HIGHER

6.13 Capture Recapture: Test Pack

EDEXCEL 1MA1 · Calculator allowed · about 60 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 During a capture-recapture study no marked animals were recaptured (the number of marked recaptures is 0). State why the usual capture-recapture estimate cannot be calculated.

(Total for Question 1 is 1 mark)

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2 The capture-recapture method is used to estimate the size of a population of animals. Write down the capture-recapture formula for estimating the population size.

(Total for Question 2 is 1 mark)

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3 20 pheasants in an estate are caught, marked and released. Later a second sample of 105 pheasants is caught. The population of pheasants is estimated to be 300. How many of the second sample were marked?

(Total for Question 3 is 3 marks)

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4 Which of the following best describes the capture-recapture method for estimating population size?

- ☐ A) Counting every individual in the population directly
- ☐ B) Catching a sample, marking it and releasing it, then using the proportion of marked individuals found in a second sample to estimate the total population size
- ☐ C) Measuring the area of the habitat and multiplying by an average density figure from a textbook
- ☐ D) Asking local residents to estimate how many animals they have seen

(Total for Question 4 is 1 mark)

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5 80 butterflies in a meadow are caught, marked and released. In one later sample, 30 are caught and 5 are marked. In another later sample, 70 are caught and 10 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 5 is 4 marks)

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6 30 snails in a garden were caught, marked and released. A second sample of 85 snails was caught later. State one assumption that is needed for the capture-recapture estimate of the population of snails to be reliable.

(Total for Question 6 is 1 mark)

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7 Match each label to its correct description.

Labels: n1, n2, m, N

Descriptions:

1. The number of individuals caught and marked in the first sample
2. The number of individuals caught in the second sample
3. The number of marked individuals found in the second sample
4. The estimated total population size

(Total for Question 7 is 4 marks)

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8 An ecologist is estimating the number of newts in a pond.
She catches 35 newts, marks them, and releases them back into the pond.
The next day she catches 42 newts. 5 of these are marked. Estimate the number of newts in the pond, giving your answer to the nearest 10.

(Total for Question 8 is 3 marks)

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9 Two students each estimate the number of woodlice under a log using the capture-recapture method.
Student A: catches and marks 20 woodlice, then a second sample of 20 woodlice contains 4 marked.
Student B: catches and marks 60 woodlice, then a second sample of 60 woodlice contains 36 marked.

(a) Show that both students obtain the same estimate for the population. **(2)**

(b) Explain why Student B's estimate is likely to be more reliable than Student A's estimate. **(1)**

(Total for Question 9 is 3 marks)

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10 In a wood, an ecologist estimates there are 260 squirrels in total. She marked 30 squirrels in the first sample. The second sample contains 45 squirrels. Calculate how many of these squirrels you would expect to be marked, giving your answer to the nearest whole number.

(Total for Question 10 is 3 marks)

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11 State three assumptions that must be made for the capture-recapture method to give a reliable estimate of population size.

(Total for Question 11 is 3 marks)

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12 A nature reserve covers 5 hectares. To estimate its hare population, 45 hares are caught and tagged in a first sample. In a second sample of 60 hares, 9 are found to be tagged.

(a) Estimate the total number of hares in the reserve. **(2)**

(b) Work out the population density of hares, in hares per hectare. **(1)**

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(Total for Question 12 is 3 marks)

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13 A researcher estimates there are 420 mice in a barn. She marked 35 mice in the first sample. She wants her second sample to contain exactly 5 marked mice. Work out how many mice she should catch in her second sample.

(Total for Question 13 is 2 marks)

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14 In a capture-recapture study, some of the marks put on animals in the first sample fall off before the second sample is taken. Explain how this would affect the population estimate.

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(Total for Question 14 is 2 marks)

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15 A wildlife survey estimates the population of red squirrels in a forest in two consecutive years using capture-recapture.
Year 1: 60 squirrels tagged in the first sample; second sample of 50, of which 12 are tagged.
Year 2: 80 squirrels tagged in the first sample; second sample of 70, of which 14 are tagged.

(a) Calculate the population estimate for Year 1 and for Year 2. **(2)**

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(b) Work out the percentage change in the population estimate from Year 1 to Year 2. **(2)**

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(Total for Question 15 is 4 marks)

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16 In a capture-recapture study, n1 = 40 animals are marked and released. In the second sample, m = 5 of the recaptured animals are marked, and this gives a Lincoln-Petersen population estimate of N = 240. Find n2, the number of animals caught in the second sample.

