Chapter 6
Population and Community Ecology

Nature exists at several levels of complexity

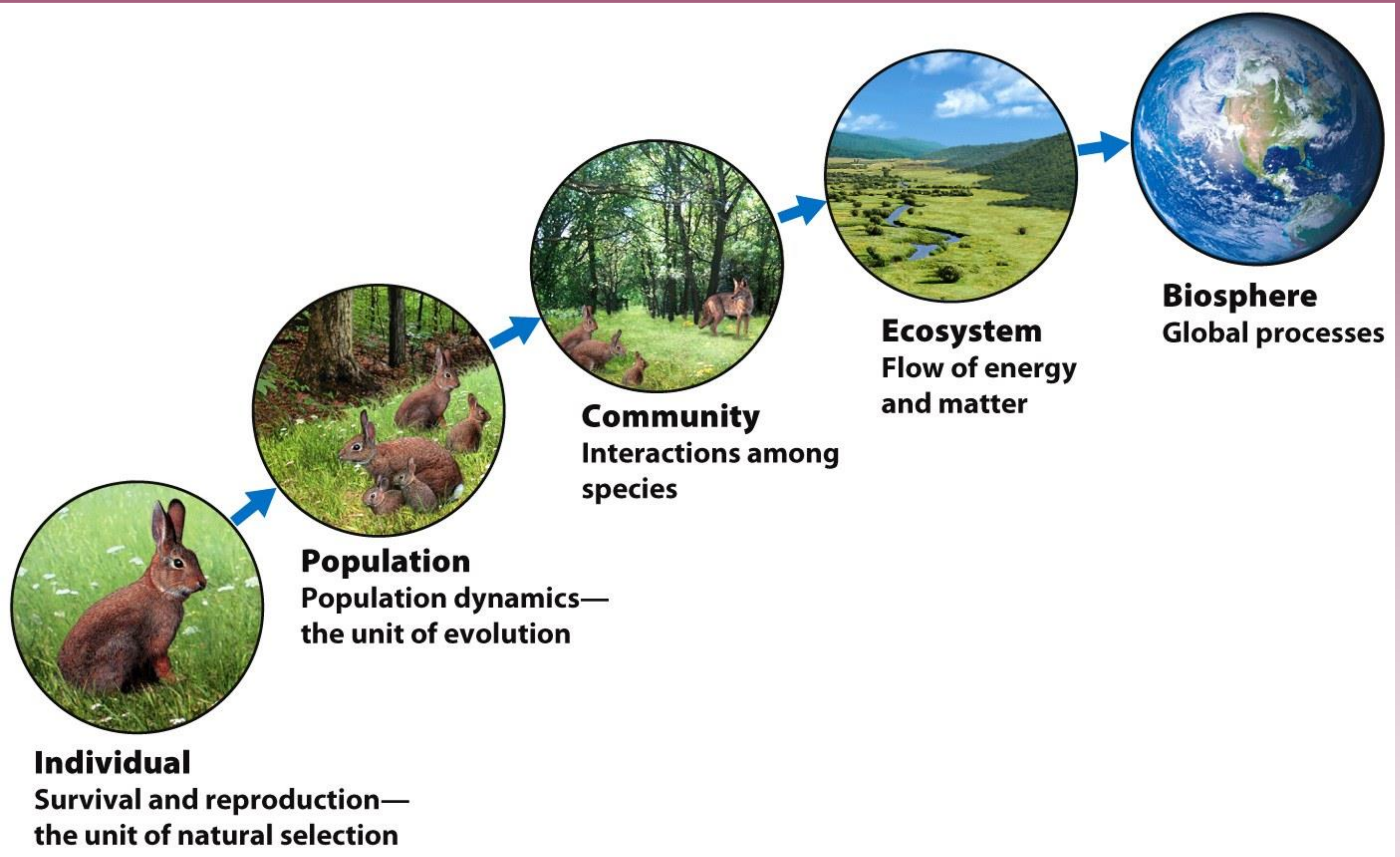

Figure 6.1
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Factors that Regulate Population Abundance and Distribution

- **Population size-** the total number of individuals within a defined area at a given time.
- **Population density-** the number of individuals per unit area at a given time.
- **Population sex ratio-** the ratio of males vs. females
- **Population age structure-** how many individuals fit into particular age categories.
- **Population distribution-** how individuals are distributed with respect to one another (3 ways).

