Biodiversity Overview

A Level

Part A Types of biodiversity

Biodiversity can be measured at different levels:

- [ ] diversity: how much genetic variation there is among individuals within a [ ]
- Species diversity: how many species there are (species [ ]) and how even their population sizes are (species [ ]) within a [ ]
- [ ] diversity: how many types of habitat are found within a chosen area

Items:

Habitat/Ecosystem **Genetic** **community** **richness** **evenness** **population or species**

Part B The importance of genetic diversity

Which of the following could happen as a result of decreased **genetic** diversity? Select all that apply.

- [ ] recessive genetic conditions become more common
- [ ] all of the crop plants in a field are killed by the same disease
- [ ] a population struggles to adapt (by natural selection) to environmental changes
- [ ] heterozygosity in the population increases

Part C The importance of species diversity

Which of the following could happen as a result of decreased **species** diversity? Select all that apply.

- [ ] habitat diversity decreases
- [ ] the populations of some species in the community increase in size
- [ ] a population of flowering plants goes extinct because of the loss of a pollinator species from the community
- [ ] species richness and species evenness both increase
- [ ] the populations of some species in the community decrease in size

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Created for isaacphysics.org by Lewis Thomson

Sampling Types in Ecology

A Level

P P P

In order to measure biodiversity in an area, ecologists take samples of the area. Three of the most common types of samples used in ecology are **random**, **systematic**, and **stratified**.

- In **random sampling**, the location of each sample is determined randomly.
- In **systematic sampling**, samples are taken at regular intervals across the area, beginning with a random starting point.
- In **stratified sampling**, the area is divided into different types of habitat, and the number of samples taken from each habitat is proportional to the area covered by that habitat type. Within each habitat type, the location of each sample is usually determined randomly.

Part A Frame quadrats

A researcher wants to measure the biodiversity of animals in a coastal area. The table below shows three different ways they could use frame quadrats to measure animal biodiversity. They plan to take 10 samples of the area.

Match the sampling type to the example.

Example	Sampling type
A random number generator is used to generate 10 pairs of numbers. These are used as coordinates to determine where each of the 10 quadrats should be placed.	
Three habitat types within the area are identified: beach (60% of the total area), sand dune (30% of the total area), and rock pool (10% of the total area). 6 quadrats are placed at random locations within the beach habitat, 3 quadrats are placed at random locations within the sand dune habitat, and 1 quadrat is placed in a randomly selected rock pool.	
A line is marked from the shore to the opposite side of the sand dunes, measuring approximately $60\,\mathrm{m}$. The first quadrat is placed at a random point on this line between 0 and $6\,\mathrm{m}$ from the shore, and then a quadrat is placed every $6\,\mathrm{m}$ along the line.	

Items:

random **systematic** **stratified**

Part B Mist nets

A researcher wants to measure the biodiversity of birds in an area. They plan to set up 5 mist-nets in the area, which will allow them to carry out a mark-release-recapture survey. The table below shows three different ways they could place the mist nets to measure bird biodiversity.

Match the sampling type to the example.

Example	Sampling type
5 locations are chosen that are evenly distributed from the edge of the forest to the opposite edge of the grassland, beginning with a randomly selected starting point. A mist net is placed at each location.	
2 locations within the forest habitat (40% of the total area) are chosen at random and 3 locations within the grassland habitat (60% of the total area) are chosen at random. A mist net is placed at each location.	
5 locations are chosen at random and a mist net is placed at each location.	

Items:

random **systematic** **stratified**

Part C Sweep nets

A researcher wants to measure the biodiversity of fish in a large pond. They plan to carry out 20 sweeps in the pond using sweep nets (sampling an equal volume of water each time). The table below shows three different ways they could use sweep nets to measure fish biodiversity.

Match the sampling type to the example.

Example	Sampling type
A sweep is carried out every $5\,\mathrm{m}$ from one edge of the pond to the opposite edge, beginning with a randomly selected starting point between 0 and $5\,\mathrm{m}$ from one edge.	
20 locations are chosen at random and a sweep is carried out at each location.	
2 locations around the edge of the pond (10% of the total pond volume) are chosen at random and 18 locations in the centre of the pond (90% of the total pond volume) are chosen at random. A sweep is carried out at each location.	

