Model Answers: Hard

1a

a) An estimate of the population density of thistle plants in the 'number of thistle plants per hectare' could be gained by following the steps outlined below…

Any **five** of the following:

- Mark out an area **OR** create a grid (of grassland) *e.g. 10 m x 10m or 20 m x 20 m or 50 m x 50 m*; [1 mark]
- Use a random number generator to randomly select/locate sampling sites / generate (a set of random) coordinates; [1 mark]
- Place quadrats at random generated sampling sites/coordinates (within a larger grid); [1 mark]
- Count the number of individual thistle plants in each quadrat; [1 mark]
- Calculate the mean/average number of thistles per quadrat; [1 mark]
- Set up a new area/grid to sample (in a different area of the grassland) *e.g. if a small initial grid is set up and more quadrats are needed*; [1 mark]
- Multiply the mean number of thistles found per quadrat by the total area of all the quadrats to get an estimate; [1 mark]

[Total: 5 marks]

1b

b) The term "*differed significantly ($p < 0.05$)*" means…

- There was a probability of less than 0.05 / less than 5 in a hundred / less than 5%; [1 mark]
- That the difference (in mean number of insect species between farms) was due to chance; [1 mark]

[Total: 2 marks]

The **converse statement** would also be accepted. For example, "there was a probability of **more than 95%** that the difference (in mean number of insect species between farms) was **not** due to chance".

1c

c) 5 would not be an appropriate number of fields to sample because…

- The number of species is still increasing / has not reached peak/maximum (so the number of species would not be reliable); [1 mark]

25 would not be an appropriate number of fields to sample because…

- The curve has flattened so there would be no benefit / no point / takes unnecessary time / takes unnecessary effort / can get same results with sampling fewer fields: [1 mark]

  OR

  No more species found so there would be no benefit / no point / takes unnecessary time / takes unnecessary effort / can get the same results with sampling fewer fields; [1 mark]

[Total: 2 marks]

2a

a) Table 2 should be completed as follows:

Quadrat	***U. dioica* percentage**	***R.***	***U. dioica* rank**	***R. obtus***

	cover	***obtusifolius* percentage cover**		
1	30	15	9	8
2	37	23	11	10
3	15	6	5.5	4
4	15	10	5.5	5.5
5	20	11	7	7
6	9	10	3	5.5
7	3	3	1	2
8	5	1	2	1
9	10	5	4	3
10	25	17	8	9
11	35	30	10	11

- **BOTH** ranking columns correct; [1 mark]
- D **AND** D^2 columns correct; [1 mark]

[Total: 2 marks]

Remember - to rank the data, the **lowest value** (here the lowest percentage cover) should be ranked as **1**, the next is ranked as 2, and so on. If there are two data values that are equal, they are given an **equal rank**. For this data set, there are two quadrats for each species where this applies.

