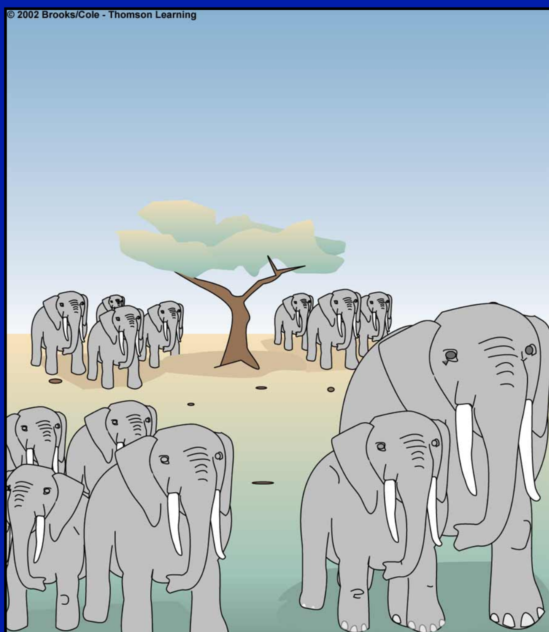
POPULATION DYNAMICS

CHAPTER 9

MAJOR CHARACTERISTICS OF A POPULATION

- POPULATIONS ARE ALWAYS CHANGING:
  - SIZE
  - DENSITY
  - DISPERSION - clumped, uniform, random
  - AGE DISTRIBUTION
- THESE CHANGES ARE CALLED **POPULATION DYNAMICS**

Population Dispersion



Clumped
(elephants)

Uniform
(creosote bush)

Random
(dandelions)

Fig. 9.2, p. 199

Limits to Population growth

- NATALITY - BIRTH
- MORTALITY - DEATH
- IMMIGRATION - MOVEMENT IN
- EMIGRATION - MOVEMENT OUT
- POPULATION CHANGE =

(BIRTH + IMMIGRATION - DEATH + EMIGRATION)

ZERO POPULATION GROWTH (ZPG)

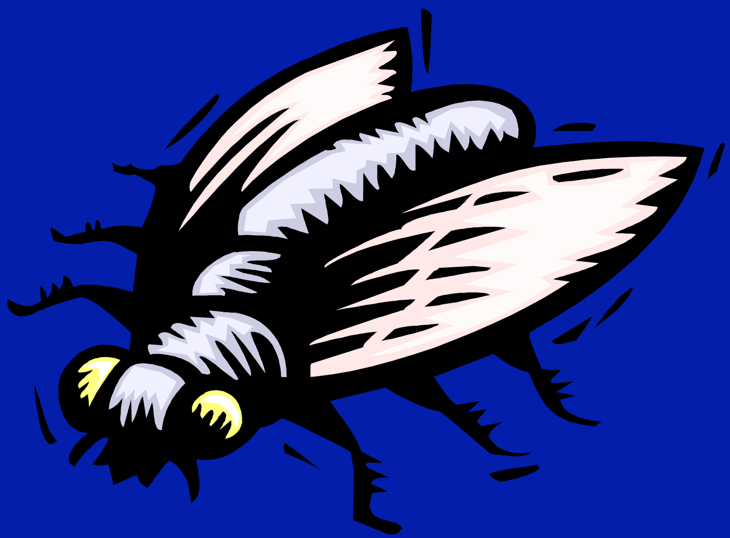
- WHEN THE NUMBER OF INDIVIDUALS ADDED FROM BIRTHS AND IMMIGRATION EQUALS THE NUMBER LOST TO DEATHS AND EMIGRATION

BIOTIC POTENTIAL

- ALL THE FACTORS WHICH CAUSE A POPULATION TO INCREASE IN GROWTH
- **INTRINSIC RATE OF INCREASE** - **(r)** THE RATE AT WHICH A POPULATION WOULD GROW ON UNLIMITED RESOURCES

POPULATIONS WITH HIGH INTRINSIC RATE OF INCREASE

- REPRODUCE EARLY IN LIFE
- HAVE SHORT GENERATION TIMES
- CAN REPRODUCE MANY TIMES
- HAVE MANY OFFSPRING EACH TIME THEY REPRODUCE.
  - EXAMPLE – HOUSEFLY



