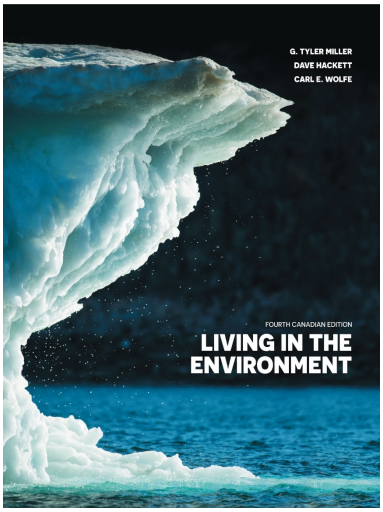
NELSON EDUCATION | Canada's Learning Advantage

NETA PowerPoint® Slides

to accompany



prepared by

Ian Dawe

Chapter 9

Population Ecology

Key Concepts

Species response to environmental stress

– Population size, density, makeup, and distribution

Species reproductive patterns

Species genetics influence population size and survival

Human impacts on ecosystems

Population Dynamics

Changes in population characteristics in response to environmental stress

- Size (number of individuals)
- Density (individuals per area)
- Age distribution

$$\text{population change} = (\text{births} + \text{immigration}) - (\text{deaths} + \text{emigration})$$

Population Dispersion

(a) Clumped
(e.g., reindeer)

(b) Uniform
(e.g., birds nesting in a colony)

(c) Random
(e.g., dandelions)

Factors Governing Population Size

Age distribution

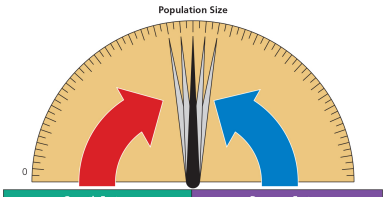
– Reproductive stage

Biotic potential

Environmental resistance

– Resource limits
– Competition
– Predation

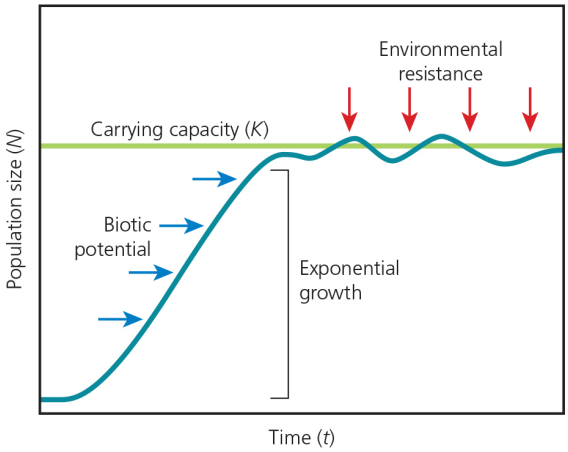
Ecological Trade-Offs



Growth Factors (biotic potential)	Decrease Factors (environmental resistance)
Abiotic	**Abiotic**
Favourable light	Too much or too little light
Favourable temperature	Temperature too high or too low
Favourable chemical environment (optimal level of critical nutrients)	Unfavourable chemical environment (too much or too little of critical nutrients)
Biotic	**Biotic**
High reproductive rate	Low reproductive rate
Generalized niche	Specialized niche
Adequate food supply	Inadequate food supply
Suitable habitat	Unsuitable or destroyed habitat
Ability to compete for resources	Too many competitors
Ability to hide from or defend against predators	Insufficient ability to hide from or defend against predators
Ability to resist diseases and parasites	Inability to resist diseases and parasites
Ability to migrate and live in other habitats	Inability to migrate and live in other habitats
Ability to adapt to environmental change	Inability to adapt to environmental change

