HIGHER

# 6.13D Capture Recapture: Fluency and Exam Drill

Total Marks

EDEXCEL Edexcel 1MA1 · Calculator allowed · about 50 minutes

Name: _____ Date: ____ / ____ / _____

**Answer ALL questions. Show all your working.**

**1** Priya marks 60 ladybirds and releases them. Later she catches 24 ladybirds, of which 8 are marked. Use capture-recapture to estimate the total number of ladybirds in the area.

**(Total for Question 1 is 2 marks)**

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**2** 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 2 is 3 marks)**

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**3** 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 3 is 1 mark)**

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**4** A student marks 45 frogs and releases them. Later she catches 30 frogs and finds 5 are marked. Estimate the frog population.

**(Total for Question 4 is 2 marks)**

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**5** A researcher tags 75 newts and later samples 40 newts, finding 10 marked individuals.
You must show your working for all parts.

**(a)** Calculate the capture-recapture estimate for the newt population. **(3)**

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**(b)** State one key assumption of the capture-recapture method. **(1)**

**(c)** The researcher used a bright coloured tag that might make marked newts easier to see. Explain briefly how this could affect the reliability of the estimate. **(2)**

**(Total for Question 5 is 6 marks)**

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**6** In the Lincoln-Petersen estimator N = n1 * n2 / m, explain what happens to N if the number m of marked recaptures doubles, all else remaining the same.

**(Total for Question 6 is 2 marks)**

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**7** A wildlife student tags 50 hedgehogs. Later she traps 80 hedgehogs and finds 20 are tagged.
(a) Estimate the size of the hedgehog population.
(b) Give two assumptions of the capture-recapture method that are relevant here.

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

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

**(Total for Question 7 is 5 marks)**

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**8** 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 8 is 2 marks)**

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**9** A pond manager tagged 90 carp. Later a sample of 60 carp produced an estimate of 270 carp in total. How many marked carp were recaptured in the second sample?

**(Total for Question 9 is 2 marks)**

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

**(Total for Question 10 is 4 marks)**

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**11** For n1 = 30, n2 = 40 and m = 6, show that the Lincoln-Petersen estimate is N = 200, and show that the proportion of marked animals in the second sample (m/n2) is consistent with this estimate, since it is approximately equal to the proportion of the population marked originally (n1/N). You must show all calculations.

**(Total for Question 11 is 3 marks)**

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# Mark scheme · 6.13D Capture Recapture: Fluency and Exam Drill

## Question 1

- **M1** use N = (number marked in first sample times size of second sample) / number of marked recaptured, i.e. N = 60 * 24 / 8 oe
- **A1** 180 cao
- **Answer: 180**

## Question 2

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

## Question 3

- **B1** cannot divide by 0 because no marked animals were recaptured (division by zero) oe
- **Answer: Cannot calculate because the number of marked recaptures is 0, leading to division by zero.**

## Question 4

- **M1** use N = 45 * 30 / 5 oe
- **A1** 270 cao
- **Answer: 270**

## Question 5

- (a) **M1** use N = 75 * 40 / 10 oe
- (a) **M1** show intermediate calculation 75 * 40 = 3000 or 3000 / 10
- (a) **A1** 300 cao
- **(a) Answer: 300**
- (b) **B1** one correct assumption, e.g. population is closed (no births, deaths, immigration or emigration) oe
- **(b) Answer: Population is closed (no births, deaths, immigration or emigration).**
- (c) **P1** identify which assumption is broken, e.g. tags change catchability (marked less or more likely to be recaptured)
- (c) **C1** state the effect on the estimate, e.g. if marked are more likely to be caught the estimate will be too low, or if less likely it will be too high oe
- **(c) Answer: The bright tags change catchability so marked newts are more likely to be recaptured; this would make the estimate too low.**

## Question 6

- **M1** state that N is inversely proportional to m, N proportional to 1/m
- **A1** therefore if m doubles then N is halved cao
- **Answer: N is halved (if m doubles and n1 and n2 do not change, N becomes half).**

## Question 7

- (a) **M1** use N = 50 * 80 / 20 oe
- (a) **M1** show intermediate calculation 50 * 80 = 4000 or 4000 / 20
- (a) **A1** 200 cao
- **(a) Answer: 200**
- (b) **B1** one correct assumption (e.g. population closed) oe
- (b) **B1** second correct assumption (e.g. marks are not lost and remain identifiable, or equal catchability) oe
- **(b) Answer: Example answers: population is closed; marks are not lost and do not affect the animals behaviour.**

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### Question 8

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

### Question 9

- **M1** use m = n1 * n2 / N substitution, m = 90 * 60 / 270 oe
- **A1** 20 cao
- **Answer: 20**

### Question 10

- **B1** 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
- **Answer: Any four distinct correct assumptions such as: closed population; marked animals mix evenly; marks are not lost; equal catchability of individuals.**

### Question 11

- **M1** Lincoln-Petersen calculation: N = 30 * 40 / 6 = 200 shown oe
- **M1** calculate both proportions: m/n2 = 6/40 = 0.15 and n1/N = 30/200 = 0.15
- **C1** conclude the two proportions are equal (both 0.15), confirming the estimate is consistent cso
- **Answer: Lincoln-Petersen: N = 30 * 40 / 6 = 200. m/n2 = 6/40 = 0.15 and n1/N = 30/200 = 0.15; the two proportions are equal, so the estimate N = 200 is consistent with the data.**

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