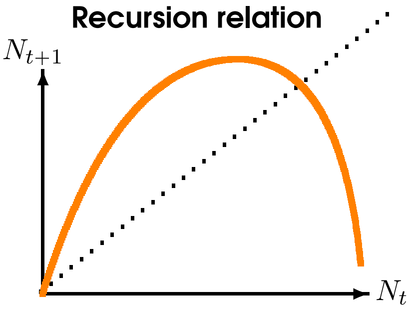
Exactly compensating density-dependence:
For high enough density (N_t), $N_{t+1} = const$, independent of initial density N_t.

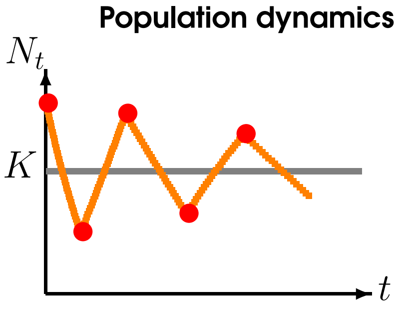




Level of compensation in density-dependence

Overcompensating density-dependence:
N_{t+1} decreases with increasing density (N_t), if N_t is high.
This type of density-dependence can potentially cause population collapse (a drop from very high N_t to very low N_{t+1}) and fluctuations in population size.





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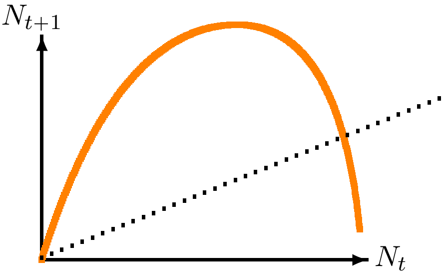
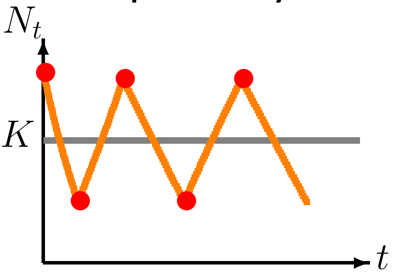
Recursion relation

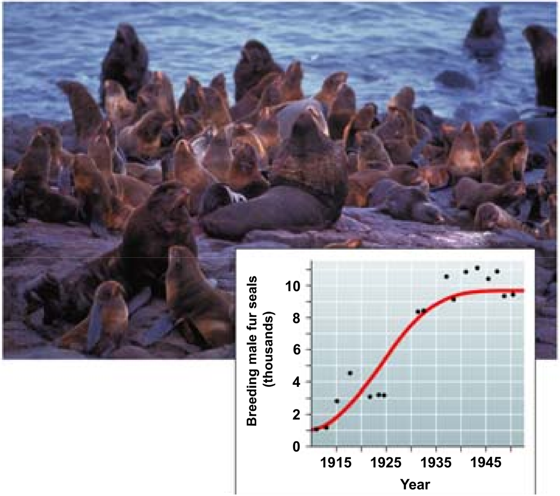


Population dynamics



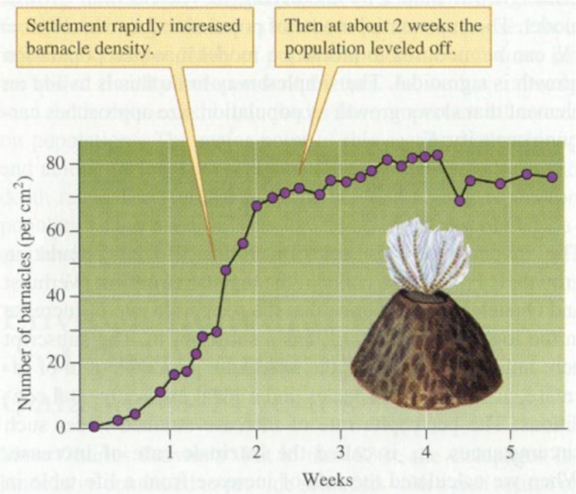
Examples of population regulation

Population recovery of fur seals in west coast of USA.



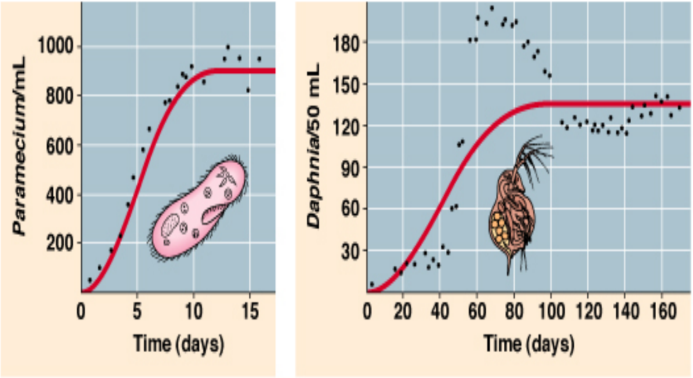
Examples of population regulation

Stabilization of population size in settling barnacles.



Examples of population regulation

Stabilization of population size in laboratory experiments.



(a) A *Paramecium* population in laboratory culture

(b) A *Daphnia* population in laboratory culture

Fluctuations in population size/density

- Self-induced
  - Time lags.
  - Overcompensating density-dependence.
  - High fecundity.
- Interspecific interactions – e.g., predator-prey.
- Stochastic effects.
  - Demographic stochasticity – individuals come in discrete units; random individual variation in demographic performance.
  - Environmental stochasticity – random variability in the environment (e.g., among years) that affect all individuals similarly.