

GCSE Biology (9 – 1)

Populations, Sampling and Biodiversity

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/3
2	/13
3	/10
4	/8
5	/6
6	/7
7	/7
8	/11
9	/14
Total	/79
%	
Grade	

Information

- The maximum mark for this paper is 79 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Ecologists use specific sampling techniques to investigate the size of populations and to measure the biodiversity of a habitat.

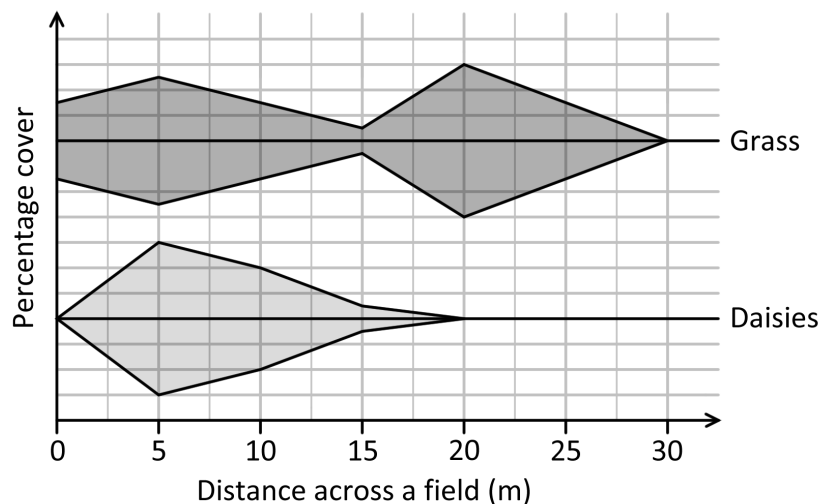
For each of the multiple choice questions below circle the letter of the correct answer for each.

- a. An ecologist wants to estimate the population of limpets, a type of snail, on a rocky shore. Her method involves capturing an initial sample, putting a small dot of waterproof, non-toxic paint on their shells, and then releasing them.

Name the ecological sampling method the ecologist is using.

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|-----------------|---------------------|-------------------|-------------------|
| A | B | C | D |
| Scaling up | Percentage increase | Aseptic technique | Capture-recapture |
| (1 mark) | | | |

- b. Ecologists collected data from a field habitat. Their results are presented in the graph below



Which technique have the students used to collect the data?

- | | | | |
|-----------------|---------------|------------|-------------------|
| A | B | C | D |
| Random quadrats | Belt transect | Scaling up | Capture-recapture |
| (1 mark) | | | |

- c. The size of a population of organisms is affected by various factors.

Which of the following is a biotic factor that would cause a population to decrease?

- A** An increase in the availability of food.
- B** An increase in light intensity.
- C** The introduction of a new predator.
- D** A decrease in soil moisture.

(1 mark)

(Total for Question 1 is 3 marks)

2. A biology teacher wanted to demonstrate how abiotic factors, such as light intensity, affect the distribution of daisy plants.

To do this, she ran a tape measure in a straight line from the base of a large tree out into an open field.

At one-metre intervals along the tape, she placed a quadrat on the ground and recorded the percentage of it covered by daisies. The figure below shows the teacher.



The table below shows the results the teacher obtained.

Distance from the tree (m)	Percentage of ground covered by daisies (%)
1	8
2	16
3	25
4	33
5	42
6	50
7	56
8	60
9	72
10	80

- a. Use the data from the teachers results to plot a graph and draw a line of best fit.



(5 marks)

- b. The teacher now wants to estimate the total population of daisy plants across the entire school field, not just near the tree. She tells the students they must use random sampling.

Explain why it is important to choose the sampling points randomly when estimating the population size of the whole field.

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(2 marks)

- c. Describe how the students could use two tape measures and a random number generator to make sure their quadrat positions are random.

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(3 marks)

- d. The teacher thinks that shade from the tree is affecting the distribution of daisy plants. Explain how the teacher's results show this.

