Name:

Date:

Student Handout:
Manipulating the Carrying Capacity

For this assignment, you will work in groups to raise duckweed (*Lemna minor*) in an "environment". You will then explore how the carrying capacity could change if you adjusted certain limiting factors in the "environment".

Background Information:

Duckweed is a freshwater aquatic plant that is found throughout the United States in ponds and other areas where there is stagnant water. Duckweed usually has a single round leaf (2-5mm in diameter) and a short root (6-10mm in length). It provides food for fish and wildlife and can reproduce every three days at the optimal temperature and nutrient levels.

Duckweed can reproduce either sexually or asexually. In asexual reproduction, they produce a new plant in tiny pockets found on the main leaf. Eventually, these new plants will break off from the parent plant. The life span of duckweed is five to six weeks.

For this experiment, there are five different groups. Four of the groups will represent environments in which one characteristic or factor has been altered. One group will represent a Control in which no treatment or factor has been altered. Each group will have five replications, therefore there will be a total of 25 cups.

The first group will be the control group.

1. Get five cups.
2. Using a marker and tape, label the cups Control #1, Control #2, Control #3, Control #4, and Control #5.
3. Pour 200mL of spring water into each cup. Mark the water level on the outside of the cup.
4. Place 40 duckweed plants in each container. Each leaf is a single plant. If you have two leaves on a plant, count them as two separate plants. Use a magnifying glass to help you count the plants.
5. Record this number under week 1, sample 1 on the data sheet provided.
6. For the next 4 weeks, twice a week, you will count the number of plants you have in your environment and record your data in the chart provided. (Remember; count each leaf as a separate plant, even if it is still attached to the parent plant.)
7. Place your plants next to a light source (window or grow lamp).
8. You will also need to check the water levels when you check your plants. If the water level has dropped, add more spring water to the container. Be sure not to go over the mark.

The second group will provide the same amount of water in their "environment" as the control group, but will offer nutrients in the form of liquid fertilizer.

1. Get five cups.
2. Using a marker and tape, label Nutrient #1, Nutrient #2, Nutrient #3, Nutrient #4, and Nutrient #5.
3. Place 200mL of nutrient water (already prepared) into each cup. Mark the water level on the outside of the cup.
4. Place 40 duckweed plants in each container. Each leaf is a single plant. If you have two leaves on a plant, count them as two separate plants. Use a magnifying glass to help you count the plants.
5. Record this number under week 1, sample 1 on the data sheet provided.
6. For the next 4 weeks, twice a week, you will count the number of plants you have in your environment and record your data in the chart provided. (Remember; count each leaf as a separate plant, even if it is still attached to the parent plant.)
7. Place your plants next to a light source (window or grow lamp).
8. You will also need to check your water levels when you check your plants. If the water level has dropped, add more nutrient water to the container. Be sure not to go over the mark.

The third group will provide the same amount of water "environment" as the control group, but will offer more space.

1. Get five plastic sandwich containers.
2. Using a marker and tape, label them Space #1, Space #2, Space #3, Space #4, and Space #5.
3. Place 200mL of spring water (already prepared) into each container. Mark the water level on the outside of the cup.
4. Place 40 duckweed plants in each container. Each leaf is a single plant. If you have two leaves on a plant, count them as two separate plants. Use a magnifying glass to help you count the plants.
5. Record this number under week 1, sample 1.
6. For the next 4 weeks, twice a week, you will count the number of plants you have in your environment and record your data in the chart provided. (Remember; count each leaf as a separate plant, even if it is still attached to the parent plant.)
7. Place your plants next to a light source (window or grow lamp).
8. You will also need to check your water levels when you check your plants. If the water level has dropped, add more spring water to the container. Be sure not to go over the mark.

The fourth group will provide the same amount of water "environment" as the control group, but offer more space and nutrients.

1. Get five plastic sandwich containers.
2. Using a marker and tape, label them Space and Nutrients#1, Space and Nutrients#2, Space and Nutrients#3, Space and Nutrients#4, and Space and Nutrients#5.
3. Place 200mL of nutrient water into each container. Mark the water level on the outside of the cup.
4. Place 40 duckweed plants in each container. Each leaf is a single plant. If you have two leaves on a plant, count them as two separate plants. Use a magnifying glass to help you count the plants.
5. Record this number under week 1, sample 1.
6. For the next 4 weeks, twice a week, you will count the number of plants you have in your environment and record your data in the chart provided. (Remember; count each leaf as a separate plant, even if it is still attached to the parent plant.)
7. Place your plants next to a light source (window or grow lamp).
8. You will also need to check your water levels when you check your plants. If the water level has dropped, add more nutrient water to the container. Be sure not to go over the mark.

