Lesson 3.1 Teaching Instructions:

Lesson 3.1 is a supplementary lesson that can be substituted for Lesson 3 if you do not have enough time or if your students need more scaffolding and direct instruction in data analysis. The lesson handout should **not** be used as a worksheet that is simply passed out for students to complete. Rather, it should be approached as a guided reading and data analysis activity in which students work in pairs or small groups with frequent teacher check-ins and whole group processing time.

1) The lesson begins with an explanation of the overall activity as well as an overview of the data that will be used. Have student volunteers read each section out loud, and ask other students to repeat or summarize key ideas from what was just read.

   Take time to process the graph and data about global mean surface temperature, using probing questions to make sure that students understand the graph.

2) Have students study the graph and answer question #1. They can answer with a Think-Pair-Share routine, or you can have the Turn and Talk with a partner and then write down an answer.

   Have a student read the explanation of the different color lines on the graph, and use probing, open-ended questions to assess their understanding.

3) Next, have students study the next graph on Arctic sea ice, and have them Turn and Talk, and then answer question #2.

4) Then have students work in pairs or small groups on questions 3-6, which ask them to summarize the two graphs, analyze the patterns and relationships they see, and make some connections between the two. Students should reach the logical conclusion that warming temperatures may very likely be causing Arctic sea ice to melt, as warmer air melts more ice.

   Proceed to the next page and review the explanation with the students, having volunteers again read out loud. Discuss the idea that correlation does not mean causation, and maybe take the time to view some of Tyler Vigen's amusing graphs (http://www.tylervigen.com/spurious-correlations).

5) Proceed to the bottom of page 4 and review the instructions for the data analysis they will now do. Then move on and have students study Table 1.

Have students read and discuss the explanation between Table 1., and then have them Turn and Talk and answer question 7, parts a, b, and c, as well as #8.

Give students time to think, talk, and write, and then review their ideas with them. If students are sharing ideas that are not correct, ask other students to share their thinking, and work as a group to develop better answers (in other words, force the students to do the thinking and resist the temptation to just provide the right answer).

6) Move on to Table 2 and give students time to study it. Have students answer question #9, and then move on to analyze the tables. Then have them answer question #10 and #11. At this point, again take some time to have students share their thinking, question each other, and work to clarify or expand their answers as needed.

   Students should be noting that there seems to be a positive, fairly direct relationship between precipitation and phosphorous and nitrate levels. They may have trouble making conjectures in #11, but encourage them to think and do their best (again, don't do the thinking for them).

7) Advance to Table, which is more complex, and talk through it with students to be sure they understand the data. Have students Turn and Talk and then answer question #12. Take a few moments to again have students share and expand their thinking.

8) Finally, have students work in pairs or small groups on the chart and questions 13-18. They are to look across all of the data tables and reach some general conclusions, and then they should make some scientific conjectures that might explain the relationship they are observing (when precipitation gets very high, levels of phosphorous and nitrate in the water increase quite a bit as well). Finally, students should think about what might happen to water quality if severe weather events continue to increase in frequency. Be sure to read the questions with students and explore their understanding of what is being asked.

   Encourage students to develop some initial, basic explanations that they can then text and explore in later lessons and learning.

   As students work on the final questions in pairs or groups, you may choose to call the whole class together to share thinking and make their reasoning visible. It is important to do lots of processing and questioning on this last section, having students share their thinking and ask questions of each other.