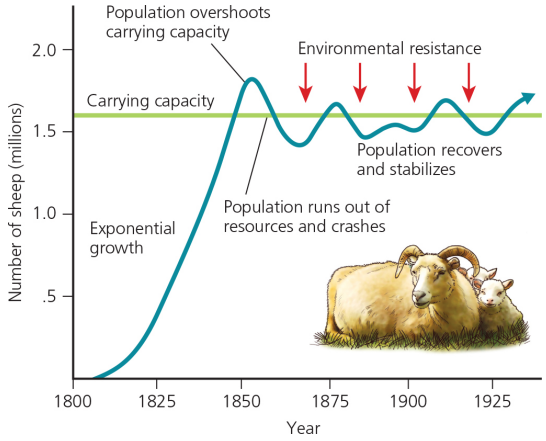
7

Exponential *vs.* Logistic Population Growth



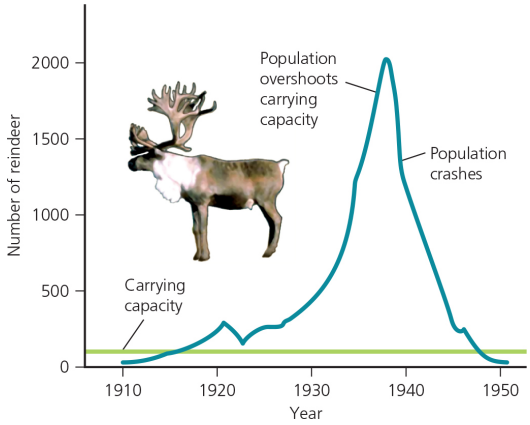
8

Logistic Growth: Tasmanian Sheep



9

Exponential Growth, Overshoot, Population Crash



10

Population Density Affects Growth — Sometimes

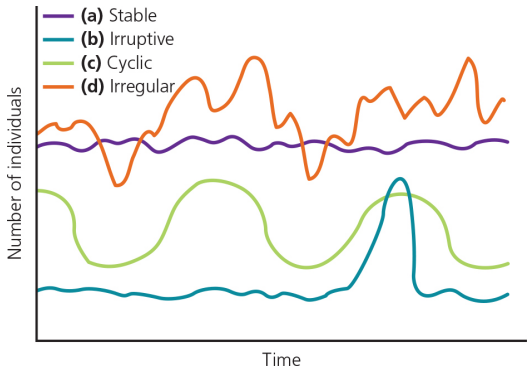
Density-independent controls

– *For example, weather events, fire, habitat destruction*

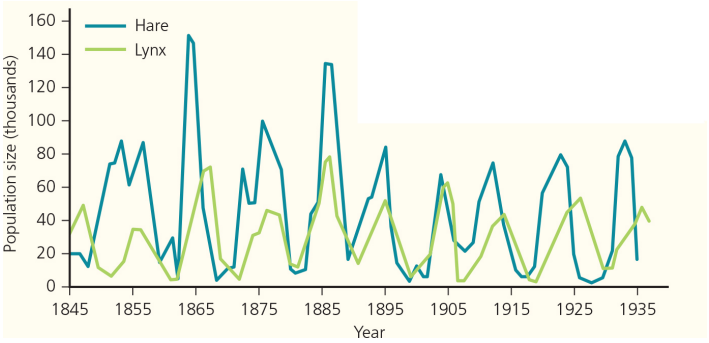
Density-dependent controls

– *For example, competition, predation, infection*

Natural Population Curves



Predator-Prey Relationship Controls Population Size



Source: Data from D. A. MacLulich

How Do Species Reproduce?

Asexual reproduction

Sexual reproduction:

Advantages

- Genetic diversity
- Males hunt, gather, protect

Disadvantages

- Males cannot give birth
- Genetic errors
- Courtship and mating require time and risk

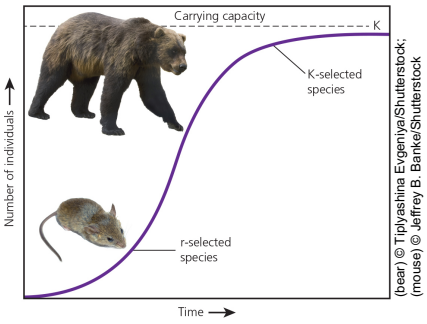
What Reproductive Patterns Do Species Have?

r-selected species

- High rate of population increase
- Opportunist species

K-selected species

- Low rate of population increase
- Competitor species



15

What Reproductive Patterns Do Species Have?

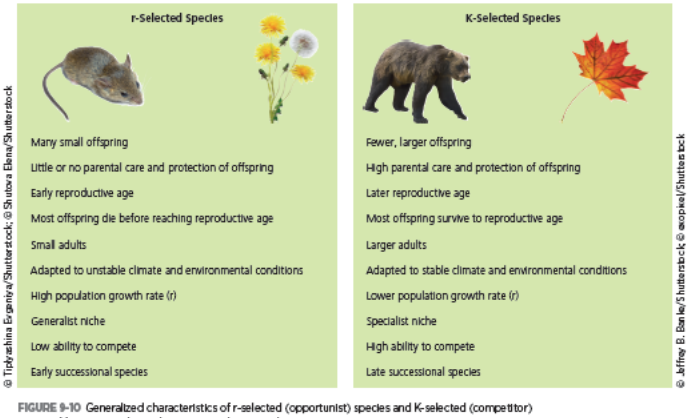
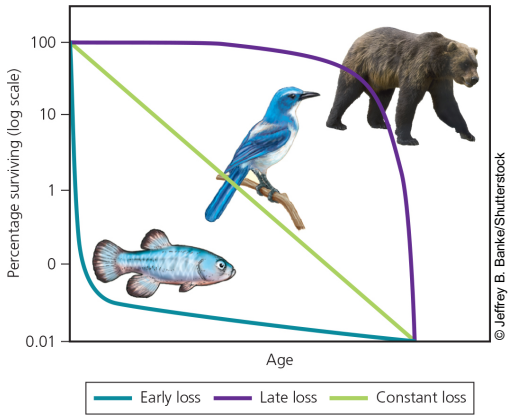


FIGURE 9-10 Generalized characteristics of r-selected (opportunist) species and K-selected (competitor) species. Many species have characteristics between these two extremes.