Random:
No apparent pattern in the location of the individuals

Uniform:
All individuals maintain a similar distance from one another

Clumped:
Individuals are grouped for extra protection, look out for predators

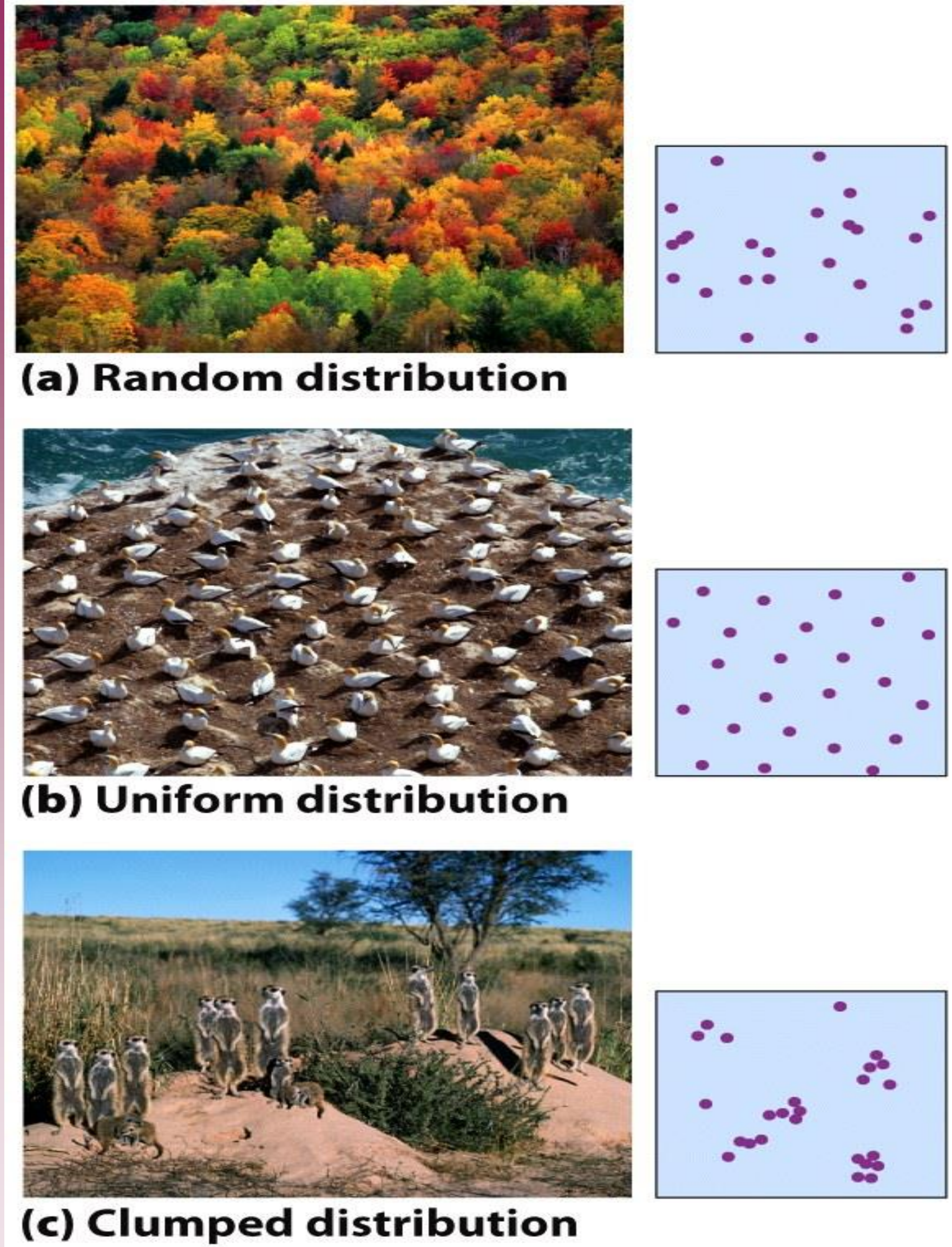

Figure 6.3
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Factors that Influence Population Size

- **Density-dependent factors-** the size of the population will influence an individual's probability of survival and reproduction.

  - ***Limiting Resource*** – (Amt. of available food, water..etc) a resource a population cannot live without and if quantities reduce, population will be affected.
  - **Carrying Capacity (K)**– limit to how many individuals the food supply (resource) could sustain. Plateau to an exponential growth curve.

Factors that Influence Population Size

Density-independent factors- the size of the population has no effect on the individual's probability of survival and reproduction.

Ex. A tornado can uproot & kill a large number of trees in an area, regardless of the density (size) of the initial population.

Other density-independent factors include hurricanes, floods, fires, and other climate events.

An individuals likelihood of mortality increases during such event regardless of a population is low/high density.

Population Exponential Growth Model...

- Mathematical equations that can be used to predict population size at any moment in time.

- **Growth rate-** the number of offspring an individual can produce in a given time period, minus the deaths of the individual or offspring during the same period (Births minus Death in same period of time from an individual).
- **Intrinsic growth rate (r)-** under ideal conditions, with unlimited resources, the maximum potential for growth (death decrease).
- A high number births & low number of deaths produce a high population growth rate (ideal conditions)

Exponential Growth Model

- J-shaped curve- when graphed the exponential growth model looks like this.

Nt = future population size
No = current reproducing individuals (population)
t = time
e = 2.72 (constant value)
r = intrinsic rate of growth

Think E. growth like a bank account with an annual interest rate…your balance will always increase based on the initial interest rate (ideal conditions – not limited by resources)

Exponential Growth is Density – Independent because no matter how much "money" you have in the account, the value will always grow by the same "interest percentage" every year.

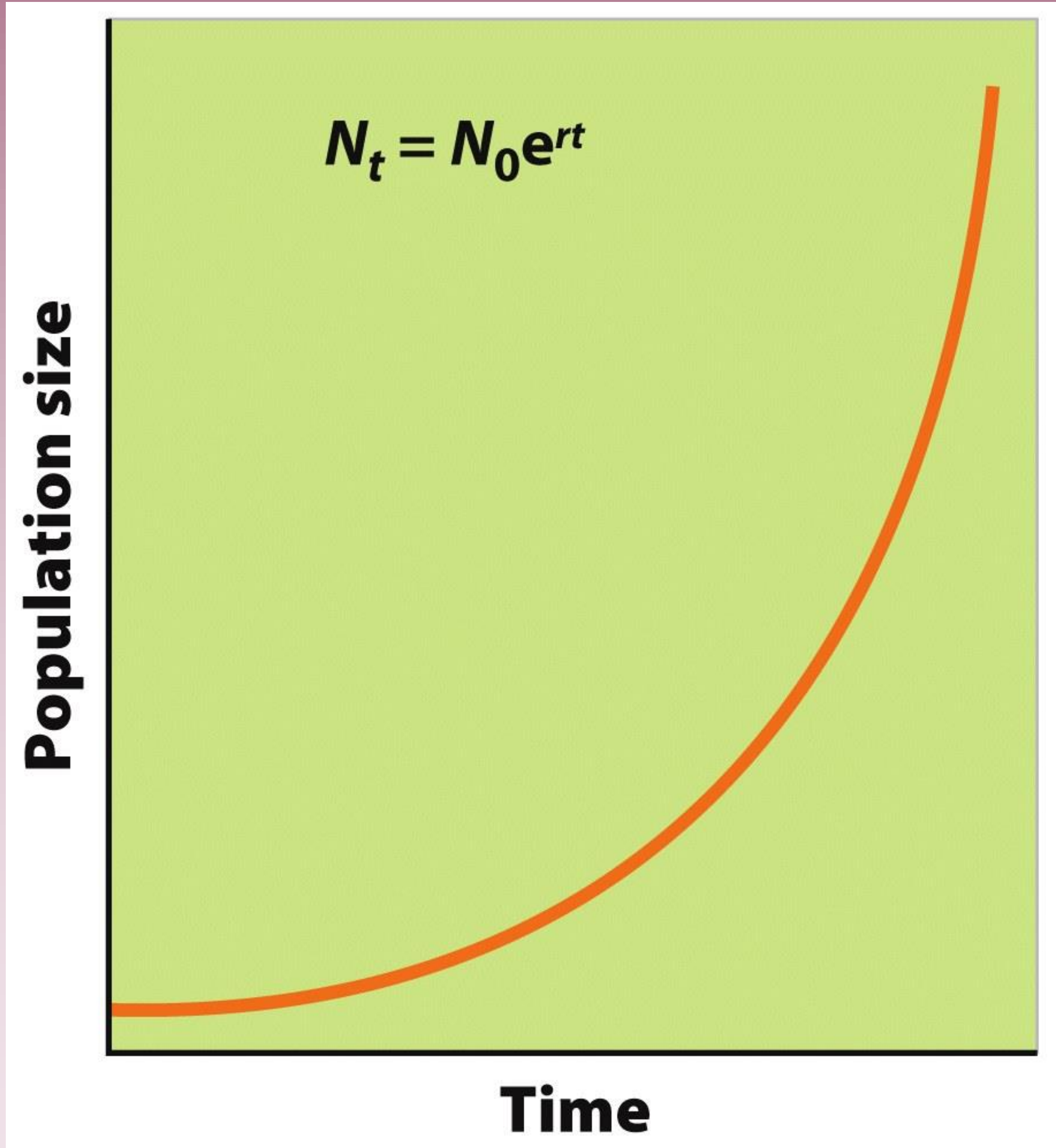

Figure 6.5
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Logistic Growth Model

- **Logistic growth-** when a population whose growth is initially exponential, but slows as the population approaches the carrying capacity.
- S-shaped curve- when graphed the logistic growth model produces an "S".

Logistic growth model is Density – Dependent constraints such as increase competition for food, water, shelter & predation.

