HIGHER

6.13 Capture Recapture: 2-hour Pack

EDEXCEL 1MA1 · Calculator allowed · about 120 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 100 tortoises in a nature reserve are caught, marked and released. In one later sample, 95 are caught and 5 are marked. In another later sample, 55 are caught and 10 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 1 is 4 marks)

2 Some hedgehogs in a park were caught, marked and released. Later, a sample of 65 hedgehogs contained 2 that were marked. The population of hedgehogs is estimated to be 1300. How many hedgehogs were marked in the first sample?

(Total for Question 2 is 3 marks)

3 A biologist catches 20 butterflies in a meadow, marks each one and releases them. A week later she catches 35 butterflies and finds that 7 of them are marked. Work out an estimate for the total number of butterflies.

(Total for Question 3 is 2 marks)

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4 50 bats in a cave system are caught, marked and released. Later a second sample of 70 bats is caught. The population of bats is estimated to be 350. How many of the second sample were marked?

(Total for Question 4 is 3 marks)

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5 A biologist catches 180 butterflies in a meadow, marks each one and releases them. A week later she catches 140 butterflies and finds that 6 of them are marked. Over the next year the population of butterflies falls by 10%. Using the capture-recapture estimate, work out the expected population after the change.

(Total for Question 5 is 4 marks)

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6 Some tortoises in a nature reserve were caught, marked and released. Later, a sample of 20 tortoises contained 15 that were marked. The population of tortoises is estimated to be 700. How many tortoises were marked in the first sample?

(Total for Question 6 is 3 marks)

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7 A scientist uses capture-recapture to estimate the number of fish in a lake. 35 were marked in the first sample and the second sample had 55 fish. Give one assumption she must make.

(Total for Question 7 is 1 mark)

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8 80 snails in a garden are caught, marked and released. Later a second sample of 80 snails is caught. The population of snails is estimated to be 3200. How many of the second sample were marked?

(Total for Question 8 is 3 marks)

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9 Some butterflies in a meadow were caught, marked and released. Later, a sample of 50 butterflies contained 6 that were marked. The population of butterflies is estimated to be 1525. How many butterflies were marked in the first sample?

(Total for Question 9 is 3 marks)

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10 A biologist catches 185 tortoises in a nature reserve, marks each one and releases them. A week later she catches 90 tortoises and finds that 5 of them are marked. Work out an estimate for the total number of tortoises.

(Total for Question 10 is 2 marks)

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11 A biologist catches 120 hedgehogs in a park, marks each one and releases them. A week later she catches 70 hedgehogs and finds that 20 of them are marked. Over the next year the population of hedgehogs falls by 20%. Using the capture-recapture estimate, work out the expected population after the change.

(Total for Question 11 is 4 marks)

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12 120 fish in a lake are caught, marked and released. Later a second sample of 125 fish is caught. The population of fish is estimated to be 1875. How many of the second sample were marked?

(Total for Question 12 is 3 marks)

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13 A scientist uses capture-recapture to estimate the number of butterflies in a meadow. 60 were marked in the first sample and the second sample had 30 butterflies. Give one assumption she must make.

(Total for Question 13 is 1 mark)

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14 105 deer in a forest are caught, marked and released. In one later sample, 80 are caught and 15 are marked. In another later sample, 20 are caught and 5 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 14 is 4 marks)

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15 A biologist catches 155 snails in a garden, marks each one and releases them. A week later she catches 130 snails and finds that 2 of them are marked. Work out an estimate for the total number of snails.

(Total for Question 15 is 2 marks)

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16 A biologist catches 195 deer in a forest, marks each one and releases them. A week later she catches 90 deer and finds that 9 of them are marked. Over the next year the population of deer falls by 40%. Using the capture-recapture estimate, work out the expected population after the change.

(Total for Question 16 is 4 marks)

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17 A scientist uses capture-recapture to estimate the number of fish in a lake. 40 were marked in the first sample and the second sample had 80 fish. Give one assumption she must make.

(Total for Question 17 is 1 mark)

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18 80 tortoises in a nature reserve are caught, marked and released. In one later sample, 85 are caught and 2 are marked. In another later sample, 75 are caught and 15 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 18 is 4 marks)

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19 A biologist catches 150 snails in a garden, marks each one and releases them. A week later she catches 100 snails and finds that 10 of them are marked. Work out an estimate for the total number of snails.

