Mark scheme

Question				Answer/Indicative content	Marks	Guidance
1		i		thylacine has low<u>est</u>, genetic diversity / proportion of heterozygous gene loci ✓ antechinus **and** dunnart (and wombat) / three species with highest (genetic) diversity , have least concern ✓ species with more genetic variation are less vulnerable ✓ **ora**	2 max (AO 3.2)	**CREDIT** scientific names **ALLOW** all least concern species except wallaby have high genetic diversity **ALLOW** all species with genetic diversity above 0.0017 have least concern *Needs to be a general statement about a pattern inferred from the table* **ALLOW** there is a correlation between genetic diversity and conservation status **ALLOW** the higher the genetic variation the lower the concern **Examiner's Comments** Most responses scored here, and all marking points were regularly seen. Merely citing a single supporting example (other than the Thylacine itself) did not gain any credit as there were much more convincing pieces of evidence, such as those described in the 2nd and 3rd marking points, which could be offered. Answers that did not score tended to explain why low genetic diversity might lead to extinction rather than to offer evidence in support of a conclusion.
		ii		koala is vulnerable but (tammar) wallaby is least concern / AW **ora** ✓ (tamar) wallaby is least concern but has (relatively) low genetic diversity / koala's genetic diversity is (relatively) high but it is vulnerable ✓	1 max (AO 3.2)	**CREDIT** scientific names **ALLOW** any working that communicates the point, e.g. species with genetic diversity 0.0013 has higher concern than 0.0007 **ALLOW** AW for describing conservation status **Examiner's Comments** Most answers achieved this mark. Those that did not, often attempted to discuss the effects of hunting.
				Total	**3**	
2		i		**FIRST CHECK ON ANSWER LINE** **If answer = 16.8 award 3 marks**	3 (AO 2.4)	**CREDIT** working marks seen anywhere **ALLOW** 1 mark for correct summation of candidate's '(O-E)2/E' column

	O	E	O-E	(O-E)^2	(O-E)^2/E
A	44	40	4	16	0.4
O	56	40	16	256	6.4
S	20	40	20	400	10

✓ (under O-E column) ✓ (under (O-E)^2/E column)

$\Sigma U(O.E)^2/E = 16.8 / 16.80$ ✓

ALLOW 2 marks for…

- 17 / 16.800

ALLOW 2 marks for common errors with Expected numbers (**IGNORE s.f.**)

- 165.6 (E = 120)
- 16.4 (E = 44)
- 25.7 (E = 56)

Examiner's Comments

Around half of candidates scored all 3 marks and many of those that didn't gain some credit for summing (O-E)^2/E, calculating the expected values, or both. Miscalculation of the expected values was the most common repeated error.

(i)   **OCR support**

The maths skills handbook and the guidance on statistics for biologists offer further support on the use of statistical tests.

Additional support on all the maths skills can be found on 'Maths for Biology' resources on 'Teach Cambridge'.

| | | ii | differences (between observed and expected) are significant ✓

(less than) 5% chance that (difference is) due to chance ✓

reject , null hypothesis / H$_0$ ✓

there is an association between tree species and wood sorrel population / AW ✓ | 3 max
(AO 3.1) | **ALLOW ora** if candidate answer in (i) is below 5.991

ALLOW (>) 95% confident that (the difference is) not due to chance

ALLOW tree species affects wood sorrel
ALLOW wood sorrel less likely to grow near sycamore **ora**

Examiner's Comments

This question differentiated well, and all marking points were regularly seen. Candidates seemed better at discussing statistical significance correctly than in previous years. There were, for example, fewer responses that ascribed significance to 'results' or 'data', rather than to a 'difference'. |