Items:

random **systematic** **stratified**

Part D Choosing a sampling type

The most appropriate sampling type will depend on the area and what we want to measure/estimate.

Choose the most appropriate sampling type for each scenario in the table below.

Scenario	Sampling type
The area consists of a single habitat type, and we are estimating population sizes in the area.	
The area consists of multiple distinct habitat types, and we are estimating population sizes in the area.	
The area shows a gradual change in habitat from one side to the other, and we are measuring how the distribution of each species relates to this.	

Items:

random **systematic** **stratified**

Created for isaacphysics.org by Lewis Thomson

Gameboard:

STEM SMART Biology Week 31 - Biodiversity

Invasive Plants

A Level

C C C

Figure 1 shows eight $2\,\mathrm{m} \times 2\,\mathrm{m}$ quadrats that have been placed at random locations in a $14\,\mathrm{m} \times 10\,\mathrm{m}$ field that has recently been colonised by a small invasive plant (each plant is shown by a flower symbol).

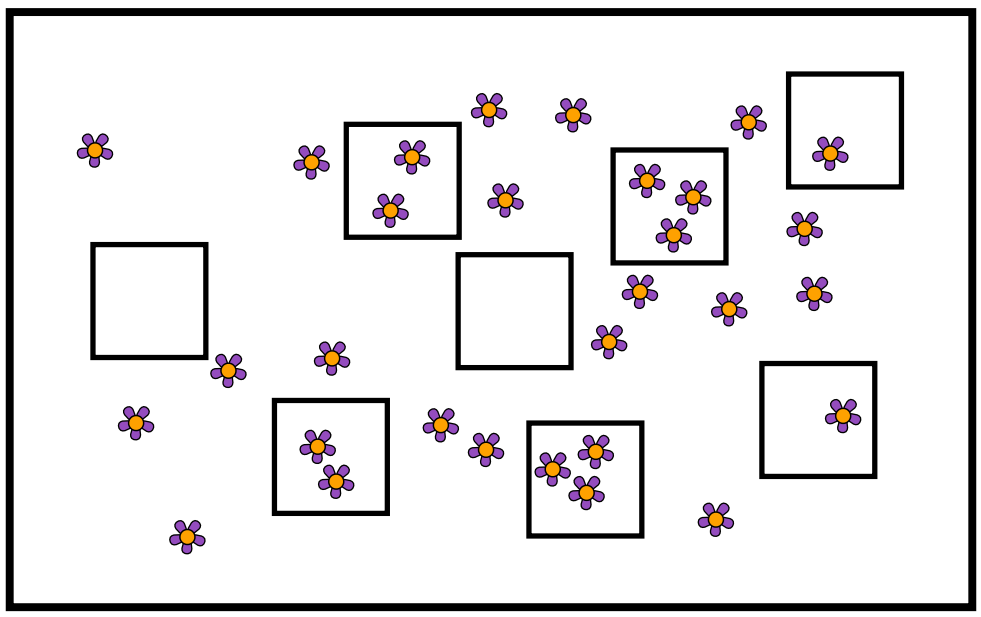

Figure 1: Eight quadrats placed in a field containing invasive plants. (Diagram not to scale)

Part A Pros and cons

What is the main **advantage** of using quadrats in a study like this?

- The quadrats prevent the organisms from moving, so they can be more easily counted.
- It provides a more accurate estimate of population size than counting all of the individuals in the field would, because you are less likely to make mistakes when counting smaller numbers.
- It allows you to calculate the exact number of individuals in the population without counting all of them.
- Quadrat sampling provides more accurate population estimates than line transects.
- The quadrats ensure that the sampling is systematic.
- It is much quicker than counting all of the plants in the field.

What is the main **disadvantage** of using quadrats in a study like this?

- The plants are too large for the quadrats used in this study.
- Quadrats cannot be used in random sampling.
- The sample may not be representative, which will lead to an inaccurate estimate of population size.
- The quadrats cannot stop the organisms from moving.
- Estimating population size takes longer than simply counting all of the individuals in the field.
- Quadrats cannot be used to accurately estimate population size.

Part B Frequency of occurrence

Calculate the frequency of occurrence of the species in the quadrats. Give your answer as a percentage.

