**Calculating Productivity**

Define; *gross productivity*, *net productivity*, *primary productivity* and *secondary productivity*.

Define and calculate both *gross primary productivity* (GPP) and *net primary productivity* (NPP) from given data.

Define and calculate both *gross secondary productivity* (GSP) and *net secondary productivity* (NSP) from given data.

**These problems are from Newport High School (**[**www.newportapes.com**](http://www.newportapes.com)**)**

1. If the GPP for a patch of forest is 10 kg Carbon /m2 /year, and the amount of carbon dioxide LEAVING the ecosystem (don’t ask how we measured this!) is 5 kg Carbon /m2 /year, what is the NPP?

NPP is the actual biomass produced.

GPP **=** 10 kg Carbon /m2 /year

R = 5 kg Carbon /m2 /year

GPP – R = NPP = 5 kg Carbon /m2 /year

2. In the patch of forest from Problem #1, how much energy is available at the producer level for herbivore consumption? Assume 1 kg of carbon produces 10,000 kJ of energy.

5 kg Carbon /m2 /year x 10,000kJ/m2/year = 50,000 kJ

3. Imagine we run an experiment on the algae *Cladophora glomerata*. We place equal amounts of algae into a light bottle and a dark (covered) bottle. We immediately measure the dissolved oxygen (DO) in both bottles and find it is 10 mg/L. We let both bottles sit for one week. After one week, the light bottle has a DO value of 11 mg/L and the dark bottle has a DO value of 5 mg/L. Calculate respiration (R), net primary productivity (NPP) and gross primary productivity (GPP).

(Light - Initial) = (11-10) = 1 mg/L/week = (GPP - R) = **NPP**

(Initial - Dark) = (10 - 5) = 5 mg/L/week = **R**

(Light - Dark) = (11 - 5) = 6 mg/L/week = (NPP + R) = **GPP**

*Reference for Light/Dark bottle experiments for calculating NPP:**<http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/energyflow/energyflow.html>*

**Productivity Practice Problems**

1. Which will produce more apples; Orchard A with 1037 J/m2/day of NPP, Orchard B with 773 J/m2/day, or Orchard C with 2,000 J/m2/day?
2. Which will give you more crops (by mass); a corn field with a GPP of 5 kg/m2/harvest or a wheat field with a GPP of 10 kg/m2/harvest?
3. Assuming GPP of Forest A = GPP of Forest B = GPP of Forest C, which has the highest rate of respiration in its trees given that Forest A’s NPP = 1254 J/m2/day; Forest B’s NPP = 2157 J/m2/day and Forest C’s NPP = 779 J/m2/day?
4. Which has a higher rate of respiration; Bog A with NPP = 300 g/m2/day or Bog B with NPP = 100 g/m2/day? (Assume GPP of Bog A = GPP of Bog B)
5. If a forest has a GPP of 200 J/m2/day and 100 J/m2/day worth of carbon dioxide flows out of that forest, what is the NPP?
6. If a dark bottle loses 1 g of biomass/mL and a light bottle gains 5 g of biomass/mL, what is the NPP? What is the GPP? How can it be calculated?
7. You start a light bottle/dark bottle measurement on algae *Species X* with 10 mg/L of DO in both bottles. You let the bottles sit for one week so that photosynthesis and respiration rates can be calculated. At the end of one week, you have 7 mg/L of DO in your dark bottle and 10 mg/L of DO in your light bottle. What is the NPP, GPP, and respiration? Express your answers in moles of carbon per liter per week. Remember 1 mg of DO contains approximately 3 x 10-5 moles of oxygen.
8. Use the following information to respond to the prompts below the data table.

|  |  |  |
| --- | --- | --- |
| **Trophic Level** | **Net Production**  (kJ m-2yr-1) | **Respiration**  (kJ m-2yr-1) |
| **Top Carnivores** | **63** | **25** |
| **Carnivores** | **1321** | **280** |
| **Herbivores** | **6178** | **7900** |
| **Producers** | **36922** | **50060** |

a) Draw a pyramid of productivity for this data.

b) Calculate GSP for each of the trophic levels indicated above.

c) Identify what information is unaccounted for in the data and outline how this is important to determining the productivity of a consumer.

d) Explain why pyramids of productivity must always be upright and cannot be inverted