(Total for Question 19 is 2 marks)

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20 A biologist catches 105 deer in a forest, marks each one and releases them. A week later she catches 100 deer and finds that 30 of them are marked. Over the next year the population of deer rises by 40%. Using the capture-recapture estimate, work out the expected population after the change.

(Total for Question 20 is 4 marks)

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21 A scientist uses capture-recapture to estimate the number of snails in a garden. 95 were marked in the first sample and the second sample had 75 snails. Give one assumption she must make.

(Total for Question 21 is 1 mark)

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22 A biologist catches 125 tortoises in a nature reserve, marks each one and releases them. A week later she catches 115 tortoises and finds that 5 of them are marked. Work out an estimate for the total number of tortoises.

(Total for Question 22 is 2 marks)

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23 60 butterflies in a meadow are caught, marked and released. In one later sample, 30 are caught and 4 are marked. In another later sample, 40 are caught and 5 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 23 is 4 marks)

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24 A biologist catches 135 pheasants in an estate, marks each one and releases them. A week later she catches 125 pheasants and finds that 9 of them are marked. Over the next year the population of pheasants rises by 40%. Using the capture-recapture estimate, work out the expected population after the change.

(Total for Question 24 is 4 marks)

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25 A biologist catches 20 snails in a garden, marks each one and releases them. A week later she catches 105 snails and finds that 6 of them are marked. Work out an estimate for the total number of snails.

(Total for Question 25 is 2 marks)

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26 90 fish in a lake are caught, marked and released. In one later sample, 70 are caught and 3 are marked. In another later sample, 50 are caught and 10 are marked. Use each sample to estimate the population, then give the mean of the two estimates.

(Total for Question 26 is 4 marks)

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27 A conservation group tags 120 rabbits. Later they capture 80 rabbits and find 24 are tagged. Estimate the size of the rabbit population.

(Total for Question 27 is 3 marks)

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28 A gamekeeper wants to estimate the number of pheasants on his estate.
On Monday he catches 60 pheasants, rings each one, then releases them.
On Thursday he catches 90 pheasants and finds that 18 of them are ringed.

(Total for Question 28 is 2 marks)

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29 State four assumptions needed for the standard Lincoln-Petersen capture-recapture method. One mark for each correct statement.

(Total for Question 29 is 4 marks)

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30 A wildlife student tags 50 hedgehogs. Later she traps 80 hedgehogs and finds 20 are tagged.

(a) Estimate the hedgehog population. **(3)**

.....

(b) Give two assumptions of the method (one per line). **(2)**

(Total for Question 30 is 5 marks)

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31 A marine biologist tags 80 turtles in a bay. Two months later, she takes a second sample of 60 turtles and finds that 15% of them are tagged.

(a) Work out the number of tagged turtles in the second sample. **(1)**

.....

(b) Use your answer to part (a) to estimate the total number of turtles in the bay. Give your answer to the nearest whole number. **(2)**

(Total for Question 31 is 3 marks)

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Mark scheme · 6.13 Capture Recapture: 2-hour Pack

Question 1

100 x 95 / 5 oe	M1
100 x 55 / 10 oe	M1
(1900 + 550) / 2 oe	M1
1225 cao	A1

Answer: 1225

Question 2

M/1300 = 2/65 oe	M1
M = 1300 x 2 / 65	M1
40 cao	A1

Answer: 40

Question 3

20 x 35 / 7 oe or 7/35 = 20/N	M1
100 cao	A1

Answer: 100

Question 4

50/350 = R/70 oe	M1
R = 50 x 70 / 350	M1
10 cao	A1

Answer: 10

Question 5

180 x 140 / 6 oe	M1
4200	A1
90% or 0.9 x 4200	M1
3780 cao	A1

Answer: 3780

Question 6

M/700 = 15/20 oe	M1
M = 700 x 15 / 20	M1
525 cao	A1

Answer: 525

Question 7

a valid assumption, e.g. there has been no change in the population between the two samples (no births, deaths or migration)	B1

Answer: There has been no change in the population between the two samples (no births, deaths or migration)