					Candidates who had miscalculated the chi-squared value in part (i) were able to access all of the available marks.
		iii	age / size / height , of tree ✓ gradient (of ground) ✓ density / AW , of surrounding trees ✓ *idea of* direction of sunlight ✓	2 max (AO 3.3)	**ALLOW** shading from adjacent trees **IGNORE** light intensity unqualified **ALLOW** e.g., whether they are all on the same side of a hill **IGNORE** presence of other species **IGNORE** all other variables **Examiner's Comments** Unusually for a 'identify some control variables' question, the usual answers common to a range of laboratory-based investigations did not apply to this environmental context. Hence only a minority of candidates scored at all, and it was very rare to award both marks. Most commonly candidates gained a mark for suggesting that size (age, height or girth) of trees should be controlled as far as possible. References to density of surrounding trees and slope were seen but much less frequently. Although ensuring that the mineral or water content of the soil were controlled might well have been beneficial, such levels of control in a field study context are impractical. Time of day was a regular incorrect response but taking readings at different times of day would not realistically affect the number of small herbaceous plants growing under a tree. ⟳ **Assessment for learning** Although time and resource constraints can make field trips difficult, experience of conducting a study such as this one in a site larger than school grounds is a useful way to learn about the issues involved in carrying out a scientific investigation in an environmental context.
		Total		**8**	
3	a	**1**	reduction in (species / habitat) diversity ✓	max 1	**ALLOW** organisms / animals / plants for 'species' **ALLOW** named species reduction (in diversity)

		2 species may, decrease / disappear, as they relied on the, keynote species/trees, for their, food / habitat ✓ **3** species may increase as they are not competing for (named) resources ✓		**IGNORE** species will become extinct **ALLOW** habitat will be damaged for organisms so they will disappear **Examiner's Comments** Answers often lacked detail with statements referring to the destruction of the ecosystem without any reference to components within the ecosystem. Many answers referred to organisms not surviving but did not connect the role of the oak tree in determining their fate. Conversely answers discussed the role of the oak tree in an organism's niche but did not state what effect its loss would have on the organism.	
b	i	non-random / systematic ✓	1	**Examiner's Comments** Random sampling was often stated which would not be appropriate when using a transect line. Candidates that did recognise this as a non-random sampling method often stated stratified sampling which would not require a transect line. Some answers referred to the equipment involved, e.g. quadrats withoutnaming the sampling method.	

| | ii | **FIRST CHECK THE ANSWER (if answer not on answer line look in the table)**

 If answer = 0.71 award 3 marks

 0.71 ✓✓✓

 If final answer incorrect or not to 2 sig fig, award 2 marks:

 0.29 ✓✓

 If ∑(*n/N*)² / 0.29 incorrect, award 1 mark for:

 row values for, n/N **and** (n/N)², correctly entered ✓ | 3 | (see table below) | |

Species	Number of organisms (n)	n / N	$(n / N)^2$	
Foxglove	3	0.13	0.02	
Meadow buttercup	7	0.30	0.09	
Oxeye daisy	9	0.39	0.15	**ECF** for **one**
Yellow rattle	4	0.17	0.03	
	$N = 23$		$\Sigma(n/N)^2 = 0.29$	
			$1 - \Sigma(n/N)^2 = 0.71$	

					incorrect rounding in table: **ALLOW 2 marks for** $\sum(n/N)^2$ **and** $1 - \sum(n/N)^2$ to 2 sig fig ✓✓ **e.g.** $[(n/N)^2]$ 0.09, 0.15, 0.02 so $\sum(n/N)^2 =$ 0.28 and $1 - \sum(n/N)^2 = 0.72 = 2$ marks **Examiner's Comments** The question was well answered with good use of the table and a consistent approach to decimal places. Errors occurred when answers were rounded too quickly, particularly when calculating the square of n/N. ⓘ **OCR support** The [Mathematical skills handbook](#) – decimal places and significant figures is a great resource for candidates. There are also a range of resources on [Maths for Biology](#), including a tutorial and quiz for every maths skills assessed in the qualification.
		iii	(biodiversity is) high ✓	1	**ALLOW** low as **ECF** from 1(a)(ii) **ALLOW** field / it, is diverse / has high species evenness **and** richness **Examiner's Comments** The question was well answered with candidates showing a clear understanding of the relevance of the Simpsons Index Diversity value calculated. A few answers stated high species evenness or richness andit should be appreciated that species biodiversity is a combination of the two.
	c		**1** (in both areas kick for) same number of times ✓ **2** same, kicking method used / depth of sweep net ✓	max 1	**e.g.** kick sampling for 5 minutes in each part of river **e.g.** heel of foot kicking (in the direction of the net) / kick with same force / same person does the kicking

