MODLIN™

MODLIN EDUCATION (PTY) LTD

Strand			Environmental Studies											
Topic			Population ecology											
Type of question			Multiple choice											
LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔					✔			✔		

What do we call a population of similar cells?

A. a person
B. an organ
C. a tissue
D. a system

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				✔					✔			✔		

If you use the word “population” to refer to any one type of living organism, what has the largest population in South Africa?

A. humans
B. insects
C. bacteria
D. invertebrates

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In a normal stable environment, would the population of any one type of organism grow:

A. very quickly?
B. very slowly?

C. not at all?
D. at a very steady pace?

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If we find out how a population of micro-organisms such as yeast changes in different conditions, does this tell us anything about how a population of elephants or people changes?

Answer 'Yes' or 'No' and then choose the best explanation for your answer.

A. In science we are trying to find common features of living organisms. The science of population studies investigates the factors that affect all living organisms. For example, a study of yeast cells can tell us something about elephant because they both have the features of life.

B. Yeast and elephants have nothing in common and therefore we cannot use the yeast population to explain what we observe in the elephant population.

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Insert pic from page 2 – a shoal of fish

Why is this shoal of fish considered to be a population?

A. All the fish are the same species.
B. The fish live together.
C. The fish all belong to the same species and live in the same area.
D. The fish breed with each other.

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Insert a photo of a typical waterhole scene – impala, kudu, giraffe, zebra – type of animals is not important, as long as there are definitely more than one species present in the photo.

Why does this photo NOT represent a population?

A. The area represented is not large enough.
B. The animals represented are not all from the same species.
C. These animals do not all live in the same area.
D. There is insufficient evidence from the photo to answer the question.

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Insert photo of flamingos from top of p4 but no caption

We know these flamingos belong to the same species because

A. they look alike and behave in the same way.
B. they can interbreed with each other.
C. both A and B
D. neither A nor B

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The meaning of the word species is not always clear. It is an idea that scientists have invented to explain things around us. The idea of a species comes from the work of Carl Linnaeus (1701 – 1778) and other biologists who saw the world as consisting of different types of living things that are distinct from one another and unchanging.

Who challenged this scientific definition of a species?

A. Carl Linnaeus
B. Gregor Mendel
C. Charles Darwin
D. Charles Lyall

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Why did Darwin's theories challenge the previously held definition of a species?

A. His theory suggested that types of living things are not distinct and are always changing as a result of evolution.
B. Darwin believed that the word "species" cannot be defined because each type of organism changes with time.
C. Darwin's theory rejects fixity of species.
D. All of the above.

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insert photo from top of p3 – no caption please

Why is this group of gannets regarded as a population?

A. They are all the same species of bird.
B. They are all the same species, in the same area and they can interbreed.
C. They can breed with each other.
D. They are not regarded as a population.

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Study each of the examples below. In each one, decide whether or not the word *population* is used as it has been scientifically defined. Record your decision and your reasons for it.

1. The population of South Africa is 48 million people.
2. The population of the world is over 6 000 million people.
3. The population of bacteria in our gut helps to keep us healthy.
4. The cheetah population of Africa is getting smaller every year.
5. The population of trees in Inkwezi forest is being damaged by people looking for firewood.
6. The population of *Amoeba* cells in the puddle is increasing because it has been raining a lot.

1. Yes, because it is one species in one area and there are no limits (except social) on breeding.
2. Yes, for the reasons given in Number 1 but it could also be argued 'no' because breeding may not be at random if people cannot move about freely in the world.
3. No, because there are many different species of bacteria in our gut.
4. No, because in South Africa cheetahs live in many isolated areas that do not have free access to each other so random interbreeding cannot happen.
5. No, because the forest has many different species of trees and populations consist of one species.
6. Yes, because we are discussing one species in one clearly defined area. However, *Amoeba* does not readily or usually breed sexually so it could be argued that this is not a true population.

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Please insert the graph from p4 but DON'T label the circles A, B and C – leave the circles blank.

Label the circles A, B and C after reading the following niche descriptions.

Species A is adapted to living in a cool, dry climate such as the coniferous forests of northern Europe.
Species B is adapted for living in a hot, wet climate such as tropical rainforests.