Logistic growth models does not account for unpredictable events (natural disasters)

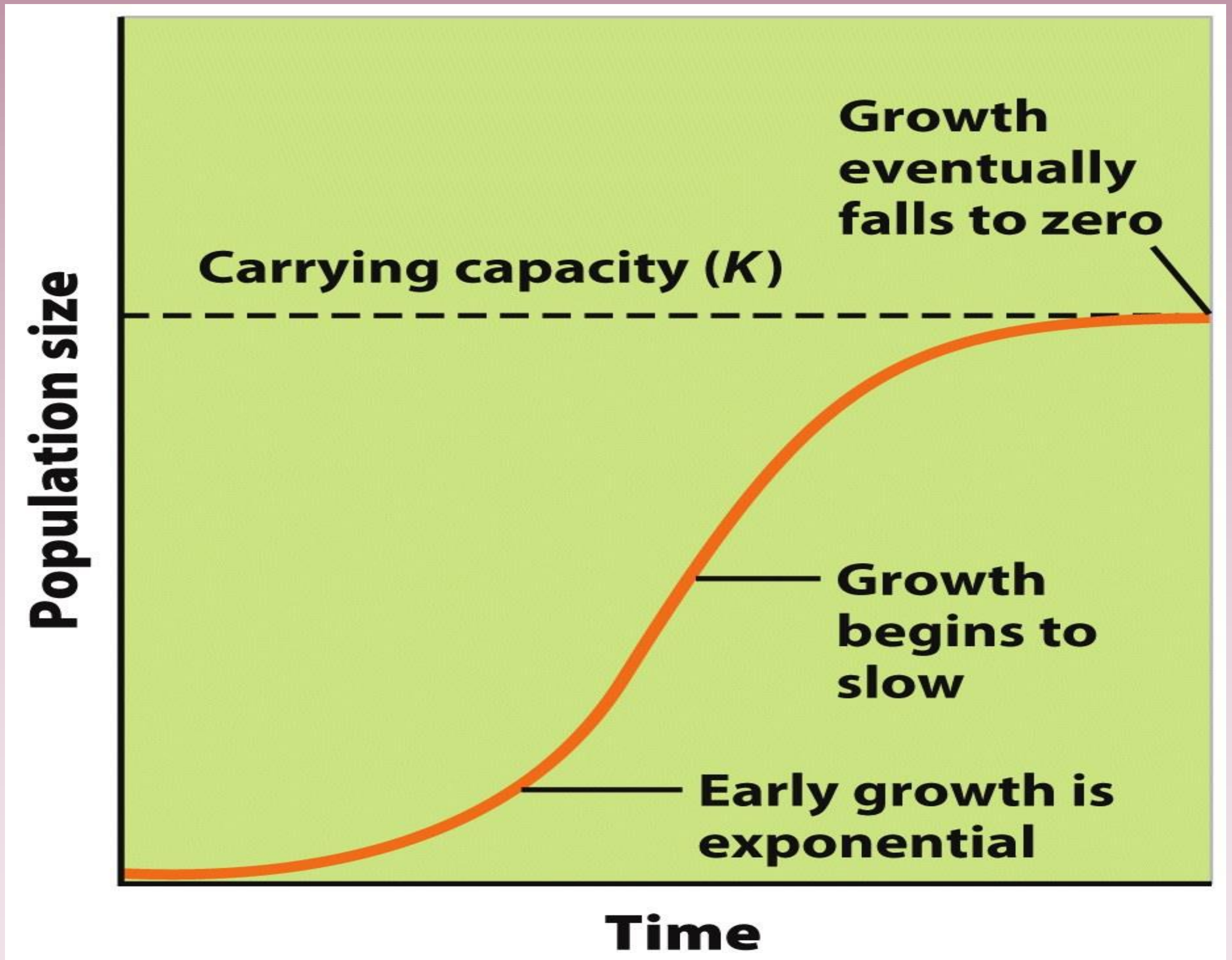

Figure 6.7
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Variations of the Logistic Model

- If food becomes scarce, the population will experience an overshoot by becoming larger than the spring carrying capacity and will result in a die-off, or population crash (not enough food to feed the larger population).

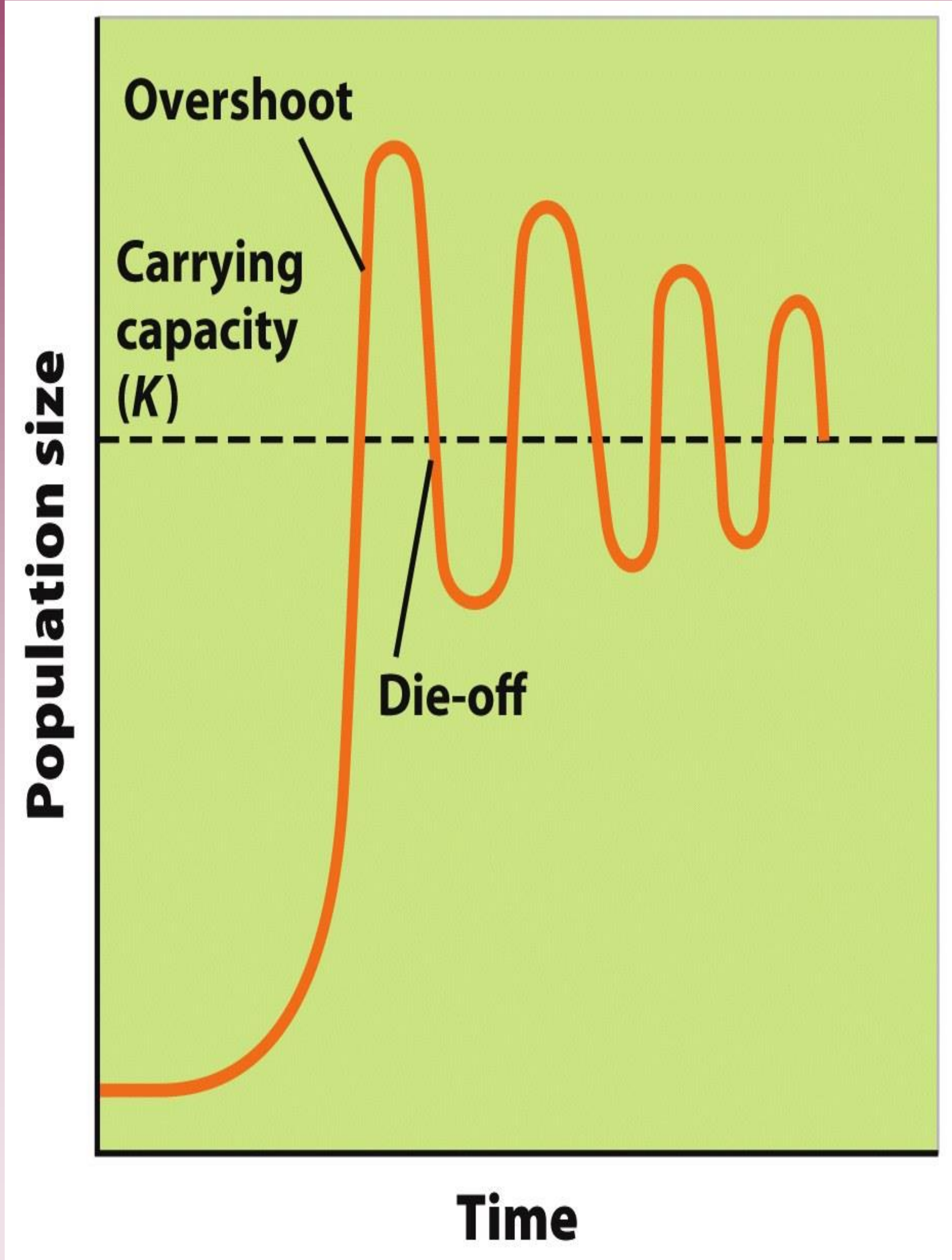

Figure 6.9
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Reproductive Strategies

- **K-selected species-** the population of a species that grows slowly until it reaches the carrying capacity. Ex. elephants, whales, and humans.

