Chapter 6
Population and Community Ecology

Nature exists at several levels of complexity

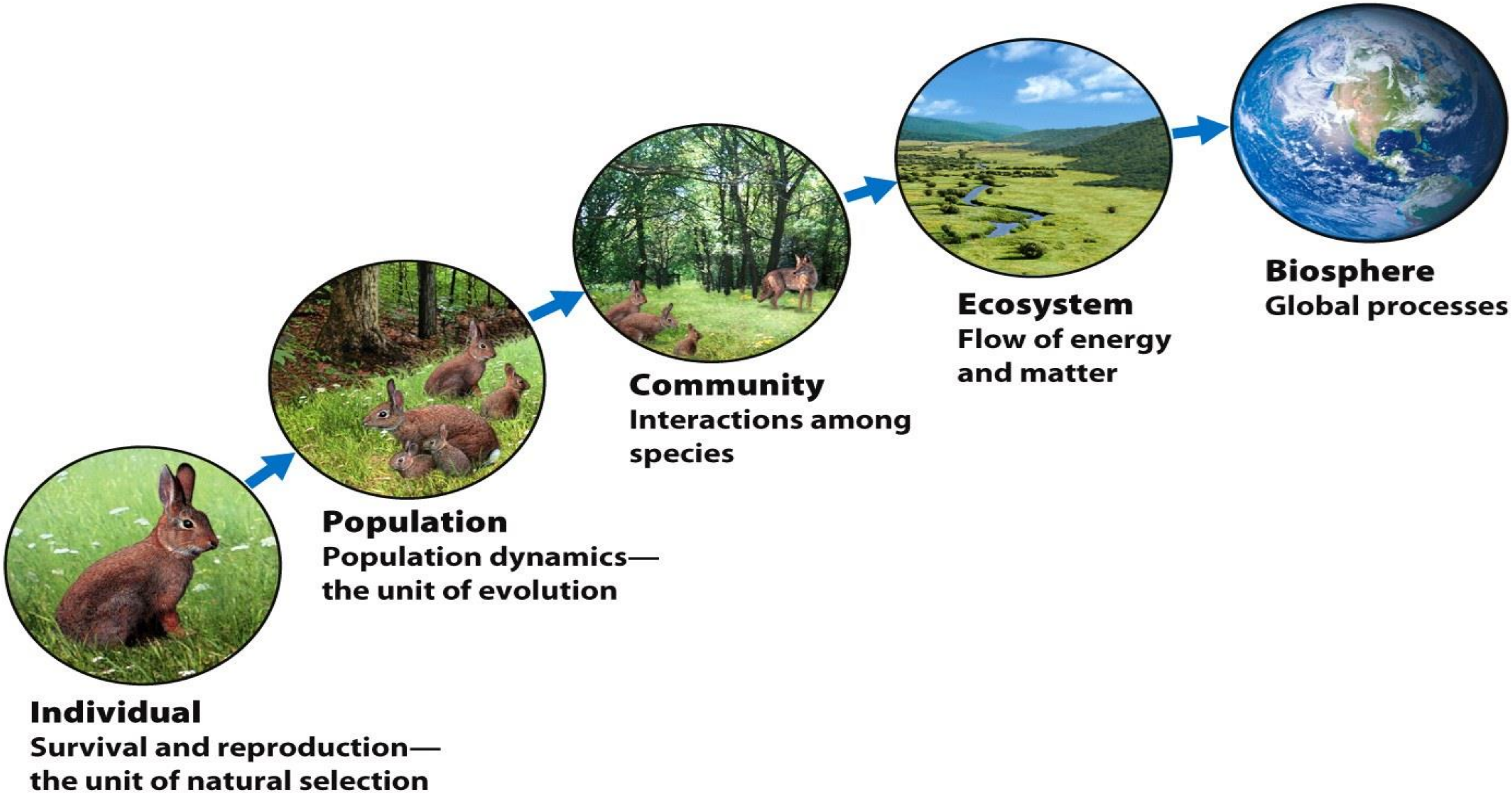

Figure 6.1
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Factors that Regulate Population Abundance and Distribution

- **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, Uniformed, Clumped*).

Factors that Influence Population Size

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

  - ***<u>Limiting Resource</u>*** – (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 individual's 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).

  Biotic potential – max. # of offspring that an organism can produce w/o any enviro. resistance.

- A high number births & low number of deaths produce a high population growth rate (ideal conditions)

Exponential Growth Model – predict population size at any moment in time

- J-shaped curve- when graphed the exponential growth model looks like this *(biotic potential –* max. # of offspring that an organism can produce w/o any enviro. resistance).