		3	sweep net is, downstream of student kicking / facing upstream ✓		**Examiner's Comments** Many answers referenced 'reliability' of the data collected with suggestions of repeating the method.Candidates often suggested a different method or a different location which does not pay attention tothe request for an improvement to the method. Candidates should be aware that validity for a method is referring to controlled variables. ⓘ **OCR support** Further guidance on Language of measurement can be found on [Teach Cambridge.](#)
		Total		**7**	

4	a		I: large(r) sample size / AW ✓
			
			E: more representative / better representation (of populations / area) / AW ✓
			
			I: stratified sampling / described ✓
			
			E: avoids missing, species / populations (in different areas / in river / on one side of river) ✓
			
			I: use frame <u>quadrat</u> (rather than point quadrat) / described ✓
			
			E: less likely to miss (rare) species
			    or
			    easier to measure, tall plants / shrubs / bushes
			    or
			    less likely to harm small animals
			    or
			    more representative / better
				4 max	***Only award Explanation mark if linked to correct improvement***
					e.g. 'generate more (than 10) coordinates'
					
					e.g. 'higher chance of samples being taken from all three areas' / 'more, accurate / valid, estimate of population size' / '(otherwise) might not cover all, species / biodiversity (in area)'
					IGNORE ref to accuracy / validity unqualified
					
					IGNORE 'quota sampling'
					
					e.g. 'divide area into three zones and take random samples in each zone, with the number of samples proportional to the area of the zone' / 'sample from all three regions on map'
					
					ALLOW more representative / better representation (of area)
					ALLOW (because) different areas have different species
					ALLOW phonetic spelling e.g. quadrrat, quadratte
					e.g. 'use a quadrat with squares' / 'use a grid quadrat'

		representation (of population / area) / AW ✓
		
		I: use (a number of) transects (from bank into grassland) ✓
		
		E: more representative of population / AW
		    or
		    less likely to miss (rare) species ✓
		
		I: ref to sampling at different times of the year ✓
		
		E: more representative of population / AW
		    or
		    less likely to miss species (growing at different times of the year) ✓
				ALLOW 'as there is an environmental gradient from the river'
				
				Examiner's Comments
				
				Many candidates gained marks for describing larger sample sizes, the use of stratified sampling and the use of a frame quadrat as potential improvements to the method. Some candidates explained these improvements in terms of providing better representation of the area or populations. Vague explanations such as 'to improve accuracy' or 'to collect more data' were not credited. A small number of candidates described the use of transects and sampling at different times of year as possible improvements.
				
				Answers that described the use of one transect did not gain credit because this would be less representative than several random samples, partly because it would be restricted to one side of the river. Answers that focused on changes to the method in the river were not credited because these suggestions rely on too much unknown information. For example, if the river is shallow, clear or slow moving, the use of quadrats is plausible. Otherwise, if little plant life is observable in the river, it could be omitted from the sampling.

	b	i	mammals greater, threat / %, from human exploitation
			                          / AW
			
			or
			
			birds smaller, threat / %, from human exploitation
			                          / AW✓
			
			mammals smaller, threat / %, from, climate change / pollution / AW
			
			or
			
			birds larger, threat / %, from, climate change / pollution / AW
				2 max	**ALLOW** 'vulnerable', 'susceptible', 'sensitive', 'face more', 'affected (more / less)' in place of 'threat'
					
					ALLOW refs to **qualified** data quote
					
					e.g. human exploitation has 37% threat in mammals but **only** 16% in birds' / 'mammals more, threat from / affected by, human exploitation / hunting'
					
					e.g. 'mammals have less threat from climate change and pollution'
					
					e.g. 'pollution is twice the threat for birds compared to mammals'
					
