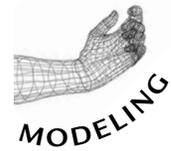# Clam Catch

2-3
40- to 50-minute sessions

MODELING

ACTIVITY OVERVIEW

Students build their understanding of population fluctuation and the factors that affect it by modeling what happens to a population of clams. Some students role-play plankton that sweep by other students role-playing the clams in a clam bed. The size of the clam population over time is recorded. Students then extend the model to observe the effect an introduced population of zebra mussels may have on native clam populations.

KEY CONCEPTS AND PROCESS SKILLS

(with correlation to NSE 5–8 Content Standards)

1. Students communicate scientific procedures and explanations using models. (INQUIRY: 1)

2. Students think critically and logically to make relationships between evidence and explanations. (INQUIRY: 1)

3. Students construct graphs to reveal patterns that are not immediately apparent in data tables. (INQUIRY: 1)

4. A population consists of all individuals of a species that are together at a given place and time. (LIFE SCIENCE: 4)

5. The number of organisms an ecosystem can support depends on the resources, such as food that is available, competition, and abiotic factors. (LIFE SCIENCE: 4)

KEY VOCABULARY

competition

fluctuation (optional)

habitat

introduced species

population

predator (optional)

MATERIALS AND ADVANCE PREPARATION

For the teacher

 1 Transparency 84.1, "Map of Clam Catch Game"

 1 Transparency 84.2, "Population Graphs"

 1 transparency of Student Sheet 84.1, "Population Data"

* 1 overhead projector

* 1 whistle or bell (optional)

* 1 clipboard (optional)

 1 Scoring Guide: ORGANIZING DATA (OD)

 1 Scoring Guide: ANALYZING DATA (AD)

For the class

 1 piece of chalk

* 25 red arm bands

For each student

 1 Student Sheet 84.1, "Population Data"

* 1 sheet of graph paper

  Student Sheet 77.2, "Anticipation Guide: Introduced Species—Zebra Mussels," from Activity 77

 1 Science Skills Student Sheets 4a and 4b, "Scatterplot and Line Graphing Checklist" (optional)

 1 Scoring Guide: ORGANIZING DATA (OD) (optional)

 1 Scoring Guide: ANALYZING DATA (AD) (optional)

*Not supplied in kit

Masters for Scoring Guides are in Teacher Resources III: Assessment. Science Skills student sheets are in Teacher Resources II: Diverse Learners.

Select an outdoor area in which to conduct the activity. A large paved area, where chalk can be used to draw lines (as shown on Transparency 84.1, "Map of Clam Catch Game"), is best. Check with the athletic department and administrative staff to prevent any scheduling conflicts.

When drawing circles for the clam bed, leave approximately 4–5 feet between circles. Each circle should be approximately 1.5–2 feet in diameter. Make enough circles for 1⁄2–2⁄3 of your average class size, i.e. if your average class is 32 students, make 16–20 circles.

■ **Teacher's Note:** This spacing is designed to be large enough for one or more students to stand in a circle and to have approximately an arm span between circles. The idea is for some, but not all, of the students role-playing clams to be able to catch some food during each round. Modify the spacing if it appears that it is too easy or too difficult for the clams to catch food.

TEACHING SUMMARY

Getting Started

1. Review the concept of population fluctuation.

Doing the Activity

2. Explain how to conduct the model.

3. The class models the size of a clam population over ten years.

4. (OD, AD ASSESSMENT) Summarize data from Part A.

5. Explain the introduction of zebra mussels into the ecosystem. The class models the size of both clam and zebra mussel populations over ten years.

Follow-Up

6. (OD, AD ASSESSMENT, LITERACY) Students summarize the data and respond to Analysis Questions.

Extension

Modify the model to investigate what might happen if a clam predator was introduced into the ecosystem.

BACKGROUND INFORMATION

Competition

Competition for limited resources can occur between individuals of the same species or between individuals of different species. When organisms of different species regularly compete, they are competing for similar niches in an ecosystem. Within an established community of organisms in an ecosystem, most of these competitions have already played out over time and species have adapted to occupy slightly different niches. For example, on the African savanna, zebra eat early-growth grass and wildebeest eat older grass. In this way, the two grass-eating species do not compete directly and can therefore co-exist.

