Sampling A03

1. The abundance and distribution of plants can be surveyed in different ways.

Some students wanted to survey abundance and distribution of plants on a small area of grass outside the school. The area was roughly 20 m × 20 m in size.

They used the following method:

1 Lay two 20 m tape measures at right angles starting in the south east corner of the grass area.
2 Use a random number generator to select *x* and *y* coordinates.
3 While facing north, place the left-hand corner of a quadrat on the point where the coordinates meet.
4 Identify the species present in the quadrat using a key.
5 Count the number of each species present.
6 Record the information in a table.
7 Generate a new set of coordinates and repeat steps 2 to 6 until 10 quadrats have been sampled.

The teacher said that this method would not allow the students to measure the distribution of plant species.

i. Suggest an improvement to the method that would allow the distribution of plants to be measured.

[2]

ii. Identify a limitation with step 3 of the students' method and explain why this limitation might affect the data collected.

[2]

2. A study was carried out on moorland vegetation in the North of England. A number of 10-metre interrupted belt transects were carried out in this area.

1. Mark a line with a string.
2. Make an observation at varying points along the string.
3. Count how many different species of plants are found at each point.
4. Note down what you think the names of each of these species are.
5. Record your results as a table.

Here are some instructions for carrying out an interrupted belt transect:

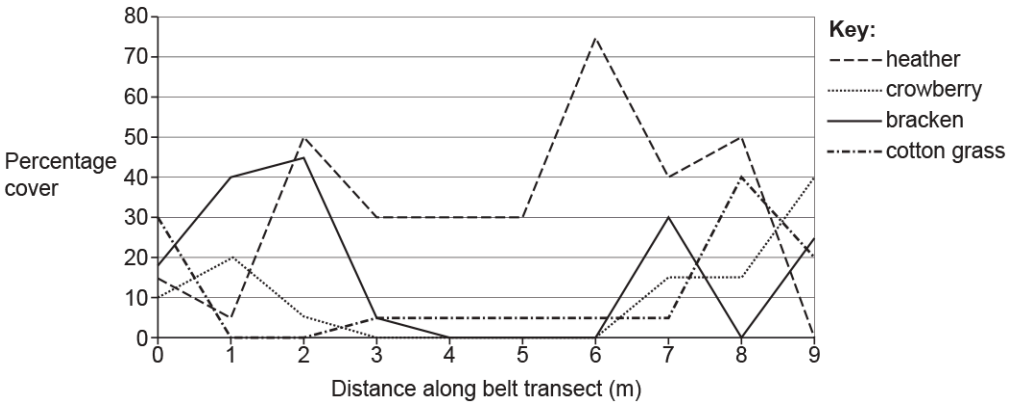
i. Suggest **two** improvements you could make to these instructions.

Improvement 1

Improvement 2

[2]

ii. Results of the four most abundant species from the study are shown in the graph below.

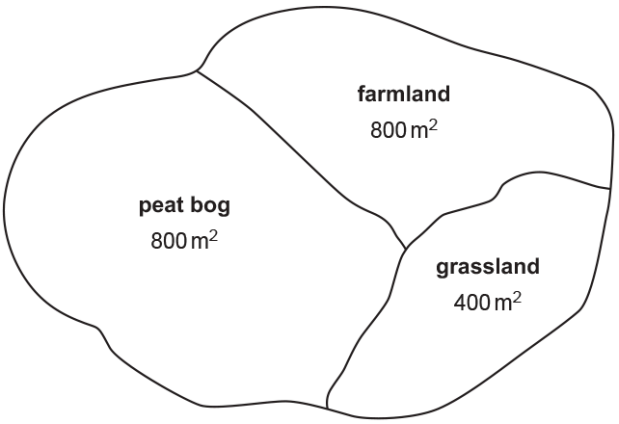


When presented with an aerial photograph of the moorland community being studied, a student stated that bracken and heather are not found growing in the same area.

