Q1.

(a) *Malva sylvestris* is a plant species.

A student wanted to determine the mean height of *M. sylvestris* plants growing in a field.

Describe how the student should obtain measurements of the plants **and** then process these measurements to obtain a reliable mean height of plants growing in that field.

(5)

(b) The student wanted to present the results for the distribution of plant heights in a histogram.

The figure below shows the outline of a results table.

Use the figure below design a suitable results table the student should use for a histogram of plant height measurements ranging between 60 cm and 120 cm.

(2)

(c) A student investigated biodiversity in a community of bee species in a field of wild flowers.

The student trapped and identified the bee species in the field over 6 months.

The table below shows some of the student's results.

Bee species	**Total number of trapped bees after 6 months**
Cuckoo bee	250
Domestic honeybee	800
Clover bee	200

The index of diversity in a community of organisms is determined using the formula

$$d = \frac{N(N-1)}{\sum n(n-1)}$$

where N = total number of organisms of all species
and n = total number of organisms of each species.

Use the formula and information in above table to calculate the index of diversity in this community of bee species.

Answer _____

(2)

(d) In a different investigation, the student found that:

- the species richness of plants in a field of wild flowers is greater than the species richness of plants in a field of wheat
- the species richness of **bees** in a field of wild flowers is greater than the species richness of **bees** in a field of wheat.

Suggest **one** reason why the species richness of bees in a field of wild flowers is greater than the species richness of bees in a field of wheat.

Explain your answer.

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(2)

(Total 11 marks)

Q2.

(a) Define the biological term **population**.

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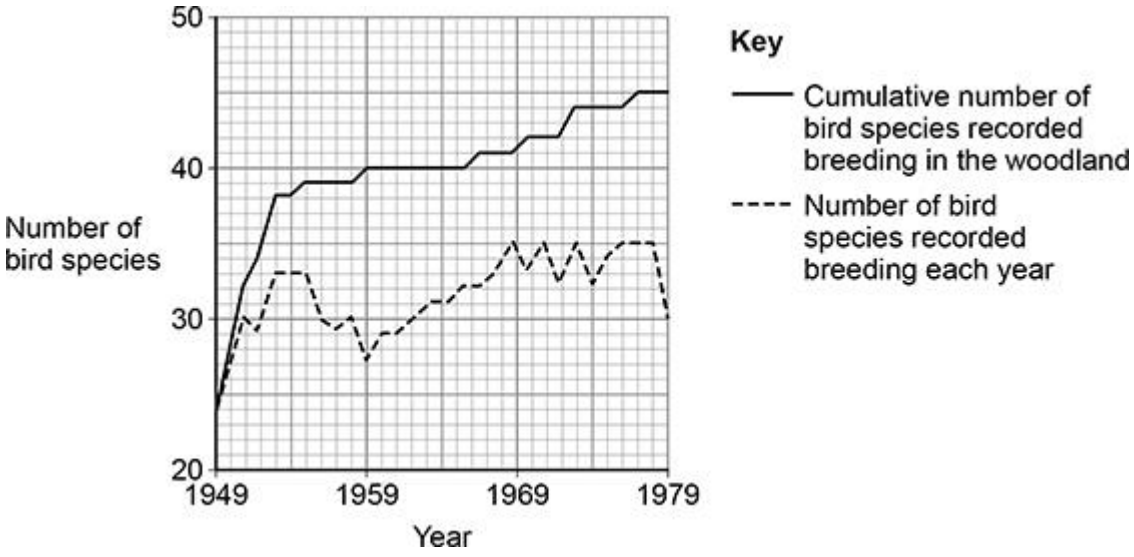
(2)

Ecologists monitored the biodiversity of birds in a protected woodland.

They recorded the number of bird species breeding in the woodland on the same day, every year for a 30-year period.

Figure 1 shows their results.

Figure 1



(b) Which statement correctly represents the species richness of the woodland?