Nt = future population size
No = current reproducing individuals (population)
t = time
e = 2.72 (constant value – "e" function on calculator)
r = intrinsic rate of growth (under ideal conditions, no limits)

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.

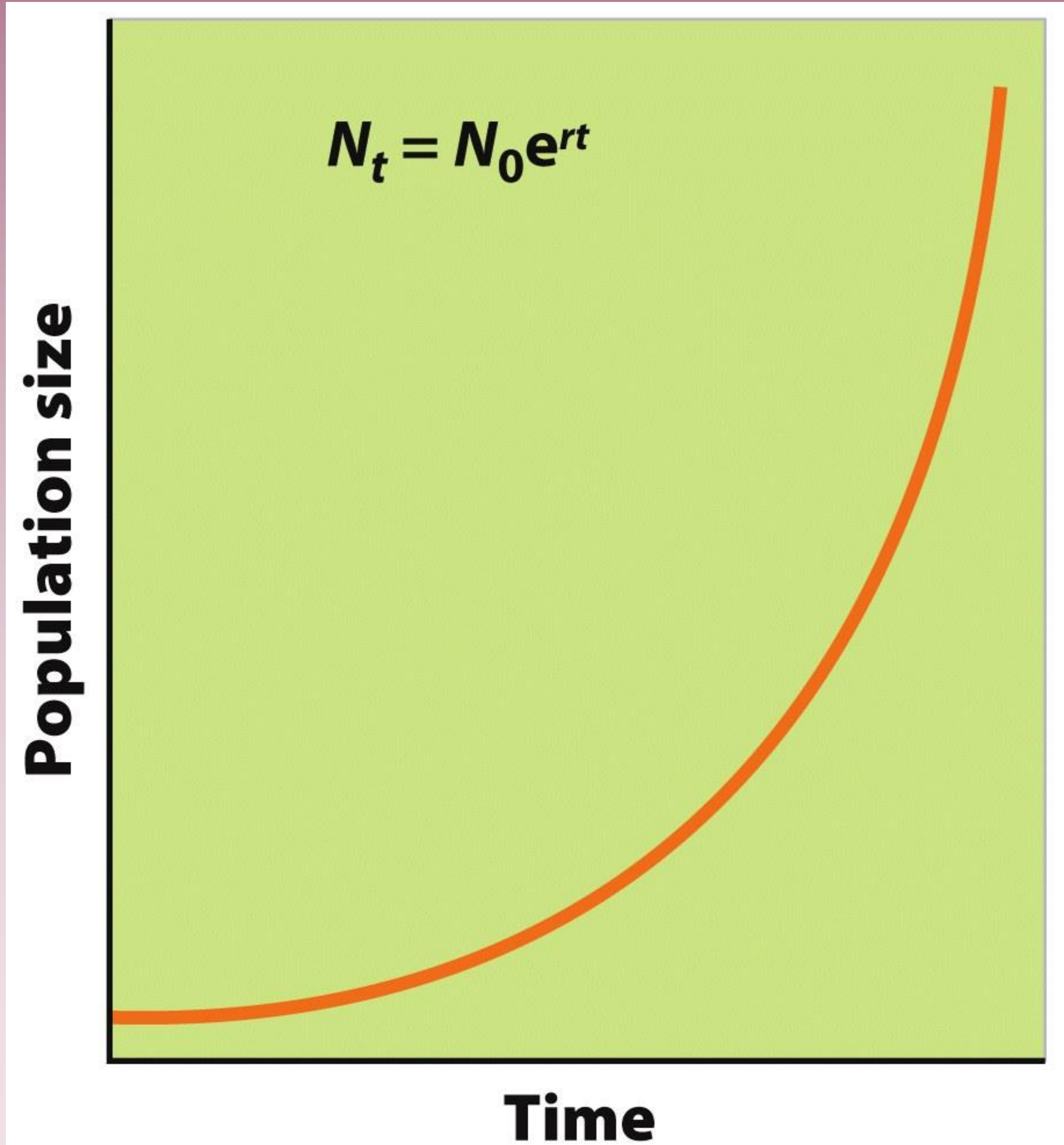

Figure 6.5
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- Consider a population of squirrels that has an initial population size of 10 individuals. Let's assume that the intrinsic rate of growth for a squirrel is .5, *which means that each squirrels produces a net increase of .5 squirrels each year.* What will the size of the squirrel population 2 year from now be?

$N_t = N_o e^{rt}$

No = 10 individuals *(current reproducing pop.)*

r = .5 *(intrinsic growth rate…ideal conditions)*

T = 2 years *(timeline)*

e = 2.72 *(constant value)*

Nt = ?? *(future pop)*

$$N_t = 10 \times (2.72)^{.5 \times 2}$$

$$N_t = 10 \times (2.72)^1$$

Nt = 27.2 rabbits in 2 years

Population of rabbits increased from 10 to 27.2 in 2 years.