Using the data in the graph, evaluate the student's statement.

[4]

3. Ecologists were studying an area that contained three different habitats. The area is shown in the diagram below.



The ecologists sampled the area to estimate insect biodiversity.

Describe how the ecologists should choose the number and locations of their samples to ensure that the sampling is representative.

Use a calculation to support your answer.

[3]

4(a). The spruce pine plant is given the binomial name *Pinus glabra*.

A scientist sampled the species of trees present in two different habitats containing *Pinus glabra.*

The results of the sampling are shown in Table 5.

Species	Number of individuals in habitat A	Number of individuals in habitat B
P. glabra	45	60
M. grandiflora	23	10
F. grandiflora	55	20
L. styraciflua	0	10
L. tulipifera	0	0
S. shumardii	23	4

Table 5

Using Simpson's Index of Diversity, the scientist calculated the biodiversity (*D*) of Habitat A as 0.71.

Use the formula given to calculate the biodiversity of Habitat B.

Show your working.

State which habitat, A or B, has the greater biodiversity.

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

D (Habitat A) = 0.71

D (Habitat B) = ...

Habitat with the greater biodiversity = ...

[2]

(b). Habitat B was situated beside a lake and showed evidence of ecological succession.

The scientist planned to investigate how the biodiversity changed from the edge of the lake to the other side of habitat B.

i. State the collective name of the animal and plant populations that are present at the end of primary succession.

[1]

ii. Suggest how the scientist could achieve the following during their investigation:

Sample all stages of succession in the habitat

Minimise sampling bias

Sample insect biodiversity

[3]

iii. The scientist also measured primary production in both the woodland and lake habitats. Suggest the units the scientist should use to measure primary production in the two habitats.

Woodland

Lake

[1]

5(a). The downy birch tree, *Betula pubescens*, produces varying numbers of leaf hairs.

These hairs are between 200 μm and 500 μm long in response to different environmental conditions.

A group of students investigated the relationship between the distance of different trees from a river and the mean leaf hair density.

Table 25 shows the results of their investigation.

Distance from river (m)	Rank of distance	Mean leaf hair density (number mm^{-2})	Rank of hair density	Difference in ranks *(d)*	Difference squared (d^2)
9.1	4	33.1			
13.7	1	34.8			
5.5	7	11.3			
0.3	10	3.4			
5.4	8	27.3			
11.5	3	30.3			
1.7	9	6.3			
6.0	6	22.9			
11.9	2	5.7			
6.8	5	23.2			

Table 25

i. Complete Table 25 by calculating the difference between the ranks and then squaring the difference.

[Answer on Table 25] **[2]**

ii. Use the formula below to calculate Spearman's rank correlation coefficient for this data.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

[2]

(b). The students concluded that there is a positive correlation between distance of the tree from the river and mean leaf hair density.

i. Suggest reasons for this positive correlation.

[2]

ii. For this investigation, the students randomly selected leaves from ten downy birch trees at varying distances from the river.

Suggest **three** ways in which the students could improve the validity of their sampling method.

1

2

3

[3]

(c). Another group of students repeated this investigation and calculated r_s = 0.589. The critical value of r_s at the 5% level for 9 degrees of freedom is 0.600.

They concluded that their results showed a weak positive correlation between leaf hair density and distance of the tree from the river.

Evaluate the conclusion of this group of students.