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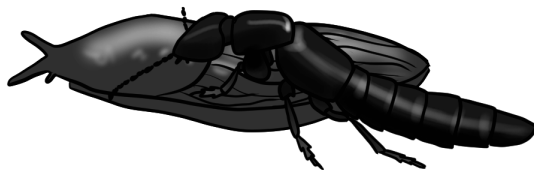
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(3 marks)

(Total for Question 2 is 13 marks)

3. A student is investigating the population of slugs in their school's vegetable garden. The slugs are eating the school's lettuce plants. To solve this problem, the student decides to use biological control by introducing Rove beetles that prey on slugs. The figure below shows a Rove beetle preying on a slug.



First, the student estimates the slug population using the capture recapture method.

After releasing the beetles, the student waits several weeks and then repeated the experiment to measure the effect on the slug population. The results of the second experiment are shown below:

Number of slugs in 1st sample	Number of slugs in 2nd sample	Number of marked slugs in 2nd sample
96	56	8

- a. Using the following equation, estimate the number of slugs in the habitat.

$$\text{Estimated population size} = \frac{\text{first sample size} \times \text{second sample size}}{\text{number of recaptured individuals}}$$

Estimated population size = ...
(2 marks)

- b. For the estimate to be valid, the student must make some assumptions. State **two** assumptions made when using the capture-recapture method.

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(2 marks)

- c. The student continues to monitor the populations. Over a long period of time, the numbers of slugs and beetles in the garden will fluctuate in a cyclic pattern.

Describe and explain this predator prey cycle.

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(4 marks)

- d. Using biological control is often better for the environment than using chemical pesticides. However, the student finds that even with the beetles present, the lettuce plants still suffer some damage from slugs.

Using your knowledge of predator-prey cycles, explain why the Rove beetles do not completely remove the slugs from the garden.

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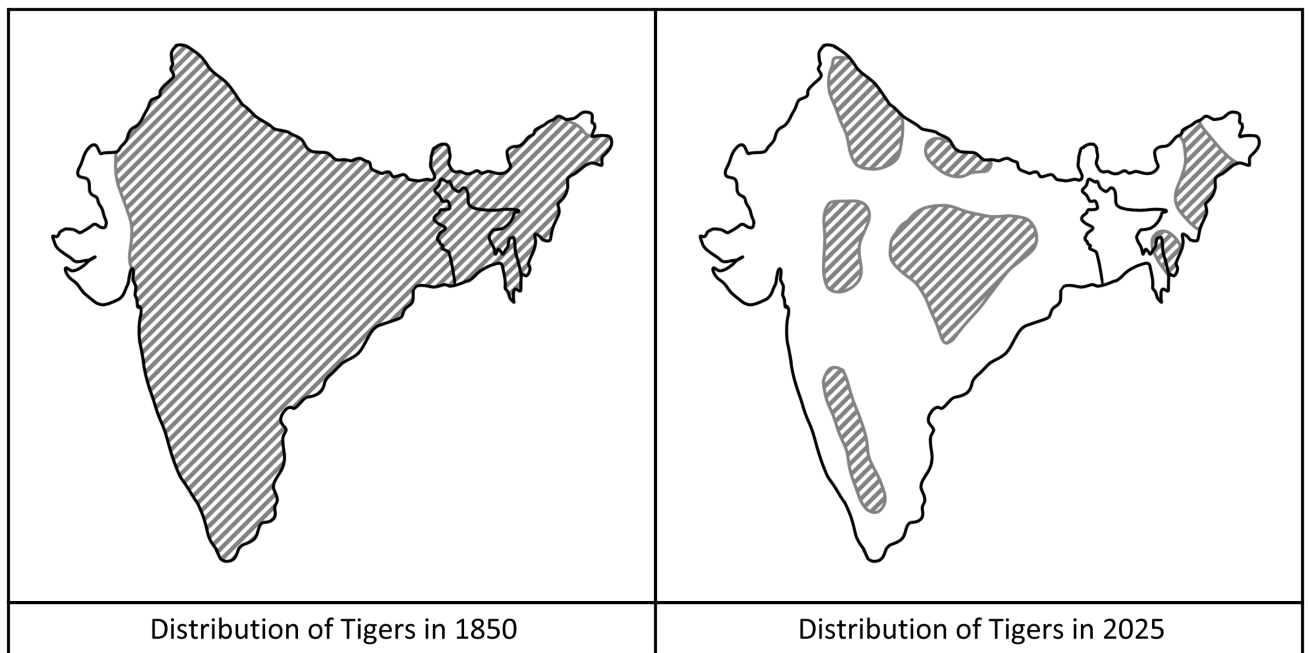
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(2 marks)