When a new species invades an ecosystem, its requirements may overlap with those of native species. In most cases, the invading species is less adapted to local conditions and the native species prevails. But in some cases, the introduced species has an advantage. It may grow or reproduce more quickly, it may be more aggressive, or it may lack any predators in the new ecosystem. In such situations, the introduced species can compete more successfully for a limited natural resource such as light (in the case of plants) or food, and displace the native species.

In the case of the zebra mussel's introduction into the Great Lakes ecosystem, it is not yet clear how the zebra mussel population will affect native clam populations over the long term. Research is still in progress. Clams are found on the bottom of lakes and they have a siphon to take water in from just above the surface of the mud. Their gills filter out the plankton and bits of detritus. Zebra mussels will attach to any hard surface, including rocks, pipes, and other shellfish such as clams. Zebra mussels do not have a siphon, but filter water directly over their gills.

TEACHING SUGGESTIONS

■ GETTING STARTED

1. Review the concept of population fluctuation.

Begin by asking students, ***What do organisms need to live?*** Focus on potentially limited resources, such as space, food, and, in the case of plants, sunlight. Review the idea that both non-living factors (such as climate) and living factors (such as predator populations) can affect the size of a population from year to year.

Ask, ***Imagine an ecosystem in which most things stay the same from year to year. There is no change in the types of species found there, and the average yearly rainfall, temperature, and other conditions stay about the same. Would you expect the population of each species to stay the same each year?*** Why or why not? Cue students to think back to their work in Activity 77, "Ups and Downs." Students may realize that, although an ecosystem may appear to be the same, factors affecting population size may not be readily apparent. While populations may be fairly stable long-term, they can still fluctuate within ranges.

Inform students that they will be playing a game to model the size of a clam population over a ten-year period. Ask students, ***Do you expect the population of clams to stay exactly the same in each year of the game? Do you expect a population of real clams to stay the same? Explain.*** Consider having students write down their predictions before playing the first part of the game.

■ DOING THE ACTIVITY

2. Explain how to conduct the model.

Display Transparency 84.1, "Map of Clam Catch Game." Identify about 1/3 of your class to role play the initial clam population. Point out that students will be playing different roles over the course of the activity and should therefore pay attention to directions for both roles. Inform the "clams" that they will be standing inside the circles in the center of the map, with only one clam per circle. Clams can use only one hand (representing their siphon) when trying to tag plankton and must remain inside the circle (neither foot may leave the circle) at all times.

Assign the rest of the class to be plankton. "Plankton" will begin each round in the safety zone area of the map. Inform the class that plankton cannot go outside the occupied part of the clam bed area, i.e. around the person on either end of the line of clams.

■ **Teacher's Note:** You may find it helpful to assign one student (perhaps a student who cannot participate for some reason) the sole task of recording data. He or she can be in charge of recording the population of clams at the end of each year. Provide the student with a clipboard containing a transparency of Student Sheet 84.1, "Population Data," and an overhead marker. Note that the initial population of clams can be recorded at this time.

The class will measure the population of the clams from year to year (i.e. round to round). Each year begins at your direction and ends when all of the untagged plankton reach a safety zone. At your signal (such as a whistle), the plankton will attempt to run through the clam bed to the other safety zone without being tagged by a clam. Tagged plankton should stay with the clam that tags them until all of the untagged plankton reach the safety zone. At the end of the year, all of the tagged plankton become clams. Any clam that did not tag at least one plankton is considered dead and now becomes plankton. This models the process of clams feeding, reproducing, and dying. (Fluctuation in the plankton population is a part of this model; you may wish to collect those data as well.) The new clams should stand in unoccupied circles next to the other clams. Do not allow clams to leave empty circles between them, as all the plankton will run through the gap, affecting the class data. For the same reason, make sure that you stand near one end of the clam bed to remind students that plankton may not escape by running around either end.

3. **The class models the size of a clam population over ten years.**

It is highly recommended that this activity be conducted outdoors or in another fairly large area. Outline behavior expectations to the class and let students know what the signal will be for them to freeze and be silent at the end of each round.