Logistic Growth Model

- **Logistic growth-** when a population whose growth is initially exponential but slows as the population approaches the carrying capacity. Reproduction Growth tend to respond more quickly to resistance
- 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)

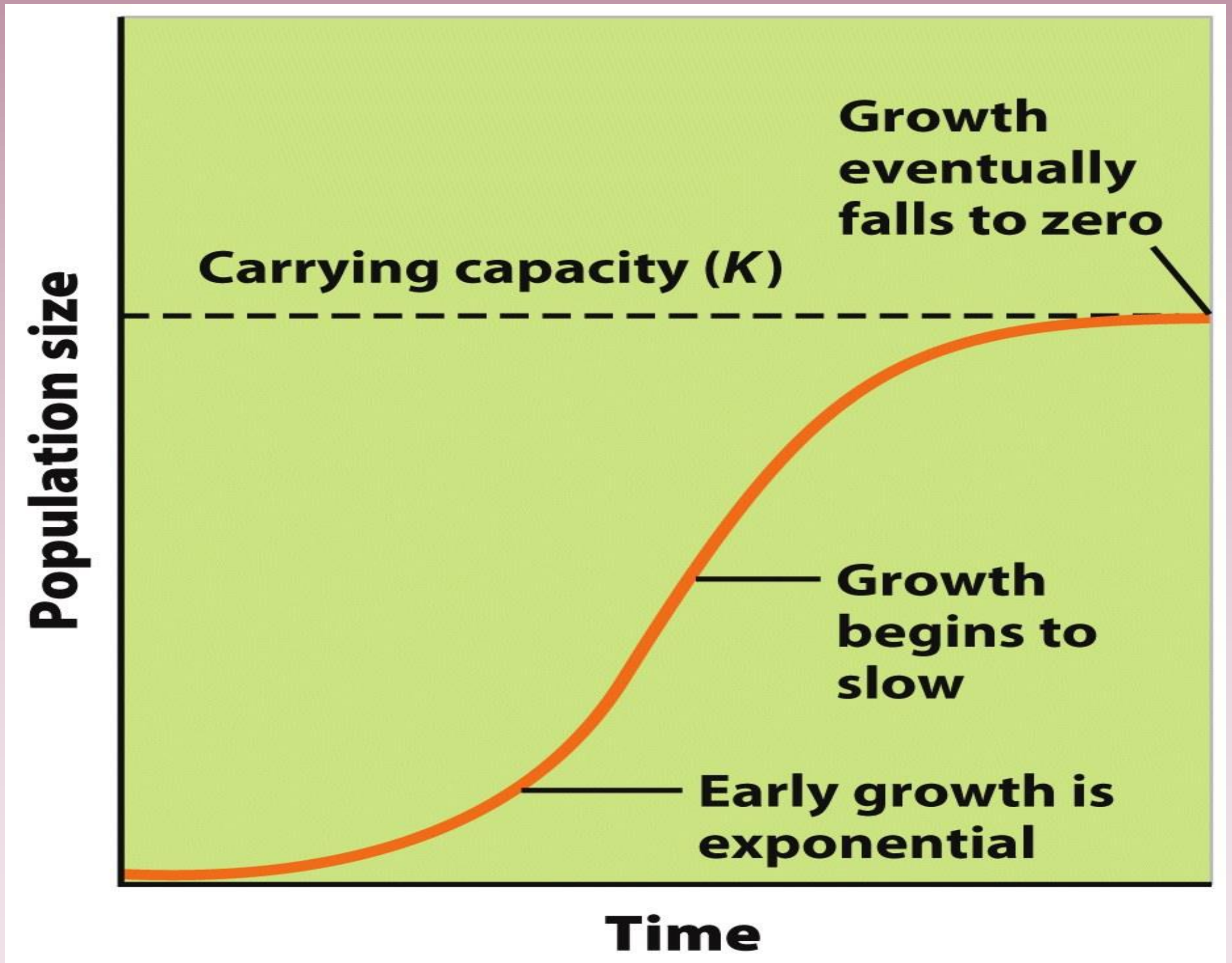

Figure 6.7
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Variations of the Logistic Model

- R-strategists…pop growth will overshoot the carrying capacity and then dieback.
- 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)….*Creating an oscillation effect.*

