



Net Primary Productivity

PURPOSE

- Measure net primary productivity (NPP) of rye grass, comparing NPP measurement methods for reliability
- Apply the NPP concept to problems of crop growth and higher trophic level support

INTRODUCTION

Net primary productivity (NPP) is defined as the amount of carbon from the atmosphere that gets added to green plants per unit of time. It is a rate, the quantity of new vegetable matter added per day, per week or per year. Net primary productivity is calculated as the total gain of biomass from photosynthesis minus the losses due to plant respiration. It is this net gain that is available to other organisms as food. The higher the NPP is in a region, the higher the overall biomass and diversity.

You will measure NPP by comparing the changes in dry mass of rye grass growth over the course of one week. The class will be divided into two groups. One group will follow the entire plant removal method and the other group will carry out the clipped grass procedure. Both procedures measure the net primary productivity as an increase in dry weight over a one week period.

Materials

- potting soil
- rye grass seeds
- aluminum foil
- plastic trays about 30 cm × 50 cm × 5 cm deep

Prelab Preparations

1. Fill the trays with potting soil to near the top.
2. Plant rye grass seeds so that the seeds are no more than 0.5 cm apart.
3. Cover the seeds with a thin layer of the potting soil.
4. Water the trays enough to ensure that the soil is saturated but with no standing water.
5. Place the trays to expose them to sunlight or under artificial lights designed for plants.
6. Continue to water the seeds when necessary as they sprout and grow to grass plants.
7. It will take about two to three weeks for the plants to be large enough to start the experiment.

Procedures

Note: If you are experimenting in a classroom, space will be a consideration. Your group will not be able to harvest all the grass in a 1-m² plot. Your raw data will be added grams of carbon from a few plants over a few days. You will need to convert these data into units of grams of carbon per square meter per year (or g C/m²/yr).

Entire Plant Removal Method (EPR)

- Step 1** Take five complete plants, roots and all, from the soil, removing as much soil as possible.
- Step 2** Place the plants on an open container made from aluminum foil, and put in the drying oven for 48 hours at a temperature between 90° C and 95° C.
- Step 3** In the section of the tray from which you took your samples, count the number of plants in a 5 cm-by-5 cm area. Record this count in your data table.
- Step 4** After the plants are dry, weigh and record the mass. This is the starting dry mass.
- Step 5** Allow the remaining grass to grow for one week more, watering when necessary.
- Step 6** Remove five more plants and repeat the drying and weighing procedure. This is the final dry mass.
- Step 7** Find the difference in dry mass. This number is in grams of added carbon per five plants. Scale this value up by using the number of plants growing in 25 cm². Then convert units of cm² to m² and also the number of days between samples into years.
- Step 8** Calculate and report the net primary productivity in units of grams of carbon per square meter per year.

Clipped Grass Procedure

- Step 1** Harvest 15 plants, all from the same area in the tray, by cutting the plants 0.5 cm above the soil.
- Step 2** In the section of the tray from which you took your samples, count the number of plants in a 5 cm-by-5 cm area. Record this count in your data table.
- Step 3** Place the clippings on an open container made from aluminum foil, and put in the drying oven for 48 hours at a temperature between 90° C and 95° C.
- Step 4** After the plants are dry, weigh and record the mass. This is the starting dry mass.
- Step 5** Allow the remaining grass in the tray to grow for one more week.
- Step 6** Harvest an additional 15 grass plants by clipping the plants 0.5 cm above the soil. Repeat the drying and weighing procedure. This is the final dry mass.
- Step 7** Find the difference in dry mass. This number is in grams of carbon per 15 plants. Scale this value up by using the number of plants growing in 25 cm². Then convert units of cm² to m² and also the number of days between samples into years.
- Step 8** Calculate and report the net primary productivity in units of grams of carbon per square meter per year.

Analysis

1. What is the definition of net primary productivity? Why is this rate such an important piece of information for ecologists?

2. Compare the NPP figures from the entire plant method to those of the clip method. Explain why the figures are the way they are. Are they as you would expect? Why?

3. Which procedure appears to give the most reliable data? Why? How could you find a valid way to compare data from the two methods?

4. Why are the results expressed as "net productivity" instead of "gross productivity"?

5. Grass seed could have been replanted on the plot from which the grass was removed in the EPR experiment and the amount of new plant growth compared and recorded as productivity. Comment on the reliability of such data.

6. Suppose the rye grass plants continued to grow at the same rate over a six-month growing season. What would be the net productivity for a field that is 1 km²?

7. Comment on the availability of energy from the plant, if it is consumed by herbivores after the six-month growing season. Explain how energy availability affects the timing of farmers' harvest of their grain crops.

8. In the eastern United States, in particular from Massachusetts to Virginia, climax hardwood forests are being rapidly replaced with large, single-family homes and townhouse complexes. Based on the outcome of this investigation, explain one reason why the deer herds in those states have drastically increased.

Analysis

- 9a.** Design an experiment by which you could measure the net primary productivity of a field in the wild. Describe it.

- b.** How could this NPP be used to determine the number of herbivores that could be supported by the field? For example, how many cows could feed there?

- c.** How would you estimate the number of trophic levels that could be sustained in the field?

- d.** Describe how remote sensing could be used to determine the NPP of an area.