16

Survivorship Curves



17

Effects of Genetic Variations on Population Size

Can have greatest affect on small, isolated populations

Loss of genetic diversity due to:

- Founder effect
- Demographic bottleneck
- Genetic drift
- Inbreeding

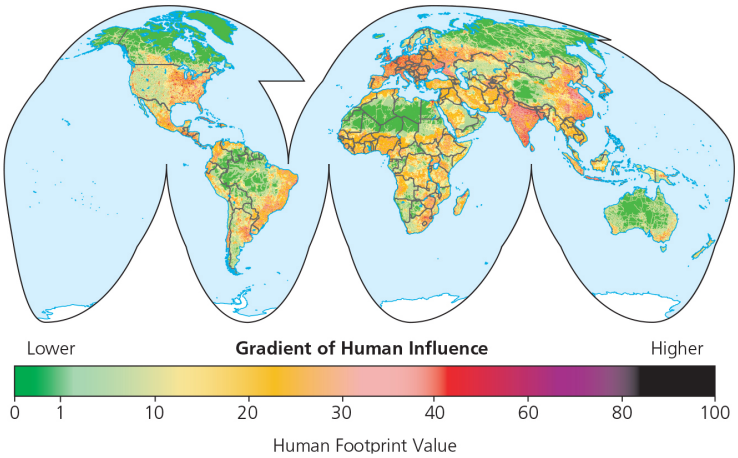
Metapopulation interactions aid in survival of small populations

18

Human Impacts on Natural Systems

Habitat degradation and fragmentation
Ecosystem simplification
Use and waste of primary resources
Genetic resistance
Predator elimination
Introduction of non-native species
Overharvesting renewable resources
Interference with ecological systems
Creating fossil fuel dependent systems

Human Footprint on the Land



Source: Data from Wildlife Conservation Society and the Center for International Earth Science Information Network at Columbia University (CIESIN). Reprinted by permission.

How Can We Live More Sustainably?

Property	Natural Systems	Human-Dominated Systems
		
Complexity	Biologically diverse	Biologically simplified
Energy source	Renewable solar energy	Mostly nonrenewable fossil fuel energy
Waste production	Little, if any	High
Nutrients	Recycled	Often lost or wasted
Net primary productivity	Shared among many species	Used, destroyed, or degraded to support human activities

How Can We Live More Sustainably?

FIGURE 9-14 **SOLUTIONS**

Principles of Sustainability

The four principles of sustainability derived from observing nature have implications for the long-term sustainability of human societies. We can learn to understand and work with nature.

How Nature Works

- Runs on renewable solar energy
- Recycles nutrients and wastes; produces little waste
- Uses biodiversity to maintain itself and adapt to new environmental conditions
- Regulates a species' population size and resource use by interactions with its environment and other species

Lessons for Us

- Rely mostly on renewable solar energy.
- Prevent and reduce pollution, and recycle and reuse resources.
- Preserve biodiversity by protecting ecosystem services and preventing premature extinction of species.
- Reduce births and wasteful resource use to prevent environmental overload and depletion and degradation of resources.

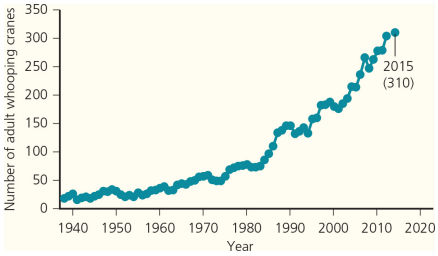
(Left: © Rich Carey/Shutterstock; (Right: © Sean D/Shutterstock

Growth of Whooping Crane Population

After falling to a population size of 22 in 1941, population has been growing

Approaching wetland carrying capacity

Numbers good, but flocks are still relatively small and isolated



Source: Data from the International Crane Foundation and the U.S. Fish & Wildlife Service

Conclusion

Population size and growth are determined by a number of factors.

Environment imposes limits on population size.

Populations can interact.

At-risk populations can bounce back with good management.