[2]

END OF QUESTION PAPER

Mark scheme

Question			Answer/Indicative content	Marks	Guidance
1		i	(description of) systematic sampling / transect ✓	1(AO1.2)	**IGNORE** stratified **Examiner's Comments** Around half of candidates immediately spotted the need to reference distribution and promptly cited transects and/or systematic sampling. Many responses discussed doing more quadrats, using point quadrats, or measuring percentage cover within each quadrat, none of which were given marks.
		ii	(placement could be) not accurate / biased ✓ position of coordinates difficult to judge ✓ method does not specify top (left) or bottom (left) ✓	2 max(AO3.4)	**Examiner's Comments** Few responses achieved both marks in this question but it did differentiate well. Many spotted the ambiguity about which left hand corner was needed. Fewer seemed aware of the routine limitation with this kind of investigation which is the difficulty in judging the position of the coordinate when you are standing some distance from a tape measure. There were a large number of regular incorrect responses. Many did not seem to appreciate that if a quadrat lay outside the 20 × 20 grid, this would not invalidate the results. Many seemed to think that there would be some difficulty in deciding in which direction north lay while others thought the centre of the quadrat should be placed over the coordinate. This all suggests that many students may have, understandably, had restricted access to fieldwork opportunities during their course. Some struggled to understand the method and were concerned that only those plants associated with 'the north' (either in terms of where they were growing or facing) were being included in the investigation. A few candidates thought north would move.
			Total	**3**	
2		i	*any two from:* 1 use a tape measure to mark the line ✓ 2 at, fixed / 1m, intervals (along the tape) ✓ 3 use quadrat to measure percentage cover ✓ 4 identify with, key / field guide / app ✓ 5 repeat / use group data (not just your own results) ✓	2 max (AO3.3)	

		ii	*any four from:* statement true as only heather is present at, 4-6m / 8m ✓ statement true as only bracken is present at 9m ✓ statement false as bracken and heather both present at 0-4m / 7m ✓ comparative % (cover) figures for heather and bracken at one point with units ✓ only one of the two species present at 5 out of 9 points ✓	4 max (AO3.3 AO3.4)	
			Total	**6**	
3			stratified (sampling) ✓ detail of stratified sampling ✓ *correct calculation:* 40% (in farmland), 20% (in grassland), 40% (in peat bog) **OR** proportional numbers ✓	3 (AO3.3) (AO3.4)	e.g. number of samples in each sector is proportional to the area or implied by correct calculation / random sampling within each sector e.g. 8, 4 and 8 samples
			Total	**3**	
4	a		(Habitat B =) 0.61 ✓ Habitat with the greatest biodiversity = A ✓	**2**	**DO NOT ALLOW mp 2 if value of D not calculated** **ALLOW ECF** if B has been identified as the habitat with greatest biodiversity, (if value of D calculated for habitat B greater than 0.71) **<u>Examiner's Comments</u>** Most candidates gained both marks here. Candidates who showed clear working and an understanding of the method to calculate Simpson's index scored well, but without clear workings, answers were often wrong. Some candidates forgot to take their calculated number from 1. Most candidates who had correctly calculated the biodiversity for habitat B understood the significance of the result and stated that habitat A had a greater biodiversity.
	b	i	climax <u>community</u> ✓	**1**	**<u>Examiner's Comments</u>** Many candidates gained credit by making reference to the climax community. Unsuccessful responses often indicated that the candidate had not understood the question and their response related to the beginning of the process of primary succession. Common errors included pioneer species and climax population.
		ii	belt / line, transect / described **or**	**3**	e.g. ' lay tape from edge of lake and sample along it'

