**The Tides of Change…**

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**Length of Lesson:** Two to three 50-minute class periods.

**Intended audience & Topic:** Life Science, Biology or Environmental Science. Due to the reading level in the primary research publications, this lesson is most appropriate to upper level High School students. Using age-appropriate articles, this lesson could be adapted to any grade 4-12.

**Appropriateness for High School Students:**
The topic of global climate change is one that is often fraught with debate. As we prepare our high school students to be productive members of society and informed decision makers, it is essential that they are given opportunities to read primary research documents and compare them to media offerings in order to draw their own conclusions about important societal issues. Students must be taught how to determine the validity of a source of information, looking for possible bias, and misinformation. To be savvy consumers of information, it is important that students understand the value of primary sources of information, and the distortions that often occur as this information is adapted for more general public consumption. Even among primary resources, it is our goal that students will investigate the authors of scientific studies to uncover any sources of bias built within the research itself. Only when students reach this level of scrutiny, will we feel that we are producing scientifically literate citizens.

**Concepts:**
Although there is a strong correlation between human activities and recent global climate changes, there is a debate among the general public as to whether a clear cause and effect can be verified. Although we are aware that temperature and climate patterns vary widely over the course of Earth's history, recent data collected by a variety of respected scientific studies have shown a close relationship among greenhouse gas emissions, temperature rise and increase in large scale climactic events such as droughts, storms and flooding. One way to approach such a broad and controversial topic is to present snapshots of specific data highlighting local issues of interest to students. By focusing specifically on the needs of sea turtles and how these species are being affected by some of the changes that are already occurring, students will be encouraged to draw their own conclusions on a smaller scale, which in turn will be a step towards a greater understanding of the larger issue of the relationship between anthropogenic activities and global environmental changes.

**Sources:**
http://climate.nasa.gov/evidence, http://www.epa.gov/climatechange/science/
http://www.ucsusa.org/global_warming/science_and_impacts/science/

**Florida State Standards (NGSSS) and Common Core State Standards (CCSS) with Cognitive Complexity:**

| Benchmark Number | Benchmark Description | Cognitive Complexity |
|---|---|---|
| SC.912.N.1.4 | Identify sources of information and assess their reliability according to the strict standards of scientific investigation. | Level 3: Strategic Thinking & Complex Reasoning |
| SC.912.N.1.5 | Describe and provide examples of how similar investigations conducted in many parts of the world result in the same outcome. | Level 2: Basic Application of Skills & Concepts |
| SC.912.N.2.5 | Describe instances in which scientists' varied backgrounds, talents, interests, and goals influence the inferences and thus the explanations that they make about observations of natural phenomena and describe that competing interpretations (explanations) of scientists are a strength of science as they are a source of new, testable ideas that have the potential to add new evidence to support one or another of the explanations. | Level 3: Strategic Thinking & Complex 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 |
| LACC.1112.WHST.3.8 | Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. | Level 4: Extended Thinking &Complex Reasoning |
| LACC.1112.WHST.3.9 | Draw evidence from informational texts to support analysis, reflection, and research. | Level 3: Strategic Thinking & Complex Reasoning |

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**Performance Objectives:** *Students will be able to*:

- Conduct research to determine the current and potential threats to sea turtles caused by changes in the Earth's climate.
- Differentiate among several types of primary and secondary informational sources to determine the level of validity of each.
- Evaluate sources of information, recognizing potential sources of bias based on the possible motives of the authors or those who support the author's work.
- Synthesize information collected into a summary statement or report assessing the relative danger of each potential threat.

**Materials List and Student Handouts**

- Students will need access to information regarding the effects of global climate change on sea turtle species. This may be provided in the form of internet-connected computers on which students my conduct their own research, or teacher may decide to choose a selection of sources ahead of class and make copies for students to use (either by downloading to non internet connected computers or reading devices or through photocopies).
- If readings are selected ahead of class, it is suggested that the teacher compile at least 2-3 sources per category of impact. These sources should be varied. For example, a mix of research publications, newspaper articles, magazine features, governmental publications, etc. are best. This will set the ground for a productive discussion of the differences among primary and secondary resources.

**Advance Preparations**

- Students should have some familiarity with the issues surrounding Global Climate Change before this lesson.
- Students should have a basic familiarity with the life stages of sea turtles. The following website has a wealth of sea turtle information: http://conserveturtles.org/sea-turtle-information.php
- The teacher should determine how groups will be divided before class begins. Ideal group size to encourage productive discussion is from three to five students per group.
    - For the exploration, there should be one or more groups per stage in the sea turtle's life cycle.
        - Suggested stages are eggs & hatchlings, juvenile turtles and adult (breeding age) turtles. These are the "expert groups".
        - Some issues that groups should address include: effects of changes in nest incubation temperatures, sea level rise as it relates to loss of beach habitat for nesting and flooding of nests, changes in food supply due to increasing water temperature, ocean acidification, the effects of increasing severe storms, changing ocean currents, etc.
        - It is expected that there will be some overlap of information between groups.
    - For the explanation, groups will need to be formed with one member from each of the "expert groups." So each group should have at least one expert in each topic.

**Safety**

- Any time students use the Internet, it is important to closely monitor their activity to ensure they are using only educationally appropriate websites.