(Total for Question 3 is 10 marks)

4. The figure below shows the distribution of Tigers in India over 175 years.



- a. Deforestation is reducing the size of tiger habitats.
Explain how a reduction in habitat can increase the risk of tigers becoming extinct.

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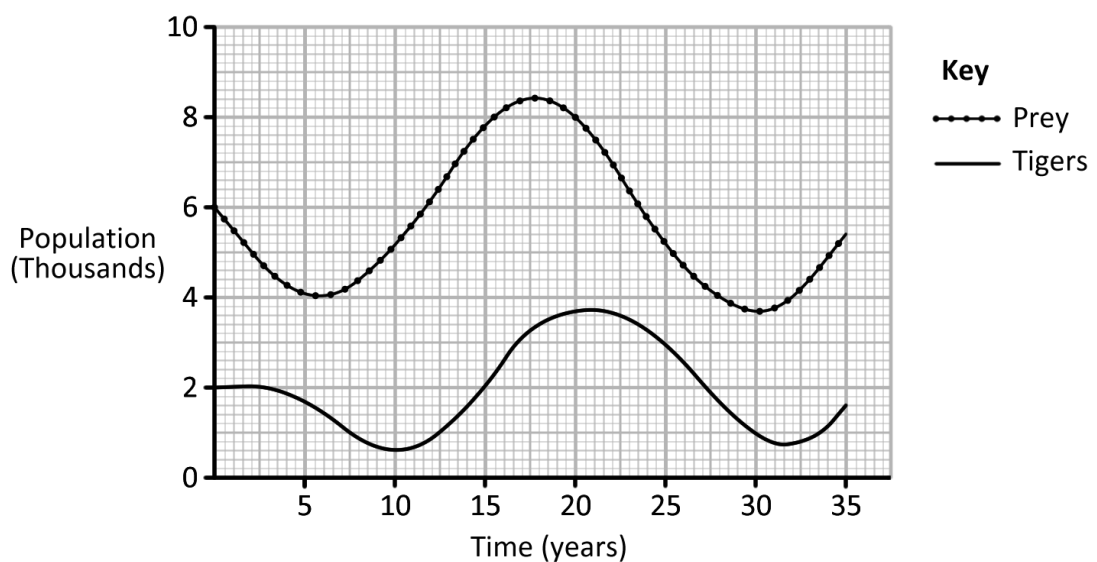
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(3 marks)

The graph shows the relationship between populations of tigers and their prey over 35 years.



- b. Calculate the percentage increase in the prey population between year 5 and year 10.
Show your working.

Percentage change = ...
(2 marks)

- c. Using information from the graph, explain the biological reasons for the change in the prey population between year 5 and year 10

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(3 marks)

(Total for Question 4 is 8 marks)

5. A farmer needs to estimate the total population of thistle plants in a large field.



a) Describe how you would use a 1 m² quadrat and random sampling to collect the data needed to make this estimation.

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(3 marks)

The farmer wants to check if the conditions in a field are suitable for growing a new crop.
To do this, they need to measure several abiotic factors.

b) Describe how the farmer could measure **three** different abiotic factors in the field.
Do not include soil pH in your answer.

