Model Answers: Medium

1a

a) A simple comparison between species diversity and species richness should include the following points…

- Both species richness and species diversity measure the number of different species (in a community); [1 mark]
- Species diversity takes into account the evenness of the abundance of species / relative abundance distribution, whereas species richness does not; [1 mark]

[Total: 2 marks]

Species diversity is more commonly used as it takes into account not only the number of different species but also the **number of individuals of each species**. Species richness doesn't always reveal the full picture. For example, a forest could have only two or three species of trees and so would have a low species richness value. However, there could be hundreds of individuals for each tree species!

1b

b) Fertiliser contaminating the stream could result in a high density of specific organisms but a low index of diversity as…

Two marks awarded per suggestion/explanation pair:

Suggestion 1: The presence of fertiliser causes eutrophication / oxygen depletion / toxicity / death; [1 mark]

Explanation 1: Which prevents several/many species from colonising/reproducing/surviving **OR** only a few species survive as a result; [1 mark]

OR

Suggestion 2: Fertiliser acts as a source of minerals/nutrients for some (aquatic) plant species / species of algae; [1 mark]

Explanation 2: Only those species increase in number; [1 mark]

[Total: 2 marks]

Fertiliser can have major negative impacts on streams and rivers as they cause algal blooms and oxygen depletion. This makes the living conditions very harsh and only a few species can survive in them.

1c

c) As the conservationist moves further away from the farm, the index of diversity will…

- Increase; [1 mark]
- As the fertiliser will be (more) diluted further from the farm; [1 mark]

[Total: 2 marks]

As the fertiliser becomes more diluted, the conditions will become less harsh / more favourable for a wider range of species to survive.

1d

d) Taking a large number of samples is important because…

- (It) produces a more reliable mean/average **OR** makes sure that the samples are representative (of the species richness) **OR** reduces the effect of extreme values / anomalies; [1 mark]

Random sampling (taking samples at random sites) is important because…

- (It) removes bias; [1 mark]

[Total: 2 marks]

Make sure you have addressed both marking points here. The question asks you to explain the importance of large sample sizes **and** random sampling.

2a

a) The biological term *niche* describes...

- The (specific) role/function of an organism/species in an ecosystem/habitat: [1 mark]
  OR
  *An adequately detailed description of a niche e.g. where the organism/species is in the ecosystem **AND** how it obtains energy **AND** its interactions with the physical environment and with other species (in the ecosystem/habitat)*; [1 mark]

The biological term *ecosystem* describes...

- A (relatively) self-contained interacting community of organisms **AND** the environment/abiotic conditions in which they live and interact with; [1 mark]

[Total: 2 marks]

A niche is relatively easy to describe for an exam once you learn that it is the specific role or function of an organism in the habitat or ecosystem in which it lives. In reality, an organism's niche can be very complex and therefore difficult to fully define, as the niche is a combination of many different factors to do with that organism, including many aspects of its life history such as where it feeds, what it feeds on, how much it eats, where it nests, what feeds/preys on it...the list is almost endless!

An ecosystem can be a bit tricky to define for an exam, so you can either learn a set definition from a textbook (such as the one above) or explain it in your own words, as long as you remember that your description must include: the community of organisms in a given area, the abiotic conditions (e.g. weather) in that area, how those different species interact with each other and lastly, how they interact with the abiotic factors mentioned above.