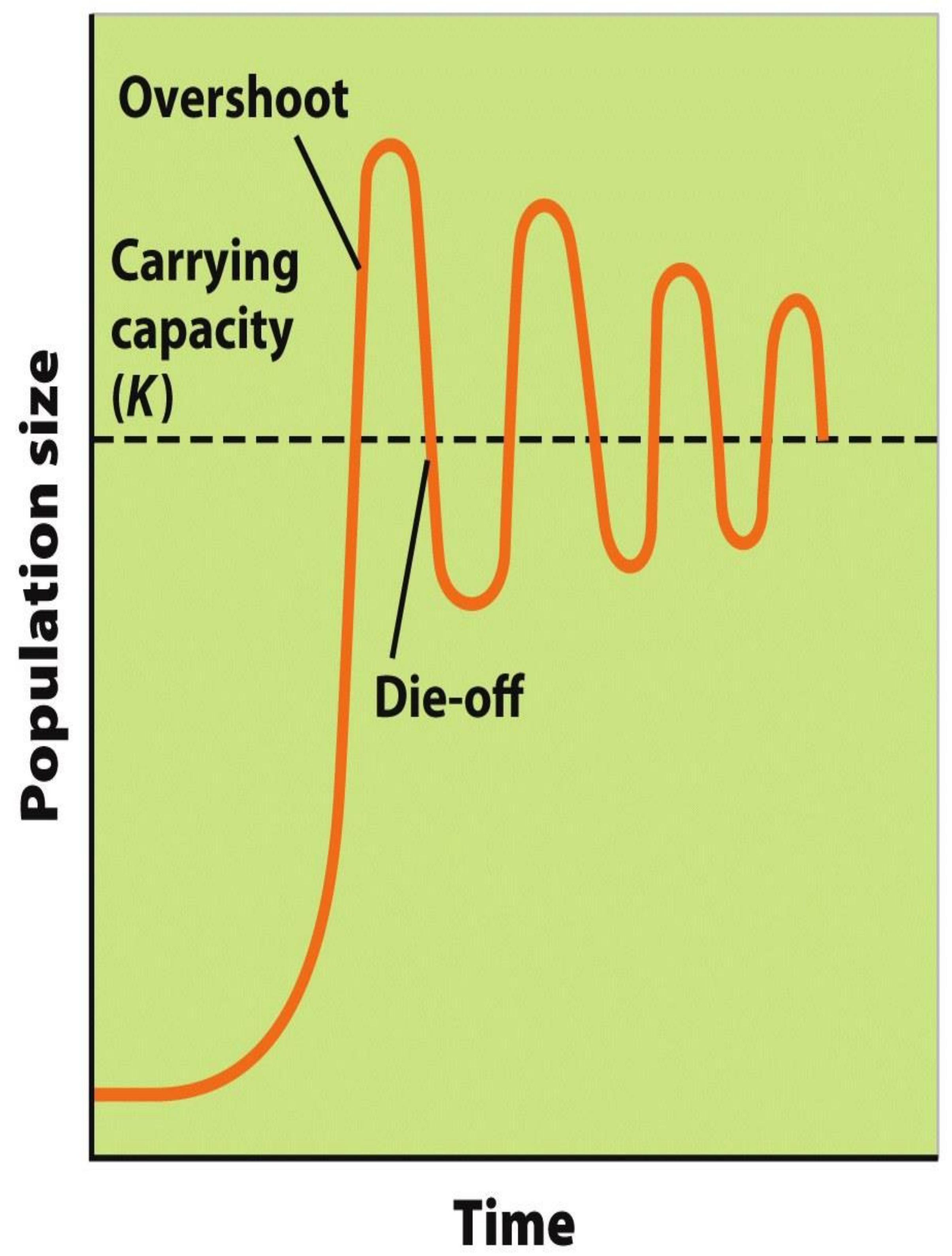

Figure 6.9
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Reproductive Strategies

- **K-selected species-** the population of a species that grows slowly until it reaches the carrying capacity. Ex. elephants, whales, and humans. *(K– representing carrying capacity – limits/logistic)*

- **R-selected species-** the population of a species that grows quickly and is often followed by overshoots and die-offs. Ex. mosquitoes and dandelions *(R- representing intrinsic growth rate = J-shape*

