The Nature of Wildlife Populations
Characteristics and Growth

ESRM 304

The Nature of Populations

- Population: a group of conspecific individuals occupying a particular place at a particular time with the potential to interbreed

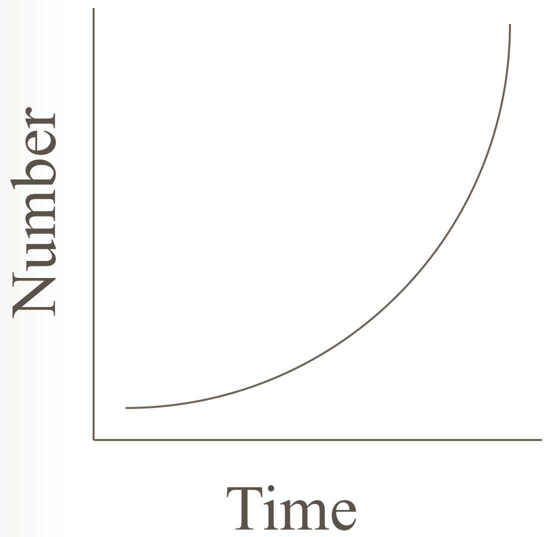
Population Features and Terms

- Abundance: number of individuals
- Density: number of individuals/unit area
- Natality: production of new individuals
- Mortality: loss of individuals due to death
- Emigration & Immigration: loss or gain to a population due to movement of individuals

Factors of Change in Abundance

$$
\begin{array}{ccc}
 & \text{Birth} & \\
 & \downarrow & \\
\text{Immigration} \rightarrow & \text{Abundance} & \rightarrow \text{Emigration} \\
 & \downarrow & \\
 & \text{Death} &
\end{array}
$$

Geometric Population Growth

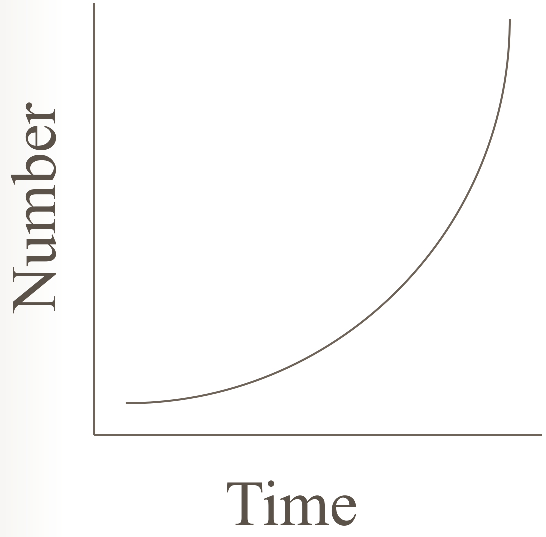


- Growth under ideal conditions
- Occurs in populations in early stages of growth

$$\frac{\Delta N}{\Delta t} = rN$$

ΔN: change in number
Δt: change in time
r: per capita growth rate (birth – death)
N: size of population

Geometric Population Growth

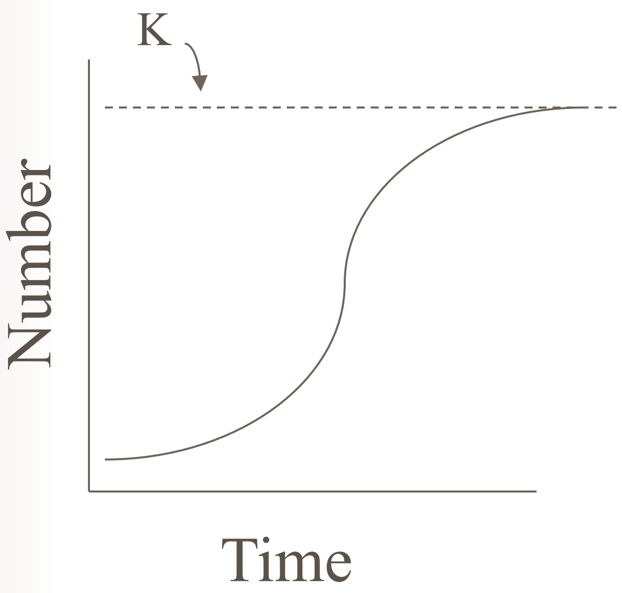


$$\frac{\Delta N}{\Delta t} = rN$$

If r=0.2 and N=50, at the next time interval, $\Delta N/\Delta t = 0.2(50) = 10$.

