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Chapter 5 Population dynamics

Question set 5.1

1 A population is a group of species living in one place at one time.

2 r-selected species seize the opportunities that changes to an ecosystem bring. They will often move in after a fire or land-clearing, colonising new environments as quickly as they are able.

3 K-selected species exist close to the carrying capacity of their environment. They will compete for resources, unlike r-selected species that colonise an area with unlimited resources.

4 A healthy ecosystem has a variety of species. Pressure on species may create vulnerability and possibly extinction.

Worked example 5.1

1 growth rate $= (br + ir) - (dr + er)$

growth rate $= (59$ per $1000 + 105$ per $1000) - (86$ per $1000 + 40$ per $1000)$

$\qquad = 38$ or 3.8%

2 growth rate $= (br + ir) - (dr + er)$

growth rate $= (150$ per $1000 + 59$ per $1000) - (29$ per $1000 + 30$ per $1000)$

$\qquad = 150$ or 15%

Worked example 5.2

1 **a** $65 \div 2 \text{ m}^2 \times 24 = 1.35$ individuals per m^2

   b $110 \div 5 \text{ m}^2 \times 12 = 1.83$ individuals per m^2

Worked example 5.3

1 Total population $= \dfrac{30 \times 50}{10} = \dfrac{1500}{10} = 150$ individuals in the total population

2 Total population $= \dfrac{10 \times 200}{50} = \dfrac{20000}{50} = 400$ individuals in the total population

Experiment 5.2: Estimation of population size

Discussion

1 Responses will vary.

2 Responses will vary.

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3 Some advantages of the capture–mark–recapture method:

- This method is accurate for mobile species in a defined area.
- Not all individuals need to be counted, when using this method.
- Animals are unhurt when captured and released (although they may be stressed when captured).
- This method allows for extended analysis if the population is sampled over a long period of time.

Some disadvantages of the capture–mark–recapture method:

- The chances of each individual being caught are not equal. This can lead to inaccuracy.
- Sometimes 'trap happy' individuals will be sampled over and over.
- The mark on the individual may disappear or the marked individuals may have moved away from the sample area or died.

Question set 5.2

1 Birth rate, death rate, emigration rate and immigration rate

2 Populations are distributed in three basic patterns:

- Random distribution: organisms are spaced unevenly, at random.
- Uniform distribution: organisms are evenly spaced.
- Clumped (grouped) distribution: a number of groups of organisms make up the population as a whole.

3 The abundance is the number of a species in a population, whereas geographic distribution is the places in the ecosystem where individuals of the species are found. Population density refers to the number of individuals in a given area, whereas the carrying capacity is the size of a population that an ecosystem can support.

4 In an open ecosystem, population growth depends not only on birth and death rates but also on immigration and emigration whereas, in a closed ecosystem, growth depends only on birth and death rates.

5 growth rate $= (br + ir) - (dr + er)$

$$= (1000 + 72) - (345 + 108)$$

$$= 1072 - 453$$

$$= 619 \text{ in one thousand or } + 61.9\%$$

6

Method	Brief description	Best used for
Direct observation	Counting individuals in a given area or counting individuals passing a point at a given time	Mobile organisms
Sampling: • transect	Straight line drawn through an environment	Environmental gradients (vertical and horizontal changes in environment)
Sampling: • quadrat	Several quadrats representative of an area are sampled at random. The total number can be calculated and density can be calculated: $$D = \frac{\text{total number of individuals}}{\text{area of each quadrat}} \times \text{number of quadrats}$$	Distribution, abundance and density
Sampling: • capture–mark– recapture	Total population $(N) = \dfrac{M \times n}{m}$ M = number marked in first sample n = total recaptured m = number of recaptured animals that are marked	Random sample of mobile species
Telemetry	Remote tracking using technology such as GPS	Predicting future needs and resource management

Question set 5.3

1 Responses will vary.

2 Environmental resistance involves environmental factors that adversely affect populations.

3 Survivorship curves illustrate the probability of a species' survival.

Question set 5.4

1 a When environmental conditions change and favour a rapid increase in numbers of a species at the expense of others, that species can become a pest.

b Advantage: rapid control

Disadvantages: accumulation of chemicals, perhaps non-biodegradable; species other than the target species may be affected.