ENVIRONMENTAL RESISTANCE

- ALL THE FACTORS THAT LIMIT THE GROWTH OF A POPULATION
- ENVIRONMENTAL RESISTANCE + BIOTIC POTENTIAL DETERMINE **CARRYING CAPACITY (K)**
  - NUMBER OF INDIVIDUALS OF A SPECIES THE ENVIRONMENT CAN SUSTAIN INDEFINITELY

MINIMUM VIABLE POPULATION (MVP)

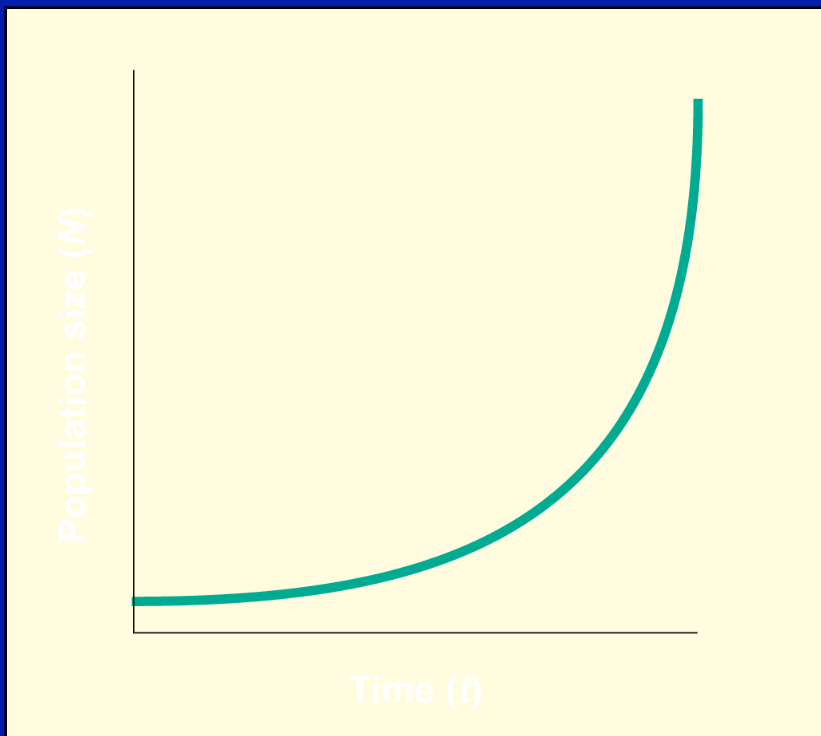
- MINIMUM POPULATION SIZE
- BELOW THIS
  - INDIVIDUALS MAY NOT BE ABLE TO FIND MATES
  - MAY HAVE INTERBREEDING AND PRODUCE WEAK OFFSPRING
  - GENETIC DIVERSITY MAY BE TOO LOW TO ENABLE ADAPTATION TO NEW ENVIRONMENTAL CONDITIONS.