The fifth group will provide the same amount of water "environment" as the control group, but will offer less light.

1. Get five cups.
2. Using a marker and tape, label them Low Light #1, Low Light #2, Low Light #3, Low Light #4, and Low Light #5.
3. Place 200mL of spring water into each container. Mark the water level on the outside of the cup.
4. Place 40 duckweed plants in each container. Each leaf is a single plant. If you have two leaves on a plant, count them as two separate plants. Use a magnifying glass to help you count the plants.
5. Record this number under week 1, sample 1.
6. For the next 4 weeks, twice a week, you will count the number of plants you have in your environment and record your data in the chart provided. (Remember; count each leaf as a separate plant, even if it is still attached to the parent plant.)
7. Using a petri dish as the template, trace the outline of the petri dish onto construction paper. Cut out the circle, and then fold it in half and cut along the fold (cutting it in half). Tape this shape onto the petri dish to block out half of the light available to the plants.
8. Place your plants next to a light source (window or grow lamp).
9. You will also need to check your water levels when you check your plants. If the water level has dropped, add more spring water to the container. Be sure not to go over the mark.

At the end of the experiment, you will share your data. Chart the growth of each group and estimate each of the carrying capacities. Then answer the questions.

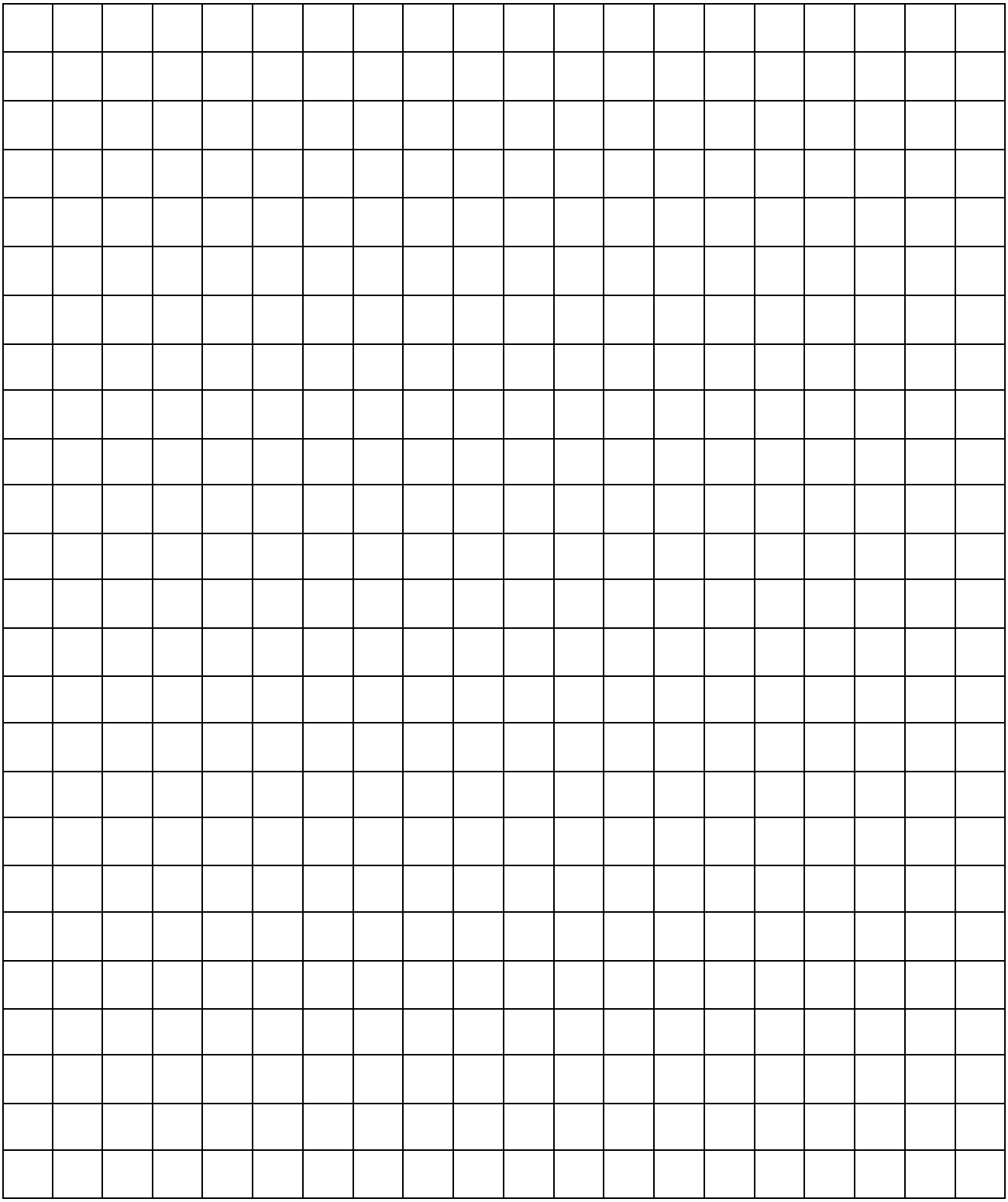
Since this is an experiment, you will need to form a hypothesis. Do you think the carrying capacity can be manipulated if you alter the limiting factors? State your hypothesis below.