Species C has a more restricted ecological niche for these two factors because it is adapted to live in an area with an average temperature of about 18ºC and an average annual rainfall of about 500mm.

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food, **space**, **shelter**, **water**, **mates, disease, predation**

Use one of the density dependent factors listed above to identify each kind of competition described below:

Two impala rams are seen fighting with each other.
mates

In a famous experiment reported in Scientific American magazine in 1962, scientist John B. Calhoun kept a colony of rats for more than two years in a 1 000 m_2 cage. He started with five pregnant females and provided plenty of water, food and nesting material. Rats breed quickly and five females could produce a colony of 50 000 rats in two years. However, the population was never more than 200, and was usually about 150 rats.
space

The closer organisms are to each other, the easier it is for the pathogen to infect more animals. In very dense populations, pathogens can spread very quickly and kill many animals.
disease

If you put fruit flies into a closed bottle that contains plenty of their food, the population increases because they reproduce very quickly. Eventually the population growth will decrease.
food

In dry periods, populations tend to gather around waterholes. Many fights break out around the waterhole.
water

If the population becomes too large, predators can find individuals easily and the population will not increase. If there are too many breeding pairs, the young will be preyed upon more easily and the population will decrease.
shelter

The increased number of lions will cause the impala population to decrease.
predation

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If there are 200 fish in a 100 m^2 farm dam, what is the population density?

A. 200 fish per m^2
B. 2 fish per m^2

C. 10 fish per m^2
D. 1 fish per m^2

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✔	✔	✔	✔								✔		✔	

Tribolium is a small, black beetle that lives in fl our. A bag of 500g flour may contain many beetles.

insert diagram from p8

A scientist followed the following method to calculate the number of beetles in the flour.

1. Gently shake the container to mix the flour and beetles well.
2. Use the balance to weigh out 5g of the mixture.
3. Spread the 5g of mixture on the sheet of white paper and count the number of beetles in it.
4. Record the number of beetles in the sample. Use the pin to gently separate the beetles out as you count them.
5. Replace the sample.
6. Shake the container gently again.
7. Repeat Numbers 2 to 6 ten times.
8. Use your data to calculate the average number of beetles in 5g of the habitat. To work out the average, add the number of beetles in the ten samples and divide the total number by ten.
9. Your 5g sample is 1% of the habitat. Use this to calculate the total population size.

(a) The scientist got some irregular readings. Should he use any irregular readings when calculating the average, or should he leave them out?
It is likely that one or more readings will have deviated quite a lot from the others.
Irregular readings should be included. Scientists should never ignore readings that conflict with what they are expecting.

(b) Do you think that the calculated population size is a close estimate of the real total?

It is generally accepted that a 10% sample should give a good estimate. Ten estimates of 1% each are therefore likely to be a good estimate.

The scientist then poured the flour through a sieve. He put the beetles that he collected in the sieve on a sheet of
paper. He counted the beetles to check how close his calculated population size was to the actual size.

(c) What was his hypothesis?

The hypothesis must be a statement, for example, 'There are 500 beetles in the flour'.

(d) Why did he take the average of ten readings?

Ten readings were taken to bring the total sample to about 10% of the total because a 10% sample is usually seen as a suitable size.

(e) Why did he replace the sample each time after he had counted it?

The sample was replaced otherwise the following samples would not be the correct proportion of the total amount. Also,
the number in the population would have changed if the individuals were not put back.

(f) How close do you think his estimate of the population size was to the real population size?

If there were 10 samples, it is quite likely that the estimate is within 10% of the correct total.

(g) How could he improve his estimate?

By taking large samples and/or more of them. You could point out that if the learners took out one huge sample
which was the whole jarful, they would have got a 100% accurate answer. The learners may want to answer with points such as 'count more carefully' or 'not lose any of them when putting them back in the jar' but these are errors of technique
not experimental errors so are not valid here.

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✔	✔	✔	✔								✔		✔	

Leloko and Anne decided to test the transect and quadrat methods of sampling.

They found an area in their school grounds that has a variety of plants.
They measured out an area that was 10m × 10m.