So, $N_{t+1} = 50+10=60$ and $N_{t+2} = 72$. And so on, and so on, and so on…

Logistic Population Growth

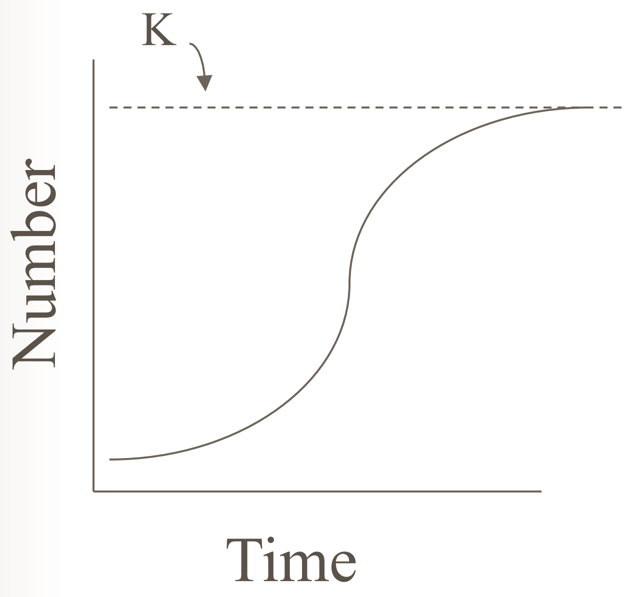


- Reality check modification of the geometric model
- Sets upper limit on population size

$$\frac{\Delta N}{\Delta t} = rN\left(\frac{K-N}{K}\right)$$

K: Carrying capacity. Maximum population size that can be sustained on an area

Logistic Population Growth

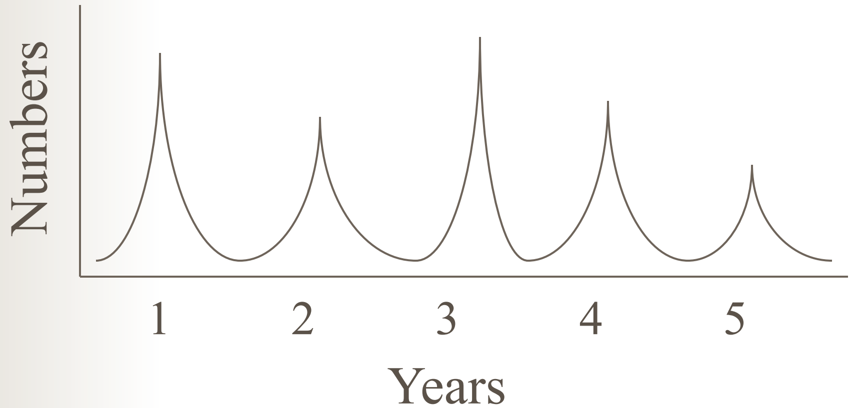


$$\frac{\Delta N}{\Delta t} = rN\left(\frac{K-N}{K}\right)$$

If r=0.2, N_t=90, and K=100,
$\Delta N/\Delta t$=0.2(90)(100-90/100)
=(18)(0.1)=1.8,
and N_{t+1}=90+1.8=91.8

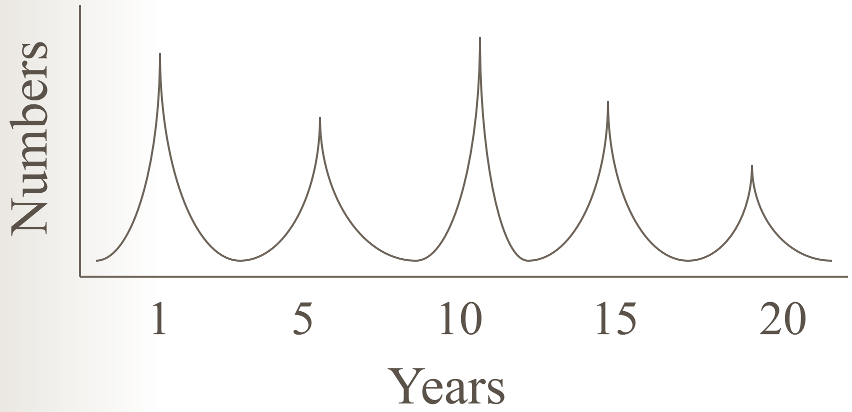
Population grows by 1.8 vs. 18 individuals. If N exceeds K, growth becomes negative.