Giant panda

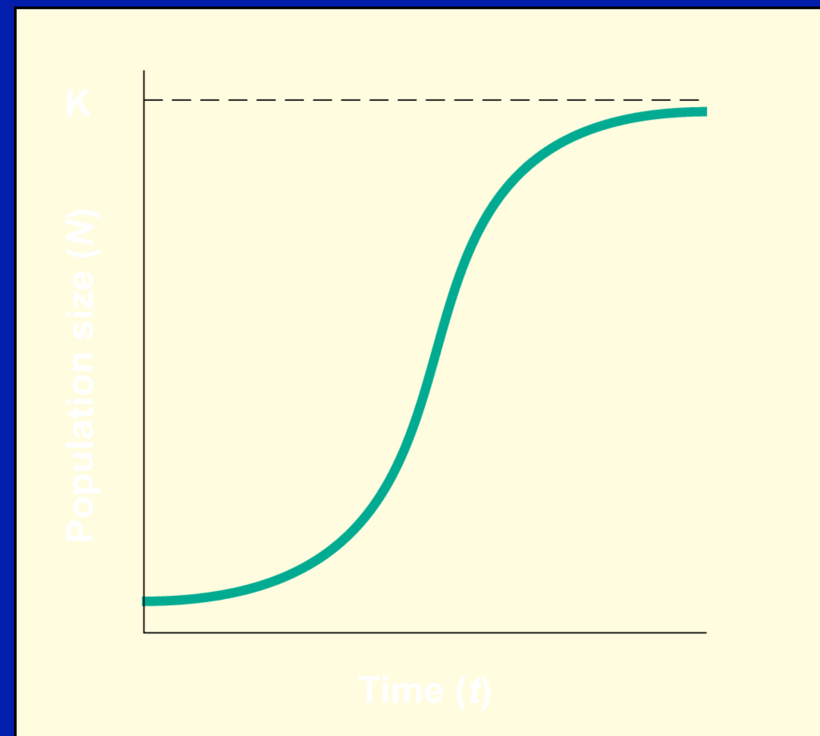
black rhino

EXPONENTIAL VS. LOGISTIC GROWTH

- **EXPONENTIAL GROWTH** STARTS OUT SLOWLY AND PROCEEDS FASTER AND FASTER
  - FORMS A J-SHAPED CURVE
- **LOGISTIC GROWTH -**INVOLVES EXPONENTIAL UNTIL POPULATION ENCOUNTERS ENVIRONMENTAL RESISTANCE AND APPROACHES CARRYING CAPACITY.
  - THEN POPULATION FLUCTUATES
  - FORMS A SIGMOID OR S-SHAPED CURVE