Leloko used the quadrat method and Anne used the transect method.

They decided which plant they would be sampling. They didn't know the name of the plant, but it was easy to recognise it growing in the grass and garden. It had small yellow flowers and thin leaves.

1. Was it a problem that they didn't know the name of the plant, do you think?
A. Yes. This is a scientific investigation and it is important to know the correct name of the plant.
B. No. The name isn't important, as long as the plant is recognised both as a young plant and a mature plant.

2. How large should their sample will be (how many quadrats or transects should they use)?
A. It doesn't matter how large the sample size is.
B. They need to sample about 10% of the total area of a small area. If they sample less than 10%, the estimates can be inaccurate.

3. How should they randomly choose the areas to be sampled?
A. They could close their eyes and throw the quadrat, transect line in a different direction each time.
B. They could number all the possible quadrats/transects on a map of the area. They write the number of each quadrat/transect line on the map onto a piece of paper and put all the pieces of paper

into a box. Each piece of paper will represent one quadrat/transect line. Then they take out pieces of paper at random from the box. The number on each piece of paper will tell them exactly where in the area they should place the quadrat/transect line.
C. Both ideas are good ones. There are several ways of choosing things at random.

4. How will Leloko and Anne get the information they need, i.e. the population density of the plant they have selected?
The information needed will be the proportion of the whole area being sampled and the number of individuals of that type in the sample. A map of the whole area, with a scale, can be used to measure the total area and the number of quadrats will give the sampled area. Then the number of weeds counted in the quadrats will give the sample size.

5. What is the best way for them to record the information?
A. On a piece of paper
B. In a table
C. In a graph
D. Verbal description

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			✔							✔		✔		

In the mark-recapture technique we use the **Petersen Index** formula:

If $\frac{\text{Marked individuals in the sample (R)}}{\text{Total sample size (C)}} = \frac{\text{Marked individuals in the whole population (M)}}{\text{Total population (N)}}$

Then $N = \frac{M \times C}{R}$

• M is the total number of marked individuals in the population, because you marked them
• C is how many individuals there are in the sample you took, because this is the size of your sample
• R is the number of marked individuals in the sample, because you can count them.
It is therefore easy to calculate the only thing in the formula you do not yet know, which is N = the total population.

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A scientist uses the Petersen index to calculate the size of a population of crabs in some rock pools.

Answer True or False:

He says that the size of the sample may affect the accuracy of his estimate.

True: Yes, because the larger the sample the more accurate the estimate will be. A sample that was 100% of the population would be completely accurate because all of them would be counted while a sample of 0% of the population would be completely inaccurate.

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What could you do to make an estimate using the mark-recapture method of determining population size more reliable?

A. Count more carefully.
B. Count all the organisms.
C. Make the sample a larger proportion of the total population.
D. Do a census.

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Suggest any two situations where the mark-recapture method of determining population size might be useful to life scientists.

A. For populations that move about and cannot all be trapped and counted in a census.
B. For plants and small organisms.
C. For very large organisms and populations that change rapidly.
D. None of the above

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An angler went fishing for trout in a farm dam. On the first day he caught 20 fish. He kept these trout alive and fixed a small metal tag securely to the gill cover of each one. At the end of the day he released his trout back into the water. The second day, he went fishing again. He did even better. On the second day he caught 25 fish. Of these, he found that 5 had his metal tags on their gill cover.

What is an accurate estimate of the total number of trout in the farm dam?

100

How did you work out your estimate? Show the calculations.

Using the Petersen formula

$$N = \frac{M \times C}{R}$$

$$N = \frac{20 \times 25}{5}$$

$$N = 100$$

How accurate do you think your estimate is? Give two reasons why you think it is either accurate or inaccurate.

Fairly accurate. Two reasons are: The sample was a large proportion of the total population; in one day there would be few births or deaths to affect the calculation.

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The accuracy of the mark-recapture technique depends on certain criteria. Decide whether you think each listed criterion is TRUE or FALSE.

1. The marking must not affect the life of the animal in any way.

TRUE / FALSE

If the marking affects the animal's behaviour so that it is less likely, or more likely than other animals to be captured, then the formula will not apply. The method depends on the fact that each animal must be equally likely to be captured each time.