Tick (✓) **one** box.

The number of all species present in the woodland	☐
The number of all species present in the woodland and their habitats	☐
The number of animal and plant species present in the woodland	☐
The number of bird species present in the woodland	☐

(1)

(c) A student studying the information in this question concluded that all woodlands should be protected to increase the biodiversity of birds.

Evaluate the student's conclusion.

(4)

(d) It is **not** possible to extrapolate the data for the number of bird species recorded breeding each year beyond 1979.

Explain why.

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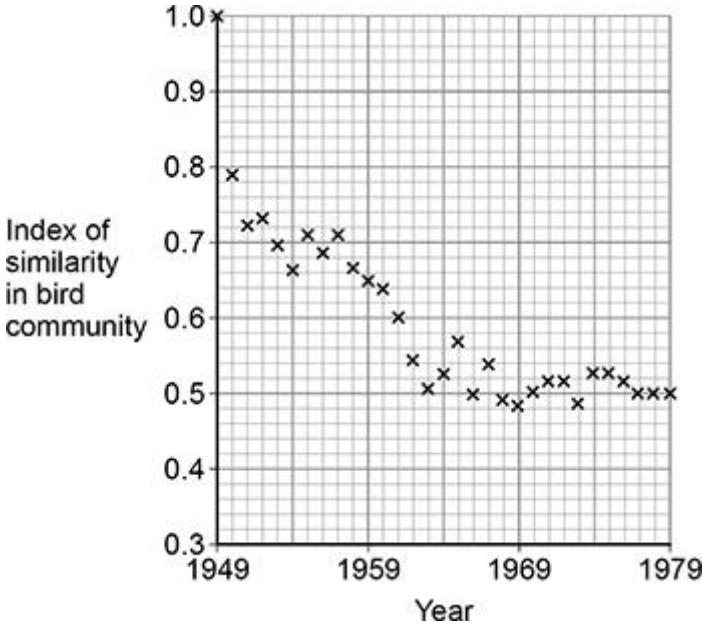
(1)

In this woodland, the ecologists measured the similarity in the bird community by comparing each year to 1949 using an index of similarity.

This index ranges from 1.0 for total similarity to 0.0 for total dissimilarity.

Figure 2 shows their results.

Figure 2



(e) Suggest how the changes in the index of similarity in the bird community provide evidence for the process of succession.

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(2)

(f) In **Figure 2**, the index of similarity for the last 10 years remains fairly constant.

Name the stage of a succession this represents.

Suggest **one** reason why the index of similarity is **not** absolutely constant.

Stage of succession _____

Reason why the index of similarity is not absolutely constant _____

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(2)

The Living Planet Index (LPI) is an index designed to monitor the state of the world's biodiversity.

The LPI is arbitrarily scaled to be 1.0 in 1970, the baseline year.

Figure 3 shows the LPI from the Living Planet Report, 2008. The dotted lines represent ± 2 standard deviations from the mean, which includes over 95% of the data.

Figure 4 shows an alternative version of **Figure 3** published on a news website.

Figure 3

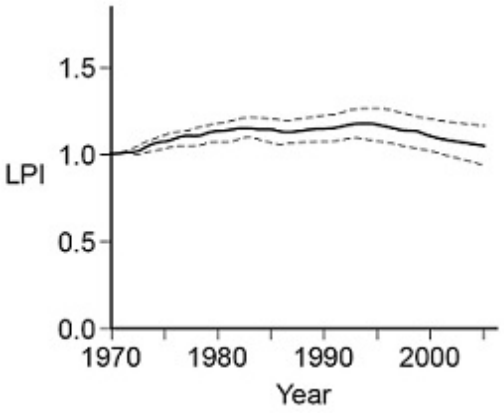
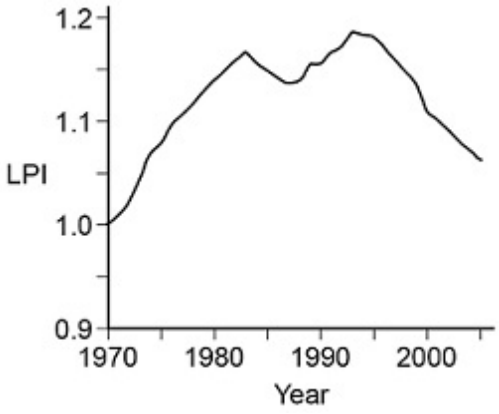