					Examiner's Comments

			✓ mammals have, similar / slightly lower, threat / %, from, habitat degradation / invasive species / AW **or** birds have, similar / slightly higher, threat / %, from, habitat degradation / invasive species / AW ✓		Many candidates were able to gain both marks. A range of different ways of describing greater/smaller threat were accepted, as well as quotes of the percentages if these were qualified in a way that shows the correct trend in the data and as a comparison between mammals and birds, e.g. 'human exploitation has 37% threat in mammals but only 16% in birds'. Candidates who described the difference in habitat degradation needed to say that there was a slightly lower/higher threat or that the percentages were similar. Candidates should be encouraged to comment on the finer detail when describing data so that they pick up on points like this.
		ii	*Supports* 1 lowest (% threat) for reptiles and amphibians **and** mammals / AW ✓ 2 threatens fewer than 11 - 13% (of species / populations) in **all**, (four) groups / animals / AW ✓ 3 ref to absolute number of species assessed being high enough to be representative ✓ *does not support (max 3)* 4 small proportion of (of total) species assessed ✓ 5 sample was not random (because species were selected from the Red List) ✓ 6 threat categories overlap / described ✓ 7 many species are threatened by more than one factor ✓ 8 effects of climate change (on biodiversity) yet to be felt / climate change impact will increase in future / AW ✓ 9 AVP ✓	4 max	**ALLOW** '**all** other categories for reptiles and amphibians **and** mammals have a greater threat / higher % (than climate change) ' **ALLOW** any value in this range e.g. 'highest % of populations affected by climate change is 12%' e.g. '3789 species are assessed is a large enough sample to be representative' **ALLOW** 'only 3,789 of the millions of animal species were assessed' / 'not assessed every species' **IGNORE** 'small sample size' **ALLOW** examples (e.g. 'human exploitation / climate change, can cause habitat loss') e.g. 'data is (8 years) old, climate change has had a greater impact since then' e.g. 'can't be generalised to all animals' / 'no statistical analysis carried out' / 'only vertebrates were studied' / 'no plants included' **Examiner's Comments** This part of Question 2 proved challenging with few candidates gaining all four marks. There were many responses that focused on the other threats being higher, which did not gain credit. The idea of it being the lowest

threat needed to be linked to named groups as this was not true for all the groups of animals. Similarly, it had to be clear that all the groups had a threat below 11-13%. A small number of candidates interpreted the data incorrectly thinking that the climate change values were highest as they went up to 100%. The strongest responses gave points in support and against the conclusion. Very few candidates identified that these species were from the Red List therefore it was not a random sample. However, a greater number realised that climate change would lead to other threats such as habitat loss, or that the impact of climate change will have increased since the data was taken. Many candidates realised that there was no statistical analysis, and some recognised that the study could not be generalised to all animals or that other groups, such as plants were not included. When answering questions of this type it would help candidates to be more succinct in their answers, as there were some quite long responses that filled the answer space while only focussing on a single point.

Assessment for learning

The majority of candidates were able to pick up some marks on this question, but exam technique could be improved to maximise their success.

The question is effectively asking candidates to 'Evaluate this conclusion: "climate change is not a major threat to species biodiversity"', which happened to be concluded by someone just looking at the graph. When candidates are asked to evaluate, they should aim to find positives and negatives. So as a minimum they should be aiming to make four points here.

Candidates need to not just look at data in the graph, but all the surrounding information to see if the conclusion drawn can be supported or not. The data cannot be analysed without understanding what they represent (i.e. what the researchers considered the principal threat to each

						population) and the limitations of the method used to collect the data. Therefore, it is important to remind candidates to use all the information linked to the graph when evaluating a conclusion.

The acronym ReBUGG could be used:

Re	read the question
B	box in command words
U	underline key points
G	gauge the number of points needed
G	glance back and read what you have written.

