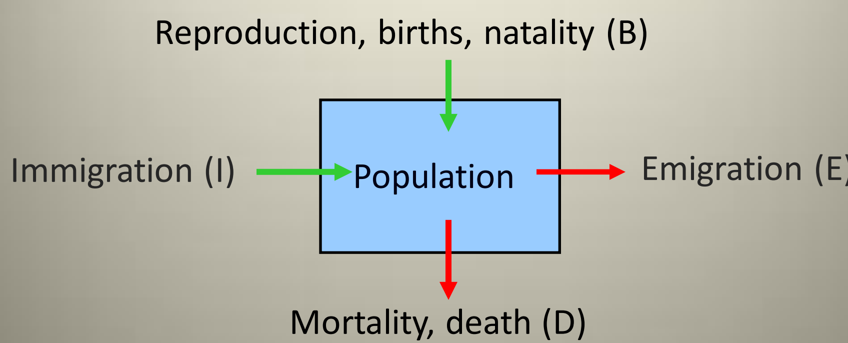
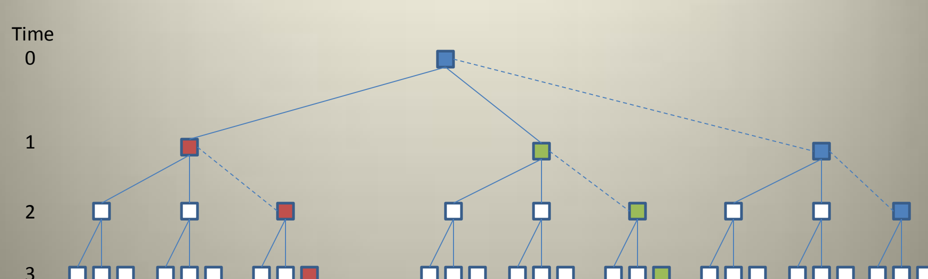
Population growth

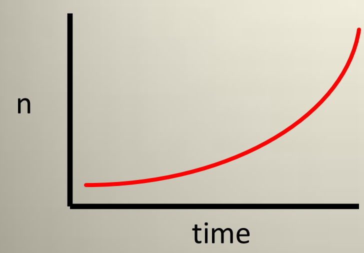


Population parameters that influence population size and change
(for now we will consider these all wrapped up into a measure of growth rate)

Exponential Population Growth in Unlimited Environments



Population growth



Classic exponential growth, unlimited resources

$n_t = n_0 * \lambda^t$

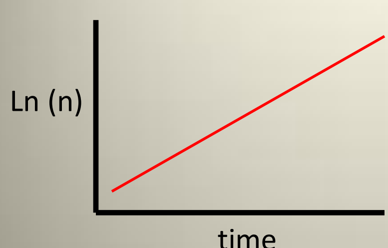
Where t = time, t0 = 0

n_t = population abundance (or index) at time t

λ = finite rate of increase (n_{t+1}/n_t)

$\lambda > 1$, increasing population
$\lambda < 1$, decreasing population
$\lambda = 1$, stable population

Population growth



Classic exponential growth, unlimited resources semi-log transformed

$Ln(n_t) = ln(n_0) + rt$

Where t = time, t0 = 0

n_t = population abundance (or index) at time t

r = instantaneous rate of increase $ln(n_{t+1}/n_t)$, or $ln(\lambda)$

$r > 0$, increasing population
$r < 0$, decreasing population
$r = 0$, stable population

Population estimates fluctuate due to

Observation Error

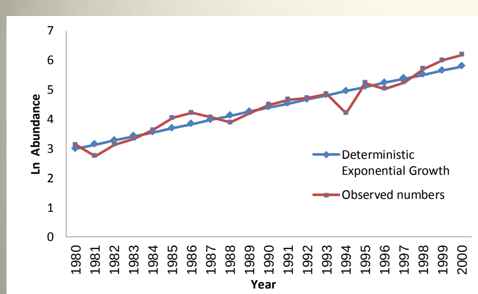
- Missed animals / Overcounted animals
- Equipment/survey limitations

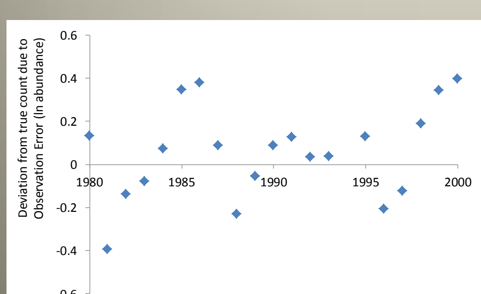
Here growth (λ, r) is deterministic and deviations from this is due to counting/estimation errors.

$\ln[N_t] = \ln[N_0] + r*t + E$

Where E is observation error and is a normal random deviate with mean = 0, and standard deviation = tau

E~normal (0, tau)





Deviations from exponential model predicted values due solely to observation error.

Growth rate can be estimated from the slope a regression line fitted to observed data.

Population estimates fluctuate due to

Process Noise

Growth rate varies from year to year due to natural factors(food weather etc), ‘good’ and ‘bad’ years.

Here deviations from exponential model are due to variation in growth rate (r) from yr to yr

ln[Nt+1] = ln [Nt] + r + F

Where F is Process noise and is a normal random deviate with mean = 0, and standard deviation = sigma
F~normal (0, sigma)

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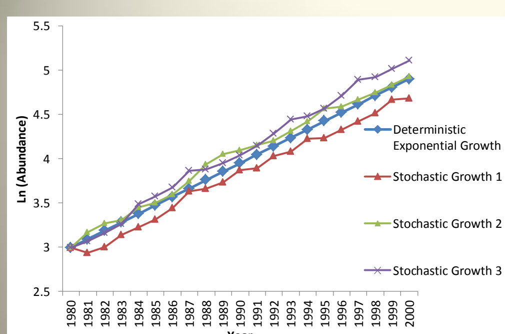
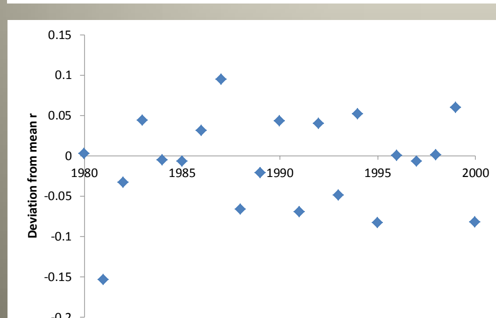




Deviations from exponential model predicted values due solely to variations in r.

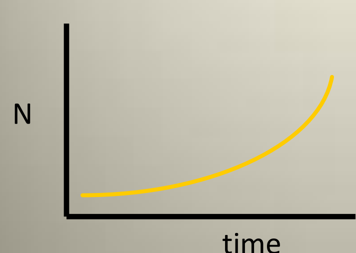
Growth rate can be estimated by averaging r’s from smaller intervals (each time step).

Do we see often see unlimited, exponential growth?

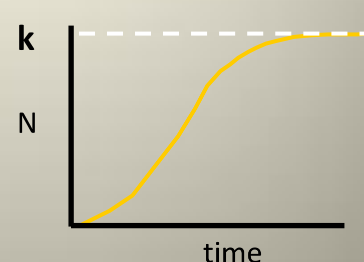
- Is it common, realistic?
  - Why not?
- When do we see it?
  - Examples?

Population growth models

Carrying capacity (k)



Classic growth curve, unlimited resources



Classic growth curve, limited resources (k)