2b

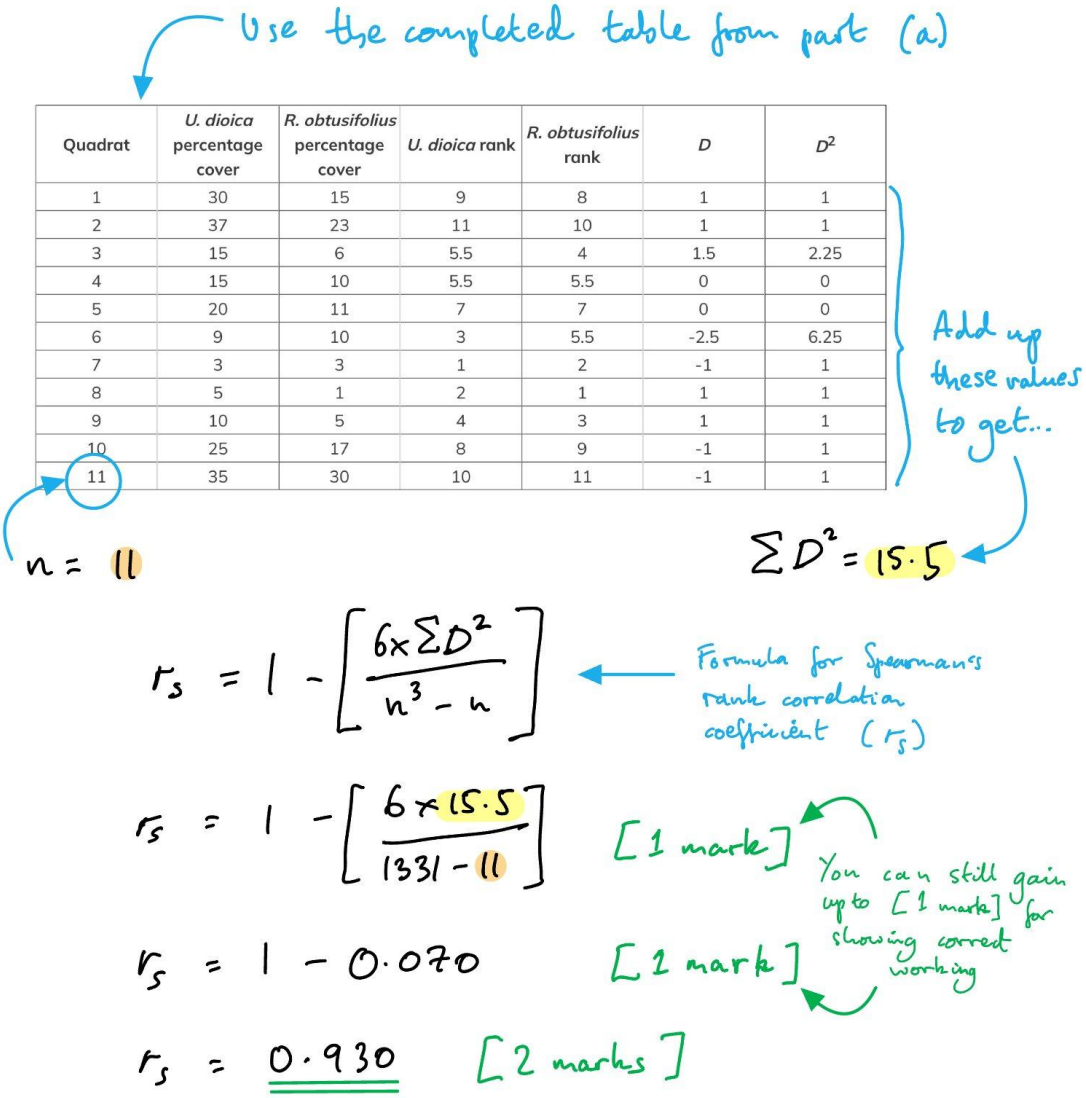
b) The Spearman's rank correlation coefficient (r_s) for the data from part (a) is...

- 1 - 0.070; [1 mark]
- (r_s =) 0.930; [1 mark]

Full marks awarded for the correct answer only.

[Total: 2 marks]

Even if your final answer is incorrect, you can still gain one mark if you have shown your working and it is similar to that seen below.



Quadrat	*U. dioica* percentage cover	*R. obtusifolius* percentage cover	*U. dioica* rank	*R. obtusifolius* rank	*D*	D^2
1	30	15	9	8	1	1
2	37	23	11	10	1	1
3	15	6	5.5	4	1.5	2.25
4	15	10	5.5	5.5	0	0
5	20	11	7	7	0	0
6	9	10	3	5.5	-2.5	6.25
7	3	3	1	2	-1	1
8	5	1	2	1	1	1
9	10	5	4	3	1	1
10	25	17	8	9	-1	1
11	35	30	10	11	-1	1

2c

c) i) The null hypothesis would be...

- There is no correlation between the percentage cover of the two species; [1 mark]

ii) The ecologist...

- Was able to reject the null hypothesis; [1 mark]
- (As) the r_s value / Spearman's rank correlation coefficient is greater than the critical value (for 11 pairs of data); [1 mark]

[Total: 3 marks]

The critical value for 11 pairs of data (at $p = 0.05$) is 0.62, as shown in Table 3. As the r_s value / Spearman's rank correlation coefficient is 0.930, the **null hypothesis** can be **rejected** and the **alternative hypothesis** can be **accepted**.

2d

d) The ecologist can conclude that...

- There is a significant (positive) correlation between the abundance/percentage cover of the two species (on the field); [1 mark]
- There is a probability of less than 0.05 / less than 5 in a hundred / less than 5%; [1 mark]

- That this correlation is due to chance; [1 mark]

[Total: 3 marks]

For the second two marking points, the **converse statement** would also be accepted. For example, "there is a probability of **more than 95%** that the correlation is **not** due to chance".

3a

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.

3b

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.