			stratified sampling / described ✓ random selection of transect sites **or** systematic sampling / place quadrats at, set / pre-determined, intervals along the transect **or** random sampling using quadrats in, selected areas / strata ✓ pooter / sweep nets / pitfall traps / light traps / tree-beating ✓		(N.B. only allow random sampling in context of stratified sampling) **ALLOW** any suitable method of trapping insects **IGNORE** capture mark recapture **Examiner's Comments** Successful responses referred to the use of a belt or line transect to sample stages of succession and a few referred to the use of stratified sampling. Candidates were less successful in describing how to minimise sampling bias, the most common error was to refer to random sampling without stating in what context this would be used. Contradictory statements referring to the use of random sampling along a transect, lost many candidates marks. Candidates showed a good understanding of methods to sample insect biodiversity, the most frequent successful responses referred to the use of pooters, sweep nets or pitfall traps.
		iii	Woodland = (k)g m^{-2} yr^{-1} / (k)J m^{-2} yr^{-1} **AND** Lake = (k)g m^{-3} yr^{-1} / (k)J m^{-3} yr^{-1} ✓	**1**	**ALLOW** (k)g h^{-1} yr^{-1} / (k)J h^{-1} yr -1 / tonnes h^{-1} yr^{-1} / (k)g (k)m^{-2} yr^{-1} / (k)J (k)m^{-2} yr^{-1} **ALLOW** (k)g (d)m^{-3} yr^{-1} / (k)J (d)m^{-3} yr^{-1} / (k)g (k)m^{-3} yr^{-1} / (k)J km^{-3} yr^{-1} **ALLOW** hectare $^{-1}$ for h^{-1} **ALLOW** y for yr **DO NOT ALLOW** 'per' **ALLOW** '/' instead of $^{-1}$ **Examiner's Comments** This was a high level question, and as expected, only the most able candidates answered this question correctly. Very few understood the idea of mass/energy +area/volume + time, make up the unit.
			Total	**7**	

<table>
<tr>
<td>5</td>
<td>a</td>
<td>i</td>
<td>differences completed correctly ✓

squares of differences completed correctly ✓</td>
<td>2</td>
<td>IGNORE all negative signs in Difference of ranks column

DO NOT ALLOW negatives in Difference squared
column

ALLOW ECF for mp 2

<table>
<tr><th>Rank of hair density</th><th>Difference in ranks (d)</th><th>Difference squared (d^2)</th></tr>
<tr><td>2</td><td>2</td><td>4</td></tr>
<tr><td>1</td><td>0</td><td>0</td></tr>
<tr><td>7</td><td>0</td><td>0</td></tr>
<tr><td>10</td><td>0</td><td>0</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td>4</td><td>4</td><td>16</td></tr>
<tr><td>3</td><td>0</td><td>0</td></tr>
<tr><td>8</td><td>1</td><td>1</td></tr>
<tr><td>6</td><td>0</td><td>0</td></tr>
<tr><td>9</td><td>(-)7</td><td>49</td></tr>
<tr><td>5</td><td>0</td><td>0</td></tr>
</table>

<u>Examiner’s Comments</u>

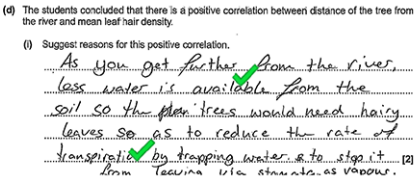
Candidates were asked to complete the table by making a number of simple calculations. Most able candidates did this successfully. A number of candidates were unable to rank the hair density correctly and therefore the difference in ranks was incorrect. These candidates could still achieve a mark if they correctly squared the difference they had calculated. A few made errors in calculating the square of the difference.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ii</td>
<td>rs = 0.576 / 0.58 ✓✓</td>
<td>2</td>
<td>ALLOW ECF from table
ALLOW one mark for working

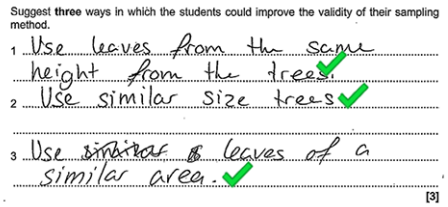
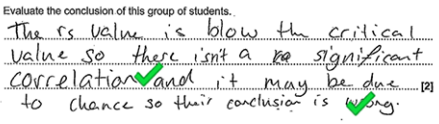
e.g. n(n2-1) = 990 ✓

6x70/10(99) ✓
0.57 = one mark (incorrect rounding)
0.580 = one mark (for incorrect rounding)
0.6 = one mark (rounding too far)

