Changes not necessarily obvious as ecosystem can be resistant

Modelling population growth – mathematical models

- Birth rate must be greater than death rate

**EXponential** growth model

- Exponential = increase that becomes more and more rapid (upwards curve)
- \( N_0 = \) initial number of individuals
- \( i = \) increase
- \( t = \) time
- \( r = \) rate of growth

\[ N_t = N_0 \times i^t \]

- \( e = \) base rate of continuous growth/decay, irrational number, 2.718...
- Any system which grows (or decays) exponentially can be defined using \( e \)
- Equation above works with annual growth but to describe continuous growth we use \( e \)

\[ N_t = N_0 e^{rt} \]

**logistic** growth model

- Resources like food, water, space limit exponential growth
- Carrying capacity of an area = \( K \)
- Population growth starts slowing down when \( N \) is reaching \( K \)
- When \( N \) reaches \( K \) population growth stalls

\[ \frac{dN}{dt} = rN \left( \frac{K-N}{K} \right) \]

‘All models are wrong, but some are useful.’ – George Box, 1979, GB

**Quantifying change:**

**Baseline**
The environment's starting point before change

- Not always easy to determine
- Cyclicity = when data is fluctuating (~ line)
- Sometimes long-term data is needed

**Sample**

- Representative subset of a population
- E.g. you can't count all the trees in a forest – you need a sample
- Sample needs to be representative of species richness
- Rarefaction curve = graph showing number of species in different sample sizes
  
  – When curve flattens out – you know sample is representative
- Also consider proportion of different species – what the most/least common species?
  
  – Record percentages %