Overview

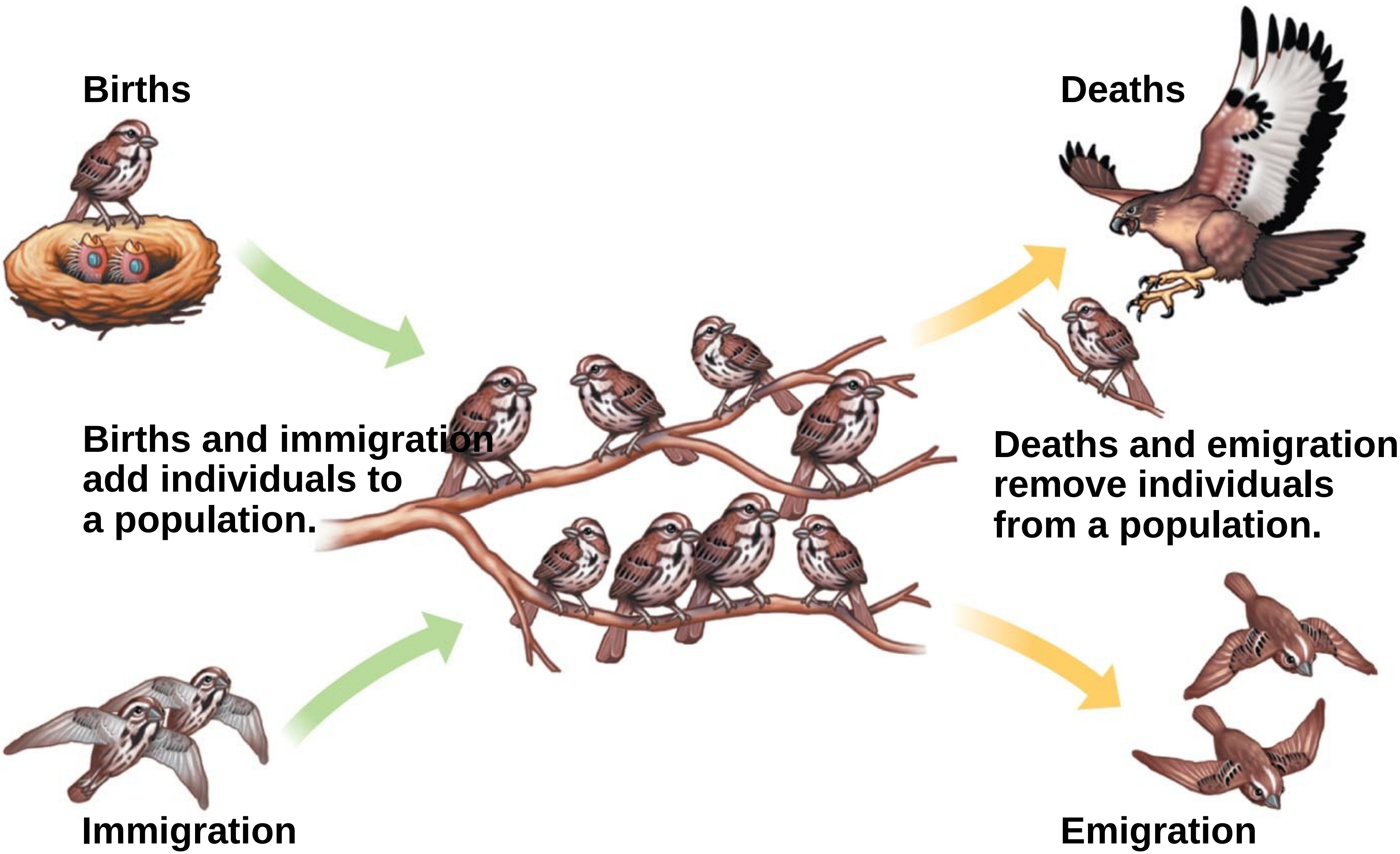
- **Population ecology** is the study of populations in relation to **environment**, including environmental influences on **density** and **distribution**, age structure, and **population size**.

- A **population** is a group of individuals of a single species living in the same general area.