Exponential Growth

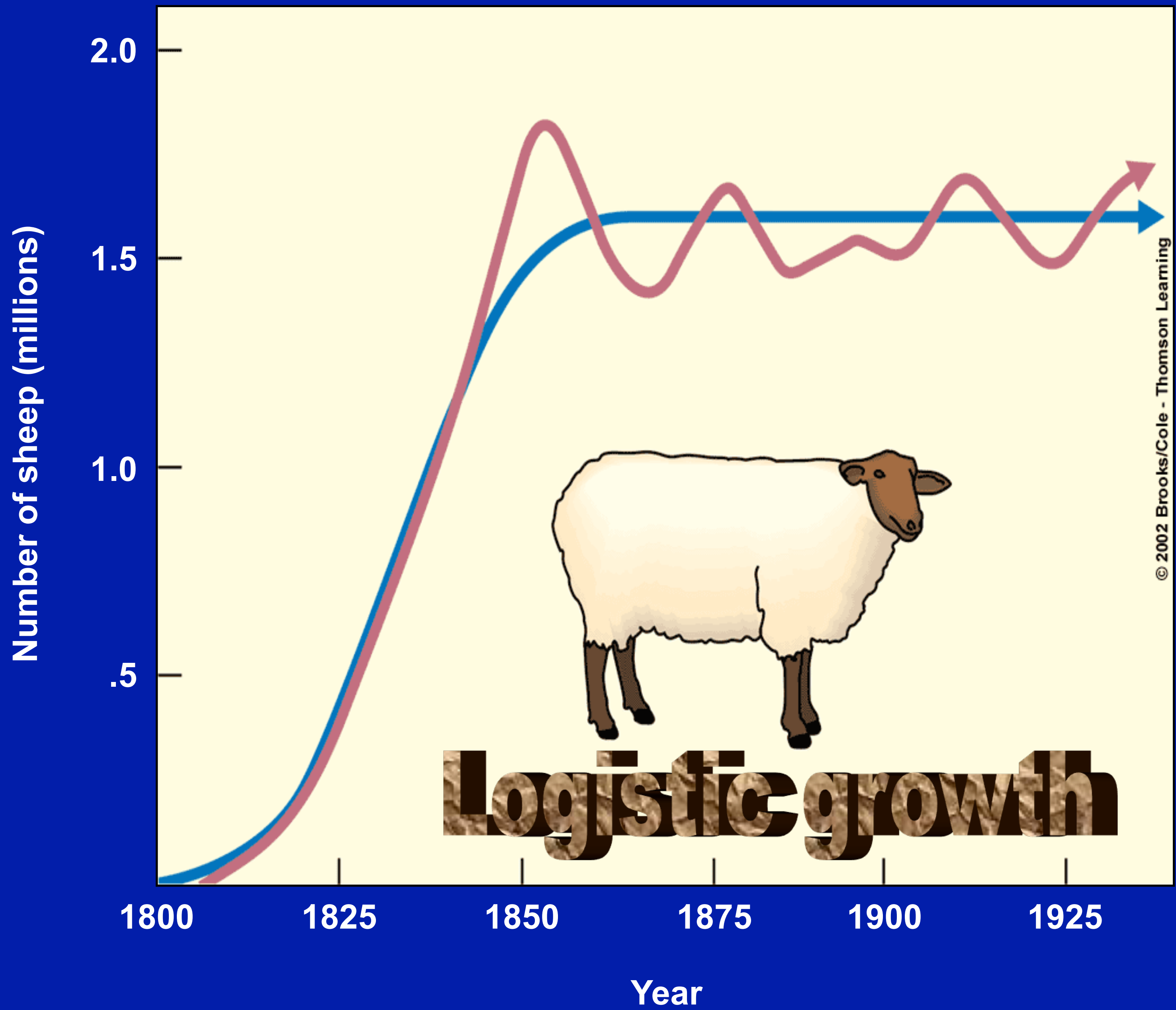


Logistic Growth

Fig. 9.4, p. 201

WHEN POPULATIONS EXCEED CARRYING CAPACITY

- SOMETIMES **OVERSHOOT**
- HAPPENS BECAUSE OF A **REPRODUCTIVE TIME LAG** - PERIOD NEEDED FOR BIRTH RATES TO FALL AND DEATH RATES TO RISE
- HAVE A **DIEBACK** OR **CRASH**
  - UNLESS ORGANISMS CAN MOVE OF SWITCH TO NEW RESOURCES
  - EASTER ISLAND AN EXAMPLE OF THIS



2.0
1.5
1.0
.5
Number of sheep (millions)
1800
1825
1850
1875
1900
1925
Year
Logistic growth
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Fig. 9.5, p. 201

WHAT AFFECTS CARRYING CAPACITY?

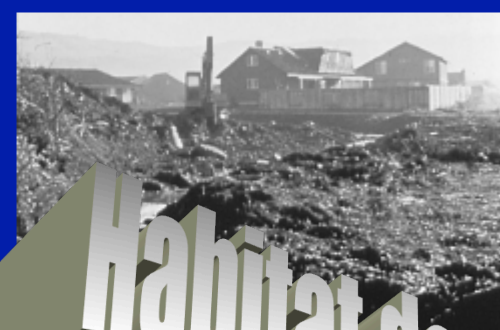
- COMPETITION WITHIN AND BETWEEN SPECIES
- IMMIGRATION AND EMIGRATION
- NATURAL AND HUMAN CAUSED CATASTROPHIC EVENTS
- SEASONAL FLUTUATION IN FOOD, WATER, COVER, AND NESTING SITES.

EFFECTS OF POPULATION DENSITY

- **DENSITY INDEPENDENT POPULATION CONTROLS**
  - AFFECT A POPULATION REGARDLESS OF POPULATION SIZE
    - **FLOODS, HURRICANES, SEVERE DROUGHT, UNSEASONABLE WEATHER, FIRE, HABITAT DESTRUCTION**

Fire

Drought



Habitat destruction

- **DENSITY DEPENDENT POPULATION CONTROLS**
- HAVE A GREATER EFFECT AS POPULATION DENSITY INCREASES:
  - **COMPETITION FOR RESOURCES, PREDATION, PARASITISM, DISEASE**
    - EXAMPLE: INFECTIOUS DISEASES

TYPES OF POPULATION FLUCTUATIONS

- STABLE - FLUCTUATES ABOVE AND BELOW CARRYING CAPACITY
  - TROPICAL RAINFOREST
- IRRUPTIVE-FAIRLY STABLE THAN EXPLODES
  - RACOONS
- IRREGULAR- NO SET PATTERN
  - SIMILAR TO CHAOS
- CYCLIC- NO REAL EXPLANATION
  - LEMMINGS