		Total		**10**		

| 5 | a | 1. *ref*. monoculture ✓

reduces genetic diversity / (crop/s) susceptible to same
2. disease / (crop) populations are unable to adapt to changing conditions ✓

3. destroys / ruins , habitats ✓

pesticide use may , cause bioaccumulation / kill organisms higher up the
4. food chain / kill non targeted insects or organisms / reduce species biodiversity ✓

reduce food supply further up the food chain / idea of
5. disrupting food webs / chains ✓

fertiliser may cause ,
6. eutrophication / described ✓

pesticides kill pollinators / pollinating insects, reduction
7. in pollination / reduced spread of plants ✓ | | 3 max | | **ALLOW** monoculture described e.g. large fields of only 1 crop

ALLOW reduces (number of) habitats / habitat diversity
ALLOW named habitats e.g. deforestation / removal of hedgerows

Examiner's Comments

Overall, candidates attempted this question well with a full range of marks being given. Candidates who were given 3 marks were able to link different agricultural practices such as 'monoculture' with their consequences like 'habitat destruction' and 'reduction in genetic biodiversity' – these being the most common marking points seen. Candidates who did not score as well discussed species richness and evenness but could not clearly link these to agriculture to gain marks and/or talked too generally about loss of biodiversity without linking to a specific type, i.e. 'species', 'habitat' and/or 'genetic' biodiversity.

(?) **Misconception**

Many candidates knew that the use of fertiliser could be harmful to aquatic |

					environments but were not given the relevant marking points as they didn't adequately explain (or name) the process of 'eutrophication'.
	b		1. climate change ✓ (human) population growth / 2. urban expansion / urbanisation ✓ 3. pollution ✓ 4. resource exploitation / tourism ✓ 5. climax community ✓ 6. hunting / poaching ✓ 7. (named) natural disasters ✓ 8. war / civil unrest ✓ 9. introduction of invasive species ✓	1 max	**ALLOW** global warming **ALLOW** deforestation **Examiner's Comments** This question was very well answered with most candidates given the mark here. The most common responses were 'climate change', 'global warming' and 'deforestation', but the full range of possible responses were seen.
		Total		**4**	
6			D ✓	1	**Examiner's Comments** The question was answered very well, showing that most candidates were clear on the different definitions in this specific topic selecting D as the correct response.
		Total		**1**	
7			B ✓	1	**Examiner's Comments** B was identified by most candidates as the correct response showing a good understanding of the definitions of species evenness and species richness, and their roles in the stability of a habitat. Although some candidates showed working out suggesting they calculated Simpsons Index of diversity, this was not required to answer the question as the data provided showed a clear increase in species evenness for Area 1 resulting in a more stable habitat.
		Total		**1**	
8			A ✓	1	**Examiner's Comments** This question was a good discriminator with most successful responses choosing the right response of A.

			Total	1	
9			C ✓	1	**Examiner's Comments** The majority of candidates selected the correct response, C. The most common incorrect response was A. Possibly some candidates were confused thinking that a botanical garden was growing plants in one place.
			Total	1	
10			B **OR** C ✓	1	**ALLOW** if labelled correctly on image **Examiner's Comments** Both B and C were accepted as correct for this question. If the increased species becomes more dominant than the rest of the species within the habitat, then the diversity (D) will decrease (answer C). If the increased species doesn't become dominant within the habitat, then the biodiversity would increase (answer B).
			Total	1	
11	a	i	(genetic) bottleneck ✓	1 (AO1.1)	**ALLOW** population bottleneck **Examiner's Comments** Most candidates correctly answered this question. Common incorrect answers included genetic drift or mass extinction.
		ii	<table><tr><th>Kakapo trait</th><th>Type of adaptation</th></tr><tr><td>Active at night to avoid predators</td><td>behaviour(al)</td></tr><tr><td>Green feathers that camouflage with its surroundings</td><td>anatomical</td></tr><tr><td>Slow digestion to extract nutrients from a high-fibre, low-protein diet</td><td>physiological</td></tr><tr><td>Strong beak and claws to climb trees</td><td>anatomical</td></tr></table> ✓ ✓	2 (AO2.1)	**2 correct = 1 mark** **4 correct = 2 marks** **ALLOW** 'anatomy' for 'anatomical' **ALLOW** 'physiology' for 'physiological' **ALLOW** 'anatomy' for 'anatomical' **Examiner's Comments** This question was well answered with most candidates gaining at least 1 mark. A minority thought that green feathers, strong beak and