<u>Examiner’s Comments</u>

Candidates were asked to calculate Spearman’s rank correlation coefficient. Many candidates managed to do this successfully. If the values in the table were incorrect the error was carried forward to enable candidates to achieve these marks using their own data from the table in part (i). Less able candidates</td>
</tr>
</table>

					often struggled to carry out this calculation correctly. Sometimes this was because they did not transfer data accurately into the table.
	b	i	further away from the river less water (available) / ORA ✓ transpiration causes water loss ✓ hairs, trap water vapour / reduce transpiration / reduce loss of water (vapour)✓ reduced water (vapour) potential gradient from inside to outside leaf ✓	2 max	**DO NOT ALLOW** 'further from source' 'no source' **DO NOT ALLOW** hairs prevent water (vapour) loss **Examiner's Comments** This question asked candidates to explain how leaf hairs enabled the plant to conserve water in the context of differing water availability at different distances from the river. More able candidates had a good idea that leaf hairs could reduce water loss. They also understood that this was required because there was less water available further from the river. Less able candidates often became confused and wrote about leaf hairs absorbing water from the less humid environment. Some even seemed to think that leaves closer to the river had more hairs which helped the leaf to lose water. **Exemplar 7**  (d) The students concluded that there is a positive correlation between distance of the tree from the river and mean leaf hair density. (i) Suggest reasons for this positive correlation. As you get further from the river, less water is available from the soil so the plan trees would need hairy leaves so as to reduce the rate of transpiration by trapping water & to stop it from leaving via stomata as vapour. [2] In this exemplar the candidate has written a clear and concise response. It shows a clear understanding that water is less available further away from the river and that the leaf hairs will reduce transpiration. The candidate goes on to explain that transpiration is loss of water vapour via the stomata.
		ii	same / similar, size / age, trees ✓ same / similar, size / age, leaves ✓ repeated leaves from each tree **and** calculate mean ✓ record results at same, time of year / day ✓ ensure leaves selected are from, same side / same height / evenly distributed around tree ✓ systematic sampling / sample at set distances (from river) / described ✓	3 max	**Examiner's Comments** This question asked for candidates to describe ways to improve the validity of their sampling techniques. Validity is all about controlling the variables around the collection of data so that the data are not affected by inconsistencies. The technique is valid if it measures what it is supposed to measure. There was a wide range of responses. It was clear that many candidates did not really

					understand the meaning of the term 'validity'. Few candidates achieved full credit and many responses described ways to improve repeatability. In many cases the responses were not well phrased. **Exemplar 8**  Suggest **three** ways in which the students could improve the validity of their sampling method. 1 Use leaves from the same height from the trees ✓ 2 Use similar size trees ✓ 3 Use similar ~~s~~ leaves of a similar area. ✓ [3] In this exemplar the candidate has given three clear statements. Each statement describes a way to remove a variable to ensure the data collected are comparable. This makes the sampling techniques valid.
	c		their conclusion is incorrect ✓ reject (the student's), hypothesis / H1 ✓ there is no, relationship / correlation, (between leaf hair density and distance from river) / the pattern seen is due to chance ✓	2 max	**ORA** accept the null hypothesis / H_0 **Examiner's Comments** Candidates were asked to evaluate a conclusion. It was clear that many candidates did not really know how to interpret the results of a statistical test. If the calculated value of Spearman's rank is below the critical value then we can say that there is no correlation. Many candidates seemed to suggest that because the calculated value was close to the critical value that was OK. Less able candidates become very confused and compared the calculated value to 5% or even to 9. Definitions of the terms associated with practical work are available in the practical skills handbook. **Exemplar 9**  Evaluate the conclusion of this group of students. The rs value is blow the critical value so there isn't a ~~no~~ significant correlation ✓ and it may be due to chance so their conclusion is wrong. ✓ [2] This exemplar shows a rare case where the candidate has a good understanding of how to interpret the results of a statistical test. The candidate makes clear that the calculated result is below the critical value and states that this means there is no significant correlation.
			Total	**11**	