Homework Assignment #3 (Due May 7, 2009)

1) We often use the idea of r versus K strategies when discussing ecological niches in biology. However, the concept was developed for terrestrial environments. Where would you put a typical dinoflagellate in terms of r versus K strategies? Do you think this is a useful concept for biological oceanography?

2) Are the oceans more, less, or equal to the diversity on land? Defend your answer.

3) If the K_s (half-saturation constant) for nitrate uptake is 0.5 μM, what concentration of nitrate would be required to reach 90% of maximal uptake assuming Michaelis-Menten kinetics? At what point do you think that phytoplankton cell is no longer nutrient-limited?

4) What are some advantages and disadvantages to being a small phytoplankton cell? Where would you expect small cells to dominate, and why?

5) We learned that it's possible to convert from one measurement to another by using "rules" such as the Redfield Ratio and Photosynthetic Quotients. If you measured the primary productivity of the water near the Santa Cruz Wharf using oxygen light/dark bottles, and the net oxygen production rate was 1 mMol/m2/d, what would that be in carbon units assuming the PQ was 1.30?

6) Define the following terms:

Critical Depth, Biodiversity, "Margalef's Mandala", Blackman Limitation

Graduate Level Questions:

1) Briefly describe the patterns in productivity over the last 10 years or so described by Behrenfeld et al. and Kahru et al. How would you explain the difference, and how accurate do you think the productivity estimates are?

2) Assuming that the Eppley paper provides total productivity in metric tons, compare their estimates for global oceanic production to the estimates provided by Field et al. Why do you think there's such a large difference between the two values?

3) Below are data from coastal California for chlorophyll-normalized primary production (PB, mg C/mg Chl/day) from two stations taken about 10 km apart. Using the instructions on the back of this sheet, calculate the depth-integrated primary production for these two stations, and answer the following questions:

   a. What are the depth-integrated Primary Production values?
   b. What is the difference (percent) between integration to 1% versus 0.1% of surface irradiance? Should there be any carbon assimilation below 1%?
   c. What effect is there of a subsurface maximum in depth-integrated primary production? If you were using a satellite, do you think estimating PP for these stations would be a problem?

	STATION 1			STATION 2	
Depth	PB	% Light	Depth	PB	% Light
0	205.8833	100	0	244.9712	100
5.894537	318.4453	50	5.894537	109.7931	50
10.23861	139.8576	30	10.23861	91.94698	30
16.13314	88.95841	15	16.13314	24.91004	15
25.47576	76.39403	5	25.47576	41.71542	5
39.16246	12.1482	1	39.16246	41.17249	1
58.74368	4.826	0.1	58.74368	25.284	0.1

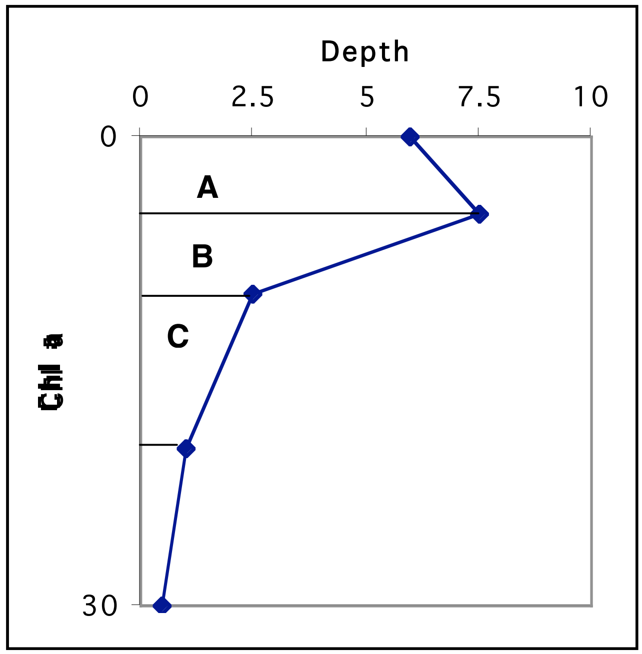
Trapezoidal Integration: In oceanography, we often collect samples at discrete depths, but we want to know what the depth-integrated concentration is. For example, in these data from MBARI, typically 12 water depths are sampled because a CTD-rosette can hold twelve sampling bottles. To create an estimate for the entire water column, we must depth-integrate the data. The trapezoid sum algorithm for numerical integration is based on the approximation of the area by looking at trapezoids associated with portions of the area, provided the function is nonnegative. This approximation has the form:

$$\int_a^b f(x)dx \cong \sum_{i=1}^{i=n} (f(x_i) + f(x_{i+1}))\frac{h}{2} \quad \text{where } h = \frac{(b-a)}{n} \text{ and } x_i = (i-1)h + a.$$

Although this looks complex, it's really very simple. To calculate the depth integrated chlorophyll a from 0 to 20 meters, where we know the following:

Depth	Chl a
0	6
5	7.5
10	2.5
20	1
30	0.5

This would look graphically like:



Where we have divided each section (between points) into a different trapezoid, labeled A, B, and C (the trapezoid from 20-30 m isn't labeled because we are only integrating to 20 m). To calculate the depth-integrated chlorophyll, we use the formula above

$$\sum_{0}^{20} Chla = \text{area of A + B + C}$$

To calculate the area for each section (or trapezoid), we use $(b_1+b_2)/2 \times H$, where b_1 and b_2 are the chlorophyll values at depth 1 and 2, and H is the difference in depth between chlorophyll values 1 and 2. So, for example, the area of our rectangles equal:

A = (6 + 7.5)/2 x (5 – 0) = 33.75
B = (7.5 + 2.5)/2 x (10 – 5) = 25.0
C = (2.5 + 1.0) /2 x (20 – 10) = 17.5

$$\sum_{0}^{20} Chla = 76.25 \text{ mg Chl a m}^{-2}$$