2. The mark must remain on the animal for the whole investigation.

TRUE / FALSE
If the mark wears off, the count of animals with a mark that were recaptured would be wrong.

3. The second and/or subsequent samples can be taken immediately the first sample is returned to the environment to speed the process up.

TRUE / FALSE
The marked animals must mix completely with the rest of the population before the second or subsequent sample/s is/are taken. If the marked animals are put in one part of a field and the second capturing happens immediately in a different part, none of the marked animals would be recaptured. The animals must be equally spread out so that each one is equally likely to be captured each time.

4. There must be no immigration into the population or emigration out of it.

TRUE / FALSE
This would change the population size so it would not be the same population that was being sampled and the totals would be incorrect.

5. This method takes into account births and deaths in the population during sampling.

TRUE / FALSE
There should be no births or deaths during the investigation because this would change the size of the population.

6. The marking must be carefully done so that the marked animal is not in any way prejudiced in its natural life.

TRUE / FALSE
The chances of an animal being captured must not change due to its age or experience of being caught. If an animal is less likely to be caught a second time, the number of marked recaptured animals would be lower than it should be. The marking must also not make the animal more likely to be caught by predators, or seen by prey if it is a predator.

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Reorganise the information in each row.

Please muddle the info across the rows for learner to sort and correct.

Type of population distribution	happens when	examples
a **clumped** distribution	the individuals in a population are attracted to each other in some way or need a particular environmental factor to survive	• tree ferns grow along watercourses because the young ferns need wet conditions to reproduce • animals that move in herds, such as elephant
a **uniform** distribution	the individuals in a population repel each other	• some tree species make chemicals that stop others of the same species from growing nearby so that the trees are more or less all the same distance apart • many birds mark out a territory for breeding, which they defend so that others of the same species cannot come near
a **random** distribution	the position of one individual has no effect on any other individuals of the same species; the distribution pattern comes purely from chance	most solitary animals and plants which do not repel each other

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Insert population parameter table from bottom p13

If you assume that the words 'high' and 'low' in this table have the same meaning for each parameter, the following would happen to each population:
(a) There would be an increase / a decrease / little change in population size.
(b) There would be an increase / a decrease / little change in population size.
(c) There would be an increase / a decrease / little change in population size.
(d) There would be an increase / a decrease / little change in population size.

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Imagine a closed population that is doubling in size every year. The table shows how the number of individuals in the population would increase if we started with a population of 10 organisms.

insert table from p14

Use the table to draw a graph that illustrates this population's growth.

ANSWER: insert the graph from TB p9

Use your graph to answer the questions:
(a) How many years (N) does it take for the population to reach 1 010 (an increase of 1 000)?
6,6 years

(b) What is the average rate of increase per year of this population (1 000/N)?
151,52 individuals per year

(c) How many years after it reaches 1 010 does it take to reach 2 010?
One year

(d) What is the average rate of increase per year of the population for this second period after reaching 1 010?
1000 individuals per year

(e) How has the rate of increase of the population changed as it has got bigger?
The rate of increase of the population has got larger and the population has got larger.

(f) What feature of your graph illustrates:
(i) the rising population numbers?
The rising slope.

(ii) the rising rate of increase of the population?
The increasing angle of the slope.

(g) The graph has a very typical shape. Would you say it is a:
(i) straight line graph? (ii) 'S' shaped curve? (iii) 'J' shaped curve?

(h) What difficulties did you experience when trying to draw the graph and read the information from it?
To fit the larger numbers on to the graph paper, the scale is so small that the earlier numbers cannot be plotted accurately.

(i) How could you overcome any problem you mentioned in (h)?
The standard approach is to use either the logarithm of the number (for example, log10 is 1, log 100 is 2, log 1000 is 3 and so on) or to use special graph paper with logarithmic lines.
The answer to (i) may not be obvious to learners who have not done logs in mathematics. The logarithm scale uses the exponent of the number, rather than the number itself. When a log is a whole number, it represents the number of 0s after a 1 in the actual number, for example, log of 10 is 1, log of 100 is 2, log of 1000 is 3 and so on.