- **R-selected species-** the population of a species that grows quickly and is often followed by overshoots and die-offs. Ex. mosquitoes and dandelions

TABLE 6.1 Traits of *K*-selected and *r*-selected species

Trait	*K*-selected species	*r*-selected species
Life span	Long	Short
Time to reproductive maturity	Long	Short
Number of reproductive events	Few	Many
Number of offspring	Few	Many
Size of offspring	Large	Small
Parental care	Present	Absent
Population growth rate	Slow	Fast
Population regulation independent	Density dependent	Density
Population dynamics	Stable, near carrying capacity	Highly variable

Survivorship Curves

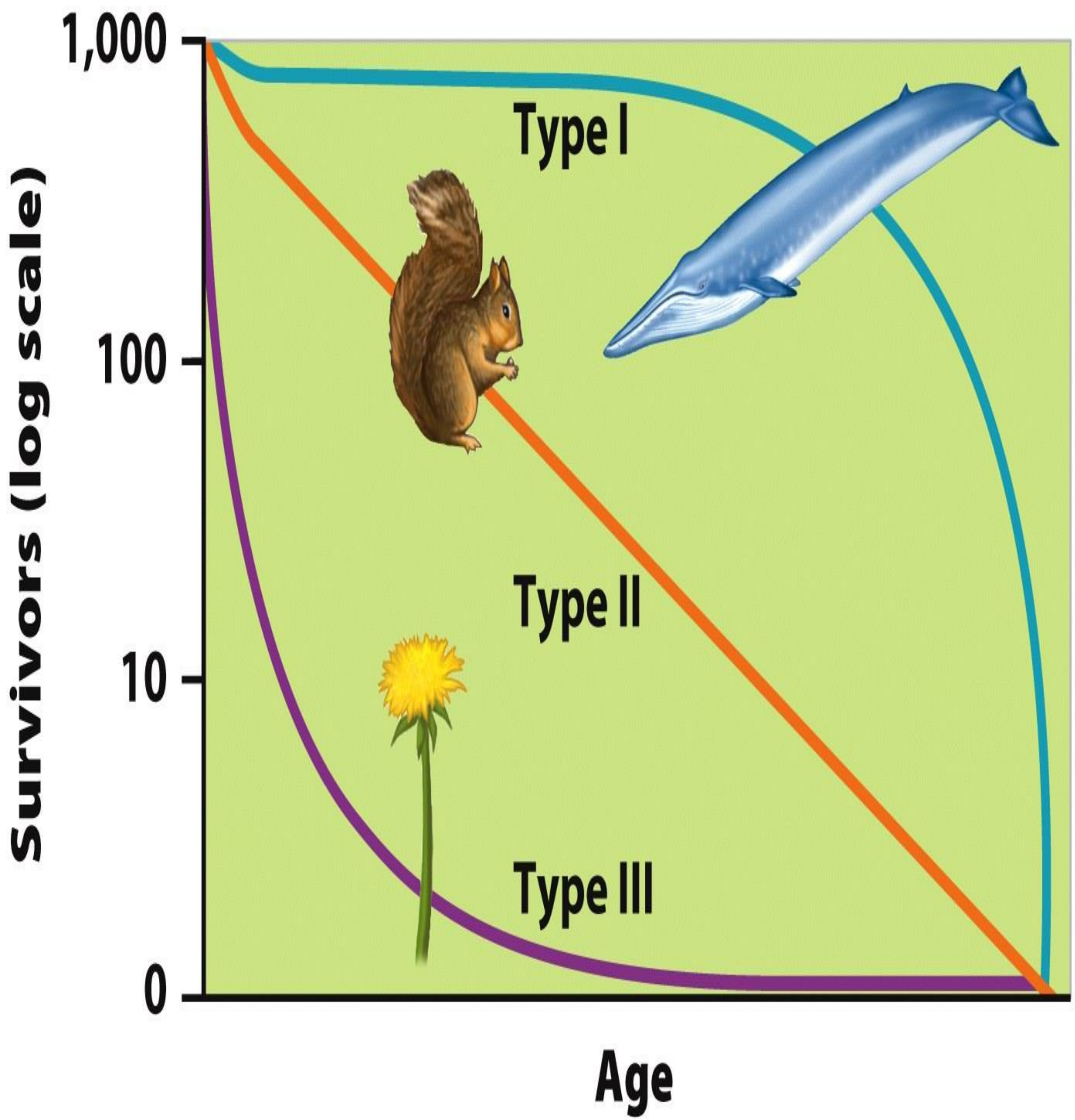

Figure 6.12
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Type I – K-selected species have **high survival rates** throughout life span, once old age hits, large groups start to die (humans, elephants)

Type II – constant decline in survivorship throughout their life span (squirrel, coral)

Type III – r-selected species, **low survivorship** early in life, very few individuals reach adulthood (mosquitos, dandelions)

Metapopulations

- **Metapopulations-** a group of spatially distinct populations that are connected by occasional movements of individuals between them (species connect by roaming across boundaries – many species are part of this…).

Ex. Populations of cougars move btwn mountain ranges allowing recolonization in areas with extinct populations, genetic diversity to existing populations and some protections against threats such as disease.

