Maths in Science
Sampling

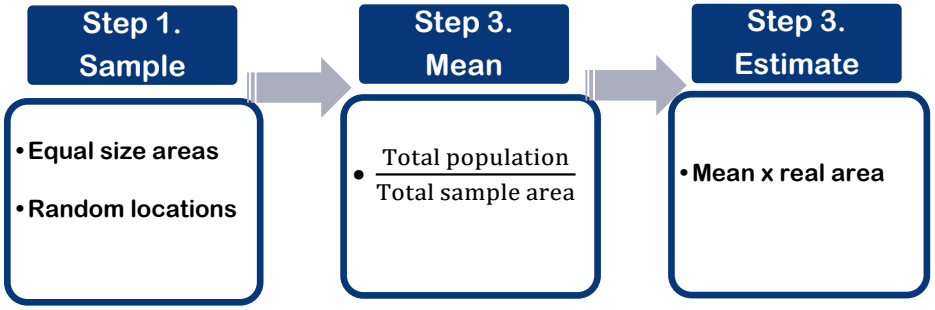
Introduction

Sometimes it is impossible to make the measurements we want. For example, it is not possible to count, exactly, the world population. When this happens, we find an approximate value called an '**estimate**'.

Estimated values are found using a set of measurements called '**sample data**'.
The more measurements we have in our sample data, the more accurate our estimate will be.
We will look at 2 different methods of using sample data.

Method 1: Random Sampling

In random sampling, we take population counts from many small areas, in **random** locations.
The sample measurements are then 'scaled up' to estimate the population of a larger area.

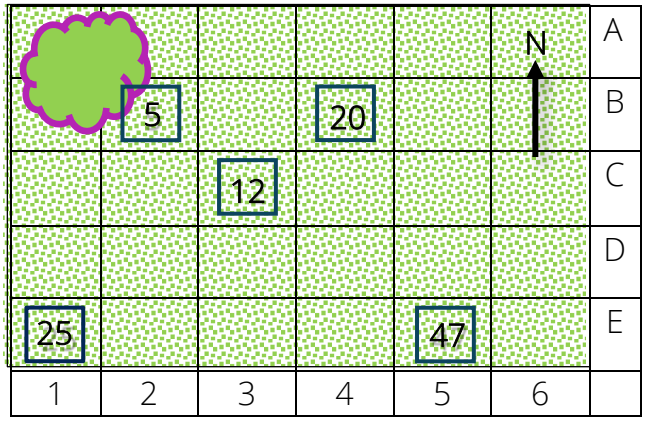


Example: A conservation group investigate the population of Daffodils in a field as shown below:

Method

1. Divide the field into a sampling grid.
2. Use a 'random generator' to select the letter and number of a grid coordinate.
3. Count the number of Daffodils in a 0.5m^2 quadrat at these coordinates.
4. Repeat steps 1-3 to obtain 5 samples.

Sampling Record (Field Area = 50m^2)



Analysis

Mean Daffodils per 1 m^2

$$= \frac{(20 + 25 + 47 + 12 + 5)}{(0.5 \times 5)}$$

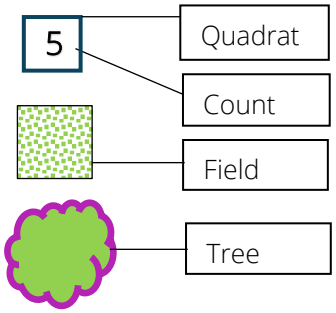
$= 44$

Estimated Daffodil population

Estimate = mean x **field** area

$= 44 \times 50$

$= 2{,}200$ Daffodils



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Method 1: Checking Understanding

A student wants to estimate the number of daisy plants in a 500 m^2 field.

She uses a 1 m^2 quadrat to sample the field.

The table below shows the results they collected.

sample number	number of daisy plants
1	5
2	2
3	6
4	3
5	4

(i) Calculate the mean number of daisy plants in a 1m^2 area of the field.

(1)

mean number of daisy plants = ...

(ii) Estimate the total number of daisy plants in this field.

(2)

.....

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.....

.....

(Total for question = 3 marks)

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Method 2: Using a belt transect

The Random Sampling method allowed us to estimate the population of an area. However, it did not tell us how the population was **distributed**. We can see in the example on page 1, that there are much fewer Daffodils in the North-West corner of the field, and more in the South-East corner.

