Additional Case Study: Calculating the Size of a Small Mammal Population

Objective

To use field study data on shrew populations to examine the characteristics of a natural population.

Materials

graph paper	notebook paper
ruler	calculator (optional)

Procedure

The masked shrew (*Sorex cinereus*) is one of the smallest mammals in North America. As a predator of many types of insects, this tiny animal is beneficial to humans. It can significantly reduce the population of sawflies, which attack both larch and spruce trees. It was successfully introduced into Newfoundland in 1958 for this purpose.

1. The data provided have been simulated to represent a typical population study that could have occurred in Newfoundland a few years after the introduction of the shrews. Information on shrews can be found in the reference book *Mammals of Canada* as well as other sources.

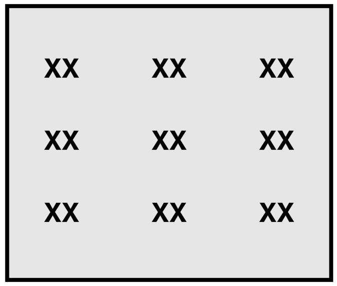
(a) Could a population of masked shrews have evolved in Newfoundland?

(b) Would you expect there to be natural predators of the shrew living in Newfoundland? Explain.

2. Biologists released 100 breeding pairs of the shrew into a defined area of Newfoundland during the spring. Each year thereafter for a period of 10 years, the population size was determined by live trapping in late August and the resulting data were recorded.
3. The release area was extremely large, measuring 10.0 km^2. Samples were taken from the area and the overall population was estimated.
4. Four trapping stations were randomly selected. Quadrats measuring 20×20 m were marked off and live traps were placed in pairs at 10 m intervals around the quadrat. In addition, one pair of traps was placed at the centre, making a total of 18 traps in all. The traps were baited and left for a three-day period. Any animals caught were marked and then released. This procedure was repeated at the same locations for the duration of the study.

(continued)

A 20 × 20 m Trapping Quadrat



The symbols "xx" in the diagram represent the locations of each pair of traps.

(c) What is the advantage of sampling the population rather than trapping the entire area?

(d) Why were the quadrats the same size, and the traps set at the same time and location each year?

(e) Why did the biologist mark each trapped shrew?

5. Each year the trapping results from the four quadrats were combined and then averaged.

(f) Why were four trapping stations used rather than one?

(continued)

6. The results of the 10 years of trapping are recorded in **Table 1**.

Table 1 Trapping Results for the Masked Shrew, from Four Quadrats over a 10-year Period

Year	Quadrat #1	Quadrat #2	Quadrat #3	Quadrat #4
1	1	1	1	2
2	1	1	0	3
3	2	1	0	4
4	2	1	0	4
5	3	2	2	6
6	5	3	2	8
7	8	4	2	9
8	10	5	4	12
9	9	5	3	12
10	12	7	4	15

(g) Record the total number of shrews trapped each year, then calculate the average number caught in each quadrat over the 10 years. Tabulate your results.

7. Draw a graph of the population changes by plotting the annual number of shrews caught (responding variable) against the time in years (manipulated variable). Leave sufficient room on your graph to permit extrapolation of your data.
8. Examine your table of data and your graph carefully.

(h) Are there any indications of a preferred habitat for the shrews? What factors might account for these differences?

(continued)

(i) Does the graph show continuous growth in the population? Explain any trends.

(j) Compare your graph with the theoretical population growth curves described in the text.

(k) Predict what might happen to the population over the next two years.

(l) What may have happened to the population in year 9?

(m) If other species of shrew were already living in the area, how might this have affected the population being studied? Explain.

Case Study Application Questions

(For each of the following questions use the appropriate formula when necessary and show your work.)

1. Calculate the following:

(a) How many square metres are there in a trapping quadrat?

(b) What is the size of a quadrat in hectares?

(continued)

(c) How many hectares are there in the total study area?

2. Using the average number of shrews per quadrat for year 10, calculate the population density in shrews per hectare.

3. From your answer to question 2, calculate the number of shrews for the total study area.

4. Explain why the answer to question 3 is usually called a population "estimate."

5. Calculate the rate of change in shrew density between years 1 and 5 and years 6 and 10. Which four-year period shows the greater population change?

6. Although there is a wide range of shrews and other small mammals all across Canada, only the meadow vole, a mouse-like animal, naturally inhabits Newfoundland. Suggest reasons why so few rodents live in Newfoundland.