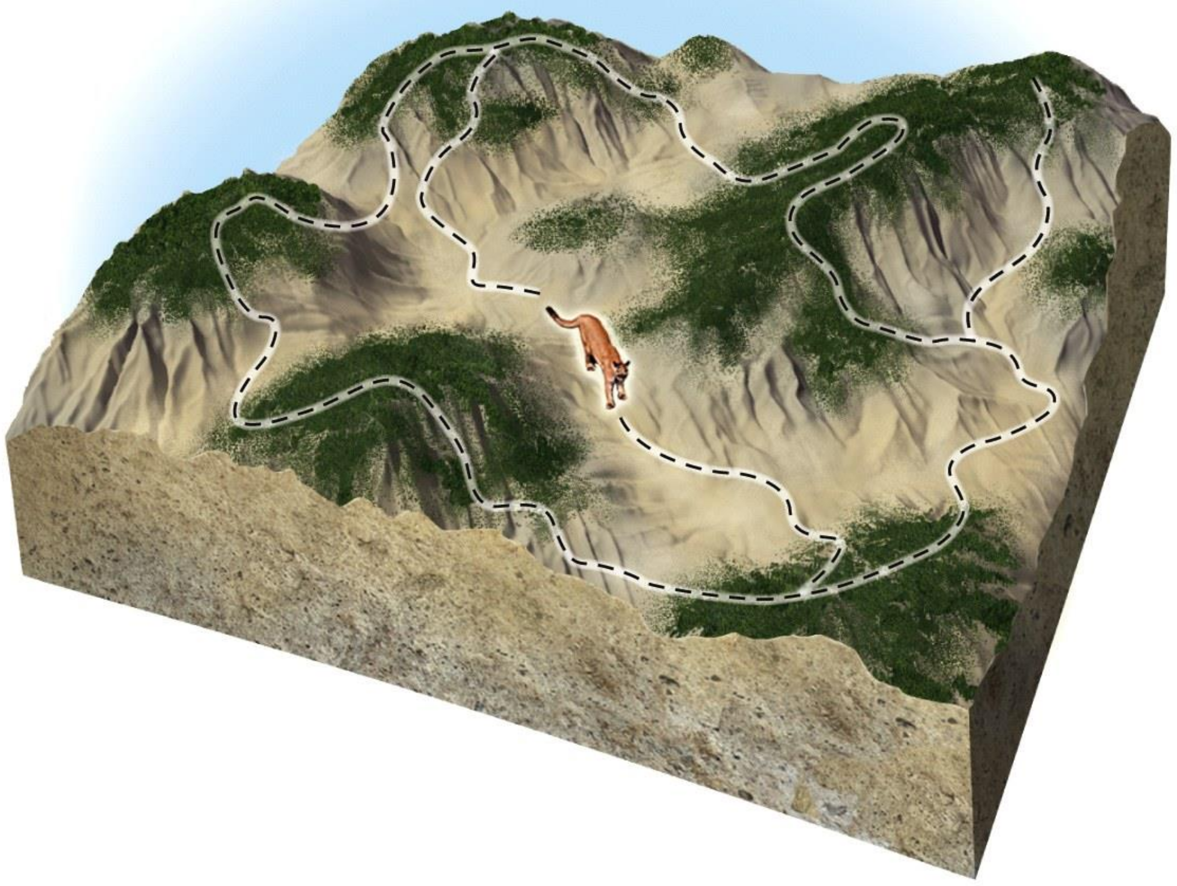

Figure 6.13
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Competition

- **Competition**- the struggle of individuals to obtain a limiting resource .

Graphs a and b, species both achieved large populations (no competition)

Graph c, When two species were grown together, one (P. aurelia) continuously grew well while the other species (P. caudatum) declined to extinction.

The declined/extinction illustrated that these 2 species both competed for the same limiting resource, cannot coexist = *competitive elusive principle*

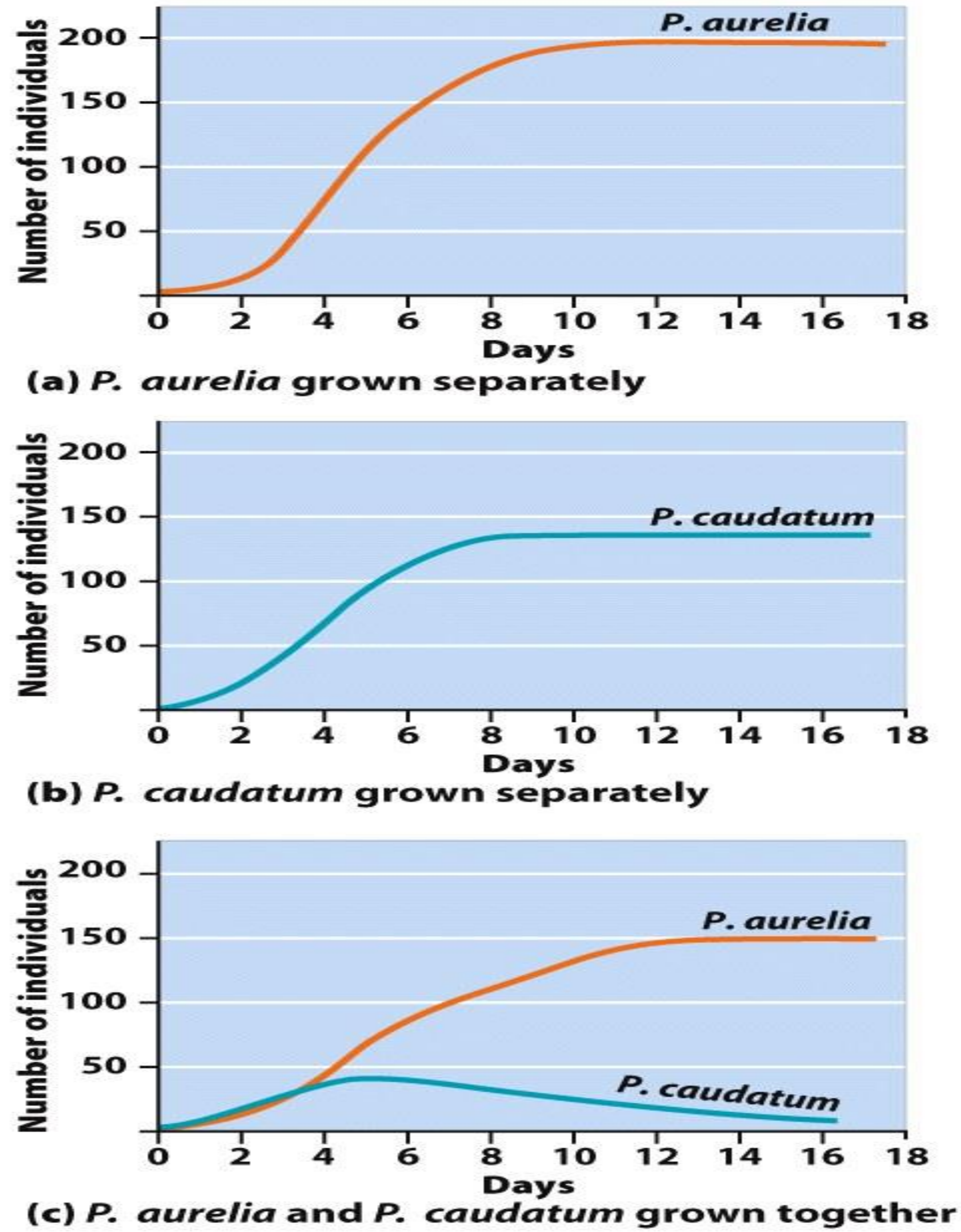

Figure 6.14
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Resource Partitioning

Competition for a limiting resource can lead to, two species divide a resource based on differences in the species' behavior or morphology, over many generations (evolve)

Natural Selection will favor individuals that overlap LESS with other species in the resource they use.

