# H13-30min Capture Recapture: 30-minute Pack

EDEXCEL 1ST0 · Calculator allowed · about 30 minutes

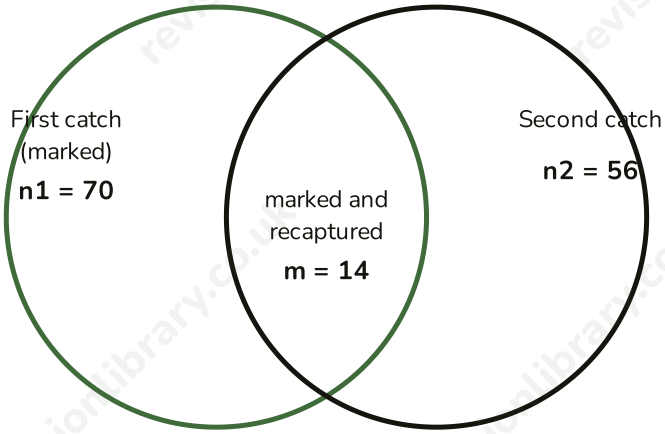
Total Marks

Name: _____ Date: ____ / ____ / _____

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

**1** Rangers at a nature reserve use capture-recapture to estimate the number of rabbits living there. The diagram shows the results of the two catches.

**Capture-recapture results for the rabbit survey**




**(a)** Use the diagram to write down the value of m. **(1)**

.....

**(b)** Use the values shown in the diagram to estimate the total rabbit population. **(2)**

.....

**(c)** Explain what the overlapping region of the diagram represents. **(1)**

**(Total for Question 1 is 4 marks)**

**2** Ecologists carry out capture-recapture surveys of water voles at three different sites. The table shows the results.

| Site | n1 (marked in first catch) | n2 (caught in second catch) | m (marked recaptured) |
|---|---|---|---|
| Site A | 80 | 60 | 12 |
| Site B | 45 | 50 | 15 |
| Site C | 96 | 40 | 8 |

**(a)** Work out the estimated water vole population at each of the three sites. **(2)**

.....

**(b)** Write down which site has the largest estimated water vole population. **(1)**

.....

**(c)** Give one reason why comparing these three estimates directly might not give a fair picture of which site truly has the most water voles. **(1)**

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

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**3** A team plans a capture-recapture survey of hedgehogs. In the first catch, 30 hedgehogs are marked. The team wants their final population estimate, N, to come out at 180, based on 5 marked hedgehogs being found in the second catch.

**(a)** Rearrange the formula N = (n1 x n2) / m to make n2 the subject. **(1)**

**(b)** Use your rearranged formula, with N = 180, n1 = 30 and m = 5, to work out how many hedgehogs, n2, would need to be caught in the second catch. **(2)**

.....

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

**4** A park ranger estimates a squirrel population is 250, based on marking 100 squirrels in the first catch, and catching 50 squirrels in the second catch. Work out how many of the 50 squirrels caught in the second catch, m, must already have been marked for this estimate to be correct.

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

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**5** A team estimates the number of grasshoppers in a meadow by repeating the capture-recapture survey on three different days. The table shows the results.

| Day | n1 (marked in first catch) | n2 (caught in second catch) | m (marked recaptured) |
|---|---|---|---|
| Day 1 | 40 | 30 | 8 |
| Day 2 | 45 | 35 | 9 |
| Day 3 | 50 | 25 | 10 |

**(a)** Work out the population estimate for each of the three days. **(2)**

.....

**(b)** Work out the mean of these three estimates. **(2)**

.....

**(c)** Explain why using the mean of several repeated surveys generally gives a more reliable estimate than using the result of a single survey. **(1)**

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

**6** A survey estimates the population of hares living in a 40-hectare field, using capture-recapture. In the first catch, 64 hares are marked. In the second catch, 50 hares are caught, of which 10 are already marked.

**(a)** Show that the capture-recapture estimate for this field is 320 hares. **(2)**

**(b)** Work out the estimated density of hares, in hares per hectare, for this field. **(2)**

.....

**(c)** A neighbouring 25-hectare field has an estimated density of 6 hares per hectare, from a separate survey. Work out how many more hares are estimated to be in the first field compared with the second field. **(2)**

.....

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

**7** A wildlife charity plans to investigate the size of the otter population along a 10 km stretch of river, using the capture-recapture method.

**(a)** Plan: Write a suitable statistical question the charity could investigate using capture-recapture. **(1)**

**(b)** Collect: Give one practical difficulty the charity might face when trying to catch and mark otters, and suggest how they could deal with it. **(2)**

**(c)** Process: In the first catch, 18 otters are caught, marked and released. In the second catch, 24 otters are caught, of which 6 are already marked. Work out an estimate for the otter population. **(2)**

.....

**(d)** Interpret: Comment on how much confidence the charity should have in this estimate, given the sample sizes used, and suggest one way they could make the estimate more reliable. **(2)**

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

**8** Two teams plan separate capture-recapture surveys of the same species of butterfly in neighbouring meadows.

Team X: catches and marks 20 butterflies in the first catch, and catches 15 in the second catch, both on the same day.
Team Y: catches and marks 80 butterflies in the first catch, and catches 60 in the second catch, one week later.