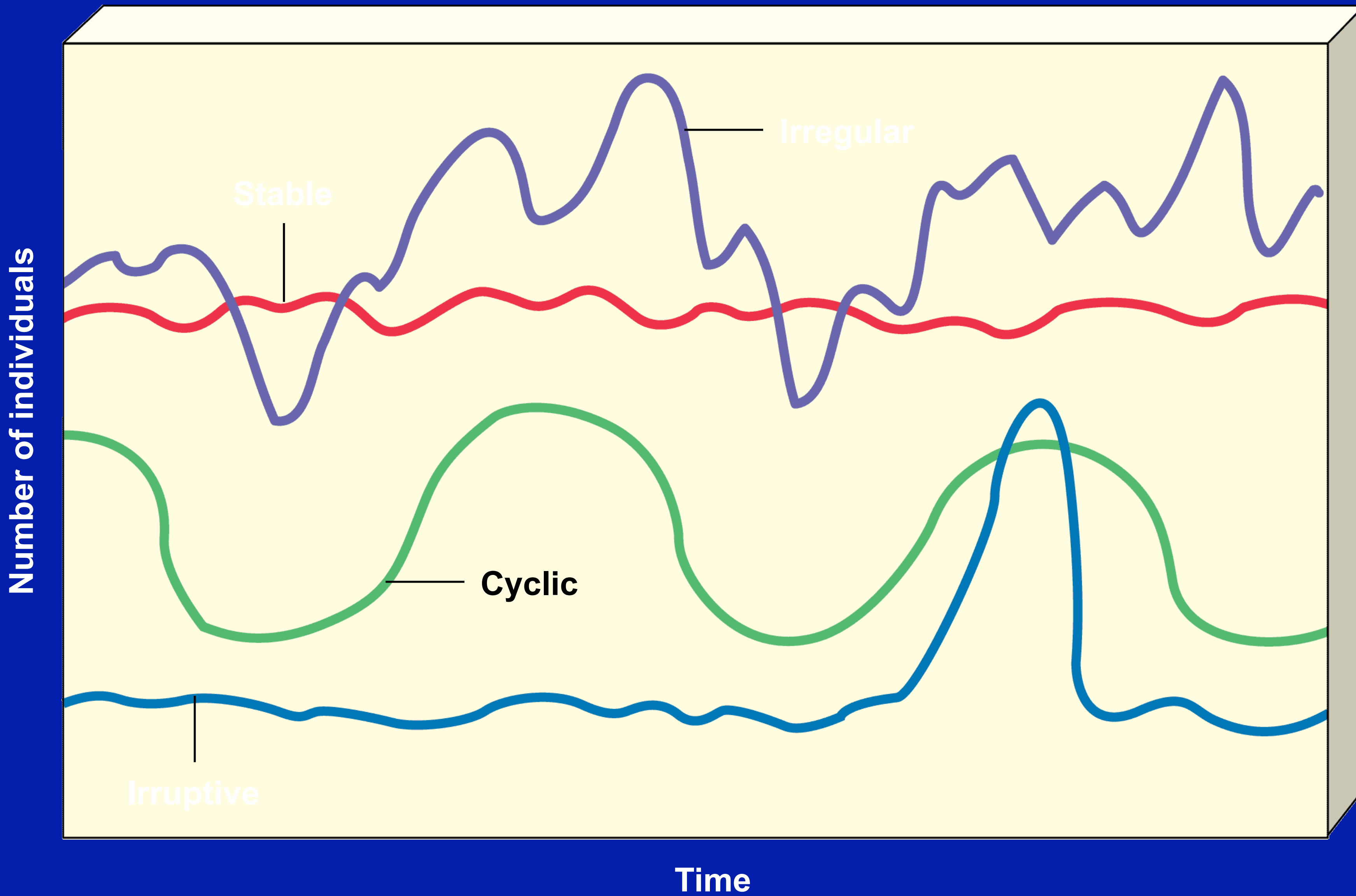
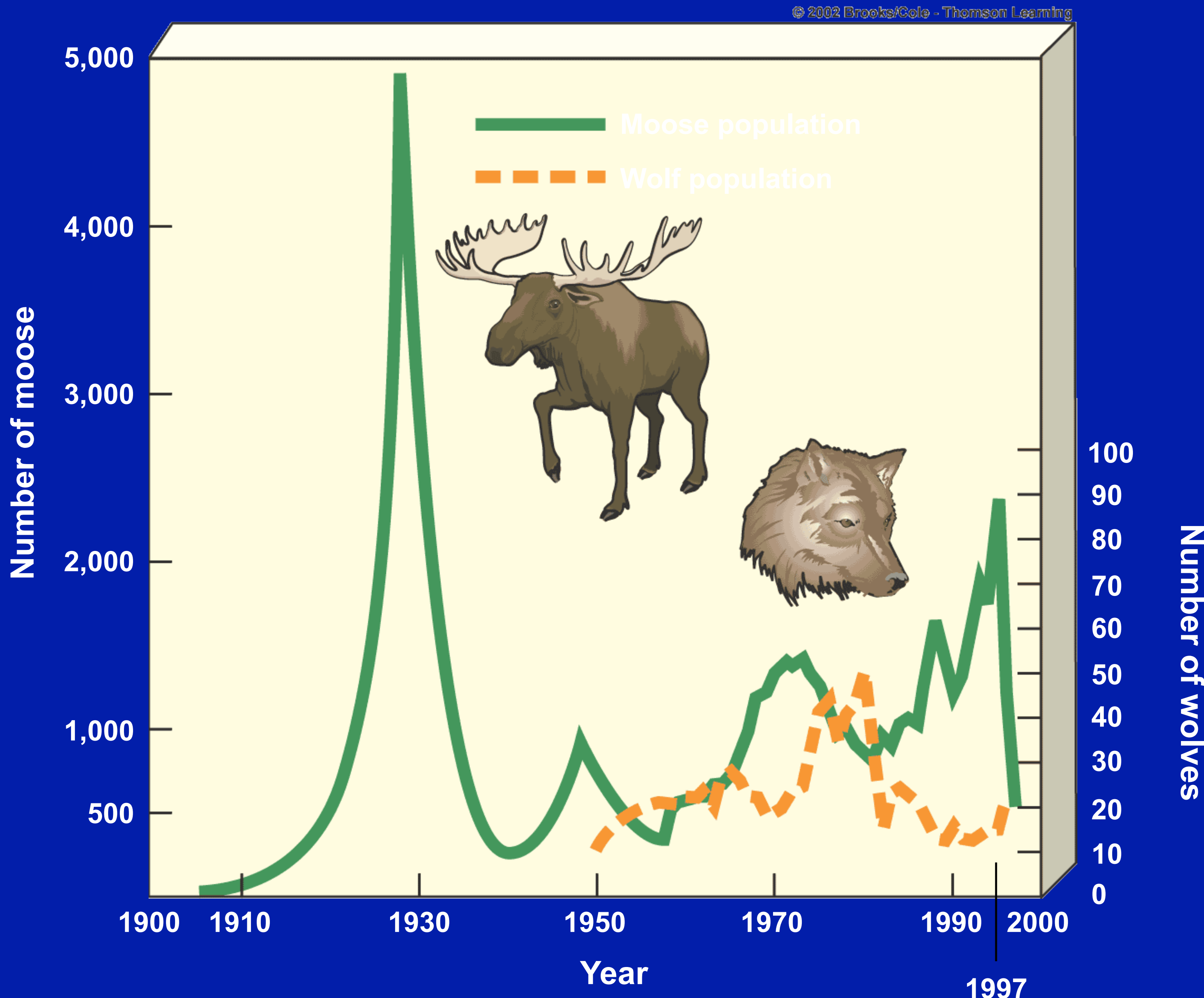

