



Populations, sampling methods and capture-recapture

About 85 minutes Calculator allowed 85 marks

Date _____

A Do Now

The first two are what this chapter needs. The rest bring back earlier chapters so nothing is forgotten.

A1 Needed today [2 marks]

Femi is planning an investigation into how much money families earn. Give an ethical issue with this plan, and say how Femi could deal with it.

A2 Needed today [2 marks]

$\frac{4}{9}$ of 27 is equal to $\frac{1}{3}$ of B . Find B .

Answer

A3 From chapter 1 [2 marks]

30 parcels are in the class $160 < m \leq 200$ (kg). Assuming they are spread evenly through the class, estimate how many are more than 164 kg.

Answer

A4 Maths skill [2 marks]

The mean of 8 numbers is 17. One more number is added and the mean becomes 19. What number was added?

Answer

Two counters are taken at random, with replacement, from a bag of 4 red and 6 blue counters. Find the probability that both are red.

Answer _____

B Examples, then your turn

Your teacher works through each example with you. Then try the one beside it.

EXAMPLE 1

A cricket club has 38 members. It wants every member's view on moving its match day. Should it use a census or a sample? Give a reason.

Hint How many members are there, and how long would it take to ask them all?

B1 A dairy fills 45 000 cartons of milk a day. It checks the volume of milk in the cartons. Give two reasons why it checks a sample, not every carton. [2 marks]

EXAMPLE 2

A school wants the views of the parents of its students. Suggest a sampling frame. Give one reason why it may not be complete.

Hint A sampling frame is a list of the whole population.

B2 A housing firm wants the views of the people living on a new estate that was finished last month. It plans to use last year's electoral register as its sampling frame. Explain why this is not a suitable sampling frame. [2 marks]

EXAMPLE 3

A club's 250 members are numbered 001 to 250. Split the digits below into groups of three, starting on the left, and use them to choose 4 members.

21944 07322 19158 25012 13607

Hint Write the numbers in threes: 219, 440, 732, ... Which can you use?

B3 A doctor's 720 patients are numbered 001 to 720. Split the digits below into groups of three, starting on the left, and use them to choose 5 patients. [2 marks]

38291 72033 82000 70184
60645 59713

Answer

EXAMPLE 4

The table shows the number of students in each year group of a school. A stratified sample of 60 students is taken by year group. Work out how many from each year group are in the sample.

Year	7	8	9	10	11
Students	182	211	161	191	195

Hint Round each number, then check the total is 60.

B4 The table shows the members of a gym by age. A stratified sample of 45 members is taken by age group. Work out how many from each age group are in the sample. [3 marks]

Age (years)	18 to 29	30 to 49	50 and over
Members	106	229	163

Answer

EXAMPLE 5

A researcher stops shoppers at a retail park until she has asked 40 people under 30 and 60 people aged 30 or over. Name the sampling method. Give one reason why the sample may not represent the adults in the town.

Hint Who decides which people are asked?

B5 A survey firm phones numbers between 10 am and noon on weekdays until it has spoken to 30 men and 30 women. Name the sampling method. Explain one reason why the results may be biased. [2 marks]

EXAMPLE 6

An ecologist marks 85 water beetles in a pond and releases them. Later she catches 64 water beetles, and 12 of them are marked. Estimate the number of water beetles in the pond, and write down one assumption she makes.

Hint The fraction marked in the second catch is about the fraction marked in the pond.

B6 A survey marks 132 field mice and releases them. In a second catch of 104 field mice, 23 are marked.

- (a) Estimate the number of field mice. [2 marks]

Answer

- (b) Marked mice learn to avoid the traps after being caught once. Explain whether this makes the estimate too high or too low. [2 marks]

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Total for B6: 4 marks

c Practice

The questions are mixed. Decide which method each one needs.

- C1** A shop takes a systematic sample of 65 customers from its list of 2600 customers. It picks a random start and then takes every k th customer. The random start is customer 27. Write down the number of the last customer chosen. [2 marks]

Answer

- C2** In a stratified sample by gender, there are 21 boys and 24 girls. There are 196 boys in the school. How many girls are in the school? [2 marks]

Answer

- C3** A hospital has 25 wards. Describe how to take a cluster sample of its patients, and give one disadvantage of this method. [2 marks]

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- C4** A ranger marks 45 rabbits. In a second catch, 7 rabbits are marked. Her estimate of the number of rabbits is 540. How many rabbits were in her second catch? [2 marks]

Answer

- C5** A forest has 2140 trees. In a random sample of 75 of them, 11 have a disease. Estimate how many trees in the forest have the disease. [2 marks]

Answer

- C6** A news website asks its readers to vote in an online poll. Of the 3500 votes, 74% are for a four-day school week. Explain why this result may not represent the views of all parents. [2 marks]

- C7** A year group has five classes of 24, 27, 30, 32 and 28 students. Zara draws one name from a hat for each class. Is this a simple random sample of the year group? Give a reason. [2 marks]

- C8** A firm wants to know how much its employees spend on lunch each day. It plans a stratified sample. Suggest a variable to stratify by and give a reason in context. [2 marks]

D Exam-style questions

Give every reason in the context of the question.