Additional Case Study: Calculating the Size of a Small Mammal Population, Solution

Application Questions

Time required: about 50 min

- Review of graphing skills if necessary.
- Small group work is recommended.

(a) Because the population does not naturally occur in Newfoundland, the population will probably not be under many of the selective pressures of a naturally occurring population. However, the shrew may compete with some indigenous small mammals.

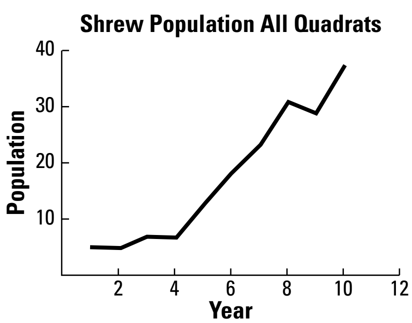
(b) No, because the rodent is not indigenous to Newfoundland.

(c) Trapping the entire area is time consuming and the trapping procedure also places small mammals at risk.

(d) To avoid over-sampling a smaller area and to control variables as much as possible.

(e) To avoid counting the same shrew twice and to monitor migration.

(f) To obtain a larger sample size. Anomalies from one site could be reduced by increasing the population.



(g) Quadrat #1 = 53 total, 5.3 average; Quadrat #2 = 30 total, 3.0 average; Quadrat #3 = 17 total, 1.7 average; Quadrat #4 = 75 total, 7.5 average.

(h) Quadrat #4, with the greatest number of shrews, may have the greatest density of larch and spruce trees, and hence the greatest number of sawflies. The sawflies provide food for the shrew. It may also have preferred reproductive sites or minimal competition from other small mammals.

(i) The general trend is continuous increases in population; however, during some years there was no increase in growth.

(j) Years 1 to 4 appear to be the lag phase, while years 5 to 10 appear to be the growth phase.

(k) Accept growth phase continuing or the beginning of the stationary phase.

(l) The drop in population may be related to food sources declining, interspecific competition, intraspecific competition, increased parasitism, or predation. Many other variables should be considered.

(m) Interspecific competition may have occurred. The more similar the animals, the greater is the competition.

Case Study Application Questions

1. (a) $20 \text{ m} \times 20 \text{ m} = 400 \text{ m}^2$

(b) $10\,000 \text{ m}^2 = 1$ ha, $400 \text{ m}^2/10\,000 = 0.04$ ha

(c) Release area = 10.0 km^2 or 1000 ha

2. Each quadrat is 0.04 ha, therefore to find the average:

$(12 + 7 + 4 + 15)/4 = 9.5$ shrews per 0.04 ha or 237.5 shrews per ha

3. 237.5 shrews/ha, total area = 1000 ha, or 237 500 shrews

(continued)

4. Each shrew is not counted. The population is determined by a random sample, which assumes that the animals are equally distributed in each quadrat.
5. Calculate density (D) from the average number of shrews per quadrat (Q) and per hectare (each quadrat is 0.04 ha).

   For year 1, 5 shrews/4 quadrats = 1.25 shrews/Q = 31.25 shrews/ha

   For year 5, 13 shrews/4 quadrats or 3.25 shrews/Q = 81.25 shrews/ha

   For year 6, 18 shrews/4 quadrats or 4.5 shrews/Q = 112.5 shrews/ha

   For year 10, 38 shrews/4 quadrats or 9.5 shrews/Q = 237.5 shrews/ha

   Rate of density change between years 1 and 5:

$$R = \frac{\Delta D}{\Delta t} \quad \text{or} \quad \frac{D_{\text{year 5}} - D_{\text{year 1}}}{}$$

$$= \frac{81.25 - 31.25}{5 - 1}$$

$$= \frac{50.0}{4} \quad \text{or} \quad 12.5$$

   The rate of density change is 1.5 shrews/ha/y.

   The rate of density change between years 6 and 10:

$$R = \frac{D_{\text{year 10}} - D_{\text{year 6}}}{}$$

$$= \frac{237.5 - 112.5}{10 - 6}$$

$$= \frac{125.0}{4} \quad \text{or} \quad 31.25$$

   The rate of density change is 31.25 shrews/ha/y. The greater population change occurred between years 6 and 10.
6. Newfoundland is geographically isolated from other land masses.