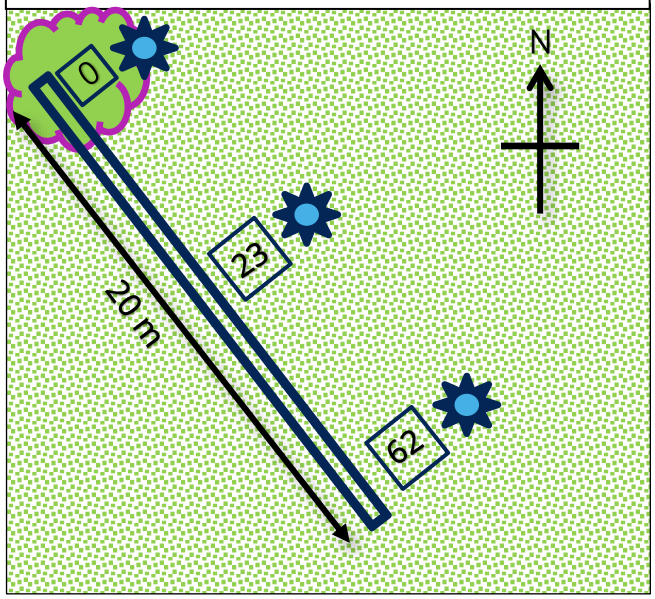
To study how a population is **distributed**, we can use a '**belt-transect**'. A belt-transect places quadrats at regular intervals along a line. This allows us to see how the population of an organism changes with distance.

Example: The conservation group now extend their investigation to see if the shadow of the tree is having an effect on where the Dandelions prefer to grow. To do this, they collect sample data using the belt-transect method as shown below:

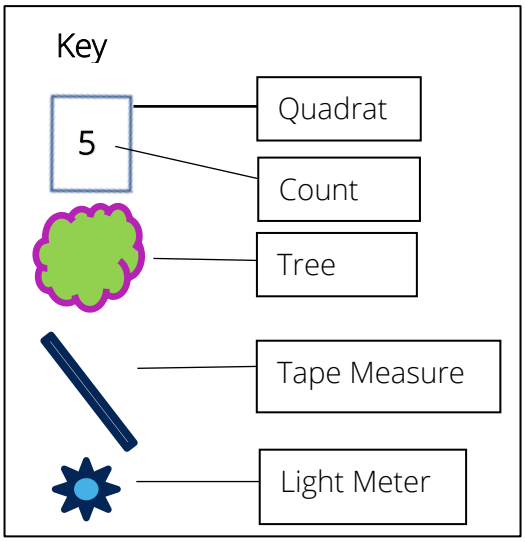
Method

1. Peg out a 20m tap measure starting at the base of the tree, in a straight line.
2. Place one side of a 0.5m^2 quadrat at the 0m mark on the tape measure.
3. Count the number of Daffodils in the quadrat.
4. Record the light intensity at each distance.
5. Repeat steps 1 - 3 at 5m intervals up to 20m.

Belt Transect Diagram (Field area = 50m^2)



Distance / m	Count	Light intensity / Lux
0	0	21
5	3	49
10	12	82
15	25	160
20	59	250



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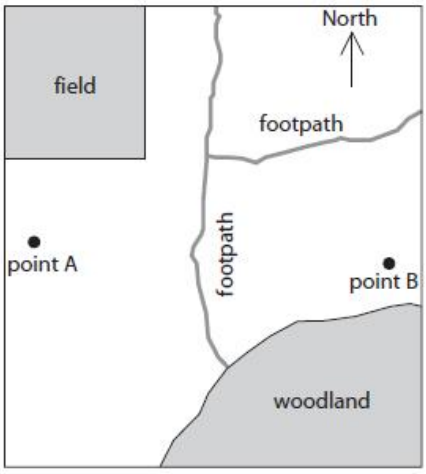
Method 2: Checking Understanding

A student investigated the distribution of poppy plants in a park. The figure below shows a sketch of the park and a diagram of a poppy plant.



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poppy plant

The student placed a 1 m^2 quadrat at 10 metre intervals between point A and point B and recorded the number of poppy plants in each quadrat.

(i) Name the technique the student used to study the distribution of poppy plants.

(1)

.....

The Figure below shows the number of poppy plants at 10 metre intervals from point A to point B.

distance from point A in metres	number of poppy plants in the 1 m^2 quadrat
0 (point A)	12
10	10
20	11
30	8
40 (point B)	6

(ii) Explain the effect of the woodland on the distribution of poppy plants.

(3)

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Mark Scheme

Method 1.

Question number	Answer	Mark
(i)	$\frac{5+2+6+3+4+4}{6} = 4$ (1)	(1)

Question number	Answer	Mark
(ii)	An answer that combines the following points of understanding to provide a logical description: • divide the field area by the quadrat size (1) • multiply by the mean number of daisies (1)	(2)

Method 2.

Question number	Answer	Mark
(i)	(belt) transect	(1)

Question number	Answer	Mark
(ii)	An explanation that combines identification via a judgement (1 mark) to reach a conclusion via justification/reasoning (2 marks): • number of poppy plants decreases (closer to the woodland) (1) and • trees block light (1) • light is needed for photosynthesis (1) or • competition (with other species/trees) (1) • for resources/named resource (1)	(3)

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