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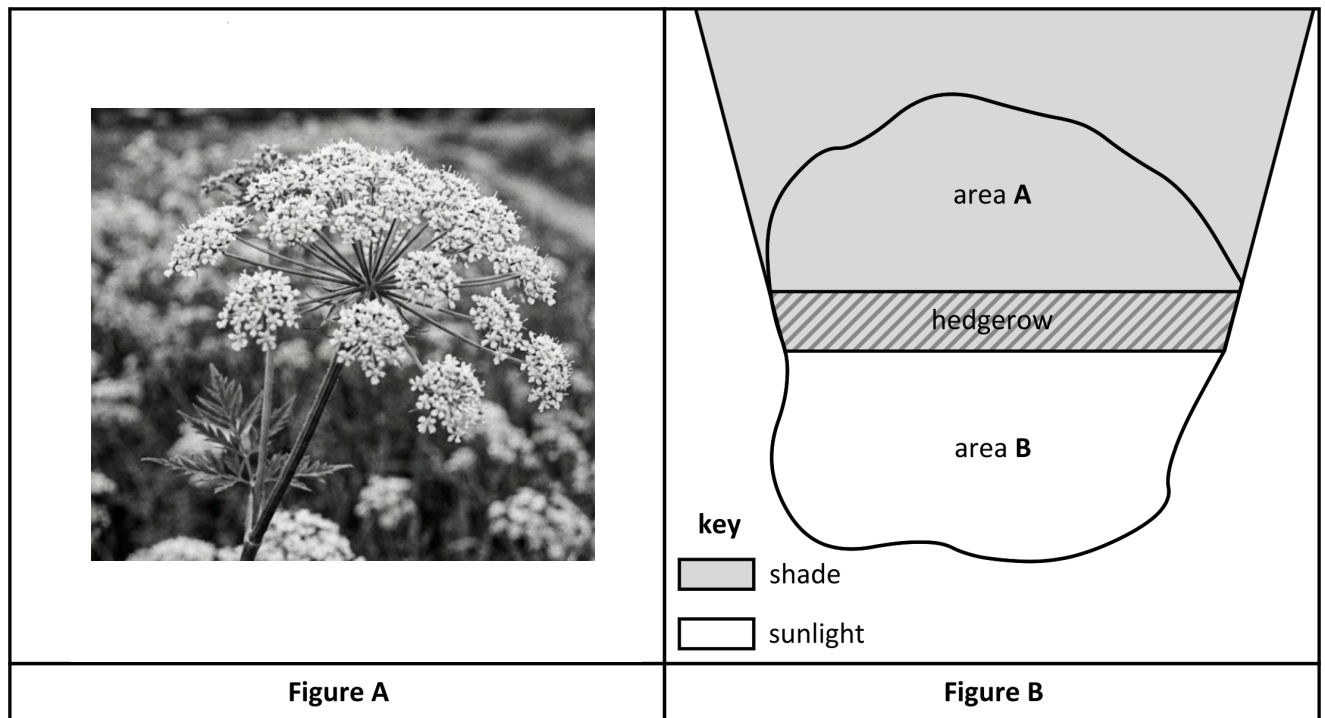
(3 marks)

(Total for Question 5 is 6 marks)

6. A student wanted to investigate how light levels affect the growth of cow parsley. They compared plants growing in two different locations: the base of a dense hedgerow and the middle of an open field.

Figure A below shows a cow parsley plant. Figure B shows a map of the area, with Area A (the hedgerow base) and Area B (the open field).

The dense hedgerow caused Area A to be in the shade for most of the day. The student decided to measure the height of the cow parsley plants in each area.



The table below shows the grouped frequency table of the students results.

Height (cm)	Frequency (Area A)	Frequency (Area B)
50 – 59	0	8
60 – 69	2	25
70 – 79	11	14
80 – 89	28	3
90 – 99	9	0
Total	50	50

- a) Calculate the estimated **mean** height of the cow parsley plants in Area A (shade).
Use the data in the table and show your working. Give your answer to **two** decimal places.

Estimated mean = ...

(3 marks)

b) The estimated mean height of the cow parsley plants in Area B (sunlight) is 65.9 cm.

Compare the results for Area A and Area B and suggest a biological reason for the difference in mean height.

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(3 marks)

c) Explain why the mean height calculated from a grouped frequency table is only an estimate.

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(1 mark)

(Total for Question 6 is 7 marks)

7. A student wanted to estimate the population size of woodlice living under a large, rotting log in their garden using the capture recapture technique.

The student's method:

- They captured a sample of woodlice from under the log.
- They carefully marked the upper side of each woodlouse with a small dot of nontoxic white paint.
- They recorded the number of marked woodlice and released them back under the log.
- Two days later, they returned and captured a second sample of woodlice from the same location.