Take the class to the activity site and have students move to their designated places. Blow a whistle to begin Year One. After the first round, make any necessary adjustments to ensure that some plankton (but not all) are caught and that some clams (but not all) catch plankton. For example, you may need to review or add rules, or increase or decrease the space between clams.

After completing the first round, ask the recorder to write down the total clam population at the end of year one in the row marked, "1" under "Year" in the table on the left. Run the game for at least nine more rounds. Make sure that the clam population at the end of each year is recorded.

4. **(OD, AD ASSESSMENT) Summarize data from Part A.**

After completing Part A of the activity, summarize the results. This is best done in the classroom by projecting the transparency of Student Sheet 84.1 on an overhead projector and having students individually record the data on their own copy of Student Sheet 84.1 (they need the data to respond to the Analysis Questions). Discuss the data by asking questions such as: *Was the population of clams the same from year to year? What prevented the population of clams from continuing to increase? Overall, was the population stable or unstable?*

■ **Teacher's Note:** Students now have enough information to create a graph of the Part A data, as directed in Analysis Question 1. (On the other hand, you may wish to conduct both Parts A and B of the simulation before convening the class to have students record the results from the transparency.) If you plan to have students compare graphs from Part A and Part B, tell them to use the same y-axis scale on both graphs. If you have students complete

Question 1 before completing Part B of the activity, recommend to them that the scale of the y-axis be large enough to accommodate the total number of students in the class (i.e. 0–32 if there are 32 students in the class).

You may wish to use Science Skills Student Sheets 4a and 4b, "Scatterplot and Line Graphing Checklist," with some or all of your students to help them with Analysis Questions 1 and 2. This Science Skills sheet can help you differentiate instruction for your students.

There are several opportunities to assess students in this activity. You may score the graphs (Analysis Question 1a) with the ORGANIZING DATA (OD) Scoring Guide. You may also assess students on Analysis Question 1b with the ANALYZING DATA (AD) Scoring Guide.

5. **Explain the introduction of zebra mussels into the ecosystem. The class models the size of both clam and zebra mussel populations over ten years.**

Begin Part B by asking, *What happens if there are more organisms in an ecosystem than resources? Do you have any examples of one species outcompeting another from your research on introduced species?* Allow students to share their examples from their research. If they do not have examples yet, you may wish to direct students to research this aspect of their introduced species. Possible questions to help research this issue could be: "With which native species does your introduced species compete? For what resources do the two species compete? Is the introduced species more successful? If so, why?"

Explain to students that they will model what happens to the clam population when zebra mussels are introduced. This will model competition between species, rather than **competition** among individuals of the same species. In this case, they will model what happens when one species (zebra mussels) competes with a native species (clams).

Zebra mussels grow closely together, so in the activity, two mussels will be able to occupy one circle (or one mussel and one clam can share a circle). Two

clams cannot share a circle. Since zebra mussels are effective filter feeders, they will be allowed to use two hands when they are trying to catch plankton.

Zebra mussels will be represented by students wearing red arm bands. Plankton caught by a zebra mussel will collect an arm band and then role-play a zebra mussel. Plankton caught by clams become clams and do not collect arm bands. Any clam or zebra mussel that has not tagged plankton dies and then role-plays plankton. Ask students to predict what they think will happen to the population of clams and zebra mussels over time.

Begin by having at least 3 students represent zebra mussels. Have one student record the initial populations of both clams and zebra mussels. Go to the activity site and conduct the model for at least ten rounds. At the end of each round, record the numbers of clams and zebra mussels.

■ FOLLOW-UP

6. (OD, AD Assessment, Literacy) **Students summarize the data and respond to Analysis Questions.**

The Analysis Questions provide the structure for summarizing the key points of this activity. (In addition, you may use Transparency 84.2, "Population Graphs," to lead a full-class discussion of the results of the graphing.) When discussing Question 2, point out to students that natural systems can be self-regulating. In a real ecosystem, more than one factor affects the size of a population. Students may have some ideas as to other factors apart from food that could affect clam populations.