Temporal Pattern of Abundance: Annual



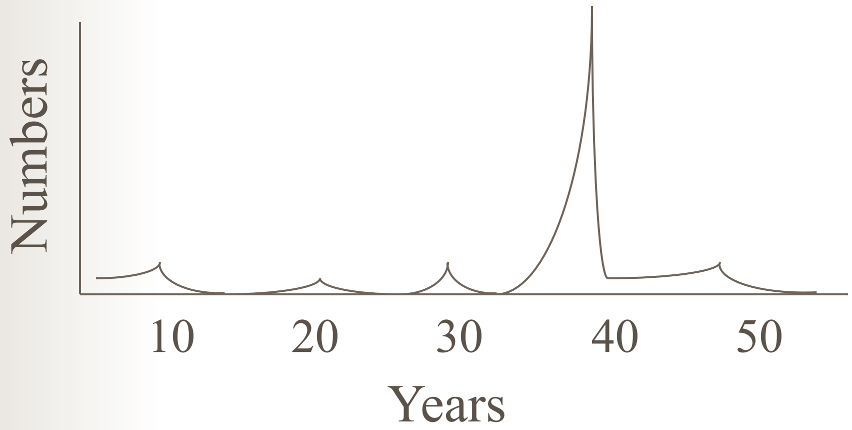
- High and low abundance in each year
- Predominant pattern in temperate regions and the most common among vertebrate species
- Simple alternation of breeding and non-breeding seasons
- Pattern can be stable or show long-term trend

Temporal Pattern of Abundance: Cyclic



- Peaks of abundance occur at regular intervals with large difference in abundance between years
- 3-5 year cycle for voles, lemmings
- 9-11 year cycle for snowshoe hares, lynx, ruffed grouse
- Relatively uncommon, but striking environmental effects

Temporal Pattern of Abundance: Irruptive



- Irregular, very large changes in abundance
- Peak abundances usually unpredictable
- Locust outbreaks, mouse plagues, defoliating insects
- Uncommon, but very strong effects on ecosystem functions

The Nature of Wildlife Populations
Measuring Populations

ESRM 304

Measuring Population Parameters

- Measuring the factors causing change in populations (birth, death, immigration, and emigration) requires individually marked animals.
  - Individuals are captured in nests or when they reach trappable age and given a permanent mark: leg band, ear tag, tattoo, pit tag, photographic record.
  - Survival of individuals and population rates are obtained by periodically censusing the population.
  - Emigration is the most difficult to measure because it is hard to distinguish from death.
- These are intensive, expensive, long-term studies that can be conducted on relatively few sites, but are essential for a thorough understanding of population dynamics.
- 351 (basic) and Fish 557 (Advanced)

Abundance

- Measuring abundance is central to most wildlife investigations and is done in different ways.
- Capture/Mark/Release is one of the most common methods used to estimate abundance for detailed, long-term population studies.
- C/M/R involves capturing animals, permanently marking them, releasing them, and recapturing them at a later time. The ratio of previously marked to unmarked individuals in subsequent samples can yield abundance estimates.