The student's results:

- Number of woodlice marked and released in the first sample = 40
- Total number of woodlice captured in the second sample = 35
- The student's final population estimate = 280 woodlice

- a) Using the student's data, calculate the number of marked woodlice that were captured in the second sample. Show your working.

Number in the second sample = ...

(3 marks)

- b) The student's population estimate of 280 may not be accurate because the conditions for the mark-recapture technique might not have been fully met.

Describe two different factors that could have caused the student's estimate to be inaccurate. For each factor, explain the effect it would have on the final population estimate.

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(4 marks)

(Total for Question 7 is 7 marks)

8. The figure below shows some Eurasian lynx. The Lynx is a medium sized cat about the size of a labrador.

Lynx have been extinct in the UK since the middle ages but are increasing in number in Europe.



Lynx commonly hunt deer and rabbits though they are capable of taking sheep as well.

There have been many calls for reintroducing Lynx back into the UK in Scotland and Northumberland to help control the population of deer. Farmers in these areas are resistant to the reintroduction of Lynx.

- a) Describe why farmers might be resistant to the reintroduction of Lynx in their areas.

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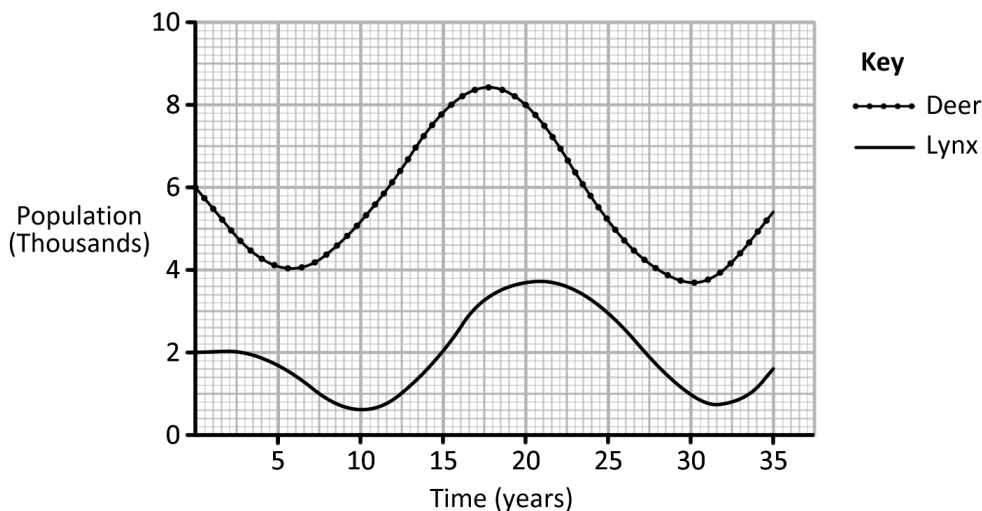
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(2 marks)

The figure below shows the changes in the population sizes of the deer and the lynx over a number of years in a forested region of Finland.



- b) Describe the pattern shown for the population of deer in the figure above.

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(2 marks)

- c) The deer is a herbivore.
Suggest **two** abiotic factors that could affect the growth of the plants that deer eat.

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(2 marks)

- d) Explain why the population of the lynx changes **after** the population of deer changes.

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(3 marks)

- e) A new disease, which only infected the deer, caused a rapid decrease in the deer population.
Describe and explain the likely effects of this disease on the lynx population.

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(2 marks)

(Total for Question 8 is 11 marks)

9. Farmers' fields are usually surrounded by hedges. An example of this is shown in the figure below.



Different plant species grow in the hedges. Ecologists are studying hedges to find the number of different plant species.

- a) Write down why they would use a quadrat and a biological key in this process.