Discuss with the class the strengths and weaknesses of this activity as a model. Ask, **How well do you think this activity modeled real populations?** One strength of the activity is that it demonstrated that populations fluctuate over time based on availability of food as well as competition between species. One major weakness of the model is that it did not address many other factors that could affect populations, such as pollution, predators, parasites, and changes in temperature. (Note, however, that predator/prey oscillation between clams and plankton

was represented. Data on plankton were not formally collected since clams and mussels, as immobile species, do not represent classic predators). The model also did not incorporate the possibility that organisms might migrate.

Another strength of the model is that it incorporated aspects of actual clams and mussels, such as the relative amount of space that they require. From previous information on zebra mussels, students may have realized that in the wild, zebra mussels can crowd together much more closely than the native clams can. The photograph in the Student Book shows zebra mussels growing on a clamshell. This is the most obvious feature of the actual zebra mussel invasion, and its representation is a strength of the model. It is not known whether zebra mussels actually catch food better than clams do; the rapid increase in water clarity caused by invading zebra mussels may be primarily due to sheer numbers. Thus, the fact that mussels are allowed to catch with two hands may be a weakness of the model.

Emphasize the role of other living organisms in affecting the population of a species; contrast this idea with the non-living characteristics of a habitat that were brought up in Activity 83, "A Suitable Habitat." Build the idea that many factors affect the size of a population. If appropriate, discuss the idea that how large a population of a species can get within an ecosystem is limited; this concept of *carrying capacity* is the focus of the next activity.

Analysis Question 2 provides additional opportunities for assessment. The graphs in Analysis Question 2a can be assessed with the Organizing Data (OD) Scoring Guide and Analysis Questions 2b and 2c can be assessed with the Analyzing Data (AD) Scoring Guide.

■ EXTENSION

Modify the model to investigate what might happen if a clam predator was introduced into the ecosystem.

Ask, **Are introduced species always successful?** Introduce a mobile predator that eats only clams. Have

students suggest ways to modify the game to include this predator. Discuss what students think will happen to the predator population and the clam population over time. Then have students test their ideas by playing the game with the addition of the predator for at least ten rounds.

## SUGGESTED ANSWERS TO QUESTIONS

Part A: Clam Population

1. a. (OD ASSESSMENT) *Graph the population of clams over time from Part A of the Procedure. Decide which type of graph (bar or line) would best represent the data. Remember to label your axes and to title your graph.*

   Since the data are continuous (a population over time), a line graph is a better choice than a bar graph. A graph containing sample data is shown below.

   Level–3 Reponse

   Clam Catch
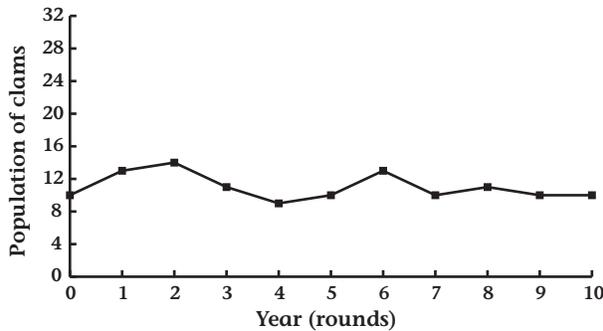
   b. (AD ASSESSMENT) *Look at your graph and describe how this population of clams changed over time.*

   In general, the population will fluctuate. In a class of 32 students, the clam population is likely to range between 10–16 students. Provided that the scale of the y-axis equals the total class population, the fluctuation will appear relatively minor. However, it is possible that there may be an extreme increase and then a crash, depending on the data collected.

   Students' descriptions should reflect the data as shown in their graphs. For example, consider the sample data.

Level–3 Reponse

The clam population remained fairly steady, fluctuating between nine and fourteen clams. Over the first two years, the population initially increased from ten to fourteen. It then decreased slightly (to nine) over the next two years. These slight variations continued to be observed for the remaining six years.

2. *What factor limited the size of the clam population?*

   The availability of plankton, or food, was the limiting factor. When more food was available, it was easier for clams to catch it and the clam population grew. When food was scarce, the clam population decreased, reducing competition for food and allowing the plankton population, about which data were not collected, to increase.