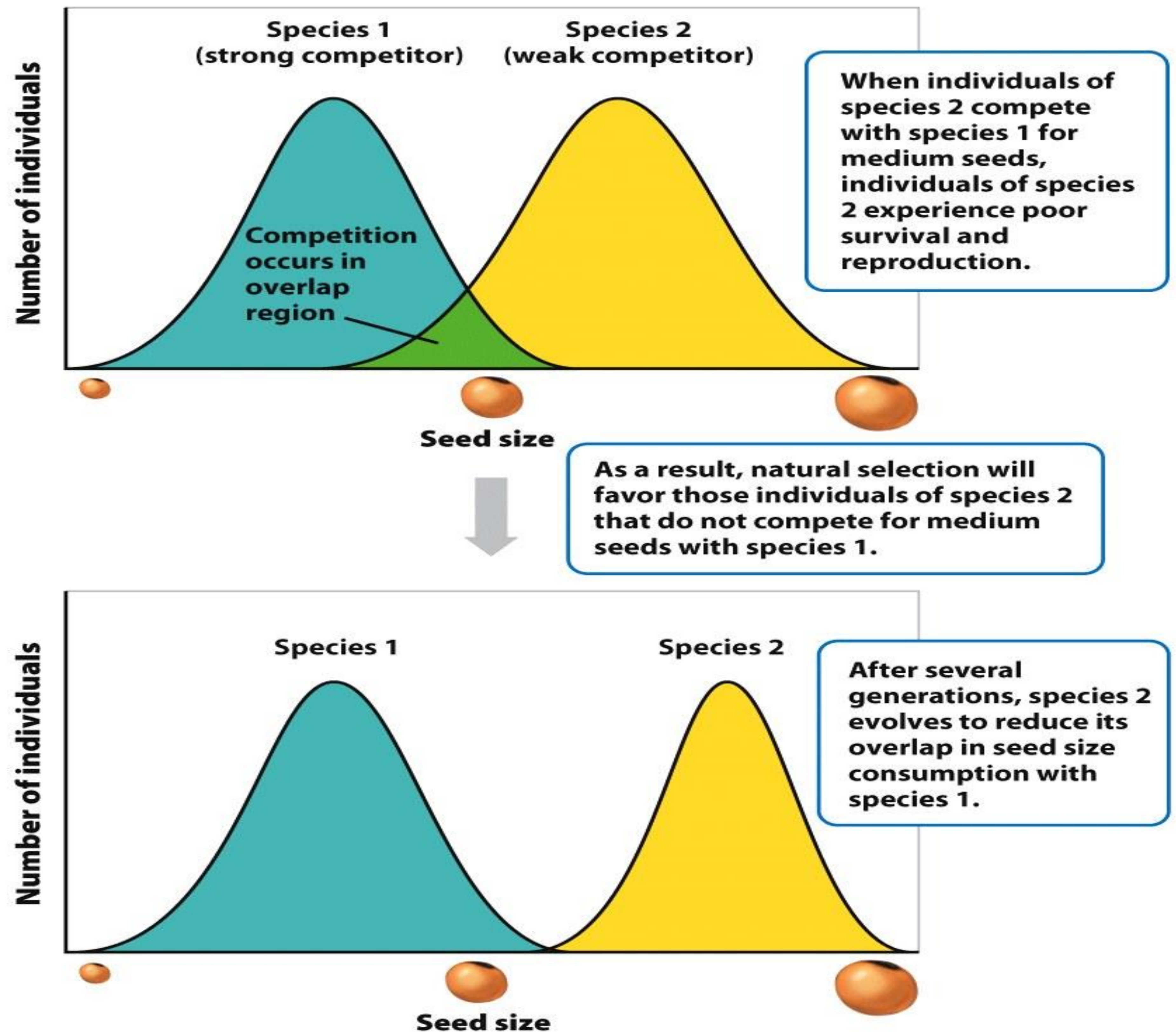

Figure 6.15
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Three types of Resource Partitioning

1. **Temporal** – species live together and try to stay out of each other's territory. Have different active/feeding times. (Ex. Wolves vs. coyotes)

2. **Spatial** – reduce competition by using different habitat. Ex. plants growing at different rooting systems, long vs. short roots…both compete for soil nutrients/water but in different locations.

3. **Morphological** – evolution of differences in body size or shape, allows each species to specialize on different sizes of prey.

Predation

- **Predation**- the use of one species as a resource by another species.
- **True predators-** kill their prey.
- **Herbivores**- consume plants as prey.
- **Parasites-** live on or in the organism they consume.
  - Parasites that cause disease in their hosts, **pathogens**, include bacteria, virus, fungi, protists, wormlike organisms *(helminths)*
- **Parasitoids**- lay eggs inside other organisms.

Mutualism – symbiotic relationship

- **Mutualism**- A type of interspecific interaction where both species benefit.

Figure 6.18
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Figure 6.18 (inset)
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Commensalism- symbiotic relationship

- **Commensalism**- a type of relationship in which one species benefits but the other is neither harmed nor helped.

TABLE 6.2 Interactions between species and their effects

Type of interaction	Species 1	Species 2
Competition	–	–
Predation	+	–
Mutualism	+	+
Commensalism	+	0

Table 6.2
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Parasitism- symbiotic relationship

- a relationship between species, where one organism, the parasite, lives on or in another organism, the host, usually causing it some harm.

Keystone Species

- **Keystone species-** a species that plays a role in its community that is far more important than its relative abundance might suggest.
- Typically exist in low numbers

Figure 6.22 (inset)
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Figure 6.22
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Beavers are keynote species because they play a role in creating new ponds and wetland habitat. (ECOSYSTEM ENGINEERS)

Ecological Succession

- The predictable replacement of one group of species by another group of species over time (from decades to centuries)
- In terrestrial communities, succession can be primary or secondary, depending on the starting point of the community.
- One species taking over another!!!

Primary Succession

- **Primary succession-** occurs on surfaces that are initially devoid of soil, such as abandoned parking lots, bare rock after a glacial retreat…etc.