2

| Method of biological control (agents)	Examples
General predators	Cane toads to control sugar pests
Specialised predators	Weevils to control water weeds Moths and flea beetles to control alligator weed Beetle and water hyacinth etc.
Parasites	Wasps and stem-girdler moths Nematodes and *Sirex* infestations of softwood plantations
Microbial diseases	Myco-insecticides (fungal) and grubs

3 Responses will vary.

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Chapter review questions

1 K-selection: while some individuals may not survive initially, over the long term a sustainable population can be maintained.

r-selection: opportunistic species quickly colonise an unstable ecosystem, leading to a pattern of rapid population increase and decrease (or crash), and eventual take over by competitors.

2 Density-dependent factors include competition, disease, parasites, predation and food supply. Density-independent factors include physical factors and chemical factors (e.g. bushfires, drought).

3 Resources would be distributed in a pattern that mirrors the population distribution pattern.

4 The mark may disappear; the marked individuals may have moved away from the sample area or died.

5 a Soil nutrients, water and amount of light

   b Breeding sites and other penguins

   c Water, sunlight, climatic conditions

6 Responses will vary.

7 a Rock pools: wave action; amount of water – danger of drying out; hardness and size of rocks.

   b Zone above the splash zone: salinity; temperature variation; slope; hardness and size of rocks.

   c The sublittoral zone: dissolved oxygen; amount of light.

8 A population is increasing in size when the birthrate and immigration rate are higher than the death rate and emigration rate.

9 Healthy population growth is likely from a population whose individuals are predominantly at the reproductive age. If population numbers show a gender bias or more individuals above and below the reproductive age, future growth is likely to be limited.

10 a Sample population density $= \dfrac{\text{total number of individuals in sample area}}{\text{area of quadrat} \times \text{number of quadrats sampled}}$

$$= 186 \div (100 \text{ cm}^2 \times 10)$$

$$= 186 \text{ per } 1000 \text{ cm}^2$$

Population size (abundance) $=$ population density $\times$ total area of study

$$= (186 \text{ per } 1000 \text{ cm}^2) \times (10\,000 \text{ cm}^2)$$

$$= \dfrac{186 \times 10000}{1000}$$

$$= 1860$$

   b Depending on terrain, a pitfall trap or Tullgren funnel could be used to obtain the count of beetles.

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11 a
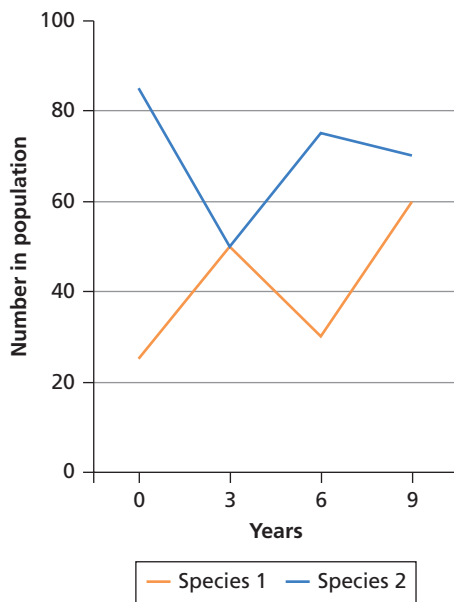
b Species 1 fluctuates over the nine years. It increases then decreases and then increases again. Species 2 also fluctuates over the nine years. It decreases then increases and then decreases slightly.

c Species 1 is likely to be the predator. The numbers of prey are normally higher than the predator numbers.

12 a Rapid response is an advantage of spraying chemicals. The potential for the accumulation of toxic chemicals/pesticides is a disadvantage.

b Winemakers are using the *Trichogramma* wasp as a specialised predator to control the population of apple moths. This is a form of biological control.

c This will depend on students' responses.

13 a Sampling determines the distribution and abundance of the wallabies. This can help us understand how the vulnerable wallaby species is able to survive any sort of disruption to its habitat.

b Sampling determines if the number of ducks in the population is at a sustainable level.

14 a Widespread, heavy rain and plentiful food such as grain crops

b Locusts are r-selected species. Their numbers rise very quickly and decline just as rapidly.

c This will depend on students' responses.

d Spray pesticides on adult locusts; spray hoppers before they start to swarm; dig up and destroy egg nests.