2b

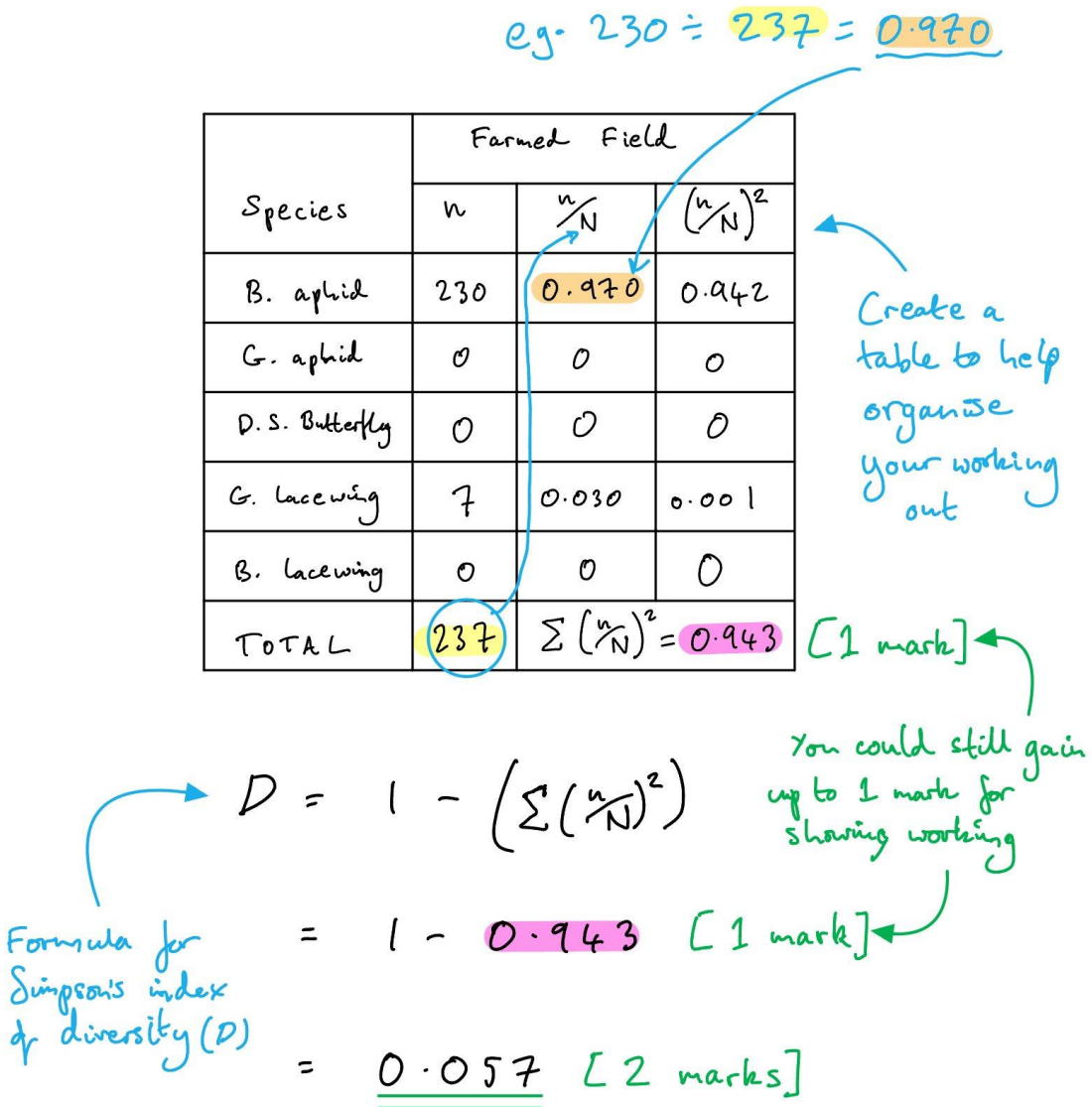
b) Simpson's index of diversity (*D*) is...

- 1 - 0.943; [1 mark]
- 0.057; [1 mark]

Full marks awarded for the correct answer only.

[Total: 2 marks]

It is good practice to always show your working because even if your final answer is incorrect, you can still gain one mark if your working is similar to that seen below in this case.



2c

c) The diversity index will be higher (no mark) because…

- More insect species are present **OR** insect species richness is higher; [1 mark]
- (Due to the fact that) there are more plant species **OR** a greater diversity of plants; [1 mark]
- (Which) provides more/greater variety of insect habitats **OR** provides more/greater variety of food sources (for insects) **OR** provides more niches for insects to occupy; [1 mark]

[Total: 3 marks]

Make sure your answer refers to the number of species and not the total number of organisms at the site. It would be wrong to assume that fewer organisms in total, means lower biodiversity.

2d

d) The statement should be evaluated by giving…

Points or arguments in support of the statement:

- The data/evidence (from Table 2.1) supports the statement **AS** insect species

diversity is/appears to be lower in the farmed field; [1 mark]

Points or arguments against the statement:

- There are limitations to the data **AS** only one type of habitat has been compared with the farmed field / a greater variety of habitats should be sampled **OR** only insect species have been surveyed / the species diversity for other taxa/groups of organisms (e.g. birds) may be higher in the farmed field; [1 mark]

[Total: 2 marks]

The command word evaluate means you need to acknowledge both sides of the argument.

3a

a) The PhD student could use the mark-release-recapture method to estimate the number of Frégate beetles on the island by...

Any **three** of the following:

- Capture/collect a sample (of beetles), mark them and release; [1 mark]
- Method of marking does not harm the beetles **OR** make the beetles more visible to predators; [1 mark]
- (Release and) leave sufficient time for the (marked) beetles to (randomly) distribute (on island) before collecting a second sample; [1 mark]
- Use the Lincoln Index to calculate the estimated number of beetles (in the population)

  OR

  ; [1 mark]

[Total: 3 marks]

Mark-release-recapture is a standard biological/ecological method used to measure the **abundance** of more **motile** species (i.e. species that move too fast for quadrat or transect sampling). It is also a common question in exams - so make sure you learn the steps above and **how to use the formula**!