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

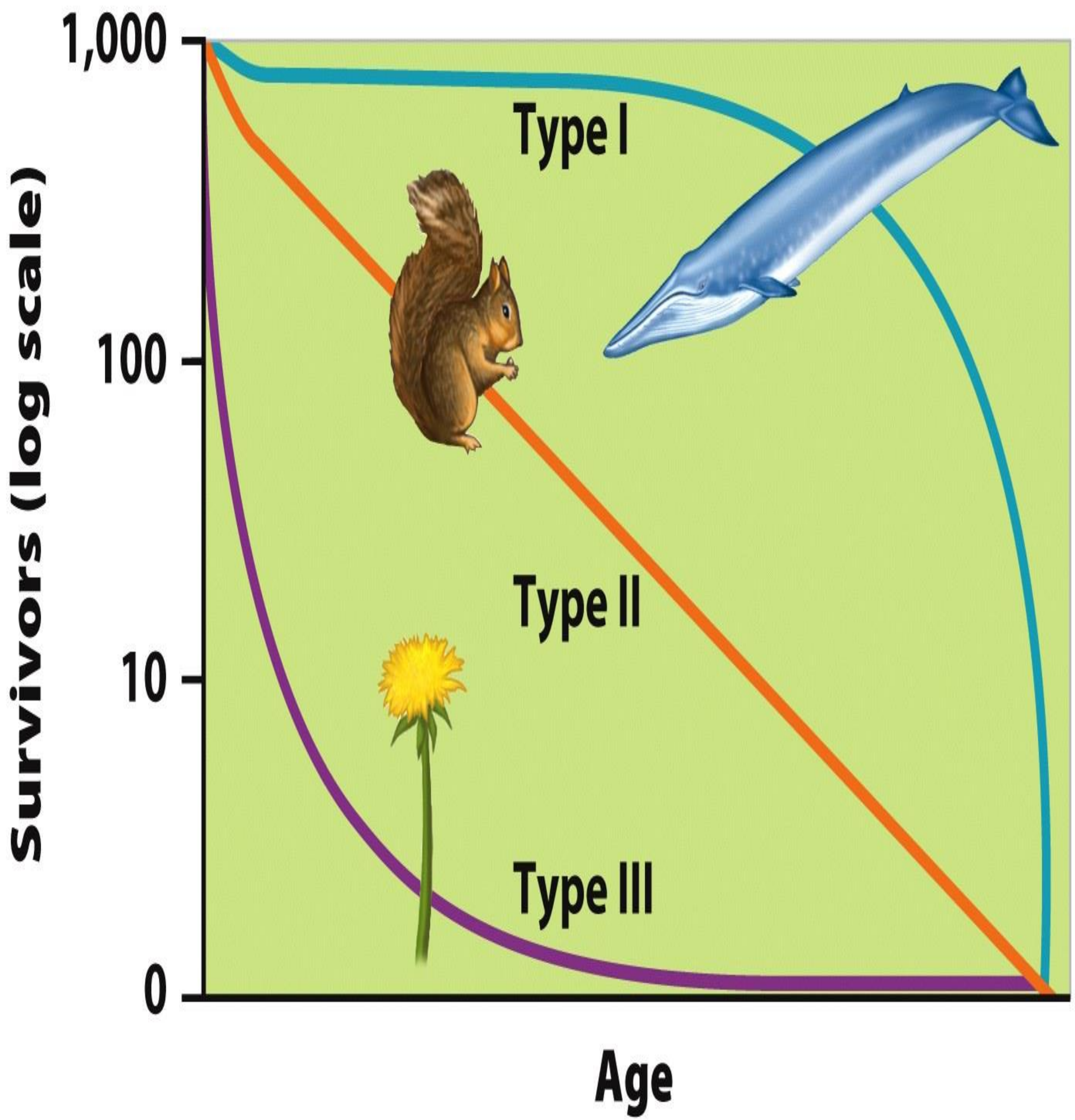

Figure 6.12
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Type I – K-selected species have **high survival rates** throughout life span, once old age hits, large groups start to die (humans, elephants)

