INTERPRETING DATA

Duration
1 class periods.

Theme
Interpreting scientific data and reaching reasonable, well supported conclusions using those data and other sources.

Objectives
Students will:

- Interpret data based on different scientific information, and notice how interpretations change with different information.
- Evaluate the validity of conclusions, based on available data.
- Determine which (if any) data would further support or challenge these conclusions.

PLOs Addressed (Activity + Extensions)

Grade(s)	Curriculum Organizer	Prescribed Learning Outcomes
8, 9, 10	Processes of Science	A3 Represent and interpret information in graphic form. A5 (Grade 8 A6) Demonstrate ethical, responsible, cooperative behaviour. A6 (Grade 8 A7) Describe the relationship between scientific principles and technology. A7 (Grade 8 A8) Demonstrate competence in the use of technologies specific to investigative procedures and research.

Background
Interpreting data can be as much of an art as it is a science. Equally, interpreting data is often just that, an interpretation of what can be learned. Rarely are data a “smoking gun” that easily and succinctly explain an event or phenomena. Rather, data are usually a collection of measurements over time or space. Interpreting the meaning and trends from this information is what makes the data understandable and powerful, but often, there is more than one way to interpret such data. In addition, conclusions drawn from the data may be dependent on other data in order to be reasonable. It’s important to compare data with a baseline or over time, as events that first appear related may diverge and be unrelated.

Students need to be wary of falling into the trap of creating a conclusion to support the data, rather than reaching a conclusion the data supports. When using data to support arguments, students should understand that there may not be a “right answer” instead there is an answer that is most reasonable based on the data. Additionally, when attempting to reach reasonable conclusions it can be important to consider past data, peer-reviewed literature, and other resources to help back up evidence that is not seen in your own data. For example, if you suspect a trend or causal relationship in the data, you may be able to back up your findings with other literature.

Materials

- Interpreting Data graphs, SET 1:
    - Temperature graphs, axes and title unlabeled, no scales on axis (Graphs 1A, 1B, 1C)
    - Salinity graphs, axes and title unlabeled, no scales on axis (Graphs 1D, 1E)
- Interpreting Data graphs, SET 2:
    - Temperature graphs, axes and title labeled, scales on axes (Graphs 2A, 2B, 2C)
    - Salinity graphs, axes and title labeled, scales on axes (Graphs 2D, 2E)
- Interpreting Data graphs, SET 3:
    - Pressure data, one hour (Graph 6A)
    - Pressure data, one week (Graph 6B)
    - Pressure data, one month (Graph 6C)
- Interpreting Data graphs, SET 4:
    - Salinity and temperature graphs, Barkley Canyon (Graph 3)
    - Salinity and temperature graphs, Cambridge Bay (Graph 5)
- Interpreting Data graphs, SET 5:
    - Salinity and temperature graphs Saanich Inlet (Graph 4A, 4B, 4C)

Activity

Discuss with students, how would they use data to support conclusions about something believed to be true?

1. Divide students into discussion groups.
2. Give each group a copy of SET 1, containing Graphs 1A, B, C, D, E. Have them discuss what they think the graph is indicating, and if they can draw conclusions based on the graphs.
3. Encourage the students to voice their initial, snap conclusions about the data, rather than asking further questions. You may want to encourage them by asking:
    - Do you see anything that looks like a trend?
    - What areas of the graph are you drawn to? Why?
    - If you were looking for something unusual, where might this appear in the data?

   Very quickly they should realize they don't actually know what they are looking at. Tell them that they are looking at water temperature and salinity data. Which is which?: temperature is red and salinity is blue.
4. After some time, ask the student to brainstorm what information would allow them to make stronger conclusions. For example, how might a better title help them? What is the actual unit and by what value does the scale increase, from where to

where? Try and encourage your students to remember things needed in mathematic graphing, and how this might help them.

5. Hand out SET 2 with the axis, proper title, and scale (Graphs 2A, B, C, D, E). How do their conclusions change based on the new information in the graphs?
6. Draw the students' attention to the scale of the graphed data. How does the scale impact the significance of the conclusion? For example, are small incremental changes in temperature as significant as incremental changes in salinity? Discuss, what warrants a "significant" change?
7. Next, hand out the pressure data (SET 3: Graphs 6A, B, C). Which data do the students find more meaningful? Why? If asked to predict what would happen in 2 months' time, which is more meaningful? If asked to predict what would happen in 2 hours' time, which is more meaningful?
8. Have the students look at the salinity and temperature comparison from Barkley Canyon and Cambridge bay (Data Set 4, containing Figures 3, 5). What conclusions would they be tempted to draw? In each graph is a dual plot of salinity and temperature over time: Ask the students to predict what a graph from another location might look like, e.g. the Dead Sea where it is really warm. Would they expect it to be less salty? Why or why not?
9. Show the students graphs 4A, 4B, and 4C from Saanich inlet. In what way does this look different?
10. Discuss with students: In the Barkley Canyon and Cambridge Bay graphs, it looked as though salinity and temperature impacted one another negatively, i.e. the warmer the water the less salty it is, and vice versa. Why do the Saanich Inlet data look different? After some discussion, explain to the students: salinity and temperature do not have a formal relationship with each other (one does NOT influence the other).

    So, what's happening here?

    Instead, they are influenced by similar outside factors (i.e. heating from the sun and freshening from rain both happen at the surface of the ocean; also, gravity pulls denser water down, lighter water floats up), making them appear related. For example, water that is colder has a greater density than warmer water and tends to sink down, and water that is saltier has a greater density than fresher water and also tends to sink down. And so, cold and salty water is typically deeper, and warmer and less salty (fresher) water is shallower.

    Therefore, water that has a lower density (less salt), OFTEN has a warmer temperature. But not always. In Saanich Inlet, the densest water comes from the adjacent Haro Strait, where later summer conditions result in salty warm water. In this case the salinity dominates over the temperature, and the salty warm water is slightly more dense than the fresher cool water. So at the seafloor, where the measurements were taken, the temperature is actually slightly higher than at mid-water level, and the observed fluctuations associated with the moving water appear positively correlated: less warm water also has less salt.

In truth, adding more salt to water will not impact the temperature, and changing the temperature will not impact the salt content. This can be proven by testing in a lab. From the direct ocean observations as well as from lab tests, we can see that the temperature of the water and the salt content have no formal relationship, but we can begin to say something about common or typical natural distribution of apparent relationships in the ocean, and their exceptions.

Discussions

- Explain why multiple sources of data are needed to make strong conclusions.
- How important are scale, location, and time series in data?
- Why might it be easy to manipulate or misinterpret data?
- What makes data "significant"? How might language lead to different conclusions?

Extensions

Grades 8–10

- How might a different representation alter our perception of the data? For example, could these data be shown as a bar graph instead? How might that alter our understanding?
- How important is time series to data?
- What is the benefit of long-term (many years) observations? Consider an area like the Arctic. Why would this benefit from long term study?