*Dr. Rebecca Freeman*

# Lesson 22 Practice Problems: Constraints on Life in the Ocean

**Answer the following questions to the best of your ability. We will go over the answers in class and you can correct your own work. Questions such as these will be on the next test.**

**We will examine real data from Pacific Ocean collected off of the Oregon Coast on the continental shelf during the summer of 2017, visualized here :** (https://datalab.marine.rutgers.edu/explorations/2019/anoxia.php) **Examine the data and try to explain the patterns you see. You will examine three types of data collected at this site:**

- *Dissolved oxygen content (DO)* tells us how much oxygen gas was dissolved in the water, with a larger number meaning more availability of oxygen
- *Temperature* tracks the water temperature through time
- *Wind direction* shows the wind direction either blowing to the north (up) or to the south (down). The more the line deviates from the middle (0), the more strongly the wind was blowing in that direction.

**Part 1: Review prior knowledge**

1. What is a *dead zone*? Define in your own words as thoroughly as you can. (Review Lessons 18 & 19 if necessary.)

2. What is the difference between *anoxia* and *hypoxia*? (Review Lessons 18 & 19 if necessary.)

3. What is *upwelling* and *downwelling*? (Review Lessons 10 & 11 if necessary.)

4. What are two potential reasons for upwelling and downwelling? (Review Lessons 10 & 11 if necessary.)

5. How does oxygen become dissolved in ocean water? (Review Lesson 8 if necessary.)

6. Where in the ocean is oxygen most abundant? Where is it less abundant? (Review Lesson 8 if necessary.)

**Part 2: Examine new data:** We will review Part 1 before tackling Part 2, but if you want to charge ahead, feel free to explore the data on your own while the rest of the class finishes. I will demonstrate how to examine the data when we start Part 2.

1. To begin Part 2, we will watch a short movie about crabs off the coast of Oregon. This video was shot at approximately the same time as the data we will interpret. As the time lapse video continued through time, what changes did you see in the behavior of the crabs?

2. Examine the first data set (dissolved oxygen in mg/L). Note that as you hover over the data points, the value of each point shows up in the upper right of the graph. Click the "next" button at the lower right of the graph for a line that delineates hypoxic/anoxic conditions from more healthy conditions. *Characterize conditions during the time that this data was collected.*

   *During this time period, hypoxic/anoxic conditions _____. A) were very rare, B) were occasional, but not very often, C) were happening about half of the time, D) were more common than healthy oxygenated conditions.*

3. Truly anoxic conditions are present when dissolved oxygen in the water is completely absent (0.0 mg/L). Hover over the data points to see how often this occurred during the study period. (Note that you can use the slider bar to zoom in and out on the data.) How often did true hypoxia occur?

   *True hypoxia (0.0 mg/L) occurred _____. A) frequently, at least half the time that oxygen conditions were hypoxic/anoxic, B) about a quarter of the time that oxygen conditions were anoxic/hypoxic, C) occasionally, at least ten times during the study period, D) very rarely (fewer than five times), E) not at all.*

4. What is the lowest oxygen level that you can find during a time that oxygen levels reached the definition of hypoxic?

   *Oxygen levels reached _____ mg/L on (date)_____.*

5. Click "Next" in the lower right corner of the graph to bring up the next data set which shows seawater temperature at the same time and place. (Note that you can use the same slider

bar to zoom in and out of this dataset.) How does it compare with the dissolved oxygen data?

*When the dissolved oxygen levels went _____, the temperature of the seawater went _____. A) up, up, B) down, down, C) up, down, D) down, up*

6. Click on the "Next" button on the lower right on the graph to bring up the third data set, wind direction. When the wind is blowing to the north, the number is positive and when the wind is blowing to the south the number is negative.

   *When the oxygen levels in the first data set are healthy, what direction is the wind usually blowing towards?*

   *When the oxygen levels in the first data set are hypoxic/anoxic, what direction is the wind usually blowing towards?*

7. Review: We are in the northern hemisphere. How do wind directions affect shallow ocean currents? (See Lesson 11 if necessary.)

   *When the wind is blowing from south to north (positive numbers), this sets in motion a surface current to the (north, south, east, west).*

   *When the wind is blowing from the north to the south (negative numbers), this sets in motion a surface current to the (north, south, east, west).*

**Part 3: Synthesize new data for deeper understanding**

1. Summarize what you know so far about the relationship between the three variables (dissolved oxygen, water temperature, wind direction).

2. Why do you think the ocean water varied in temperature? It is tempting to blame air temperatures, but remember that even though we are on the continental shelf, the water is too deep to be easily affected by daily changes in air temperature. What is another explanation? (*Hint:* Where in the ocean do we find cold water? How could it get onto the shelf?)

3. Putting all of these clues from three data sets together, come up with a scenario that explains the dying crabs that we observed in the video.

4. If you were an oceanographer living along the coast of Oregon and you wanted to warn crab fisherman to collect their crab pots immediately before the crabs died, what conditions would you be looking for?