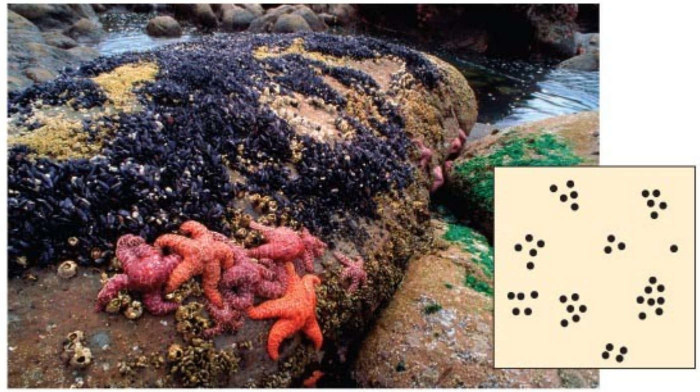
Dynamic biological processes influence population density, dispersion, and demographics

- **Density** is the number of **individuals per unit area** or volume.
- **Dispersion** is the **pattern of spacing** among individuals within the boundaries of the population.
- **Density is the result of an interplay between processes that add individuals to a population and those that remove individuals (population dynamics).**

Population dynamics

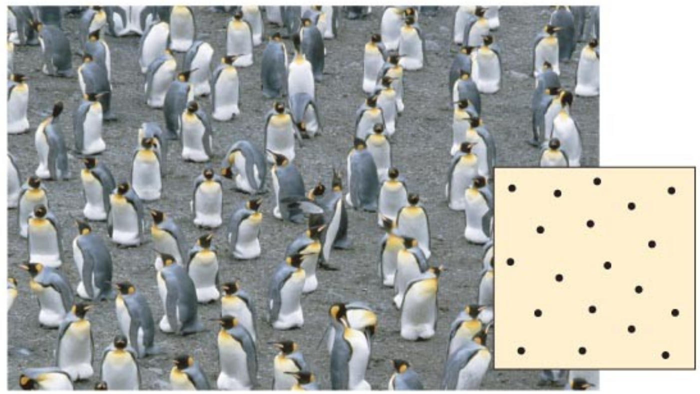


Patterns of dispersion within a population’s geographic range



(a) Clumped

In a ***clumped*** dispersion, individuals aggregate in **patches**. A clumped dispersion may be influenced by **resource availability** and behavior.



(b) Uniform

A *uniform* dispersion is one in which individuals are evenly distributed. It may be influenced by social interactions such as **territoriality.**

(c) Random

In a *random* dispersion, the position of each individual is independent of other individuals. It occurs in the **absence of strong attractions or repulsions**.