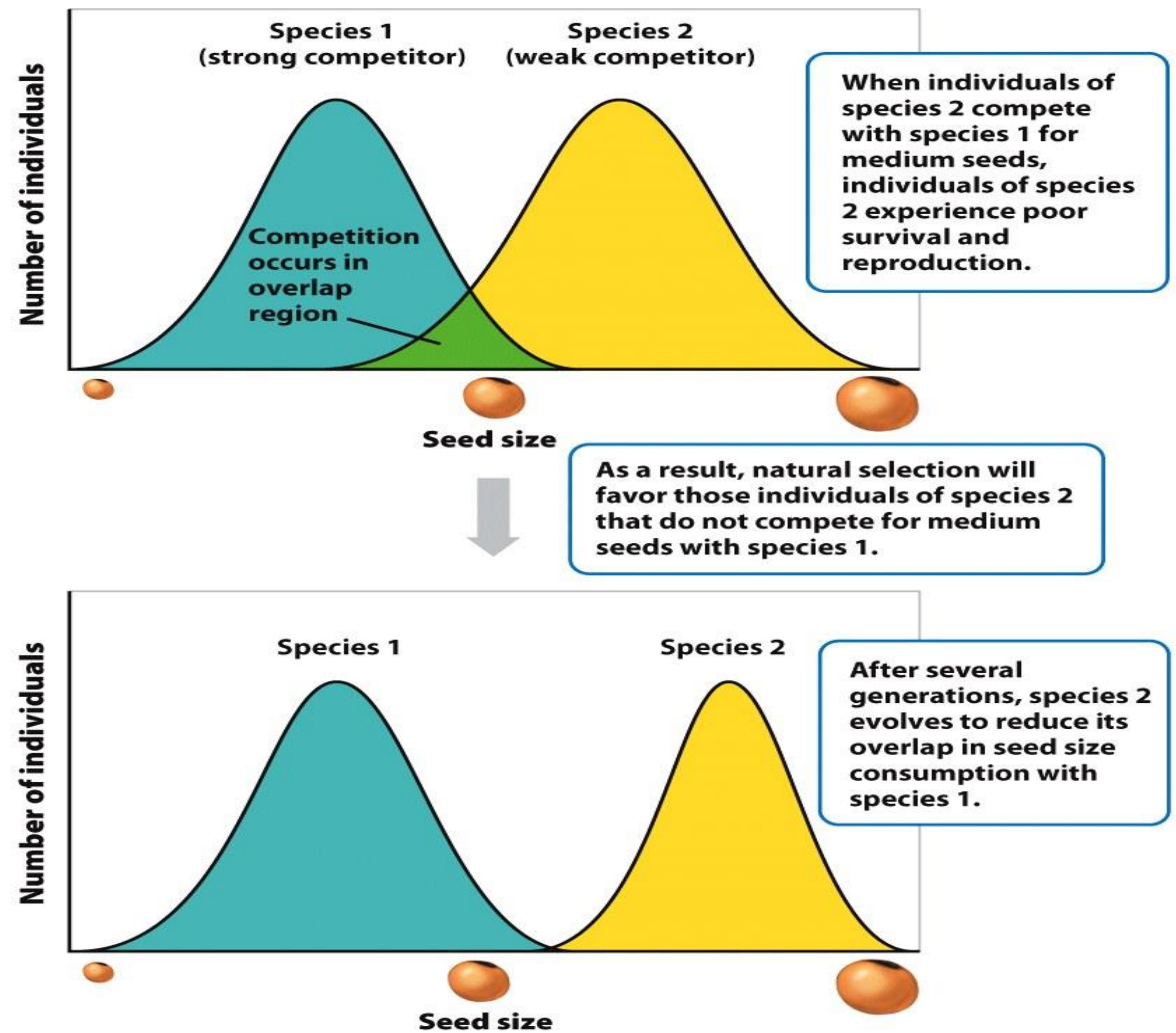
Type II – constant decline in survivorship throughout their life span (squirrel, coral)

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

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.