Irregular
Stable
Cyclic
Irruptive
Number of individuals
Time

Fig. 9.7, p. 202

HOW PREDATORS CONTROL POPULATION SIZE

- PREDATOR - PREY CYCLES - POORLY UNDERSTOOD
- SHARP INCREASE IN NUMBERS FOLLOWED BY CRASHES
  - LYNX AND HARES IN ARCTIC
- **TOP DOWN CONTROL HYPOTHESIS**
  - LYNX CONTROL HARES AND LACK OF HARES CONTROL LYNX POPULATION

- **BOTTOM UP CONTROL HYPOTHESIS**
  - HARES EAT TOO MANY PLANTS THEIR POPULATION DROPS THEN LYNX POPULATION DROPS ALSO.
- COULD BE A THREE WAY INTERACTION BETWEEN PLANTS, HARES, AND LYNXES.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Moose population
Wolf population
Number of moose
5,000
4,000
3,000
2,000
1,000
500
Number of wolves
100
90
80
70
60
50
40
30
20
10
0
1900
1910
1930
1950
1970
1990
2000
Year
1997

Fig. 9.9, p. 204

REPRODUCTIVE PATTERNS

- **ASEXUAL REPRODUCTION-** ALL OFFSPRING ARE CLONES OF A SINGLE PARENT
  - **BACTERIA**
- **SEXUAL REPRODUCTION -**COMBINATION OF GAMETES FROM BOTH PARENTS
  - **97% OF ALL ORGANISMS REPRODUCE SEXUALLY**
  - GIVES GREATER GENETIC DIVERSITY IN ORRSPRING