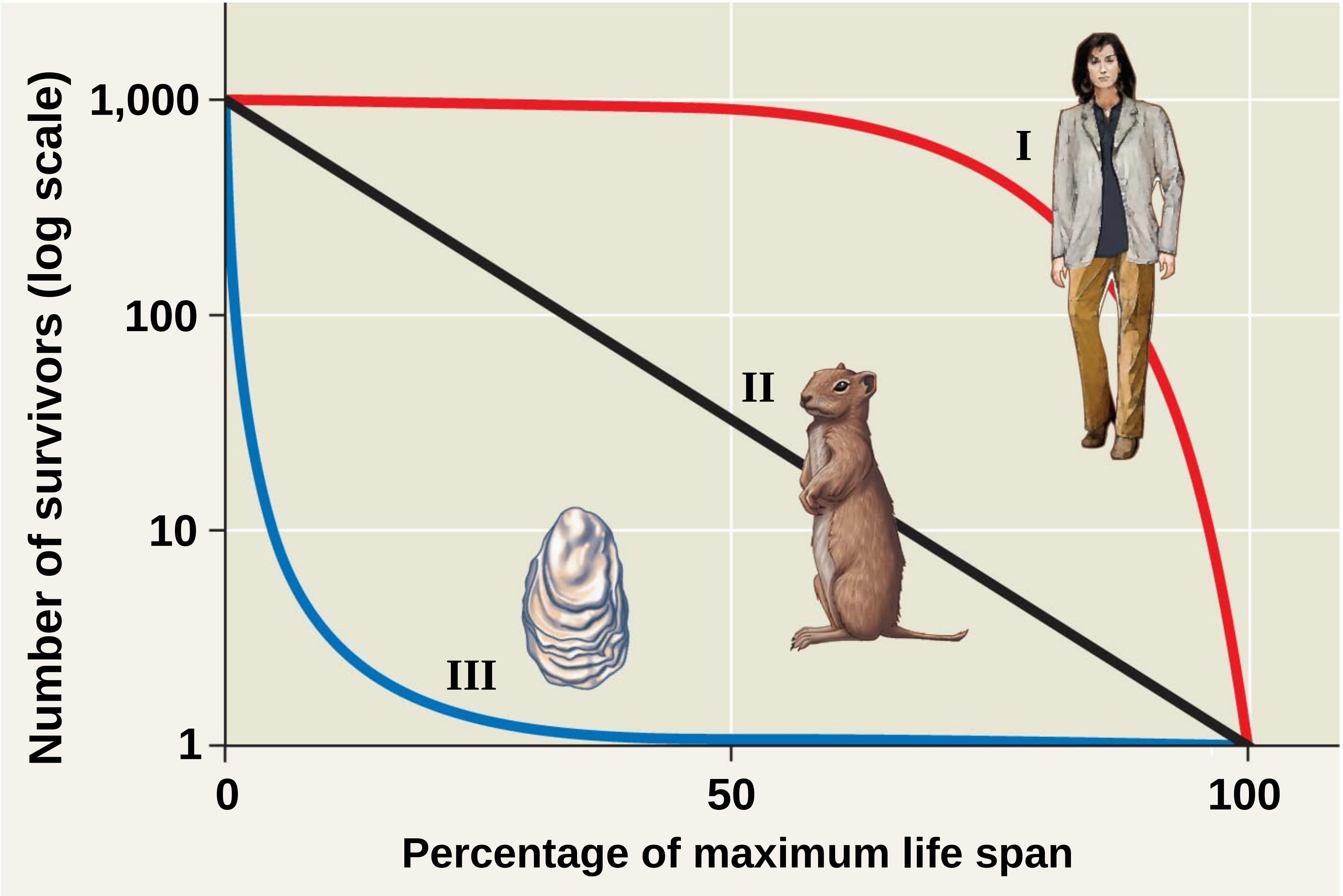
Demographics

- **Demography** is the study of the **vital statistics** of a population and how they change over time.

Death rates and birth rates are of particular interest to demographers (**survivorship curve**).

- Survivorship curves can be classified into three general types:
  - Type I: **low death rates during early and middle life**, then an increase among older age groups
  - Type II: the death rate is constant over the organism’s life span
  - Type III: **high death rates for the young**, then a slower death rate for survivors

Survivorship Curves



The exponential model describes population growth in an idealized, unlimited environment

- It is **useful to study population growth** in an **idealized situation**.
- Idealized situations help us understand the **capability of a species to increase** and the conditions that may facilitate this growth.

- **Zero population growth** occurs when the birth rate equals the death rate.

- Most ecologists use differential calculus to express population growth as growth rate at a particular instant in time:

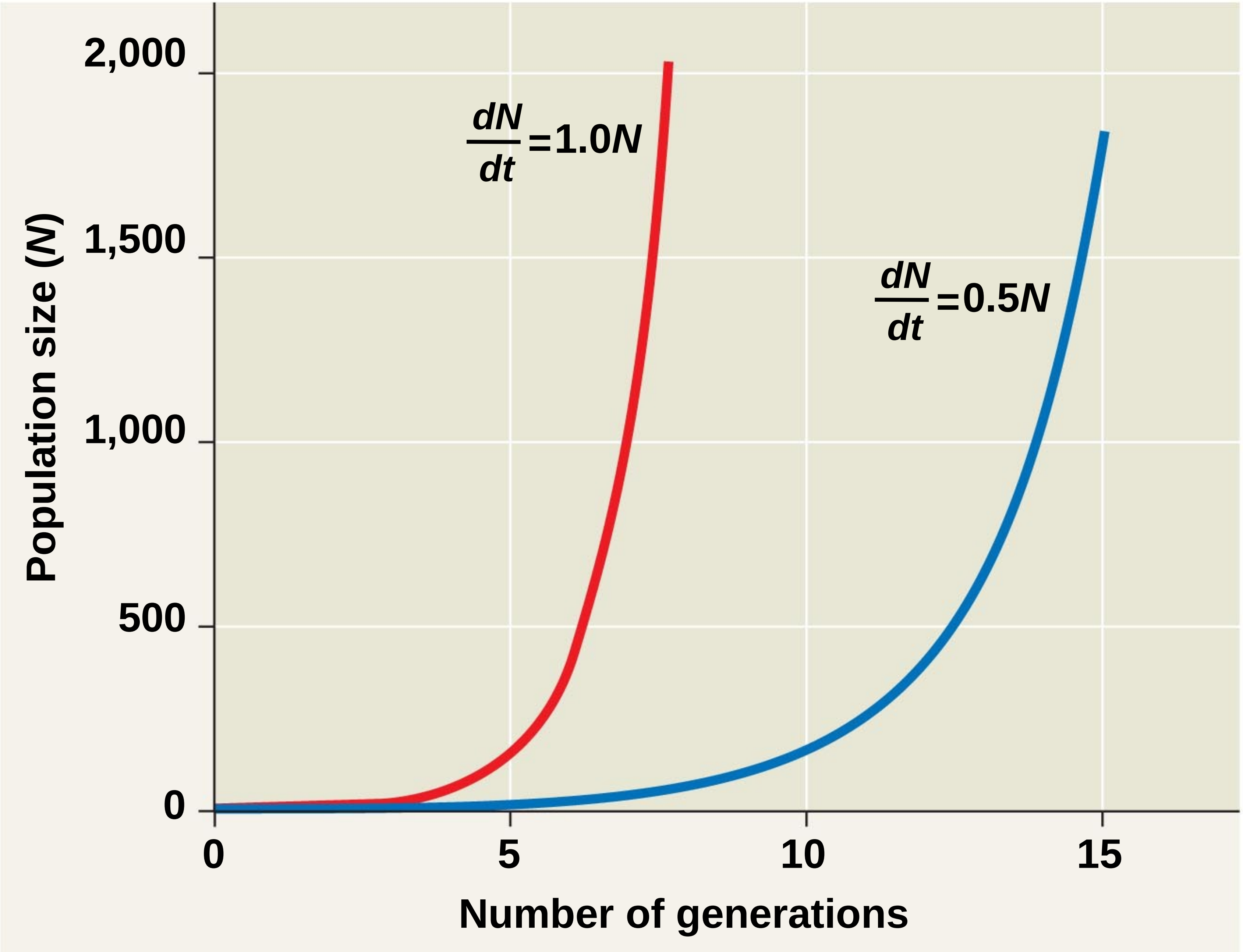
$$\frac{\Delta N}{\Delta t} = rN$$

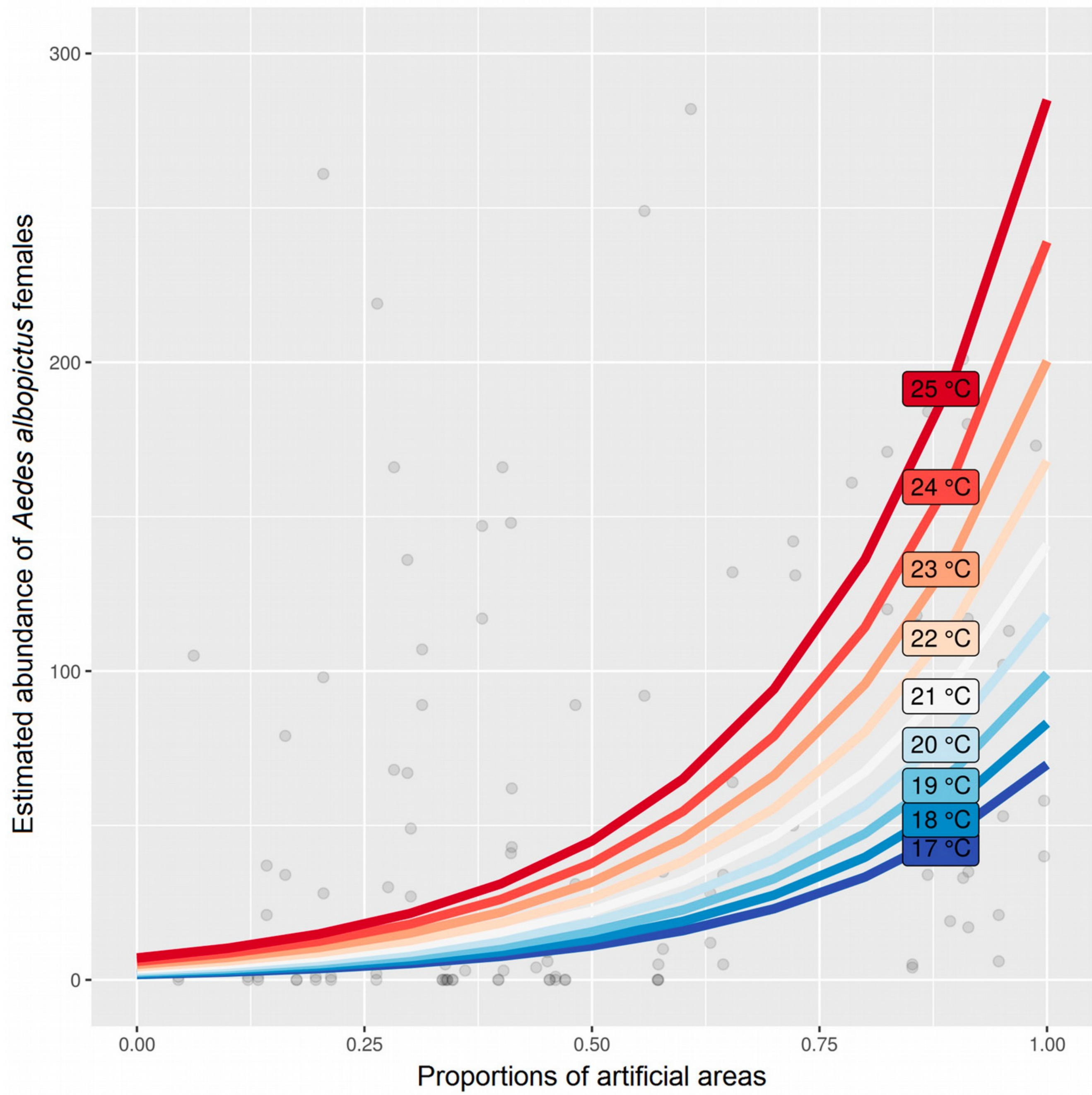
where N = population size, t = time, and r = per capita rate of increase = birth – death

Exponential Growth

- **Exponential population growth** is population increase under **idealized conditions.**
- Under these conditions, the rate of reproduction is at its maximum, called the intrinsic rate of increase.
- Exponential population growth results in a **J-shaped curve**
- Exponential Growth is not sustainable.