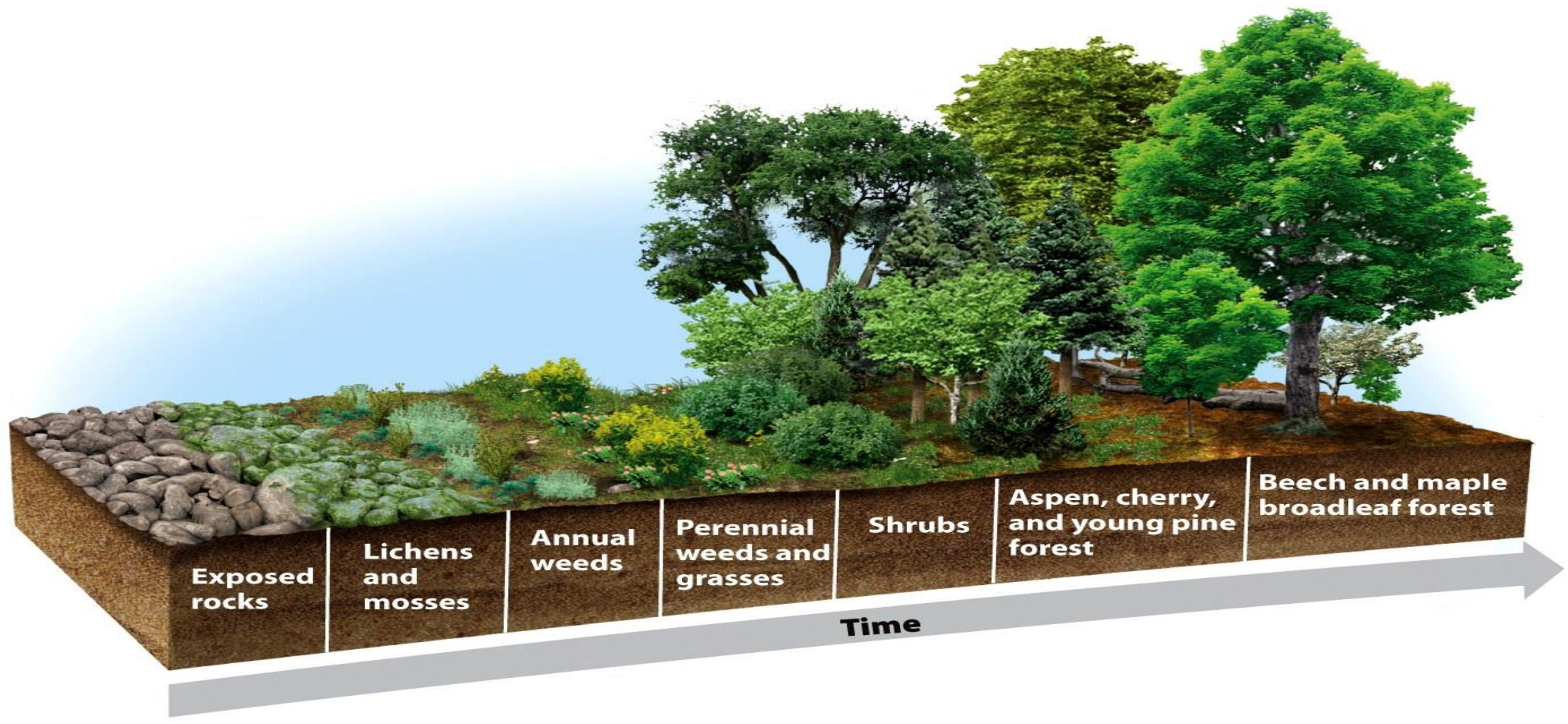

Figure 6.23
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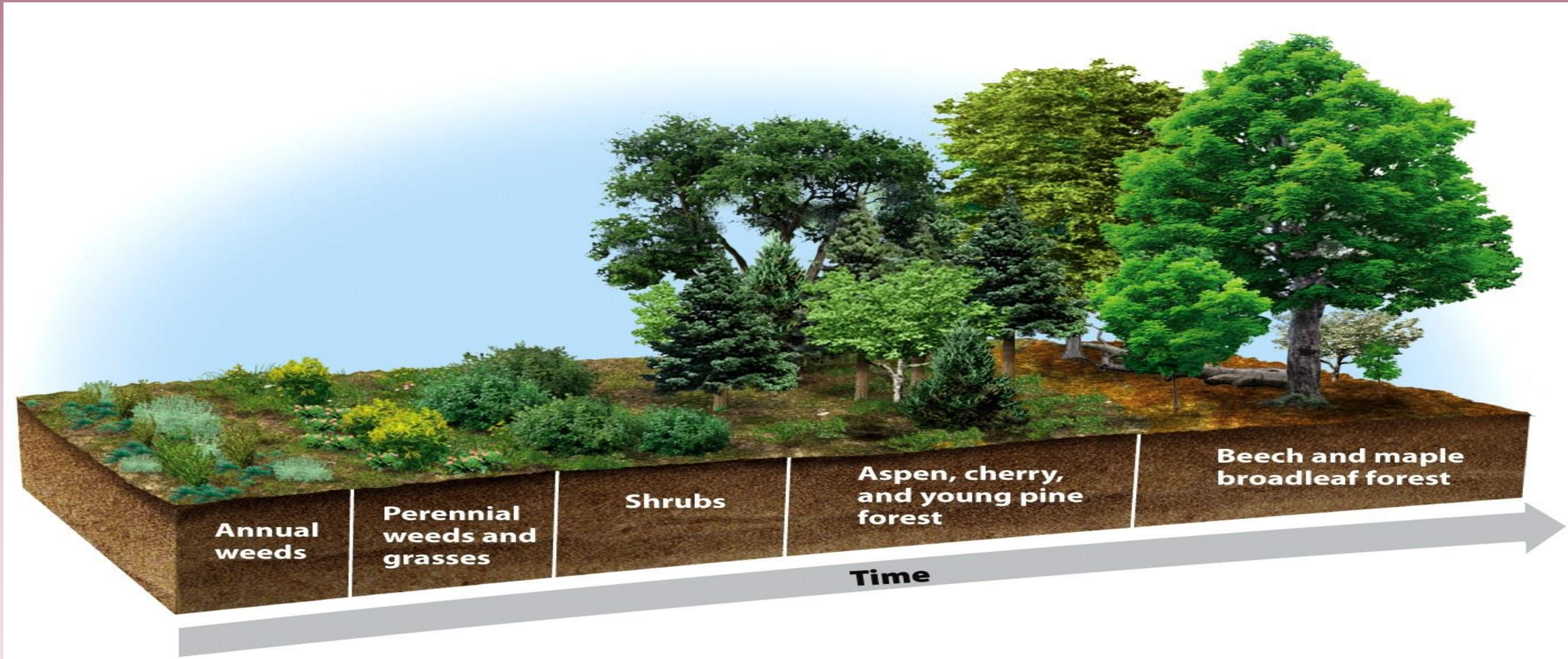
Secondary Succession

- **Secondary succession-** occurs in areas that have been disturbed but have not lost their soil, such as a forest fire, natural disaster, removes vegetation but soil is still intact.



Pioneer species – species that have the ability to colonize new areas rapidly and grow well in full sunshine (ex) cherry trees

Aquatic Succession

Over hundreds to thousands of years, lakes are filled with sediments and slowly become terrestrial habitats.