Group:

Factor that has changed in the environment:

date	**#1**	**#2**	**#3**	**#4**	**#5**
Week 1 – sample 1	40	40	40	40	40
Week 1 – sample 2					
Week 2 – sample 3					
Week 2 – sample 4					
Week 3 – sample 5					
Week 3 – sample 6					
Week 4 – sample 7					
Week 4 – sample 8					

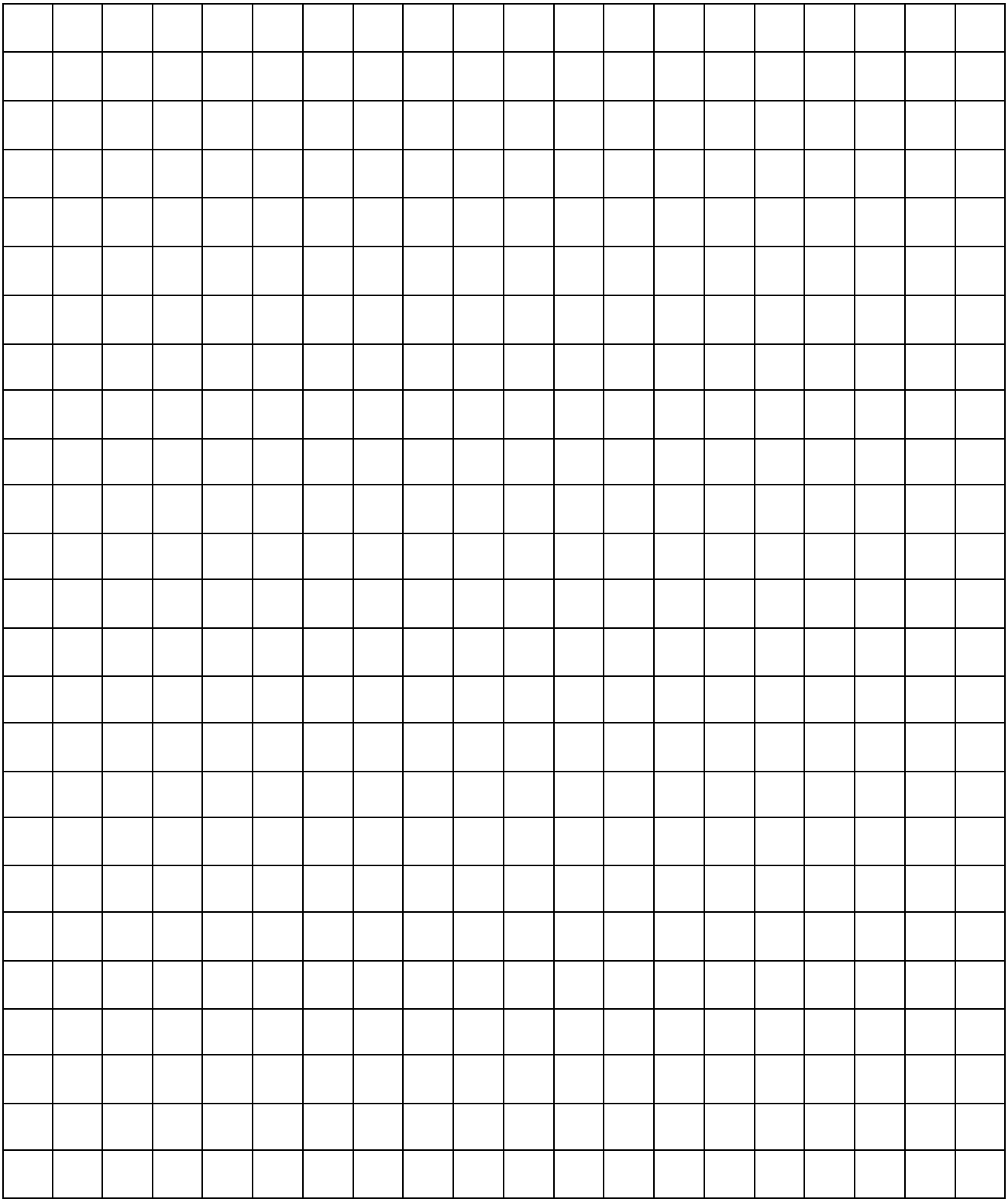
Results for:



Number of duckweed plants

Sample dates

Results for:



Number of duckweed plants

Sample dates

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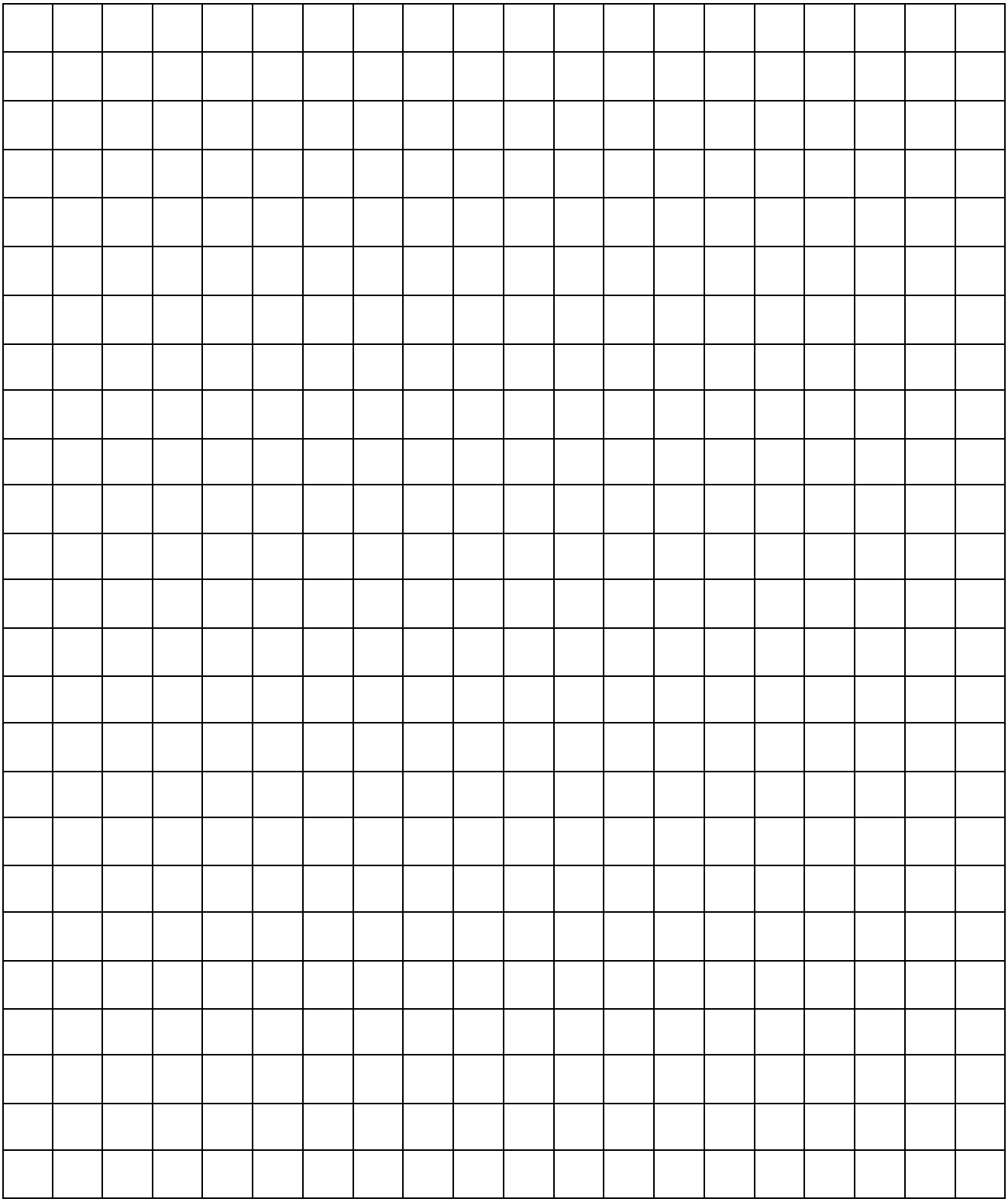