Measuring Abundance: Lincoln Index

- The Lincoln Index, a two-sample index, is the simplest C/M/R index.
- We catch 50 animals in the first sample, which we mark and release. In the second sample we catch 40 animals, 25 of which are marked.
  - We would estimate the population as $N=(M*n_1)/m_1$, where N=total population size, M=#caught and marked in first sample, n_1=#caught in second sample, m_1=# caught with marks in second sample.
  - So, in this example: N=(50*40)/25 or 80 animals

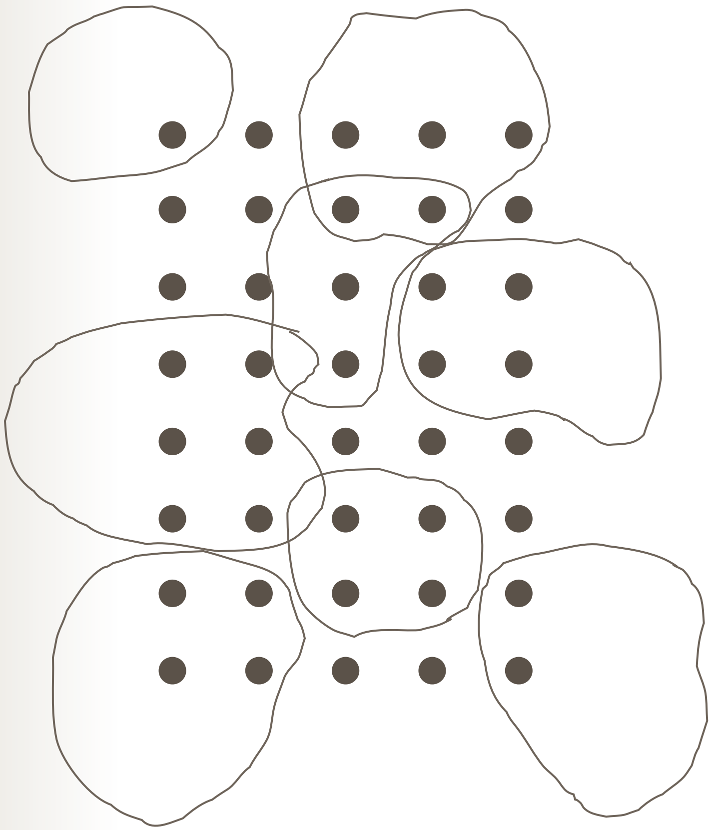
Measuring Abundance: Lincoln Index

- The index makes several assumptions, three of which are most critical:
  - 1) marked and unmarked animals are captured without bias,
  - 2) marked animals have the same mortality as unmarked animals, and
  - 3) tags are not lost
- What happens to your estimate when tags are lost?

Density

- A density estimate (# individuals/area) may be required for some purposes, such as for energy flow studies. Absolute abundance estimates (complete count) may be needed for threatened and endangered (T&E) species recovery.
  - Except in unusual circumstances (*e.g.*, reindeer on tundra islands or highly territorial and visible species) density is very hard to measure because **both** the number of individuals and the area they occupy must be estimated.
  - Estimating the area occupied is the hard part.

Measuring Density



- Consider a trapping grid with small mammals having home ranges as shown
- With 20-m trap spacing, a naive density estimate would be 8 animals/(80m *140m) or 7.1 animals/ha
- What's wrong with this estimate? Is it too high? Too low?

Measuring Density

- If natural history cooperates, density estimates for at least parts of populations can be tractable:
  - Colonial birds or marine mammals on bare rock islands can be photographed and simply counted.
  - Larval stream amphibians can be counted using a stream survey.
- Subsequent lectures will discuss methods for measuring both density and indices of abundance, but will focus on indices.

Measuring Population Parameters

- Fortunately, for many management issues density is not required. Nor is absolute abundance. An index of abundance may suffice. It is often enough to know the direction and magnitude of change caused by a management action.
- A "good" index is a measure that bears a consistent relationship to true abundance. As the actual number of animals changes, the index should change proportionately.

Catch Per Unit Effort Sampling

- Time constrained sampling is a catch per unit effort method (CPUE). The index is the number of animals caught or observed per unit time.
  - CPUE indices can be constructed for trapping returns (#caught/100 traps), fishing effort (#/net hours), tracking data (tracks/km), audio surveys (calls/km), hand searching (#/person hr), etc.
  - Other CPUE indices involve area constrained sampling (#/unit area searched)
- We will use a time-constrained approach to index amphibian abundance during the field trip.

St. Edward State Park Survey

- Consult the handout for details
- Jointly prepared field reports will be done in 3-person teams
- We will combine our results with those of previous years
- Bring your amphibian field guides