					claw were physiological adaptations and 'slow digestion' was anatomical adaptation.
		iii	*evidence for sympatric speciation* species live(d) in the same (geographical) area / AW ✓ ecological / behavioural / temporal , isolation ✓ (because) they occupy different , niches / AW ✓ *idea that* (some) kaka flew to North Island after speciation ✓ *evidence for allopatric speciation* geographical isolation as mountain range emerged / AW ✓ *idea that* (some) proto-kaka flew to the North Island and evolved into kaka / AW ✓ *idea that* (some) kaka later returned (to South Island) ✓	4 max (AO3.1) (AO3.2)	**ALLOW** ref to same location **IGNORE** ref to same / similar, environment / habitat **ALLOW** divergence / separation for isolation **IGNORE** reproductive / mechanical , isolation e.g. 'differences in diet' / 'time of activity' e.g. 'Alps creates physical barrier between populations' **Examiner's Comments** This was intended as a challenging question that required more than the standard descriptions of reproductive isolation, and few candidates were given full marks. Good answers linked the presence in the same geographical area and the differences in diets as evidence for the possibility of ecological or behavioral isolation, which can lead to sympatric speciation. Many answers also linked the emergence of the Southern Alps with possible geographical isolation, leading to allopatric speciation.
		iv	species richness is the number of (different) species (in an area or community or ecosystem) ✓ species evenness is the (relative) abundance (of individuals) in each species (in an area or community or ecosystem) ✓	2 (AO1.1)	**IGNORE** amount of different species (in an area or community or ecosystem) **ALLOW** 'species evenness is (a comparison of) the number (of individuals) in each species (in an area or community or ecosystem)' **Examiner's Comments** Many candidates had a good understanding of the difference between species richness and species evenness although less successful candidates' responses often lacked the precision required to gain both marks. For example, referring to 'amount' instead of 'number' when describing species richness, and the 'spread' or 'distribution' of a species rather than the relative abundance of

					each species, when describing species evenness.
			Total	**9**	
1 2	a		**1** Species, richness /evenness, is, greater/ higher in 2010 (compared to 1980)✓ Species richness **2** 3 species in 2010 compared to 2 in 1980 ✓ Species evenness **3** In 1980 98% of penguin pairs were one species (Adelie) **and** In 2010 only 57% of penguin pairs one species (Adelie) ✓	3 (AO2.2 × 1) (AO3.1 × 2)	**IGNORE** ref to years other than 1980 and 2010 **1 ALLOW** stronger for 'greater' **1 DO NOT ALLOW** no species richness in 1980 **2 ALLOW** (after 1980) a new species/Gentoo, has emerged **3 ALLOW** In 2010 Adelie have decreased and, Chinstrap/Gentoo, have increased (in number) so they are more even. e.g. *Adele penguins are 220 in 2010 and Chinstrap are 800 so numbers are closer.* **Examiner's Comments** Most candidates did not score well with this question. Although some candidates quoted the meaning of species richness and evenness in their answer, they did not refer to the two time periods stated in the question. Many answers referred to all the years between 1980 and 2010 without emphasising those specific years. This might be because they misunderstood the question and thought it was referring to 'from 1980 to 2010' rather than 'in the years 1980 and 2010'. The lack of focus on the appropriate years led to answers indicating that species evenness was greatest in 2000 but was very low by 2010. Many candidates did appreciate the increase in species richness with the introduction of the Gentoo penguin. Some answers referred to the species evenness and richness of each species in turn, so did not understand the definitions of these terms. (?) **Misconception** Many candidates discussed the species evenness of the Gentoo, then the species evenness of the Adele penguin, etc. Candidates should realise that the term species can mean 'within the species' but

