



- 1 A park keeper wants to estimate the number of fish in a lake.
She catches 30 fish, tags them and puts them back in the lake.
The next day she catches 40 fish. 8 of these fish are tagged.
Work out an estimate for the number of fish in the lake.

(2 marks)

$$\text{Proportion of tagged fish in the second sample} = \frac{8}{40} = \frac{1}{5}$$

Assume the same proportion of the whole population is tagged, so 30 fish is $\frac{1}{5}$ of the population

$$\text{Estimate} = 30 \times 40 \div 8 = 150$$

150

- 2 An ecologist wants to estimate the number of blackbirds in a wood.
She catches 25 blackbirds, puts a ring on each one and releases them.
A week later she catches 60 blackbirds. 5 of them have rings.
a. Work out an estimate for the number of blackbirds in the wood.
b. State one assumption you made in working out your estimate.

(3 marks)

$$\text{Proportion ringed in the second sample} = \frac{5}{60} = \frac{1}{12}$$

Assume 25 ringed birds is $\frac{1}{12}$ of the population

$$\text{Estimate} = 25 \times 60 \div 5 = 300$$

For the assumption part, one valid answer is that the marked animals mixed fully with the rest before the second sample. Alternatively, assume no marks were lost or the population did not change. Only one is required

3

A gardener wants to estimate the number of snails in her garden.

One evening she collects 45 snails, marks each shell with a dot of paint and releases them.

Two evenings later she collects 36 snails. 9 of them are marked.

- Work out an estimate for the number of snails in the garden.
- Write down one assumption you have made.

(3 marks)

$$\text{Proportion marked in the second sample} = \frac{9}{36} = \frac{1}{4}$$

Assume 45 marked snails is $\frac{1}{4}$ of the population

$$\text{Estimate} = 45 \times 36 \div 9 = 180$$

For the assumption part, one valid answer is that the marked animals mixed fully with the rest before the second sample. Alternatively, assume no marks were lost or the population did not change. Only one is required

4

A scientist wants to estimate the number of beetles in a field.

He captures 50 beetles, marks them and releases them.

Later he captures 48 beetles. 6 of them are marked.

- Work out an estimate for the number of beetles in the field.
- Some of the paint marks rubbed off before the second capture. Explain how this affects your estimate.

(3 marks)

$$\text{Proportion marked in the second sample} = \frac{6}{48} = \frac{1}{8}$$

$$\text{Estimate} = 50 \times 48 \div 6 = 400$$

If marks rubbed off, some recaptured beetles that were really marked are not recognised, so 6 is too small; dividing by a smaller number gives an estimate that is too big

5

A warden wants to estimate the number of rabbits in a nature reserve.

She traps 60 rabbits, tags them and releases them.

The following week she traps 45 rabbits. 9 of them are tagged.

- Work out an estimate for the number of rabbits in the reserve.
- State one assumption needed for your estimate to be valid.
- The warden set her second traps close to where she released the tagged rabbits. Explain what effect this could have on your estimate.

(4 marks)

$$\text{Proportion tagged in the second sample} = \frac{9}{45} = \frac{1}{5}$$

$$\text{Estimate} = 60 \times 45 \div 9 = 300$$

Trapping near the release site means tagged rabbits are more likely to be caught than untagged ones, so the fraction $\frac{9}{45}$ is too high and the population estimate is too low

For the assumption part, one valid answer is that the marked animals mixed fully with the rest before the second sample. Alternatively, assume no marks were lost or the population did not change. Only one is required

6

A ranger wants to estimate the number of deer in a forest.

He catches 80 deer, fits each one with an ear tag and releases them.

A month later he observes 120 deer. 15 of them have ear tags.

- Work out an estimate for the number of deer in the forest.
- The ranger believes the forest holds at least 800 deer. Does your estimate support his belief? Give a reason.
- State one assumption your estimate relies on.

(4 marks)

$$\text{Proportion tagged in the second sample} = \frac{15}{120} = \frac{1}{8}$$

$$\text{Estimate} = 80 \times 120 \div 15 = 640$$

640 is less than 800, so the estimate does not support the ranger's belief

The method assumes the tagged deer mixed evenly and the population stayed the same

7

Using a capture-recapture study, the number of carp in a reservoir was estimated to be 600. In that study, 72 carp were tagged.

- A new sample of 50 carp is caught. Work out how many of these carp you would expect to be tagged.
- In fact, 10 of the 50 carp in the new sample are tagged. What does this suggest about the number of carp in the reservoir? Show your working.

(4 marks)

If the population is 600, the proportion tagged is $\frac{72}{600} = 0.12$

Expected tagged carp in a sample of 50 = $0.12 \times 50 = 6$

Finding 10 tagged carp gives a new estimate of $72 \times 50 \div 10 = 360$

More tagged carp than expected means the tagged fish make up a larger share of the population, so the population is probably smaller than 600

8

A marine biologist wants to estimate the number of crabs on a stretch of shore.

She collects 150 crabs, marks their shells and returns them to the shore.

The next day she collects a sample of 200 crabs. 12% of the crabs in this sample are marked.

- Work out an estimate for the number of crabs on the shore.
- State two assumptions your estimate relies on.

(4 marks)

Marked crabs in the second sample = 12% of 200 = 24

Proportion marked = $\frac{24}{200} = 0.12$

Assume 150 marked crabs is 12% of the population

Estimate = $150 \div 0.12 = 1250$ (equivalently $150 \times 200 \div 24 = 1250$)

b) Two assumptions are that the marked crabs mixed fully with the rest and that no marks were lost. Other valid assumptions include an unchanged population and equal chances of capture