Question 8

80/3200 = R/80 oe	M1
R = 80 x 80 / 3200	M1
2 cao	A1

Answer: 2

Question 9

M/1525 = 6/50 oe	M1
M = 1525 x 6 / 50	M1
183 cao	A1

Answer: 183

Question 10

185 x 90 / 5 oe or 5/90 = 185/N	M1
3330 cao	A1

Answer: 3330

Question 11

120 x 70 / 20 oe	M1
420	A1
80% or 0.8 x 420	M1
336 cao	A1

Answer: 336

Question 12

120/1875 = R/125 oe	M1
R = 120 x 125 / 1875	M1
8 cao	A1

Answer: 8

Question 13

a valid assumption, e.g. every animal is equally likely to be caught in the second sample	B1

Answer: Every animal is equally likely to be caught in the second sample

Question 14

105 x 80 / 15 oe	M1
105 x 20 / 5 oe	M1
(560 + 420) / 2 oe	M1
490 cao	A1

Answer: 490

Question 15

155 x 130 / 2 oe or 2/130 = 155/N	M1
10075 cao	A1

Answer: 10075

Question 16

195 x 90 / 9 oe	M1
1950	A1
60% or 0.6 x 1950	M1
1170 cao	A1

Answer: 1170

Question 17

a valid assumption, e.g. there has been no change in the population between the two samples (no births, deaths or migration)	B1

Answer: There has been no change in the population between the two samples (no births, deaths or migration)

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Question 18

80 x 85 / 2 oe	**M1**
80 x 75 / 15 oe	**M1**
(3400 + 400) / 2 oe	**M1**
1900 cao	**A1**

Answer: 1900

Question 19

150 x 100 / 10 oe or 10/100 = 150/N	**M1**
1500 cao	**A1**

Answer: 1500

Question 20

105 x 100 / 30 oe	**M1**
350	**A1**
140% or 1.4 x 350	**M1**
490 cao	**A1**

Answer: 490

Question 21

a valid assumption, e.g. there has been no change in the population between the two samples (no births, deaths or migration)	**B1**

Answer: There has been no change in the population between the two samples (no births, deaths or migration)

Question 22

125 x 115 / 5 oe or 5/115 = 125/N	**M1**
2875 cao	**A1**

Answer: 2875

Question 23

60 x 30 / 4 oe	**M1**
60 x 40 / 5 oe	**M1**
(450 + 480) / 2 oe	**M1**
465 cao	**A1**

Answer: 465

Question 24

135 x 125 / 9 oe	**M1**
1875	**A1**
140% or 1.4 x 1875	**M1**
2625 cao	**A1**

Answer: 2625

Question 25

20 x 105 / 6 oe or 6/105 = 20/N	**M1**
350 cao	**A1**

Answer: 350

Question 26

90 x 70 / 3 oe	**M1**
90 x 50 / 10 oe	**M1**
(2100 + 450) / 2 oe	**M1**
1275 cao	**A1**

Answer: 1275

Question 27

state or use formula N = 120 * 80 / 24 oe	**M1**
show correct intermediate calculation (120 * 80 = 9600 or 9600 / 24) oe	**M1**
400 cao	**A1**

Answer: 400

Question 28

60 x 90 / 18 oe, correct substitution into N = n1 x n2 / m	**M1**
300 cao	**A1**

Answer: 300 pheasants

Question 29

population closed (no births, deaths, immigration or emigration) oe	**B1**
marked individuals mix fully back into the population or are evenly distributed oe	**B1**
marks are not lost and remain identifiable oe	**B1**
every individual has equal probability of being caught (no trap-shyness or trap-happiness) oe	**B1**

Answer: Any four distinct correct assumptions such as: closed population; marked animals mix evenly; marks are not lost; equal catchability of individuals.

Question 30

(a) use N = 50 * 80 / 20 oe	**M1**
(a) show intermediate calculation 50 * 80 = 4000 or 4000 / 20	**M1**
(a) 200 cao	**A1**

(a) Answer: 200

(b) one correct assumption (e.g. population closed) oe	**B1**
(b) second correct assumption (e.g. marks are not lost and remain identifiable, or equal catchability) oe	**B1**

(b) Answer: Example answers: population is closed; marks are not lost and do not affect the animals behaviour.

Question 31

(a) 9	**B1**

(a) Answer: 9 tagged turtles

(b) 80 x 60 / 9 oe (ft their part (a) answer)	**M1**
(b) 533 (awrt, nearest whole number)	**A1**

(b) Answer: 533 turtles

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