**(a)** Give one reason why Team Y's sample sizes are likely to produce a more reliable population estimate than Team X's. **(1)**

**(b)** Give one reason why waiting a week between catches, as Team Y did, rather than surveying on the same day like Team X, could reduce the reliability of the estimate. **(1)**

**(c)** Suggest a survey design that would avoid both of these problems. **(1)**

**(Total for Question 8 is 3 marks)**

# Mark scheme · H13-30min Capture Recapture: 30-minute Pack

## Question 1

- (a) **B1** 14 cao
- **(a) Answer: 14**
- (b) **M1** (70 x 56) / 14, oe
- (b) **A1** 280 cao
- **(b) Answer: 280**
- (c) **B1** the rabbits that were marked in the first catch and were also caught again in the second catch (the recaptured marked rabbits), oe
- **(c) Answer: the rabbits marked in the first catch that were caught again (recaptured) in the second catch**

## Question 2

- (a) **M1** correct method shown for at least one site, e.g. (80 x 60)/12, oe
- (a) **A1** 400, 150 and 480 all correct
- **(a) Answer: Site A = 400, Site B = 150, Site C = 480**
- (b) **B1** Site C cao, ft from part (a)
- **(b) Answer: Site C**
- (c) **B1** valid reason, e.g. the surveys may have been carried out under different conditions at each site (different weather, time of year, effort, or time between catches), so the estimates may not be equally reliable or directly comparable, oe
- **(c) Answer: e.g. the three surveys may not have used the same conditions or level of effort, so the estimates may not be directly comparable**

## Question 3

- (a) **B1** n2 = (N x m) / n1, oe
- **(a) Answer: n2 = (N x m) / n1**
- (b) **M1** (180 x 5)/30, oe
- (b) **A1** 30 cao
- **(b) Answer: 30**

## Question 4

- **M1** (100 x 50)/250, oe
- **A1** 20 cao
- **Answer: 20**

## Question 5

- (a) **M1** correct method shown for at least one day, e.g. (40 x 30)/8, oe
- (a) **A1** 150, 175 and 125 all correct
- **(a) Answer: Day 1 = 150, Day 2 = 175, Day 3 = 125**
- (b) **M1** (150 + 175 + 125) / 3, oe (or ft from part a)
- (b) **A1** 150 cao
- **(b) Answer: 150**
- (c) **B1** valid explanation, e.g. a single survey's estimate can be strongly affected by chance in exactly which individuals happen to be caught; averaging several surveys reduces the effect of this random variation on the overall estimate, oe
- **(c) Answer: e.g. averaging reduces the effect of chance variation between individual surveys**

## Question 6

- (a) **M1** (64 x 50)/10, oe
- (a) **A1** 320 confirmed cao
- **(a) Answer: 320**
- (b) **M1** 320 / 40, oe
- (b) **A1** 8 cao
- **(b) Answer: 8 hares per hectare**
- (c) **M1** 25 x 6 (= 150), oe
- (c) **A1** 170 cao (320 - 150)
- **(c) Answer: 170**

## Question 7

- (a) **B1** any suitable question linking otters and this stretch of river, e.g. 'How many otters live along this 10 km stretch of river?', oe
- **(a) Answer: e.g. How many otters live along this 10 km stretch of river?**
- (b) **B1** valid difficulty, e.g. otters are shy, nocturnal, or hard to trap, oe
- (b) **B1** valid solution linked to the difficulty, e.g. use humane traps set overnight near known otter paths or holts, oe
- **(b) Answer: e.g. otters are hard to trap because they are nocturnal; use humane traps set overnight near known otter holts**
- (c) **M1** (18 x 24)/6, oe
- (c) **A1** 72 cao
- **(c) Answer: 72**
- (d) **B1** valid comment, e.g. the samples of 18 and 24 are quite small, so a small error in catching or counting could change the estimate a lot, giving fairly low confidence, oe
- (d) **B1** valid improvement, e.g. repeat the survey with larger samples, or on several different days, and compare or average the results, oe
- **(d) Answer: e.g. confidence is fairly low because the samples are small; repeating the survey with larger samples would improve reliability**

## Question 8

- (a) **B1** valid reason, e.g. Team Y uses much larger sample sizes (n1 and n2), which generally makes the estimate less sensitive to small counting errors, oe
- **(a) Answer: e.g. Team Y's larger samples make the estimate less sensitive to small counting errors**
- (b) **B1** valid reason, e.g. over a longer time gap there is more chance of births, deaths, or migration in or out of the meadow, or marks being lost, which breaks the assumptions the formula relies on, oe
- **(b) Answer: e.g. a longer gap gives more chance of births, deaths, migration, or lost marks, breaking the formula's assumptions**
- (c) **B1** valid design, e.g. use large sample sizes (like Team Y) but with a short time gap between catches (like Team X), so the population stays closed but the estimate is not too sensitive to small errors, oe
- **(c) Answer: e.g. use large samples with a short time gap between catches**