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Topic			Population ecology											
Type of question			Terminology											
LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔					✔			✔		

Insert graphics from top p18
Age pyramids for three kinds of population
Leave out the caption under each graph and replace with an A, B, C. Also have the captions listed randomly.
Then draw up a table:

Graph	Caption
A	In this imaginary country, the population is declining
B	In this imaginary country, the population is stable
C	In this imaginary country, the population is expanding

Match the captions to the graphs.

Strand			Environmental Studies											
Topic			Population ecology											
Type of question			Data response											
LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
	✔	✔		✔							✔		✔	✔

Use the information in the table to draw an age pyramid for the South African population.

(Note that age pyramids usually use the percentages of the population for each age group, so you will need to calculate the percentage for each group. For example, you calculate the 0–4 year male population as follows: 2 602 536 ÷ total population × 100.)

Insert the table from the TOP RIGHT p19
South African mid-year population estimates for the year 2008 (based on data from Statistics South Africa)

Answer is on p12 of TG in the middle: Percent of the South African population.

Use the age pyramid you constructed to answer the following:

1. Which type of population does the age pyramid for South Africa most resemble?

A. stable
B. expanding
C. declining

D. expanding but also stabilising

2. Are there more males or females in South Africa?

3. Which gender usually lives the longest, males or females?

Strand			Environmental Studies											
Topic			Population ecology											
Type of question			Data response											
LO1 AS			**LO2 AS**			**LO3 AS**			**Level**			**Section**		
1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**Easy**	**Med**	**Hard**	**A**	**B**	**C**
	✔	✔		✔	✔		✔				✔		✔	✔

This table shows estimates of the South African population since the first complete census in 1911.

Insert table from MIDDLE LEFT of p19
Census date South African population

Draw a line graph to illustrate the population growth of South Africa.

Answer BOTTOM graph on p12 of TG
A graph showing the growth of the South African population over a period of 90 years

1. Use your graph to estimate the population of South Africa this year.

2. If present trends continue, what will be the population of South Africa in twenty years from now?

3. What are the implications for health, food production and the environment of your estimated number for twenty years time?

1. The estimate will depend on the year. For example, for 2012 it will be approximately 47 million.

2. The estimate will again depend on the year. For example, for 2032 it will be approximately 50 million.

3. The implications are: for health – increased demand on health services, especially since the large groups between ages 20 and 35 at present will be ageing and require more care; for food production – increased demand on land to produce enough food, therefore less land available for protecting the environment .

Strand			Environmental Studies											
Topic			Population ecology											
Type of question			Short question											
LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔					✔			✔		

Match each picture to the description of social organisation:

photo of troop of baboons - stronger, aggressive individuals on edge of group warn and defend the others

photo of shoal of sardines - movement of the mass of individuals confuses predators

photo of ants foraging - workers bring food back to the rest of the colony

photo of pride of lions - strict control over which animals in the group eat from the prey first

Strand			Environmental Studies											
Topic			Population ecology											
Type of question			Multiple choice											
LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔					✔			✔		

Which is NOT an adaptation by herbivores as defence against carnivores?

A. have horns, are either agile so may be difficult to catch or are large in size so may be difficult to bring down
B. are socially organised into herds
C. have large canine teeth and claws
D. are well camouflaged so may be difficult to see in surrounding vegetation

Strand	Environmental Studies
Topic	Population ecology
Type of question	Multiple choice

LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔					✔			✔		

Wild dogs benefit from a pack structure because

A. they are solitary hunters
B. some females can be left to look after the pups while the rest hunt
C. they are fast runners
D. they require a great deal of food

Strand	Environmental Studies
Topic	Population ecology
Type of question	Multiple choice

LO1 AS			LO2 AS			LO3 AS			Level			Section		
1	2	3	1	2	3	1	2	3	Easy	Med	Hard	A	B	C
				✔						✔		✔		

There is only one queen in a termite community because

A. the other termites are controlled by the queen's pheromones not to reproduce
B. only one is needed as they produce such large numbers of eggs
C. termites have division of labour
D. this is important to the survival of the group