Exponential Growth Model



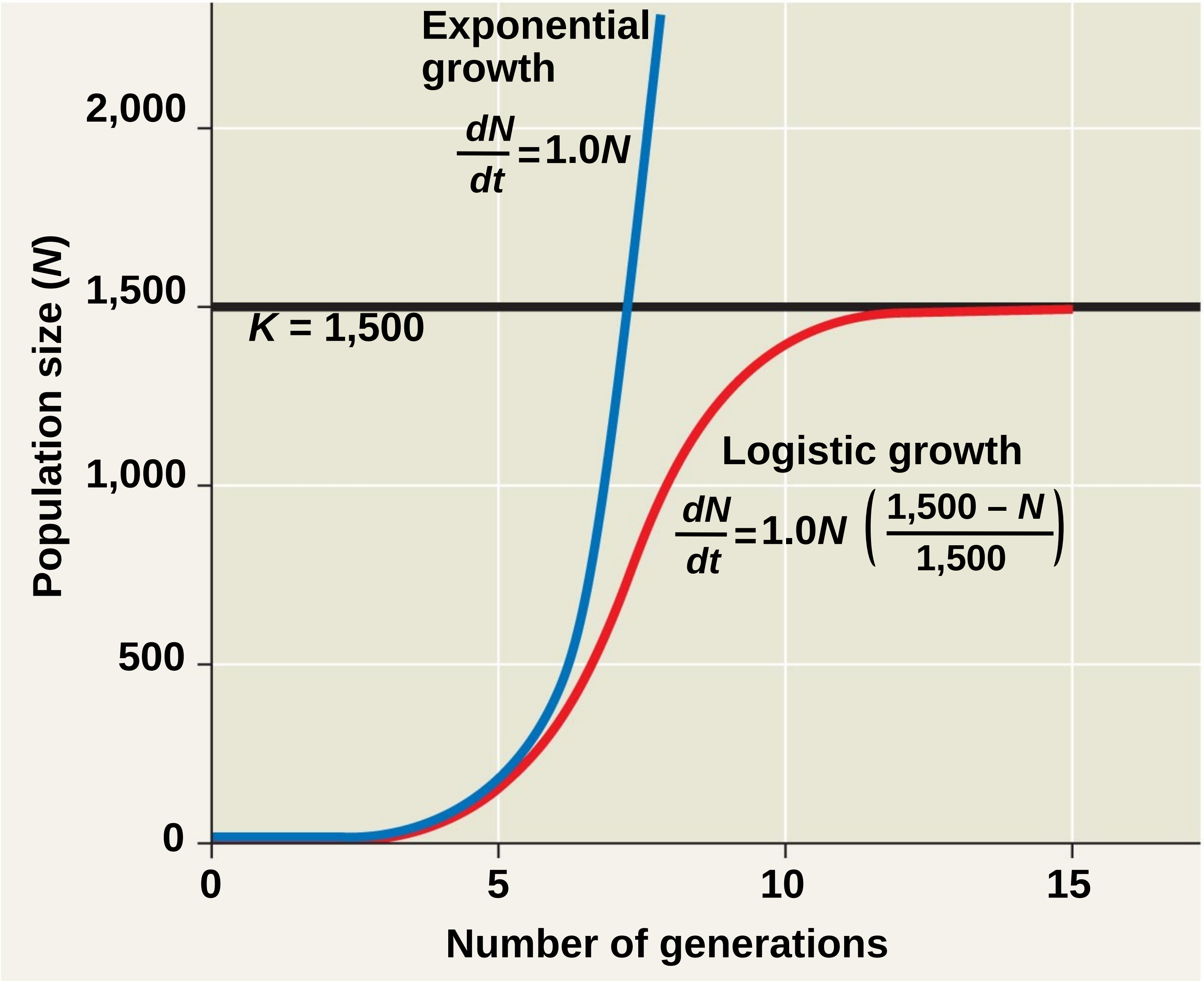


Estimated abundance of *Aedes albopictus* females
Proportions of artificial areas
300
200
100
0
0.00
0.25
0.50
0.75
1.00
25 °C
24 °C
23 °C
22 °C
21 °C
20 °C
19 °C
18 °C
17 °C

The logistic model describes how a population grows more slowly as it nears its carrying capacity

- Exponential growth cannot be sustained for long in any population. A more realistic population model limits growth by incorporating carrying capacity.
- **Carrying capacity** (*K*) is the maximum population size the environment can support.
- In the **logistic population growth** model, the *rate of* ***increase declines as carrying capacity is reached***.
- The *logistic model* of population growth produces a **sigmoid (S-shaped) curve**.