3b

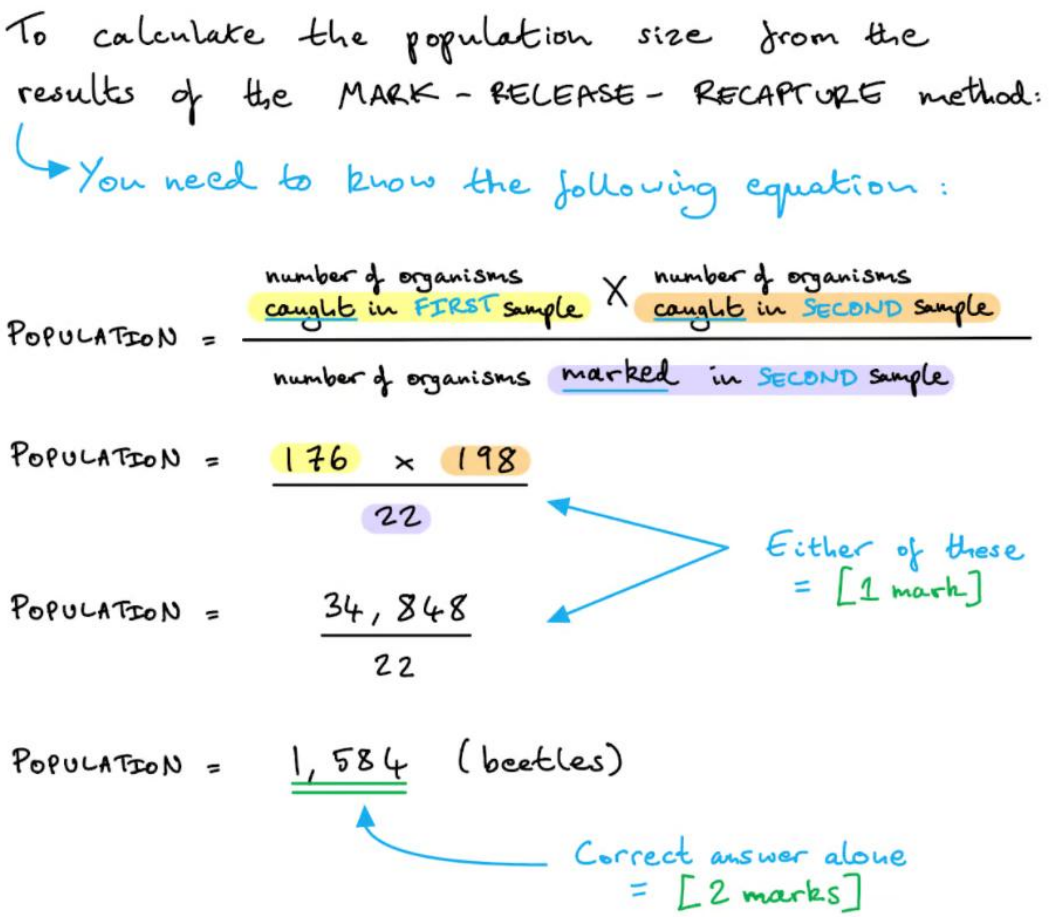
b) The number of beetles on the island is estimated to be...

- Population = (176 × 198) ÷ 22; [1 mark]
- Population = 1 584 (beetles); [1 mark]

Full marks awarded for the correct answer only.

[Total: 2 marks]

When the question asks you to **show your working**, it is important that you do this as you can gain **valuable marks**, even if your final answer is incorrect.



3c

c) The conditions required for the results from a mark-release-recapture to be valid include... Any **three** of the following:

- Marking (of organisms/beetles) is not removed/worn/rubbed off; [1 mark]
- Marking (of organisms/beetles) does not affect survival/predation **OR** marking does not make (organisms/beetles) more visible to predators; [1 mark]
- Sufficient time given for (marked) individuals to mix (within the population) **OR** sufficient time given for mixing to occur between samples; [1 mark]
- Sampling method is the same **OR** organisms/beetles caught in the same way each time; [1 mark]
- Limited/no immigration/emigration/migration (into or out of population) between first and second capture; [1 mark]
- Limited/no births **OR** limited/no deaths **OR** limited/no breeding between first and second capture; [1 mark]

[Total: 3 marks]

Be careful - you must be **specific** in order to gain either of the last two marking points. You cannot simply say that there should be no increase or decrease in the population - this would not be enough to gain a mark. You need to provide a **reason** as to **why** the population might be increasing or decreasing. Use the words above (**immigration**, **emigration, births**, **deaths** etc.) to gain full marks on questions about the conditions of mark-release-recapture.