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Disruptive selection

Keystone Species

- **<u>Keystone species-</u>** 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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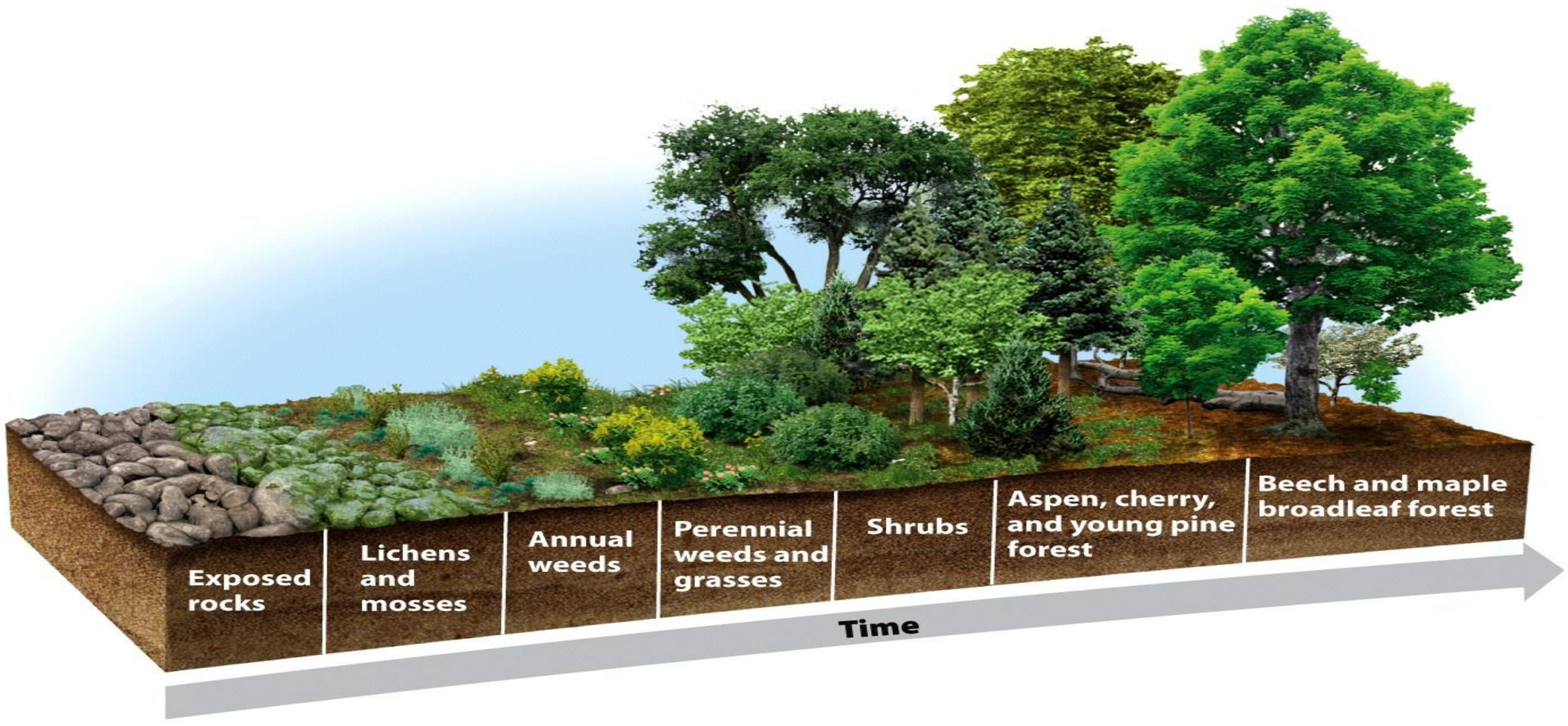
Beavers are keynote species because they play a role in creating new ponds and wetland habitat. (ECOSYSTEM ENGINEERS)

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.



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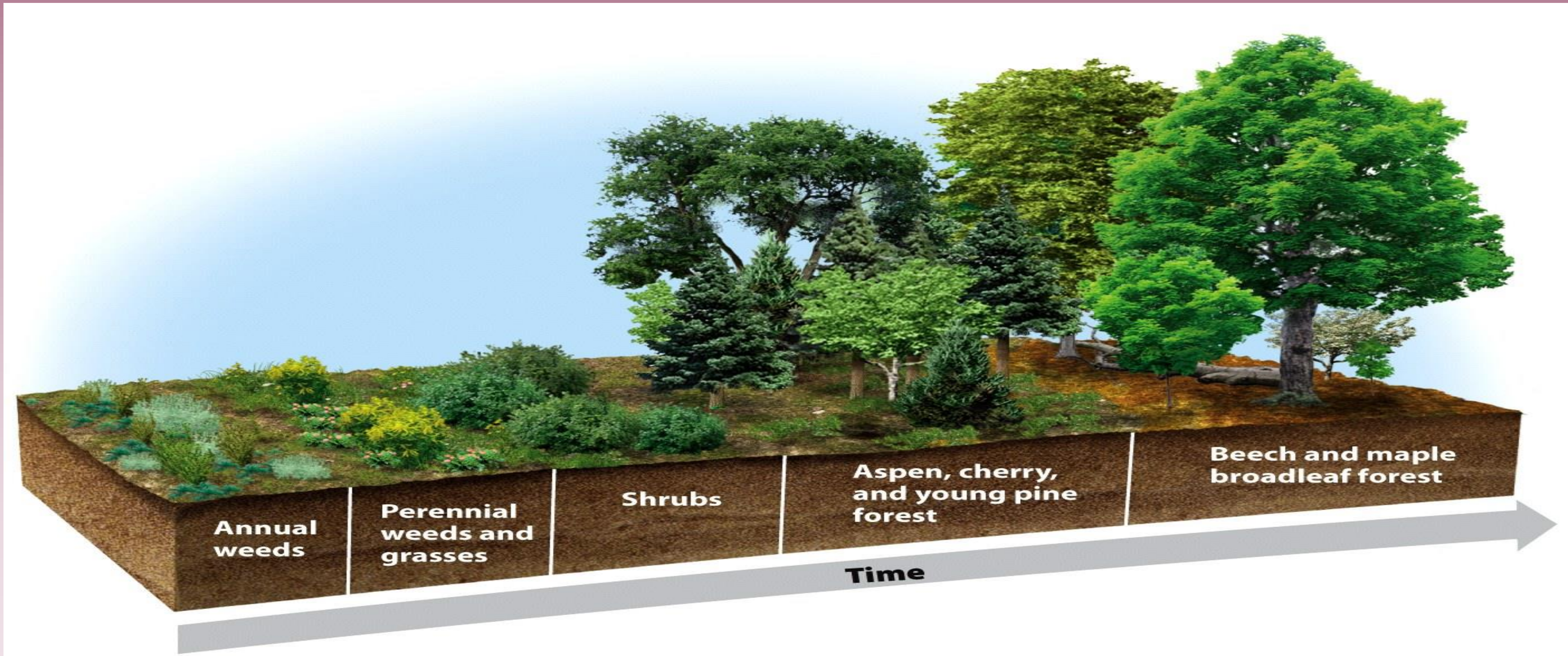
Secondary Succession