Number of duckweed plants

Sample dates

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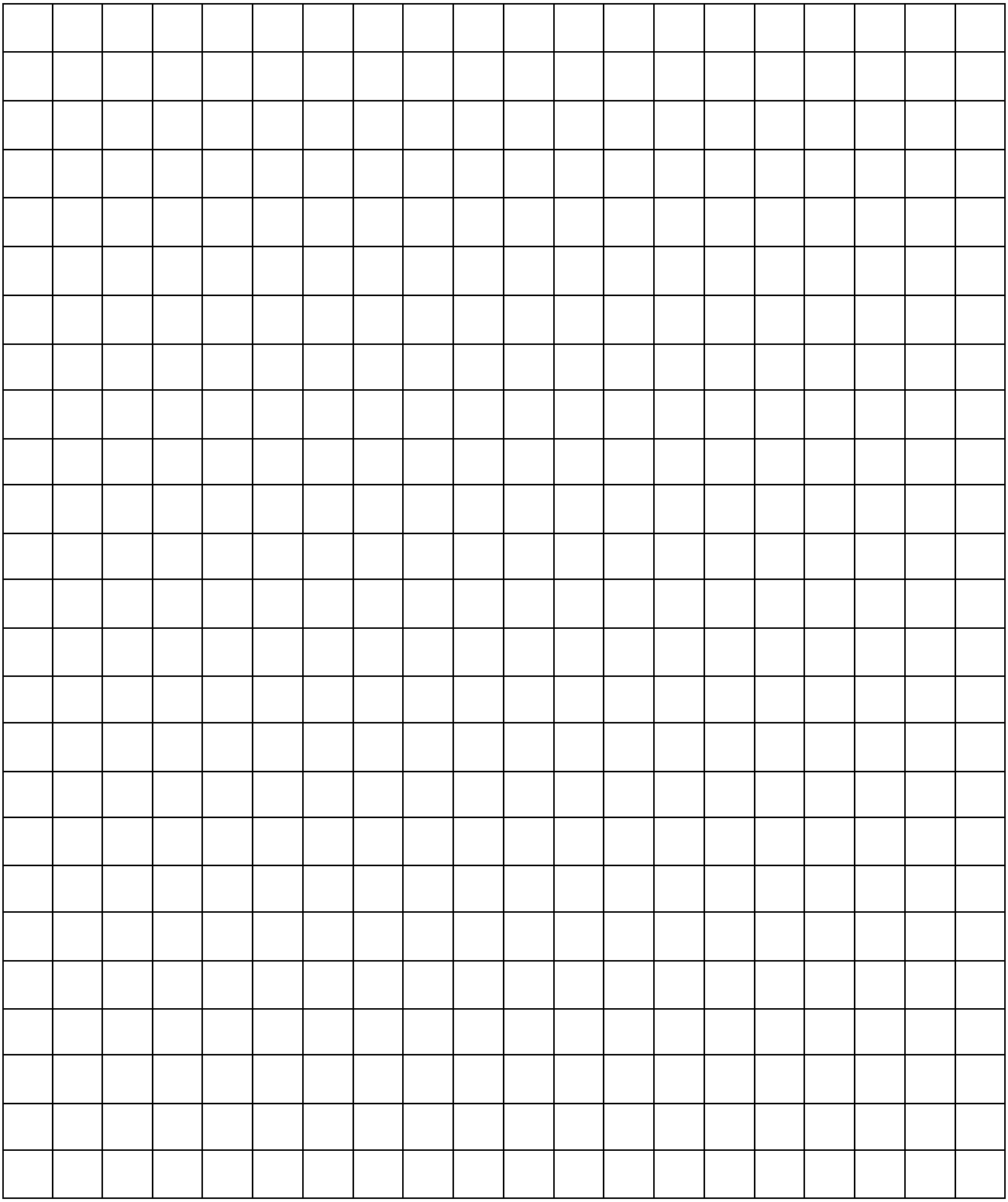