(Total for Question 16 is 2 marks)

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17 The capture-recapture formula assumes that the proportion of marked animals found in the second sample is the same as the proportion of marked animals in the whole population. Show that this assumption gives the formula N = (n1 x n2) / m.

(Total for Question 17 is 3 marks)

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Mark scheme · 6.13 Capture Recapture: Test Pack

Question 1

cannot divide by 0 because no marked animals were recaptured (division by zero) oe	**B1**

Answer: Cannot calculate because the number of marked recaptures is 0, leading to division by zero.

Question 2

N = (n1 x n2) / m oe, where n1 = number marked in first sample, n2 = number caught in second sample, m = number marked in second sample	**B1**

Answer: N = (n1 x n2) / m

Question 3

20/300 = R/105 oe	**M1**
R = 20 x 105 / 300	**M1**
7 cao	**A1**

Answer: 7

Question 4

B	**B1**

Answer: B

Question 5

80 x 30 / 5 oe	**M1**
80 x 70 / 10 oe	**M1**
(480 + 560) / 2 oe	**M1**
520 cao	**A1**

Answer: 520

Question 6

a valid assumption, e.g. the marks have not been lost or rubbed off between the two samples	**B1**

Answer: The marks have not been lost or rubbed off between the two samples

Question 7

n1 - 1	**B1**
n2 - 2	**B1**
m - 3	**B1**
N - 4	**B1**

Answer: n1-1, n2-2, m-3, N-4

Question 8

35 x 42 / 5 oe	**M1**
294 (awrt)	**A1**
290, rounded to the nearest 10 (ft their 294)	**A1**

Answer: 290 newts (to the nearest 10); exact estimate 294

Question 9

(a) both calculations attempted: 20 x 20 / 4 and 60 x 60 / 36	**M1**
(a) both equal 100 cso (answer given; full working must be shown)	**A1**

(a) Answer: Both estimates = 100 (shown)

(b) Student B used larger sample sizes, so the estimate is less affected by chance/random variation and is therefore more reliable	**B1**

(b) Answer: Student B's estimate is more reliable because larger samples reduce the effect of chance variation.

Question 10

correct rearrangement m = n1 x n2 / N oe	**M1**
30 x 45 / 260 oe	**M1**
5 (nearest whole number, awrt 5.19)	**A1**

Answer: 5 squirrels (to the nearest whole number)

Question 11

the population is closed - no births, deaths, immigration or emigration between the two samples	**B1**
marked individuals mix randomly and thoroughly back into the population before the second sample is taken	**B1**
marks are not lost or removed, and being marked does not affect an individual's chance of being caught again (any 3 acceptable assumptions from the standard list)	**B1**

Answer: Any three of: population is closed; marked individuals mix randomly; marks are not lost; marking does not affect recapture chance; sample sizes are large enough to be representative

Question 12

(a) 45 x 60 / 9 oe	**M1**
(a) 300 cao	**A1**

(a) Answer: 300 hares

(b) 60 (ft their part (a) answer / 5)	**B1**

(b) Answer: 60 hares per hectare

Question 13

correct rearrangement n2 = N x m / n1 oe	**M1**
60 cao	**A1**

Answer: 60 mice

Question 14

fewer marked animals will be found/recaptured in the second sample, so m will be smaller than it should be	**B1**
since N = n1 x n2 / m, a smaller value of m gives a larger value of N, so the population will be overestimated	**B1**

Answer: The population would be overestimated, because m is too small.

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Question 15

(a) 250 cao (Year 1)	**B1**
(a) 400 cao (Year 2)	**B1**

(a) Answer: Year 1: 250; Year 2: 400

(b) (400 - 250) / 250 x 100 oe (ft their part (a) values)	**M1**
(b) 60% increase cao	**A1**

(b) Answer: 60% increase

Question 16

rearrange N = n1 * n2 / m to make n2 the subject: n2 = N * m / n1 oe	**M1**
30 cao	**A1**

Answer: 30

Question 17

sets up the proportion m / n2 = n1 / N oe (proportion marked in second sample equals proportion marked in whole population)	**M1**
correct rearrangement, e.g. N x m = n1 x n2 oe	**M1**
N = (n1 x n2) / m cso (fully correct derivation clearly shown)	**A1**

Answer: N = (n1 x n2) / m (derived, shown)

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