					can also mean across species - it is both a plural and singular word. So the definitions of species evenness/richness means across lots of species.
	b		Any two from: **1** regulate, trade in /collection, of guano ✓ **2** penguins can, (now) breed / increase in number✓ **3** prevent trade in (live) penguins / penguin's skin and oils ✓ **4** raise awareness/educate (locals/governments) ✓	2 (AO2.1)	**IGNORE** ref to endangered status/listing species/ conserving area as this is not CITES **1 ALLOW** prevent humans from, collecting/ using guano **Examiner's Comments** A lot of candidates recognised that CITES was involved with trade, often quoting the whole name at the start of their answer. Some answers then discussed banning hunting and making it illegal to kill penguins, not appreciating that this would not be beyond the remit of trade. A few candidates discussed ex situ conservation methods so did not understand the role of CITES. Some answers referred to cleaning up the guano to provide a cleaner breeding site for the penguins, so the indicative points in the question were not clearly understood. ◎ **Assessment for learning** The CITES website is a good start to introduce candidates to the role they play and there are many examples of illegal trade that can be investigated by candidates and discussed – see this WWF factsheet as a starting point.
		Total		**5**	
1 3	a	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 ✓	2 max(AO3.4)	

		position of coordinates difficult to judge ✓ method does not specify top (left) or bottom (left) ✓			**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.
b	i	**FIRST CHECK ON ANSWER LIN** **If answer = 0.6816 award 3 marks** $\sum(n/N)^2$= 0.3184 ✓ ✓ 1 - calculated $\sum(n/N)^2$ ✓		3(AO2.4)	**ALLOW** 0.68 / 0.682 **ALLOW** any correct rounding **ALLOW ecf** from calculated value of $\sum(n/N)^2$ **Examiner's Comments** This skill has evidently been well practised, with most candidates getting the correct answer, supported by a clear and well-organised calculation.
	ii	*If treating grass as a single species…* D / calculated diversity / index , is lower ✓ **ora** $\sum(n/N)^2$ is higher ✓ **ora** *idea that* $(26/N)^2$ will be bigger than the sum of $(n/N)^2$ for individual grass species ✓		2 max(AO2.4)	**ALLOW** 'value' as AW for calculated diversity **ALLOW** 'a bigger number is subtracted from 1' **ALLOW** e.g. '0.270 is bigger than the equivalent number for individual grasses' **Examiner's Comments** Most responses gained 1 mark for recognising that the students' approach

					would have lowered the value for D. However, only a minority went on the support this with reference to which of the earlier stages in the calculation would have been affected. Responses that did not reference the calculated figure for D, merely discussing the idea of biodiversity, were not given marks.

Assessment for learning

This question could be used, or modified, to consolidate or extend a class's understanding of Simpson's Index and the impact of species richness and evenness.

			Total	8	
1 4			few gene loci studied ✓ *idea of* small sample sizes (within each population) ✓ *idea that* the two measures show different patterns of results ✓	2 max(AO3.1)(AO3.2)	**Mark as continuous prose** **ALLOW** 'only 23 gene loci studied' e.g. 'only 6 trees sampled in population A' **IGNORE** ref to different sample sizes in each population **ALLOW** descriptions such as 'B has the joint highest diversity based on polymorphic loci but only the third highest based on heterozygosity'. **Examiner's Comments** Few candidates gained both marks. Marks were given most often for saying the sample size was too small and some commented that only 23 loci were studied. The most common misconception was that the difference between sample sizes of trees in group B (16) and A/C/D (6) was a limitation. Many candidates were not familiar with the terms 'polymorphic loci' and 'heterozygosity'; hence the idea that the two measures show different patterns of results was rarely given. This lack of familiarity with the subject matter was also demonstrated by candidates who suggested that every locus should have been studied or that homozygosity should have been studied as well. Further misunderstanding was demonstrated by