- **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.

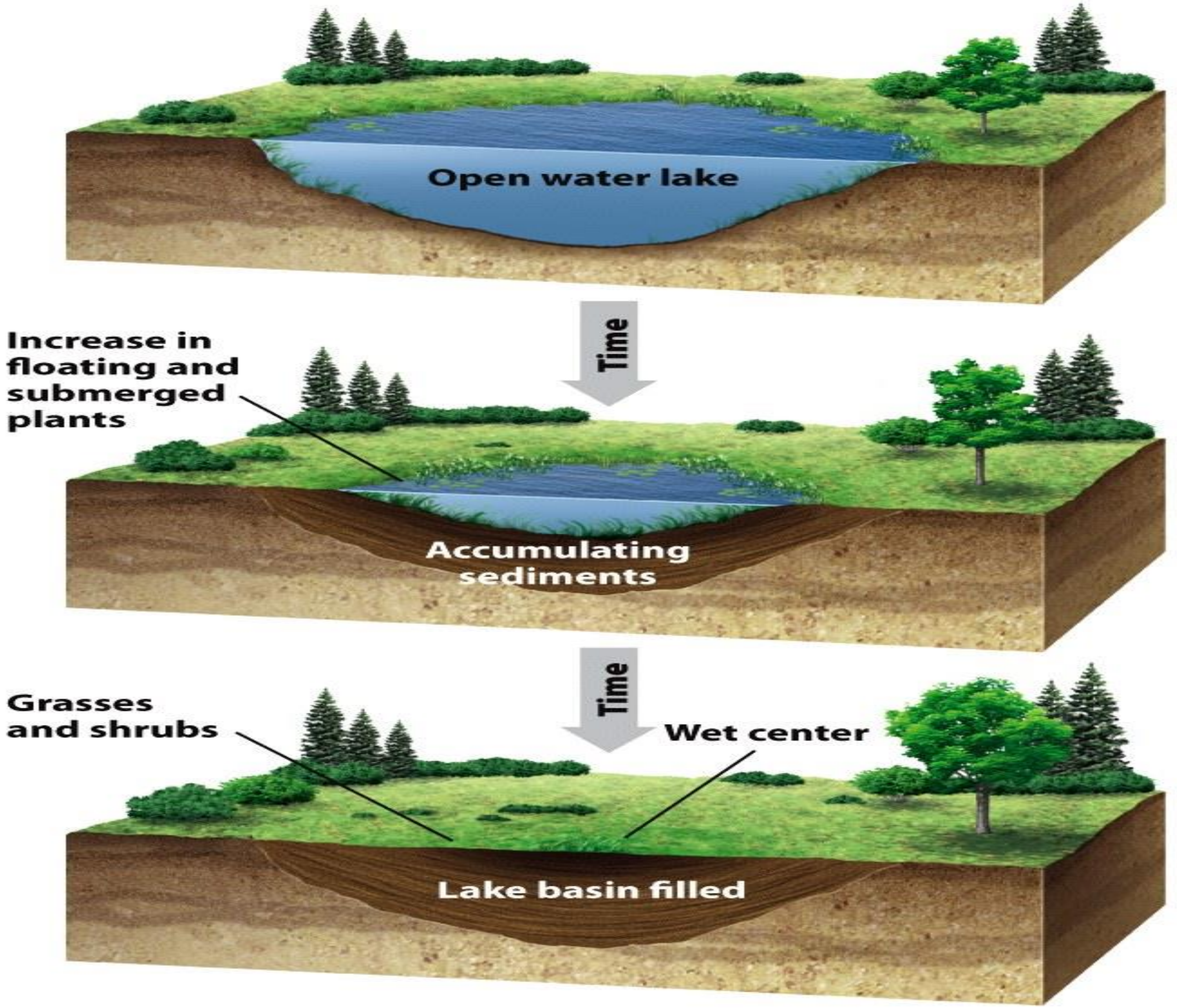


Figure 6.25
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