Part C Mean number per square metre

Calculate the mean number of plants found per square metre in the quadrats.

Part D Population estimation

Estimate the population size in the field, using the quadrat data.

Give your answer to the nearest integer.

What is the difference between the population estimate and the actual population size?

Part E Two plants per square metre

For the field as a whole, this population grows by 70 individuals per week.

How long will the population take to reach an average density of two plants per square metre in the $14\,\mathrm{m} \times 10\,\mathrm{m}$ field?

Adapted with permission from NSAA 2018 Section 2 Question B2

Gameboard:

STEM SMART Biology Week 31 - Biodiversity

Sampling Flowers

A Level

C C C

Part A Meadow buttercups

An ecologist used a $50\,\text{cm} \times 50\,\text{cm}$ square quadrat to estimate the number of meadow buttercups present in a field with an area of $50\,\text{m}^2$. The quadrat was distributed randomly on ten occasions in the field and the number of buttercups counted in each quadrat.

Quadrat	Number of buttercups
1	3
2	10
3	0
4	4
5	21
6	19
7	6
8	11
9	15
10	3

How many buttercups were there estimated to be in the $50\,\text{m}^2$ field?

Part B Dandelions and daisies

In another survey, an ecologist used a line transect to investigate the distribution of daisies and dandelions in a field.

A quadrat with sides of $0.5\,\mathrm{m}$ was used to collect the data.

The results are shown in **Figure 1**.

