

The Petersen Capture-recapture method

This is a way of estimating the size of a population, usually dealing with wildlife, where, apart from counting every member of a species, (which would be impossible), there is no other method.

Example 1

To estimate the size of the population of Caribou in a national forest in Canada, 100 Caribou are trapped at different locations through the forest (**capture**), and tags fitted to their ears. A week later another 100 Caribou are trapped (**recapture**). It is found that 4 of these have tags on their ears.

Estimate the population of Caribou in the forest.

From the second sample of 100, a good estimate of the proportion of tagged Caribou is 4%.

As 100 Caribou are tagged, then this represents 4% of the whole population.

If $100 = 4\%$,

$$25 = 1\%$$

$$2500 = 100\%$$

Hence a good estimate of the population of Caribou in the forest is 2500.

A formula for the population using capture-recapture:

A animals are captured initially and tagged out of a population of P .

Hence percentage of population that are tagged is $\frac{100A}{P}$

Later B animals are captured and C of these are tagged.

Percentage of population that are tagged is approximately $\frac{100C}{B}$

$$\text{Hence } \frac{100A}{P} = \frac{100C}{B}$$

$$\text{Hence } P = \frac{AB}{C}$$

Check this with example 4:

$A = 100$, $B = 100$ and $C = 4$.

$$P = \frac{AB}{C} = 100 \times \frac{100}{4} = 2500, \text{ so the formula works.}$$

In words this is:

$$\text{Population size} = \frac{\text{number in 1}^{\text{st}} \text{ sample} \times \text{number in 2}^{\text{nd}} \text{ sample}}{\text{number in 2}^{\text{nd}} \text{ sample that are marked}}$$

Example 2

A fish farmer wants to estimate the size of his fish stocks.

He nets 142 fish and marks them with a special ink. The fish are released back into the fish farm.

A month later he nets 127 fish. He finds that 6 of them are marked.

- Estimate the size of the fish population at the fish farm.
- What assumptions are made in obtaining this estimation?

a Method 1:

$$6 \text{ out of } 127 = 4.72\%$$

$$4.72\% = 142 \text{ of the population}$$

$$1\% = 142 \div 4.72 = 30.08$$

$$\text{Population} = 100\% \approx 3000$$

Method 2:

$$P = \text{Population} \approx 3000$$

b Four assumptions:

1. That the percentage of fish marked on the recapture is accurate. This is unlikely to be true as it is random. There could have as easily been any number from 1 to 10 marked fish.
2. That the population does not change between capture and recapture.
3. That the capture and marking does not have an effect on the population.
4. That the sampling method is identical.

As the capture-recapture method can only give an estimate, round your answers off to something sensible.

Exercise 18A

1 Use this table to estimate the population in each case.

Population	Number captured and marked	Number caught on recapture	Number marked on recapture
A	150	120	5
B	180	220	17
C	2000	2000	319
D	20	20	7
E	523	65	4

MR

- 2** **a** Which of the estimates of populations in question 1 is the most reliable and why?
b Which of the estimates of populations in question 1 is the least reliable and why?

3 Janet wanted to estimate the number of trout in a pond. She caught, marked and released 40 trout. Later she caught 72 trout at random. 16 of these were marked. Work out an estimate of how many trout are in the pond.

EV

4 A forestry organisation wanted to increase the population of red squirrels and decrease the population of grey squirrels in a woodland. They did this by removing some of the deciduous trees, which suit grey squirrels, and planting more conifers, which suit red squirrels.

This table shows the results of a capture-recapture program carried out over a 20-year period:

Year	1990	2000	2010
Number of red squirrels captured and marked	140	150	120
Number of red squirrels recaptured	100	130	140
Number of red squirrels marked on recapture	45	24	18
Number of grey squirrels captured and marked	140	145	150
Number of grey squirrels recaptured	98	110	120
Number of grey squirrels marked on recapture	24	34	58

CM

a Has the forestry organisation been successful in its aim with the re-planting scheme? Use figures to back up your answer.

EV

b What assumptions have been made in your answer for **a**?

5

To estimate the population of Tench in a lake, a net is dragged through the water. From the trapped fish it is found that there are 56 Tench. These are marked and put back in the lake.

Over the next week, anglers are asked to record how many Tench they catch and how many of these are marked. At the end of the week, 190 Tench have been caught and 24 of these were marked.

a Use this data to estimate how many Tench are in the lake.

b Comment on the method used and any assumptions made.

CM

6

A bee-keeper wants to estimate how many bees are in a hive. He catches 100 bees, marks them and lets them go. A week later he catches another 100 bees. 3 of these are marked. A week later he catches another 100 bees. Only 1 of these is marked. A week later he catches another 100 bees. 2 of these are marked.

a Explain why 5000 is a reasonable estimate of the number of bees in the hive.

b What assumption have been made?