Number of duckweed plants

Sample dates

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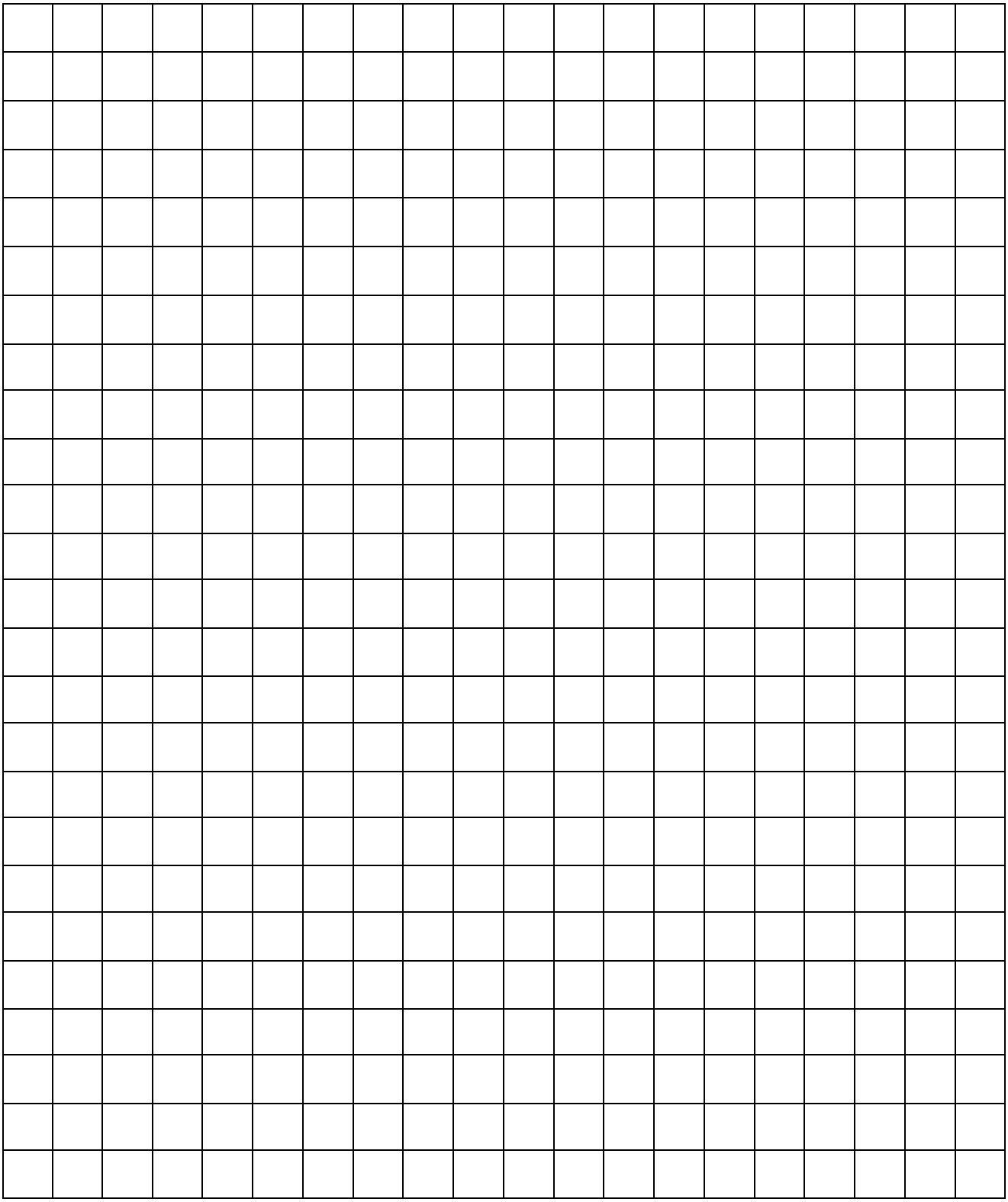

Number of duckweed plants

Sample dates

Questions:

1. What was the carrying capacity of each of the groups?

2. If the carrying capacities differed, which had the highest? Explain why you think it had the highest.

3. If the carrying capacities differed, which had the lowest? Explain why you think it had the lowest.

4. Did your results support your hypothesis? If not, why do you think they did not?

5. If the carrying capacities did not differ, what could you do differently next time in order to make the carrying capacities differ?

6. Why did each group have five containers of plants from which to gather data?

7. What were the independent variables?

8. What were the dependent variables?