**5E Lesson:**

## Engagement

Open class with a brief introduction to the life cycle of a sea turtle. This TED ed video does a nice job of delivering the basics in a n engaging manner. http://ed.ted.com/lessons/the-survival-of-the-sea-turtle

Or if you prefer, a quick you Tube search of "sea turtle life cycle" yields many more choices.

## Exploration

Students will break into "expert groups" in which each group investigates a different stage of the sea turtle's life cycle as it will be affected by changes in the global climate. Suggested stages are eggs & hatchlings, juvenile turtles, and adult (breeding age) turtles. With just three stages, it will probably be best to have more than one group for each life stage.

- Some issues that students should address include: effects of changes in nest incubation temperatures, sea level rise as it relates to loss of beach habitat for nesting and flooding of nests, changes in food supply due to increasing water temperature, ocean acidification, the effects of increasing severe storms, changing ocean currents, etc.
- It is expected that there will be some overlap of information between groups.

Once students are gathered in their groups. Have them answer the following Focus questions **BEFORE** doing any reading or research:

- What types of habitats are most important to sea turtles at this stage of life (beaches, coastal waters, deep oceans, etc.). Why are these types of habitat essential?
- Do you expect global climate change to affect the specific habitats that are most important to your life stage? Justify your answer (Why or Why not?)
- Are there other issues besides habitat that may be affected by global climate change for your stage of life? If so describe them (exposure to disease or predators, behaviors like feeding, migration, breeding, etc.).

Each group will either read a prepared selection of sources related to their issue, or use the Internet to conduct research about the effects of a changing climate on their specific part of a sea turtle's life cycle.

Once they have completed their reading and research, students should revisit the focus questions. The group should discuss their answers and revise them according to the knowledge they have gained.

The group discussion should also include a review of which resources were used and how students determined the validity of each source. (The teacher may want to have each expert group produce a brief written report of their findings complete with sources used)

## Explanation

New groups should now be formed in which each group has at least one expert from each part of the sea turtle's life cycle. Each student should spend at least one minute reporting to group members the information he or she brings from the expert group. Other members of the group should give that member their full attention, then spend a minute writing a summary of that student's report.

Once all group members have reported, the group should reach a consensus as to which threat they would like to highlight in a presentation. Groups should seek teacher approval before continuing to

the next step (This allows the teacher to ensure that a variety of issues are addressed.)

Using a poster board or large piece of paper, students will work with their group members to make a chart, diagram or other type of visual aid to present their information to the class. Each poster should highlight a particular threat and include specific evidence tying that threat to global climate change. The poster should also include a description of sources used with a justification of their validity.

**Elaboration**

Possible extensions to this activity include:

- Researching global climate change legislation, and the impacts enactment of this legislation will have on the issues surrounding sea turtle survival.
- Researching what sorts of lifestyle changes students could make to combat the climate changes that negatively impact sea turtles.
- Looking at the effects of these same issues (sea level rise, ocean acidification, warming sand on beaches, changing ocean currents, etc.) on species other than sea turtles.

**Evaluation**

The teacher may asses whether the goals of the lesson have been met through comparing before & after answers to the Focus questions used in the exploration.

The posters produced in the Explanation portion of the lesson should be evaluated looking for factual accuracy, use of valid sources, and justification of the validity of the sources used.

**Links to articles that will be useful:**

The Sea Turtle Conservancy has published articles in their newsletter, "*The Velador*" related to their work to combat the effects of Climate Change on Sea Turtles:

- Double Trouble: Climate Change and Ocean Acidification
  http://www.conserveturtles.org/velador.php?page=velart90

- Reducing the Impacts of Climate Change on Sea Turtles
  http://www.conserveturtles.org/velador.php?page=velart89

WWF has compiled a comprehensive listing of recent published research specific to the impacts of Global Climate Change on Sea Turtles. This list is organized by topic and date of publication and also has links to full text of most of the articles.
http://wwf.panda.org/what_we_do/endangered_species/marine_turtles/lac_marine_turtle_programme/projects/climate_turtles/science/

The United Nations Environment Programme (UNEP)/ Convention on Migratory Species (CMS) has published a guide highlighting the effects of Climate Change on several species, including an article specifically focused on sea turtles.
http://www.cms.int/publications/pdf/CMS_CimateChange.pdf or
http://www.euroturtle.org/27a.htm

"*Global Warming May Cook Sea Turtle Eggs*." This ***Discovery News*** article focuses on Australian beaches becoming warmer due to global climate change.
http://news.discovery.com/animals/endangered-species/sea-turtles-global-warming.htm

"*Global Warming Forces Innovative Sea Turtle Protection*." This ***National Geographic*** article focuses on effects of global warming on nest incubation temperatures and loss of nesting beaches due to sea level rise. Also highlights groups working to combat these problems through intervention and monitoring.

**http://news.nationalgeographic.com/news/2008/07/080722-sea-turtles.html**

"*Global warming could wipe out largest sea turtles: Study.*" This article in ***The Indian Express*** highlights specific threats to leatherback sea turtles, from hotter, drier nesting beaches, to changes in jellyfish populations (a major food source) due to changes in coastal and ocean water temperatures.
http://www.indianexpress.com/news/global-warming-could-wipe-out-largest-sea-turtles-study/969369/

"*Evidence of Global Climate Change Found in Marine Breeding and Habitat Shifts*." A report from the Environmental News Network highlights results from an Australian study showing the effects of ocean warming on marine animals.

http://www.enn.com/wildlife/article/46287