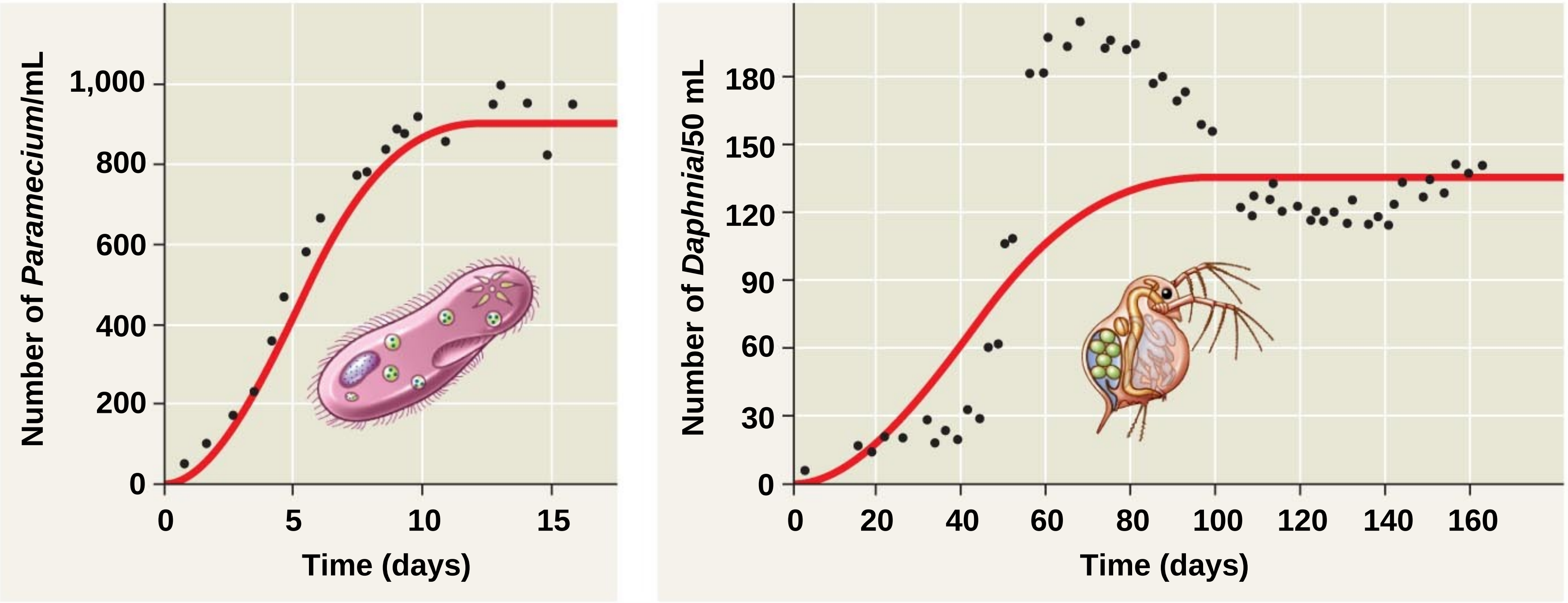
Logistic Growth model



The Logistic Model and Real Populations

- **The growth of laboratory populations of paramecia fits an S-shaped curve.**
- These organisms are grown in a constant environment lacking predators and competitors.
- **Some populations overshoot *K*** before settling down to a relatively stable density.

The growth of laboratory populations fits an S-shaped curve which hovers around the Carrying Capacity of the area.