R-SELECTED SPECIES - GENERALISTS

- SPECIES REPRODUCE EARLY AND PUT MOST OF THEIR ENERGY INTO REPRODUCTION
  - HAVE MANY OFFSPRING EACH TIME THEY REPRODUCE
  - REACH REPRODUCTIVE AGE EARLY
  - HAVE SHORT GENERATION TIMES
  - GIVE OFFSPRING LITTLE OR NO PARENTAL CARE
  - ARE SHORT LIVED

K-SELECTED SPECIES - COMPETITORS

- PUT LITTLE ENERGY INTO REPRODUCTION
- TEND TO REPRODUCE LATE IN LIFE
- ARE FAIRLY LARGE
- MATURE SLOWLY
- ARE CARED FOR BY ONE OR BOTH PARENTS
- MANY ARE PRONE TO EXTINCTION

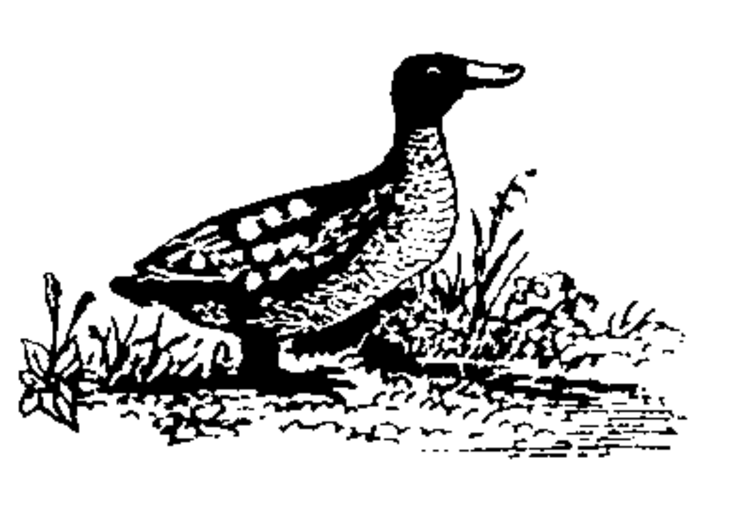
- K-selected species do better in ecosystems with fairly constant environmental conditions
  - Tend to do well in competitive conditions when their population size is near carrying capacity (K)
- R-selected species thrive in ecosystems that experience disturbances

CONSERVATION BIOLOGY

- MULTIDISCIPLINARY SCIENCE
  - INVESTIGATES HUMAN IMPACTS ON BIODIVERSITY
  - DEVELOPS PRACTICAL APPROACHES TO MAINTAINING BIODIVERSITY
  - VERY CONCERNED WITH ENDANGERED SPECIES, WILDLIFE RESERVES, ECOLOGICAL RESTORATION, AND ECOLOGICAL ECONOMICS.