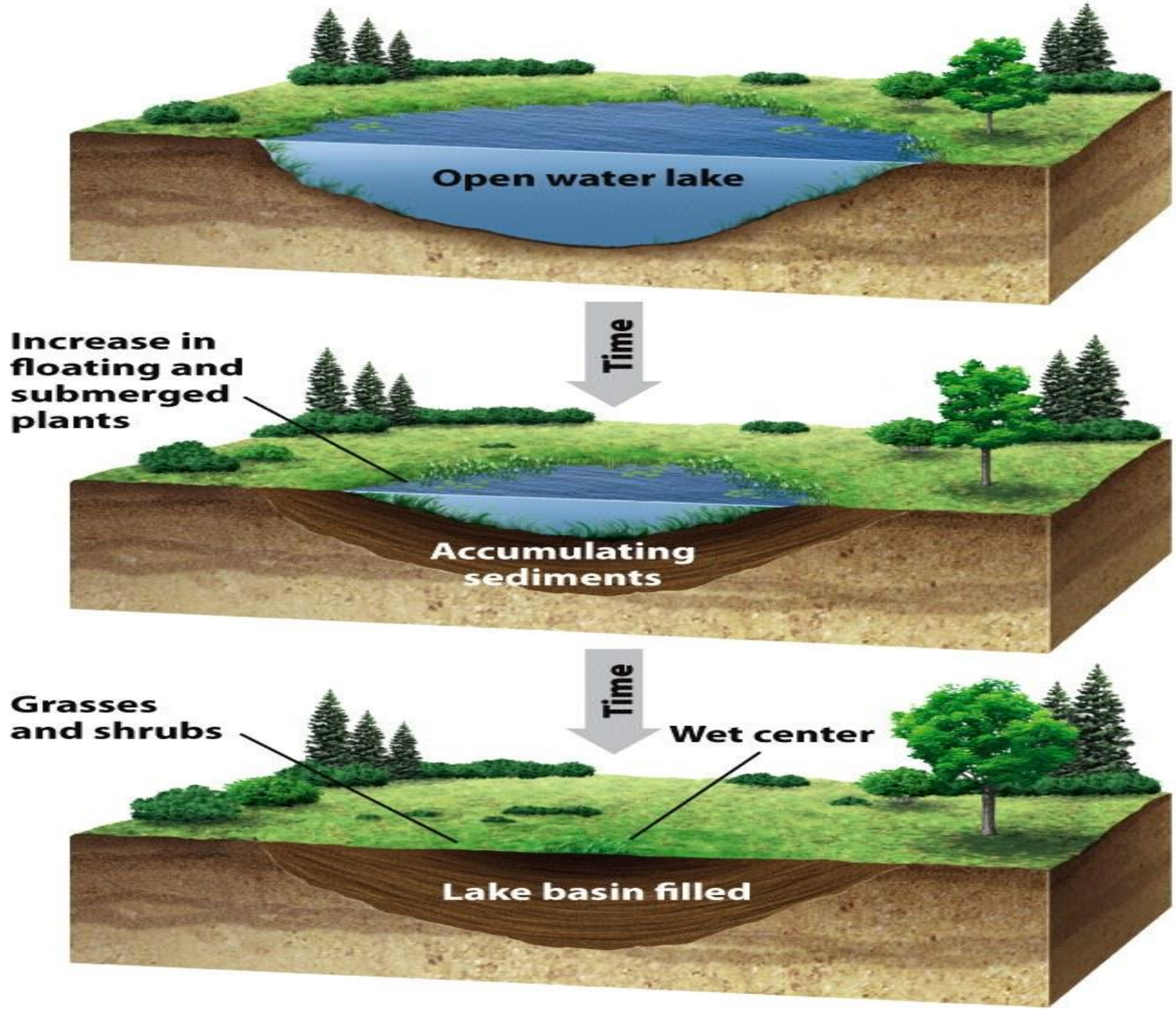


Figure 6.25
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Factors that determine *species richness*:

Richness: measure of the number of different kinds of organisms present in a particular area.

Given region within a biome the *number & type of species present* are determine by:

1. Colonization of the area by the new species
2. Speciation (evolve of new species) within the area
3. Losses from the area by extinction

Factors that determine *species richness*:

Region to Region are influenced by:

- **Latitude** – North & South Pole, the number of species declines.
- **Time** – patterns of richness, the longer a habitat exists, the more colonization, speciation, and extinction can occur.
- **Habitat size** - larger habitat typically contains more species.
- **Distance** – btwn habitat and a source of colonizing species. Distance matters b/c many species can disperse short distance, only a few can disperse long distance.

Theory of Island Biogeography

- Theory of island biogeography- the theory that explains that both **habitat size and distance (size of land) determine species richness (quantity of species).**

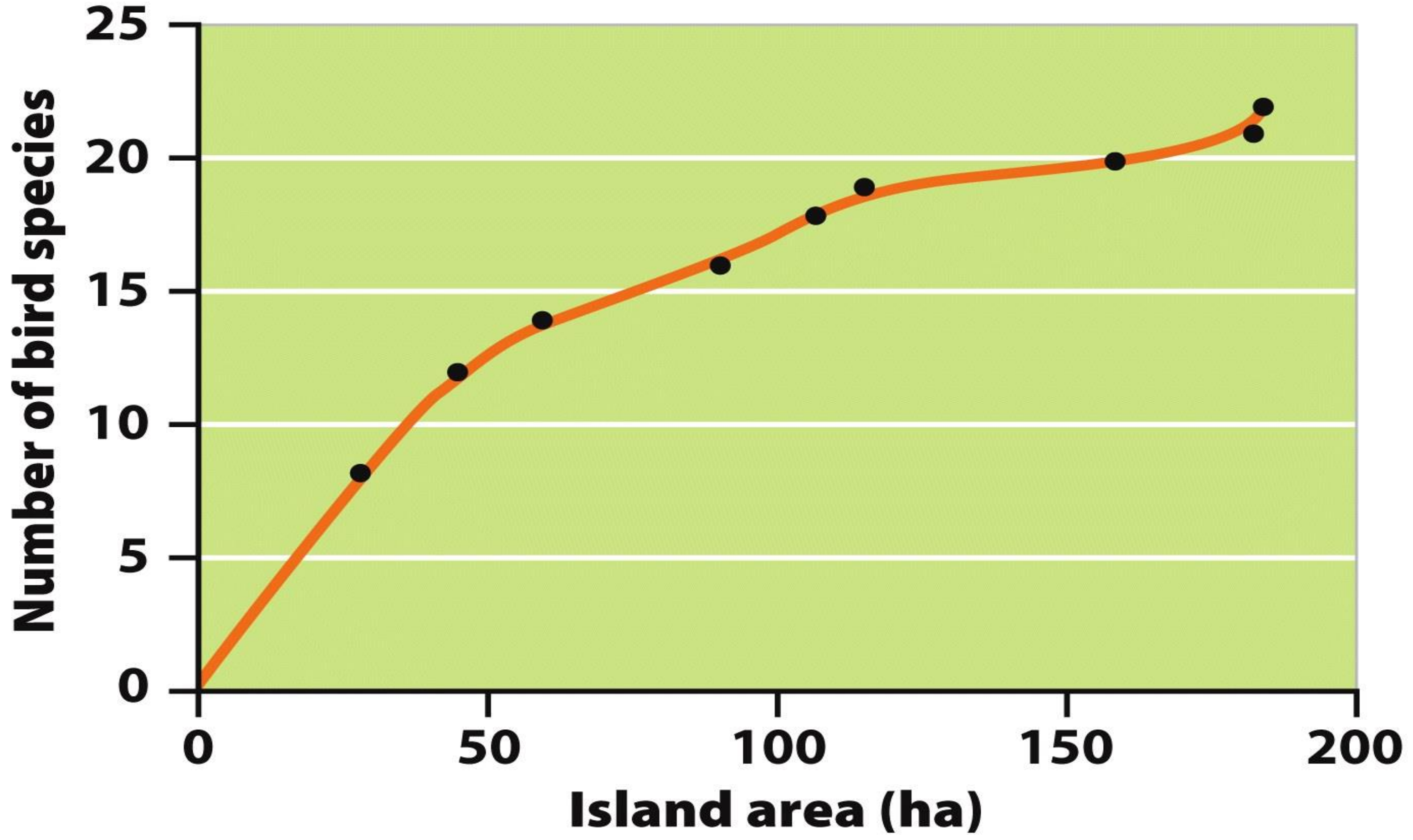

Figure 6.26
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