Part B: Competition

3. a. (OD ASSESSMENT) *Graph the population of clams and zebra mussels over time from Part B of the Procedure. Use the same type of graph you used in Part A. Remember to label your axes and to title your graph. Use a key to show what represents the clam population and what represents the zebra mussel population.*

   Since the data are continuous (a population over time), a line graph is a better choice than a bar graph. A graph containing sample data is shown below.

   Level–3 Reponse

   Clam Catch with Mussels
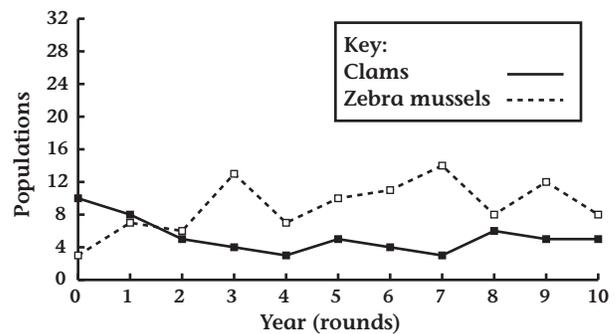
b. *(AD Assessment) Look at your graph and describe how the population of clams changed over time.*

Level–3 Reponse

In general, the clam population is likely to decline. Students' descriptions should reflect the data as shown in their graph. For example, consider the sample data. The clam population decreased from an initial population of ten to three within four years of the zebra mussel introduction. The population appeared to recover a little bit, increasing to as high as six, but never approaching its initial population level.

c. *(AD Assessment) Look at your graph and describe how the population of zebra mussels changed over time.*

Level 3–Reponse

In general, the zebra mussel population, which had the advantages of being able to grow more closely together and to feed more aggressively (by using two hands), is likely to increase and surpass the clam population over time. Students' descriptions should reflect the data as shown in their graphs. For example, consider the sample data. The zebra mussel population increased from an initial population of three to as high as thirteen. It was erratic, however, declining by as much as half within any year. Overall, its population increased rapidly during the initial rounds and remained higher than that of the clams.

4. a. *What happened to the clam population after zebra mussels were introduced?*

By comparing graphs from Part A (clams only) and Part B (clams and zebra mussels competing), it appears that the clam population began to decline after the zebra mussels were introduced. In the graph of data from Part A, the clam population fluctuated but remained relatively stable, i.e. it did not die out or maintain at an extremely larger popu-

lation. After the zebra mussels were introduced (in Part B), the clam population began to decline as the zebra mussel population increased.

b. *Why did zebra mussels have this effect on the clam population? Explain.*

The zebra mussels were able to catch more food and thus increase in population. The clams could not catch as much food and began to decline. The zebra mussels had two advantages over the clams: they could catch food more easily (with two hands instead of one) and two could crowd onto a space that was big enough for only one clam.

5. *a. In a real lake, what non-living factors might affect the size of clam and zebra mussel populations? List them. Hint: Go outside and look at an ecosystem around you. Observing an actual ecosystem may help you think of more factors.*

Water temperature, amount of sunlight (which might affect water temperature as well as food availability), pollution levels, availability of oxygen, and amount of suitable space could all be factors that would affect the size of clam and zebra mussel populations.

b. *In a real lake, what living factors might affect the size of clam and zebra mussel populations? List them.*

Predators, competition between species, and food availability all might affect population size.

6. *Fill in the "After" column for Statements 6–8 only on Sheet 77.2, "Anticipation Guide: Introduced Species—Zebra Mussels." Did your thinking change?*

Before   After

+   6.   *Populations of living things can be affected by nonliving factors, such as rainfall.*

The introduction to the activity states that populations vary from year to year and that such fac-

tors as rainfall and temperature affect these variations.

+   7. *Populations of living things can be affected by living factors, such as other species.*

The introduction to the activity states that populations can be affected by such living factors as species that provide new food sources or competition.

—   8. *Species that are introduced into a habitat are always successful.*

This came up in Activity 83 and has been addressed in discussions. In addition, if students have done the extension that involves playing the game of introducing a mobile predator that eats only clams, they have seen that the clams cannot survive, and the predator soon runs out of food.