Figure 4



(g) The news website published the headline:

The LPI shows human activities cause significant decrease in biodiversity.

Suggest **three** reasons why this headline is **not** valid.

Use all the information provided.

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3 _____

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(3)

(Total 15 marks)

Q3.

Scientists investigated biodiversity in prokaryote communities found in soil.

The scientists:

- took soil samples from fields that had been managed for 20 years with two different farming methods
- sequenced all the DNA that coded for prokaryotic ribosomal RNA in the soil samples
- compared these base sequences to give a measure of species richness and an index of diversity for the prokaryote community
- recorded the total prokaryotic biomass and the mass of stored carbon for each soil sample
- obtained the mean wheat yield from the fields.

The table below shows the scientists' results.

Data collected	**Farming method 1**	**Farming method 2**
Mean species richness (± 2 × standard deviation)	517 (± 17)	560 (± 24)
Mean index of diversity (± 2 × standard deviation)	0.251 (± 0.011)	0.230 (± 0.014)
Mean total prokaryotic biomass / kg m^{-3}	0.24	0.40
Mean carbon stored in soil organisms / μg g^{-1}	203	342
Mean wheat yield / g m^{-2}	451	377

The mean ± 2 × standard deviation includes 95% of the data.

(a) Using the standard deviation data from the table, describe the differences in prokaryotic biodiversity found in the soil with these two farming methods.

In your answer, give the definitions of **species richness** and **index of diversity**.

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(4)

(b) Genetic diversity in soil species was traditionally inferred by making observations after growing prokaryotes on agar plates.

However, it is estimated that less than 10% of prokaryotes found in soil will grow if spread on an agar plate in a laboratory.

In recent years, our knowledge of prokaryotic biodiversity in the soil has increased.

Suggest why.

(2)

(c) Evaluate the balance between conservation and farming for these two farming methods.

Use the information provided in the table above.

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(2)

(Total 8 marks)

Q4.

Scientists investigated the effect that the release of heated water into a river from a power station had on the biodiversity of a local fish community over 29 years.

They measured the species richness and the number of fish of each species at the same site in October every year. The scientists used this information to calculate an index of diversity (*d*) of fish for each year.

Figure 1 and **Figure 2** show their results.