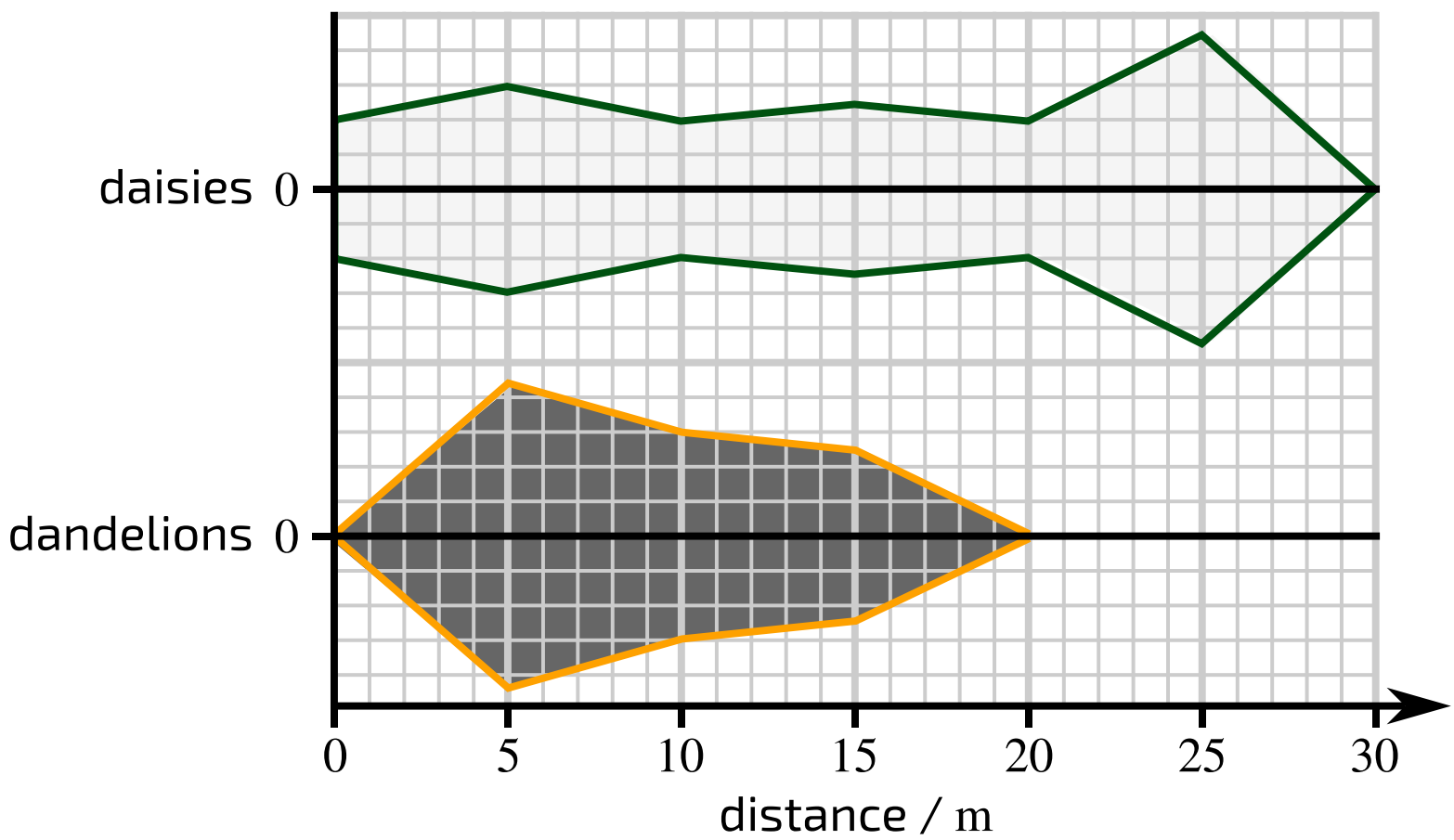

Figure 1: A kite diagram of the daisy and dandelion distribution along a transect. Each square on the vertical axis represents 1 plant. For example, in the quadrat centred at $5\,\mathrm{m}$ there were 6 daisies.

Calculate the density of dandelions at $5\,\mathrm{m}$.

Which of the following statements are correct? Select all that apply.

- [ ] Repeating the experiment along a different transect would result in an identical pattern.
- [ ] Across the transect, the number of dandelions is proportional to the number of daisies.
- [ ] Based on the data, the estimated number of daisies in the field would be greater than the estimated number of dandelions in the field.
- [ ] Based on the data, the estimated number of dandelions in the field would be greater than the estimated number of daisies in the field.
- [ ] None of the above.

Part C Quadrat sizes

The abundance of a plant species in a $100\,\mathrm{m}^2$ area of grassland was measured. **Figure 2** represents this area of grassland. Each green circle represents one individual of the plant species in this area of grassland.

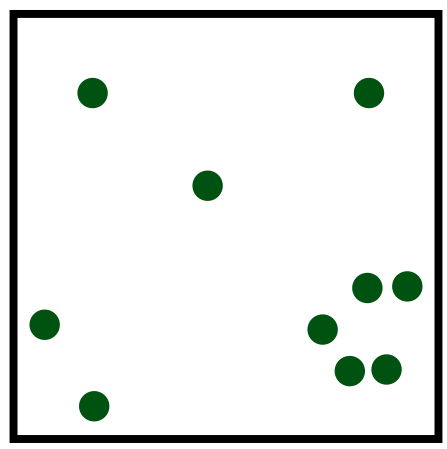

Figure 2: 10 individuals in an area of grassland.

Two different size quadrats were used to sample the area:

- large quadrat ($50\,\mathrm{cm} \times 50\,\mathrm{cm}$)
- small quadrat ($10\,\mathrm{cm} \times 10\,\mathrm{cm}$)

The area is sampled randomly, first using 10 large quadrats and then a second time using 10 small quadrats.

Which of the following statements are correct? Select all that apply.

- [ ] The overall density in the grassland estimated from sampling with either size quadrat will always be the same.
- [ ] The overall density in the grassland estimated from sampling will always be 0.1 plant per m^2.
- [ ] The frequency of occurrence obtained using the small quadrat will always be lower the that obtained using the large quadrat.
- [ ] none of the above

Question elements adapted with permission from NSAA 2019 Section 1 Q59, NSAA 2021 Section 1 Q80, and NSAA 2020 Section 1 Q74

Gameboard:
STEM SMART Biology Week 31 - Biodiversity

Catching Tadpoles

A Level
C C C

A student investigated the tadpole population in a large pond.

A net with a rectangular opening measuring $0.1\,\mathrm{m} \times 0.2\,\mathrm{m}$ was swept through the water for a fixed distance of $1\,\mathrm{m}$. This was repeated 10 times.

All the sweeps were made at the edge of the pond as the student had no waders or boat.

The number of tadpoles in each sweep was recorded in the table.