(a) A *Paramecium* population in the lab

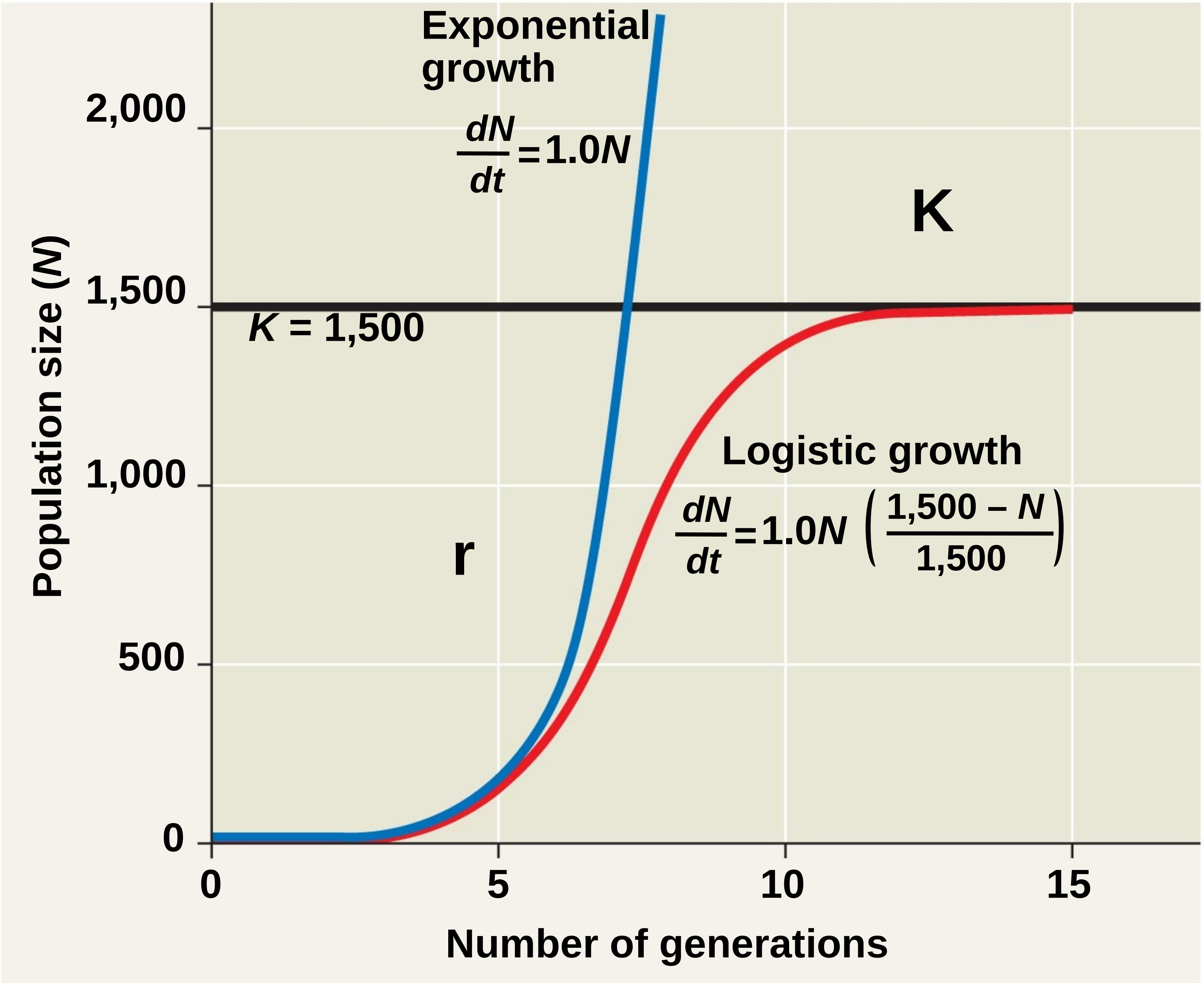
(b) A *Daphnia* population in the lab

The Logistic Model and r- and K- species

- ***r*-species** = select for life traits that **maximize reproduction; e.g. new niches available**
- ***K*-species** = select for life traits that are **related to higher competition**

WHY r- and K?

Logistic Growth model



Immigration, Emigration, and Metapopulations

- **Metapopulations** are groups of populations linked by **immigration and emigration**.
- High levels of immigration combined with **higher survival can result in greater stability in populations**.

Estimates of Earth's Carrying Capacity

- **How many humans** can the biosphere support?
- The carrying capacity of Earth for humans is uncertain.
- **The average estimate is 10–15 billion.**

Limits on Human Population Size

- The **ecological footprint** concept summarizes the aggregate land and water area needed to sustain the people of a nation.
- It is one measure of how close we are to the carrying capacity of Earth.
- Countries vary greatly in footprint size and available ecological capacity.
- *Our carrying capacity could potentially be limited by food, space, nonrenewable resources, or buildup of wastes*.