WILDLIFE MANAGEMENT

- DEALS MAINLY WITH GAME SPECIES



PRINCIPLES OF CONSERVATION BIOLOGY

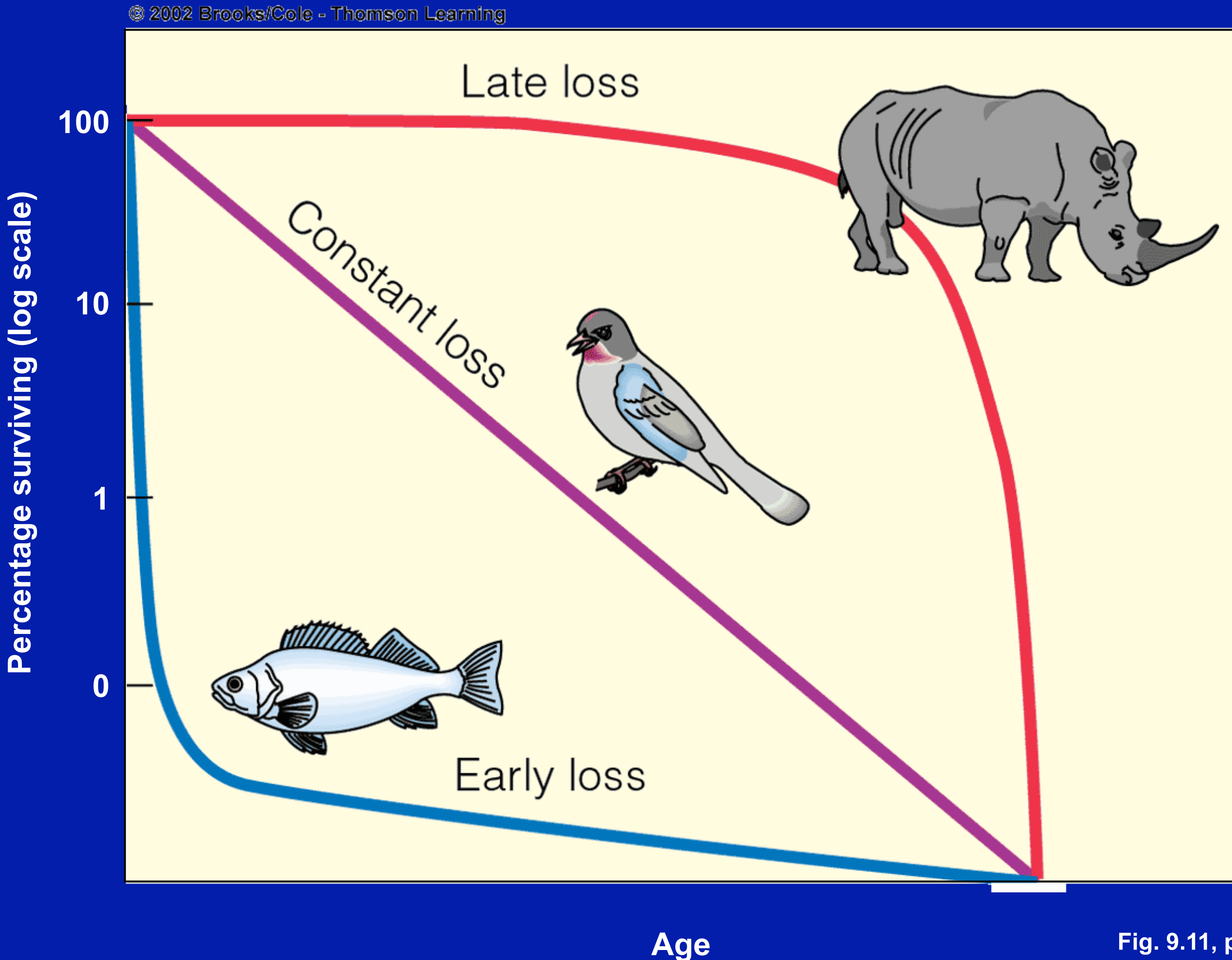
- BIODIVERSITY IS NECESSARY FOR ALL LIFE ON EARTH
- HUMANS SHOULD NOT HARM OR HASTEN EXTINCTION OF WILDLIFE
- THE BEST WAY TO PROTECT BIODIVERSITY IS TO PROTECT ECOSYSTEMS.

BIOINFORMATICS

- PROVIDES TOOLS FOR STORAGE AND ACCESS TO KEY BIOLOGICAL INFORMATION AND WITH BUILDING DATABASES THAT CONTAIN THE NEEDED BIOLOGICAL INFORMATION.

SURVIVORSHIP CURVES

- SHOW THE NUMBER OF SURVIVORS OF EACH AGE GROUP FOR A PARTICULAR SPECIES
- SELECT A COHORT
- FOLLOW THEM THROUGHOUT THEIR LIFE SPAN
- SHOWS LIFE EXPECTANCY AND PROBABILITY OF DEATH FOR INDIVIDUALS AT EACH AGE.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Percentage surviving (log scale)
100
10
1
0
Late loss
Constant loss
Early loss
Age

Fig. 9.11, p. 206

- THREE TYPES OF SURVIVORSHIP CURVES:
  - EARLY LOSS - typical for r-selected species
    - Annual plants & bony fish
    - MANY DIE VERY EARLY IN LIFE
  - LATE LOSS - K-selected species
    - Produce few offspring and care for them
  - CONSTANT LOSS - intermediate reproductive patterns

Humans effects on ecosystems

- Fragmenting & degrading ecosystems
- Simplifying natural ecosystems
- Wasting or destroying earth’s net primary productivity
- Strengthening some pest species, etc. by overusing pesticides and antibiotics
- Eliminating some predators
- Introducing alien species
- Overharvesting renewable resources
- Interfering with biogeochemical cycles and energy flow