Sweep number	1	2	3	4	5	6	7	8	9	10
Number of tadpoles	20	12	32	0	4	8	4	8	12	20

Part A Volume of water

Calculate the volume of water sampled by each sweep.

Part B Frequency of occurrence

Calculate the frequency of occurrence of the tadpoles. Give your answer as a percentage.

Part C Estimation accuracy

Which of the following statements are correct?

- It is possible to accurately estimate the number of tadpoles in the pond without any further information.
- It would be possible to accurately estimate the number of tadpoles in the pond if the average volume of a tadpole was calculated.
- It would be possible to accurately estimate the number of tadpoles in the pond if the total volume of water in the pond was known.
- It would **not** be possible to accurately estimate the number of tadpoles in the pond, even if the total volume of water in the pond was known, because of sampling bias.
- It would **not** be possible to accurately estimate the number of tadpoles in the pond, even if the total volume of water in the pond was known, because the frequency of occurrence is less than 100%.
- It would **not** be possible to accurately estimate the number of tadpoles in the pond, even if the total volume of water in the pond was known, because the sample data does not follow a normal distribution.

Adapted with permission from NSAA 2018 Section 1 Q58

Gameboard:

STEM SMART Biology Week 31 - Biodiversity

Species Diversity

A Level

C C C

Miscanthus and reed canary grass are crops that are reported to promote species diversity.

A field trial was carried out to determine which crop promotes the greater diversity of bird species:

- Two fields (**M** and **R** were sampled)
- *Miscanthus* was grown in field **M**
- Reed canary grass was grown in field **R**
- The number of individuals of each bird species (n) was recorded for both fields

The table below shows the data collected for field **M**.

Bird species	Number of individuals (n)
Dunnock	3
Song thrush	40
Reed bunting	23
Meadow pipit	12
Willow warbler	4
Common redstart	18

Part A Species richness

What is the species richness of field **M** in terms of bird species?

Part B Simpson's Index of Diversity

Simpson's Index of Diversity is a measure of species diversity that takes into account species **evenness** as well as species richness.

It is calculated using the formula

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

where

- $n =$ the number of individuals of each species
- $N =$ the total number of individuals of all species

Calculate Simpson's Index of Diversity for field **M** in terms of bird species.

Give your answer to 2 significant figures.

Part C M vs R

The Simpson's Index of Diversity (in terms of bird species) for field **R** is 0.54.

Based on this field trial, which crop promotes the greater diversity of bird species?

- *Miscanthus*
- reed canary grass
- there is no difference in bird species diversity between the two fields

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Adapted with permission from OCR A Level Biology B June 2017, Fundamentals of Biology, Question 35

Gameboard:
STEM SMART Biology Week 31 - Biodiversity

Tomato, Tomato

A Level

C C C

Commercial varieties of tomato are produced from wild varieties of tomato.

The genetic diversity of tomatoes can be measured and expressed as a number.

A population of wild varieties of tomato was found to have a genetic diversity of 0.30.

The table shows the genetic diversity of a population of commercial tomatoes grown at different times.

Year	Genetic diversity
pre-1960	0.10
1960	0.05
1980	0.20
2000	0.30

Part A Calculating genetic diversity

Genetic diversity is measured by measuring the [ ], which is [ ] ÷ [ ].

The value for genetic diversity ranges from [ ] (lowest possible value) to [ ] (highest possible value).

Items:

the total number of gene loci **the total length of all genes in the organism**

the average length of a gene in the organism **the proportion of polymorphic gene loci**

the number of polymorphic gene loci -1 0 1 10 100

Part B Changes in genetic diversity

Which of the following statements about these tomatoes could be correct?

- [ ] The addition of genetic material, enabling the tomatoes to produce memory cells so that they are resistant to diseases, increased the genetic diversity from 1960 onwards.
- [ ] The increase in genetic diversity was 50% greater during the 1960 to 1980 period than the 1980 to 2000 period.
- [ ] Selective breeding of tomatoes occurred before 1960.

Part C Rate of increase

Calculate the average rate of increase in genetic diversity per day between 1960 and 2000.

Give your answer to 2 significant figures.

Adapted with permission from NSAA 2021 Section 2 Q58