Figure 1

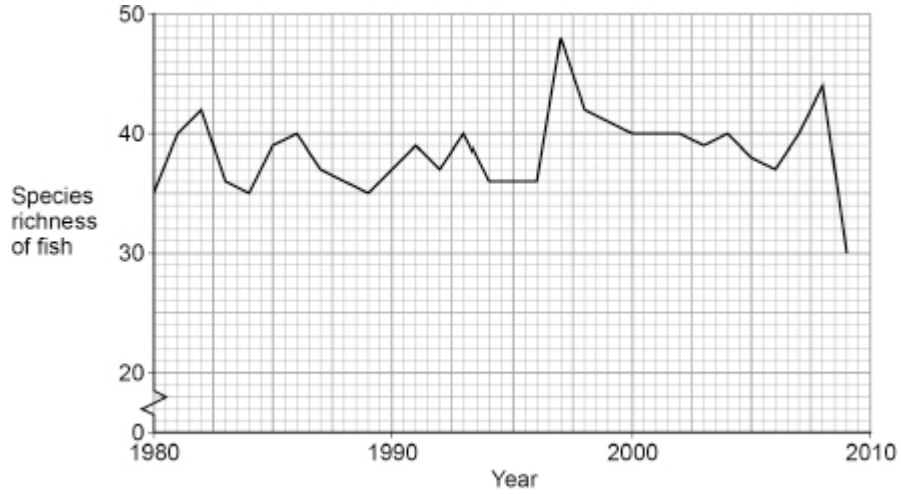
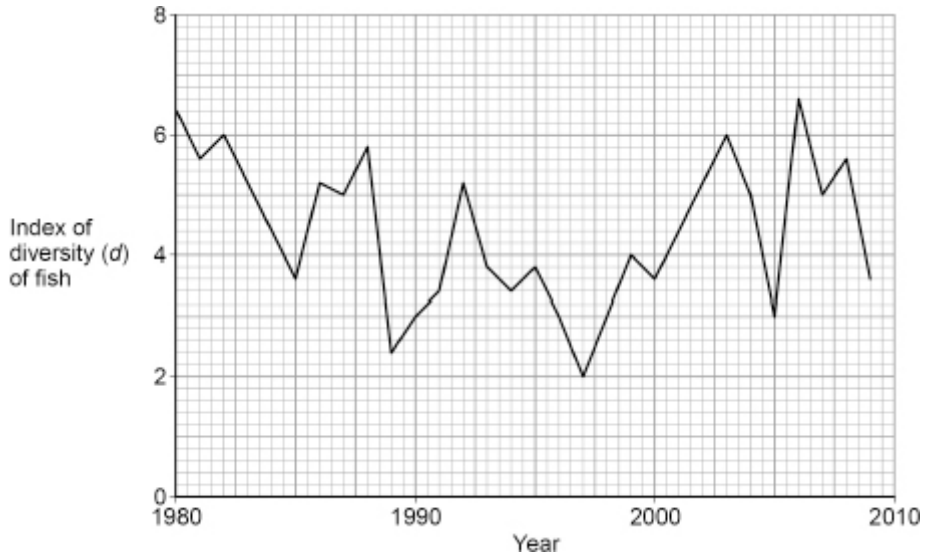


Figure 2



(a) The scientists used the following formula to calculate the index of diversity (d) of fish.

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

where N = total number of fish of all species
and n = total number of fish of each species

In some years, the values were $N = 624$ and $\Sigma n(n-1) = 64\,792$

Which years had these values?

Use **Figure 2** and the formula above to work out your answer.

Answer _____

(1)

(b) In 1997, the scientists recorded the highest species richness, but the lowest value of d over the 29 years.

Describe **and** explain how these results for 1997 were possible.

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(2)

(c) A journalist studied **Figure 1** and **Figure 2** and concluded that releasing heated water from a power station has no effect on local fish communities.

Use all the information to suggest reasons why the journalist's conclusion might **not** be valid.

(4)

(Total 7 marks)

Q5.

(a) Describe the structure and function of the nucleus.

(4)

(b) Name the main polymer that forms the following cell walls.

Plant cell wall _____

Fungal cell wall _____

(1)

Scientists investigated the effect of the number of fungal species in soil on the diversity of plant species.

The table below shows their raw data for soil containing 14 fungal species.

Plant species	**Total shoot biomass / g m^{-2}**
Poa compressa	2
Achillea millefolium	4
Aster cordifolius	5
Aster novae-angliae	7
Chrysanthemum leucanthemum	15
Daucus carota	36
Fragaria virginiana	51

(c) Suggest **one** reason the scientists used biomass instead of the number of individuals of each plant species when collecting data to measure diversity.

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(1)

(d) The scientists used this equation to calculate the plant species index of diversity.

$$d = 1 - \sum \left(\frac{n}{N}\right)^2$$

where n = shoot biomass of each plant species
and N = total shoot biomass of all plant species

Use this equation to calculate the index of diversity for the data in the table above.

Index of diversity _____

(2)

(Total 8 marks)