					candidates who described the subjectivity of observing heterozygosity.
		Total		**2**	
1 5					**DO NOT CREDIT** if any incorrect letters are given **IGNORE** B and E **IGNORE** B and E **IGNORE** F **Examiner's Comments** Around three quarters of candidates gained at least 2 marks here. Many answers omitted one of the required economic examples.
		Total		**3**	
1 6		A ✓	1(AO2.3)		
		Total		**1**	
1 7	a	habitat (biodiversity) **and** (which is) the number of different habitats / a range of different habitats (in an, ecosystem / area) ✓ species (biodiversity) **and** (which is) the richness **and** evenness of a species / the number of different species (in an ecosystem / community) ✓		2	**DO NOT ALLOW** the number of different habitats in a community **DO NOT ALLOW** species richness or species evenness as the name **DO NOT ALLOW** in a population **Examiner's Comments** Many more able candidates scored well here. However, less successful candidates did not read the question with sufficient care and defined the terms 'species' and 'habitat'. Others used 'species richness' and 'species evenness' as their types of biodiversity. A few candidates did not know their definitions well and confused the issue by writing things like 'the number of species in a population'.
	b	i	0.07(03125) ✓ ✓	2	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.07(03125) award 2 marks**

					ALLOW correct answer anywhere in answer space **ALLOW** 7(.03125)% for two marks If correct answer not given then: **ALLOW** one mark for: number of polymorphic gene loci / total gene loci **OR** 18 / 256 **OR** 9 / 128 **Examiner's Comments** The majority of candidates were able to calculate the correct proportion. In common with other questions of this type, however, there were a significant number of candidates who are not confident with the manipulation of numerical data. There are still too many candidates who do not show their working and so potentially lose a mark if they get the incorrect answer.
		ii	sample not random ✓ sample not large enough ✓ may have sampled different, zoos / individuals ✓ may not have sampled the same gene loci ✓	Max 2	**ALLOW** sample was, biased / less representative / Unrepresentative **ALLOW** only 256 loci sampled **ALLOW** smaller sample **Examiner's Comments** Many candidates appreciated that sample size was important but, in general, this question has a low performance. Most candidates attempted a response but, more often than not, this revealed a lack of understanding of the topic. A lot of candidates did not read the question carefully and thought some of the cheetahs sampled were in the wild rather than in zoos. Less able candidates seem to think that there are lots of different species of cheetah. (?) **Misconception** Two common misconceptions were seen: that technology / equipment in the 20th Century was at a primitive level compared to

					now and that natural selection and evolution has changed the appearance and genotypes of cheetahs significantly since the 20th Century.
		iii	the, population / gene pool, has become (very) small (due to, hunting / habitat destruction / disease susceptibility) ✓ (so) few(er), gene variants / alleels ✓ (so) inbreeding maintains, the same alleles / small gene pool ✓ only (rare) mutation can introduce, new / different, alleles ✓	Max 3	**ALLOW** ref to bottleneck **ALLOW** population / gene pool, has become limited **IGNORE** population gets smaller **ALLOW** low(er) genetic diversity **ALLOW** genetic diversity decreased **IGNORE** inbreeding reduces gene pool **Examiner's Comments** The majority of candidates seemed to interpret the question as 'give reasons why the cheetah populations declined'. Those candidates that ventured into population genetics revealed a poor understanding. Few seemed to appreciate that if the population becomes very small then the gene pool is small. This means that genetic diversity is significantly reduced due to the loss of alleles, and it follows that the proportion of polymorphic loci would be lower. Less successful candidates seemed to think that a polymorphic gene locus was a type of allele that gave a selective advantage or disadvantage to the possessor.
		Total		**9**	
18			**B** ✓	1	**Examiner's Comments** Most candidates gave the correct response (B). The most common incorrect response appeared to be C. Option C was the distractor in this question, where it shows a great species richness but it doesn't have the greatest species evenness, with 'Spiders' having only one species.
		Total		**1**	
19			**B** ✓	1	**Examiner's Comments** The vast majority of candidates correctly identified B as the correct organisation.

			Total	1	