3d

d) *Populations* and *communities* differ in the following way...

- A population is a group of organisms of the same species (living together in the same area at the same time) **WHEREAS** a community is (a group of) multiple different populations (living and interacting in the same area at the same time) **OR** populations of different species (living and interacting in the same area at the same time); [1 mark]

[Total: 1 mark]

4a

a) i) Simpson's index of diversity (D) for the dung beetles on the grassland site that was not grazed by cattle is...

- figures correctly calculated in table 2; [1 mark]
- figures calculated **AND** total calculated in tabled 2; [1 mark]
- (*D* =) 0.228; [1 mark]

Calculated figures should be as follows:

dung beetle species	**number of dung beetles on grassland not grazed by cattle**		
A	6641	0.873	0.762
B	774	0.102	0.010
C	108	0.014	0.000
D	85	0.011	0.000
total	7608		0.772

a) ii) The results in Table 1 and both figures for Simpson's index of diversity show that the effect of grazing by cattle on the diversity of dung beetles is as follows...

- There is greater species evenness on grazed grassland / beetles on not-grazed grassland are mostly of one species/species A; [1 mark]
- Grazing increases (dung beetle species) diversity; [1 mark]

Accept *reverse arguments for both marking points, e.g. "there is lower species evenness on not-grazed grassland" (mp1) and "Having no grazing decreases beetle diversity" (mp2).*

[Total: 5 marks]

i) Diversity index can be calculated as follows...

i) Simpson's index of diversity (D) for the dung beetles on the grassland site grazed by cattle was calculated as 0.522, using the formula:

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

Note that Σ = 'sum of'

Key to symbols:
n = number of individuals of each species present in the sample
N = the total number of all individuals of all species present in the sample

Calculate Simpson's index of diversity (D) for the dung beetles on the grassland site that was **not** grazed by cattle.

Complete Table 9.2 to show your working.

Write your final answer to **three** decimal places on the dotted line.

Table 9.2

dung beetle species	number of dung beetles on grassland not grazed by cattle	$\frac{n}{N}$	$\left(\frac{n}{N}\right)^2$
A	6641		
B	774		
C	108		
D	85		
total	7608		

Calculate $\frac{n}{N}$ for all species: Numbers all calculated to 3 d.p.

For species A = $\frac{6641}{7608}$ = 0.873

For species B = $\frac{774}{7608}$ = 0.102

For species C = $\frac{108}{7608}$ = 0.014

For species D = $\frac{85}{7608}$ = 0.011

[1 mark]

Calculate $\left(\frac{n}{N}\right)^2$ for all species:

For species A = 0.873^2 = 0.762

For species B = 0.102^2 = 0.010

For species C = 0.014^2 = 0.000

For species D = 0.011^2 = 0.000

[1 mark]

Calculate the sum of $\left(\frac{n}{N}\right)^2$ — This is $\Sigma\left(\frac{n}{N}\right)^2$

0.762 + 0.010 + 0.000 + 0.000 = 0.772

Substitute numbers into equation:

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

$$= 1 - 0.772$$

$$= 0.228$$ [1 mark]

ii) Biodiversity is measured using two factors; the number of different species present (species richness) and the number of individuals of each species present (species evenness). Table 9.1 shows that both grassland sites have the same species richness, but that the **species evenness** of the not-grazed site is lower; most of the beetles on this site are species A and the numbers of other species are low.

Both species richness and species evenness are taken into account when the index of diversity is calculated, so this results in the not-grazed site having a lower index of diversity than the grazed site. This suggests that grazing is good for beetle diversity in a grassland habitat.

4b

b) The population size of a species of beetle that does **not** feed on dung in each of the two areas of grassland could be estimated by...

- Mark-release-recapture; [1 mark]

AND

Any **three** of the following:

- Trap (beetles) using, eg. a pitfall trap; [1 mark]
- Mark (the beetles) using, e.g. a felt-tip pen/nail varnish **OR** mark (the beetles) in a harm-free way; [1 mark]
- Release the marked beetles; [1 mark]
- Carry out a second round of trapping after allowing time for beetles to mix / not giving enough time for beetles to leave/migrate; [1 mark]
- (Calculate estimated population size using) $N = (n_1 \times n_2) \div m_2$; [1 mark]

Marking points 1 and 2 must contain an example or a described method where 'e.g.' is stated.

[Total: 4 marks]

When estimating the abundance of a mobile species quadrats are of no use; instead the mark-release-recapture method combined with use of the Lincoln index can be used.