Title of Lesson: How do we know what we know about Sea Turtles?

Length of Lesson: 2 days (50 minute periods)

Grade / Topic: Grades 8-12

Source of the Lesson: *Gayle N Evans, Science Master Teacher, UFTeach, University of Florida*

Concepts: Scientific research is the foundation of all that we teach our students in science classes. It is essential that we make it clear to our students that science is not merely a collection of facts that have already been set in stone. Science is an ongoing pursuit to investigate and make sense of all that is happening in the world (and universe!) around us. Everything we hold as knowledge in science is verified by empirical observations and experimentation. In order to be confident in our assertions of what is true, scientists collect long term data, do multiple replications of experiments and revise their assertions based on the totality of collected data. There are many instances in science of well intentioned investigators coming to erroneous conclusions based on too little evidence. This exploration introduces students to the importance of long term studies, and revision of knowledge based on continuing investigation.

Florida State Standards (NGSSS) with Cognitive Complexity:

Benchmark Number	**Benchmark Description**	**Cognitive Complexity**
SC.8.N.1.3	Use phrases such as "results support" or "fail to support" in science, understanding that science does not offer conclusive 'proof' of a knowledge claim.	Level 2: Basic Application of Skills & Concepts
SC.8.N.1.4	Explain how hypotheses are valuable if they lead to further investigations, even if they turn out not to be supported by the data.	Level 3: Strategic Thinking & Complex Reasoning
SC.8.N.1.5	Analyze the methods used to develop a scientific explanation as seen in different fields of science.	Level 3: Strategic Thinking & Complex Reasoning
SC.912.N.1.3	Recognize that the strength or usefulness of a scientific claim is evaluated through scientific argumentation, which depends on critical and logical thinking, and the active consideration of alternative scientific explanations to explain the data presented.	Level 1: Recall
SC.912.N.2.1	Identify what is science, what clearly is not science, and what superficially resembles science	Level 3: Strategic Thinking & Complex

	(but fails to meet the criteria for science).	Reasoning
SC.912.N.4.1	Explain how scientific knowledge and reasoning provide an empirically-based perspective to inform society's decision making.	Level 2: Basic Application of Skills & Concepts

Performance Objectives: *Students will be able to*:

- Differentiate between claims with a scientific basis and those which are not verifiable by empirical science.
- Interpret a data set to identify trends in the data during the time period given.
- Using a limited set of green turtle nesting data, extrapolate to predict future trends in nesting.
- Given a large data set, predict how changes in sea turtle protection will affect trends in sea turtle nesting.

Materials List and Student Handouts
(https://conserveturtles.org/educational-initiatives-distance-learning-sea-turtle-research-data-evaluation/)

- Print & cut sea turtle statements.
  There should be enough cards (or slips of paper) made so that each student has one. There are ten possible statements (for each statement there should be at least 3 students with the same statement to facilitate discussion).
- Print Data Sets: A, B, C, D.
  Each student should have one of the 4 data sets so that there are at least three students with each data sets (students will form groups based on which data set they have).

Advance Preparations

- Contact Dan Evans at Sea Turtle Conservancy to arrange a date and time for the video conference. Please make arrangements at least two weeks in advance of the date of your conference request.
- Hang signs on opposite corners of the classroom. One reads verifiable / scientific statement, the other reads: Anecdotal / pseudoscientific statement.

Safety

- Any time students are using internet-connected computers, it is important to monitor them closely to ensure that they are only viewing educationally appropriate websites.

Engagement ***(20 Minutes)***

What is scientific evidence versus anecdotal / pseudoscience?

Hang signs on opposite corners of the classroom. One reads verifiable / scientific statement, the other reads: Anecdotal / pseudoscientific statement.

Give each student a slip of paper with a statement about sea turtles. Then ask students to go to the corner that best describes their statement. (for each statement there should be 3-4 students with the same statement = 10 unique statements total). Have a student read their statement, justify their choice. Ask others with the same statement raise their hand and debate placement if needed. Continue until all statements have been read & discussed.

Finish with students defining / making a list of criteria needed to consider something to be a valid scientific statement.

Bridge: Today you will be given real data sets collected by sea turtle scientists, and you will work with your partners to determine what conclusions can be drawn from the data set. Remember that each of your claims needs to be supported by evidence from your data set in order to be considered valid.

Exploration (approx. 5 minutes per group = 15 minutes total plus travel time)

Each student receives a data set of Green Turtle nesting in the Carr Refuge in Melbourne Beach, FL: A, B, C or D. Each student begins by analyzing his or her specific data set.

Then form small groups by letter (A's together, B's together, etc… you may choose to have students find pairs or number the cards A1, A2, etc to facilitate group formation- it's best to have four or fewer students per group).

Once you have had students who share a common data set reach a consensus, re- arrange students to form groups where A & B's are together and C & D's are together. Have students revisit the questions and justify any changes they have made. Students should realize that their data sets are each pieces of a larger puzzle – by putting both data sets together, a larger pattern should become evident.

Finally, form groups consisting of A, B C and D data sets showing the entire population cycle over several nesting seasons. Students should once again revisit the questions, make any necessary changes, and justify their decisions.

Questions to consider (and provide supporting evidence for each claim):

Is this data representative of a population that is growing, shrinking or stable?

What level of concern would you place on this population?

What policy or management choices would you recommend to ensure the long-term survival of this population?

Explanation Day 1 (10 - 15 minutes)

Have each mixed data group report their conclusions based on being able to see the entire data set. Ask volunteers to discuss how their thought process changed as they gained more information with each new data set. Ask the students if they see any pattern or common trends (high and low years) in the small and entire data set and what might be causing any patterns.

Explanation Day 2: Video conference with Dan Evans, Sea Turtle Scientist with STC

Dan will show a larger data set of ~15-20 years of Green turtle nesting data and ask students to identify any trends they see in the population beyond the natural cyclical variations. Students will be asked to consider the possible causes for the changes in nesting density as shown in the long-term data.

- Next, Dan will show a section of loggerhead nesting data and ask students to draw conclusions about the health and stability of the population; gradually uncovering more of the data, and having students revise their conclusions accordingly. Finally the full data set will reveal a population that was initially growing, followed by a step decline, and finally a period of recovery. Students will be asked to interpret the data to draw conclusions about the possible causes of these population changes.
- Then Dan will lead a discussion around the question: How does a scientist know when they have enough data to begin feeling confident about their conclusions?
- Dan will also discuss the time lag shown in the data resulting from sea turtles being such a long lived species.

Elaboration

Finally, time allowing, students will be asked to extrapolate the future nesting numbers based on the Green Turtle data they have so far, given different scenarios: Possible scenarios include: Endangered Species Act legislates tougher penalties for any loss of life of the Green Sea turtle species.

Because population numbers are increasing the Green Turtle is removed from the list of protected Endangered Species, as a result, the hunting of adult sea turtle for food is allowed.
Beach development is at an all time high resulting in a loss of nesting habitat for Green Turtles.
Increased nest predation and or lighting increases lead to reduced hatchling survival.

Evaluation

Students will be asked to design a research plan to determine whether their predictions from the elaboration were true. To asses whether students grasped the message of the lesson, they will need to address the following:

- What sort of data should be collected?
- What is the minimum time span for data collection before conclusions can be drawn with confidence?
- How can you determine the time span over which data should be collected to be valid (there is a different standard for different types of organisms).

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