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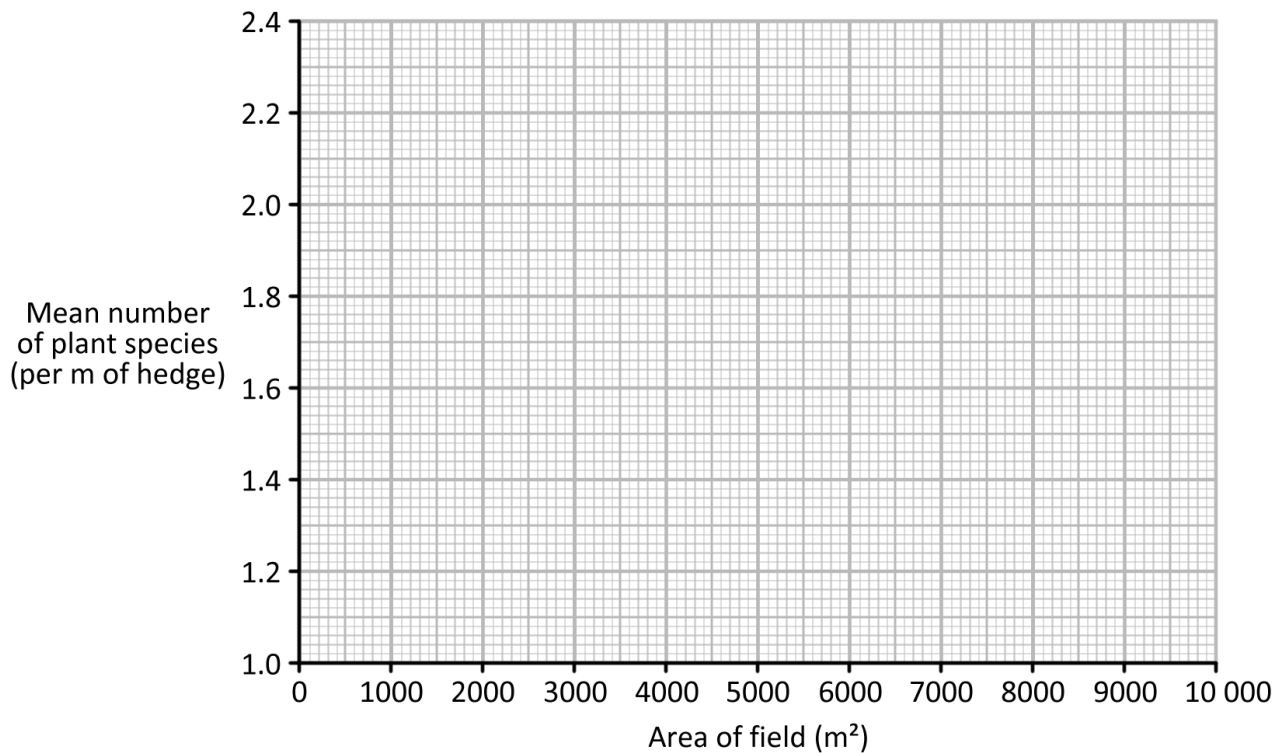
(3 marks)

- b) The ecologists want to see if there is a link between the area of a field and the number of plant species growing in the hedge. They sample hedges in five different sizes of fields, 1, 2, 3 and 4.

The table shows the ecologists results.

Field	Area of field (m ²)	Mean number of plant species (per m of hedge)
1	2000	2.2
2	5000	1.6
3	6500	1.4
4	1000	2.3

Plot the data for the four fields on the graph below and draw a line of best fit on the graph.



(4 marks)

There is a formula that can be used to estimate the age of a hedge.

$$\text{age in years} = \left(\begin{array}{c} \text{mean number of} \\ \text{plant species} \\ \text{per m of hedge} \end{array} \right) \times 110 + 30$$

The hedges in field 3 are 142 years old.

- c) Determine the age of the hedges in field 4.

Age = ... years
(2 marks)

- d) To increase crop yields and efficiency, many farmers use large agricultural machines.
Using this machinery is easier in larger fields.

Suggest **two** reasons why a farmer would choose to use larger, more efficient machinery.

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(2 marks)

e) Creating larger fields often involves removing hedgerows.

Explain the negative impact that removing hedgerows could have on the biodiversity of the farmland.
Use the data from the investigation to support your answer.

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(3 marks)

(Total for Question 9 is 14 marks)