Map of Clam Catch Game

Clam Bed

Safety Zone

Clams

Safety Zone
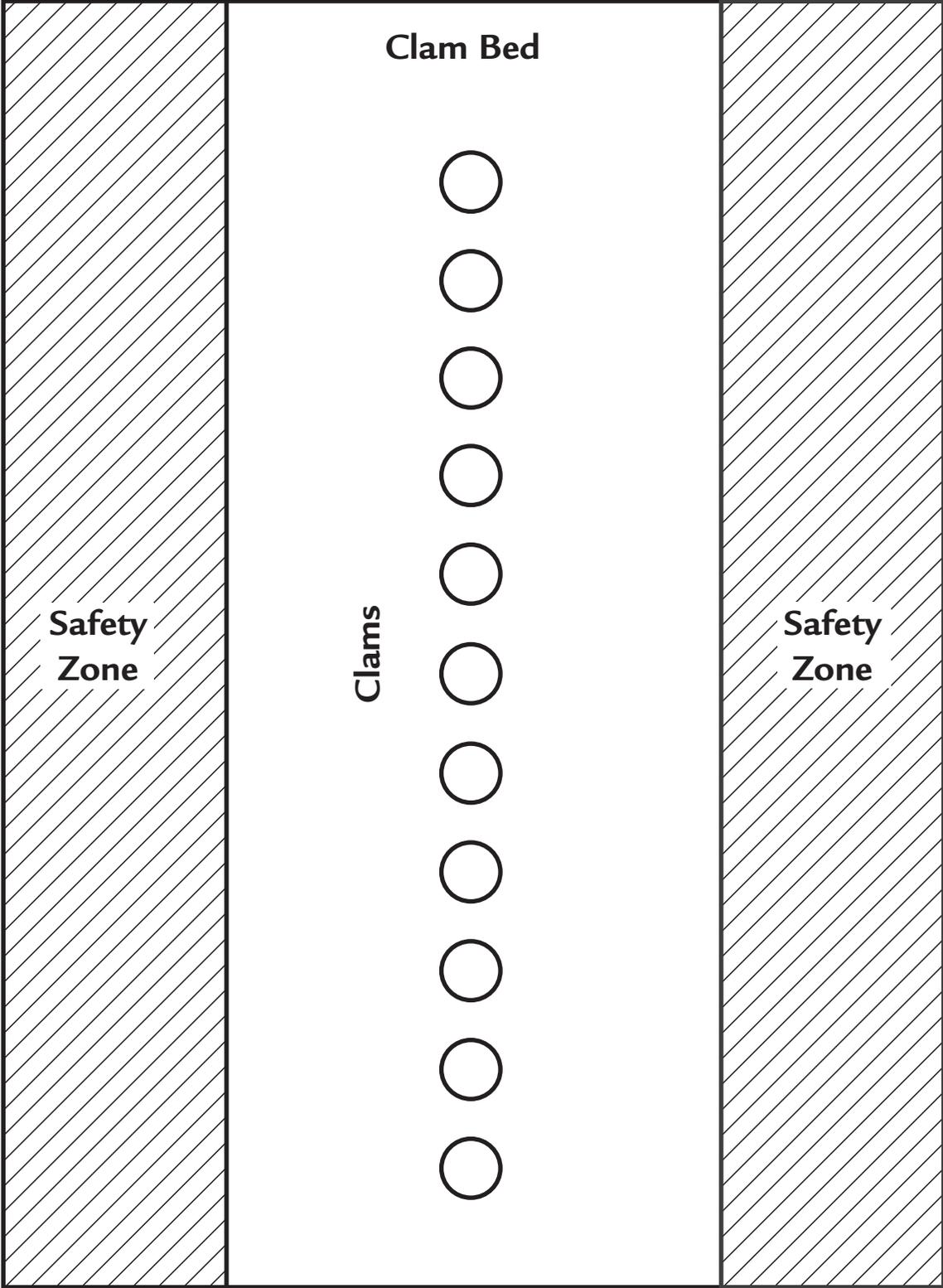
Population Graphs
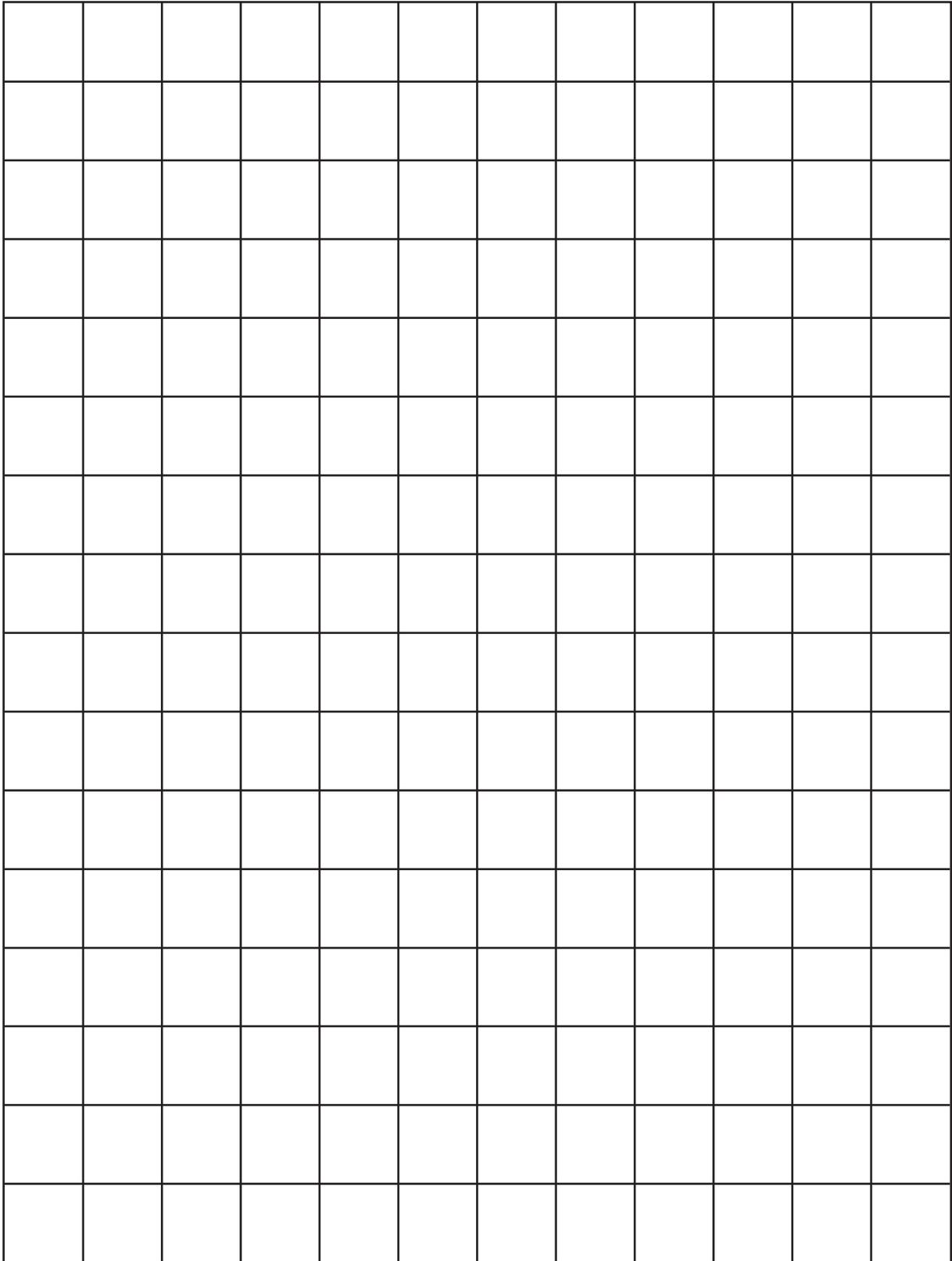
Population Data

Part A Data

Year	Population of Clams
Initial	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

Part B Data

Year	Population of Clams	Population of Mussels
Initial		
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		