- D1** Tariq says, "A systematic sample with a random start is a simple random sample, because every member has an equal chance of being chosen." [2 marks]

Explain why Tariq is wrong.

- D2** The table shows the staff of two hotels. A stratified sample of 45 staff is taken by hotel and job.

	Kitchen	Rooms	Front desk
North hotel	34	58	21
South hotel	47	72	28

- (a) How many staff who work on rooms at the South hotel are in the sample? [2 marks]

Answer

- (b) Describe how to choose these staff. [2 marks]

Total for D2: 4 marks

- D3** A nature reserve uses capture-recapture to estimate the number of slow-worms. It marks 318 slow-worms with a dot of paint. Later it catches 245 slow-worms, and 52 of these carry a paint mark.

- (a) Estimate the number of slow-worms on the reserve. [2 marks]

Answer

- (b) A report says there are about 1500 slow-worms on the reserve. Does your estimate support the report? Give a reason. [1 mark]

- (c) Some of the paint wears off in the rain before the second catch. Explain whether this makes your estimate too high or too low. [2 marks]

Total for D3: 5 marks

- D4** A market researcher takes a quota sample of 300 adults. In the area, 52% of adults are women, and 25% of the women are under 30. The quotas match these percentages. How many women aged 30 or over are in her sample? [3 marks]

Answer

D5 A city has 52 000 adults. Its council plans a survey about new cycle lanes. It will take a stratified sample of 400 adults by the ward they live in.

(a) Write down the population for this survey. [1 mark]

(b) The council plans to use its list of people with a parking permit as the sampling frame. Explain why this is not a good sampling frame. [1 mark]

(c) Riverside ward has 6875 adults. How many adults from Riverside ward should be in the sample? [2 marks]

Answer

(d) Give two reasons why the council should carry out a pilot study first. [2 marks]

Total for D5: 6 marks

D6 A supermarket chain wants to know what its staff think of their working hours. It chooses the 3 stores nearest its head office. In each store it asks the first 20 staff who arrive on a Monday morning. Assess this sampling plan. You must give a conclusion. [4 marks]

D7 A council posts a survey to 800 homes. 152 are sent back.

(a) Work out the percentage of surveys that are sent back. [1 mark]

Answer

(b) Explain why the results may be biased. [1 mark]

(c) Suggest one way to increase the number of replies. [1 mark]

Total for D7: 3 marks

- D8** A head teacher wants the views of her 1100 students on the length of the school day. Years 7 to 11 are different sizes. She could ask the first 50 students who come into the library, or take a stratified sample of 50 by year group. Recommend one method. Give two reasons. [3 marks]
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- D9** A club's 560 members are numbered 1 to 560. Saeed's calculator gives these random whole numbers from 1 to 560: 214, 509, 87, 214, 560, 33, 412. He wants 5 members. Which 5 does he choose? Explain why he does not use one of the numbers. [2 marks]
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E Extension

No route is given. The hints are at the end of the sheet. Use one at a time.

- E1** A school has only boys and girls. In a stratified sample of 50 by gender, 22 are boys. Then 40 more girls join the school, and a new stratified sample of 50 has 20 boys. How many boys are in the school? [4 marks]

Answer

- E2** A warden puts rings on 90 birds on an island and releases them. Before her second catch, she finds that 18 of the ringed birds have died. In her second catch of 120 birds, 16 have rings. Estimate the number of birds on the island at the time of the second catch. Explain why using 90 ringed birds would give an estimate that is too high. [4 marks]
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E3 A county has three towns with 1200, 800 and 400 households. A researcher [4 marks]
picks one town at random, then a simple random sample of 50 households
from that town. Work out the probability that a given household in the
smallest town is chosen, and the same probability for a household in the
largest town. Is this a simple random sample of the county's households?
Give a reason.

F How did it go?

Colour one circle on each line.

	Not yet	Nearly	Yes
I can choose between a census and a sample and judge a sampling frame.	☐	☐	☐
I can take a simple random or systematic sample and say why each member has an equal chance.	☐	☐	☐
I can work out a stratified sample, round it and check the total.	☐	☐	☐
I can name quota, cluster and other samples and assess a sampling plan.	☐	☐	☐
I can estimate a population with capture-recapture and say whether the estimate is too high or too low.	☐	☐	☐

Extension hints

Use one hint at a time. Cover the ones below it with a sheet of paper.

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- E1**
- Hint 1** Call the number of boys b and the number of girls g . The first sample gives $\frac{b}{b+g} = \frac{22}{50}$.
- Hint 2** The second sample gives $\frac{b}{b+g+40} = \frac{20}{50}$.
- Hint 3** From the first, $b+g = \frac{50b}{22}$. Put this into the second and solve for b .
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- E2**
- Hint 1** How many ringed birds are alive at the second catch?
- Hint 2** Use $90 - 18$ ringed birds with a catch of 120 and 16 ringed.
- Hint 3** Work out the estimate with 90 instead and compare.
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- E3**
- Hint 1** The household's town must be picked first.
- Hint 2** Then the household must be one of the 50 chosen from its town.
- Hint 3** Multiply: $\frac{1}{3} \times \frac{50}{400}$ for the smallest town.