National Park Service
U.S. Department of the Interior

Fire Island National Seashore
Long Island, New York

Considering Climate Change: Fire Island and Storms

Background:

The National Park Service (NPS) comprises over 400 areas covering more than 84 million acres in the United States and surrounding territories. Though one may imagine Yellowstone when thinking about national parks, the NPS system actually comprises much more, including historical sites, monuments, and seashores.

Fire Island's dynamic seashore environment, and how people have and continue to interact with it, as well as the cultural legacy represented by the historic William Floyd Estate, have placed the park as one of our nation's treasured resources – one significant enough to be included in our National Park System.

Fire Island is a 32-mile long barrier island, one in a chain of barrier islands that parallel the South Shore of Long Island, New York. Most of the acreage of the barrier island is designated as a national park site – Fire Island National Seashore. Barrier islands are dynamic coastal landscapes; their shorelines are shaped each day by the wind, waves, and currents. Powerful storms like Hurricane Sandy are the drivers of what is termed *barrier island evolution*, the slow rolling over of the island on itself.

Climate change will no doubt influence the way the sea shapes the barrier island landscape. With global temperatures on the rise and increased ocean temperatures, there is likely to be an increase in the frequency of more powerful storms.

One of the most powerful storms ever recorded struck the east coast of the United States and Fire Island National Seashore, on October 29, 2012. Though it made landfall as a post-tropical cyclone, Hurricane Sandy not only impacted the lives of billions, but also forever changed the Fire Island landscape.

On Fire Island, the history-making hurricane brought with it high water levels and large waves that scoured sand from the dunes and beach face. In some places, the force of moving water pushed sand over the top of dunes and across the width of the island. The storm also resulted in three breaches. Two breaches occurred on Fire Island and the third occurred on the barrier island to the east, West Hampton Island. The two easternmost breaches were filled in by the Army Corps of Engineers shortly after the storm but the breach located within Fire Island's wilderness area, in the vicinity of Old Inlet, remains open.

Breaches and inlets are natural features of barrier islands. These channels are carved out by powerful storms, connecting two water bodies – in this case, the Atlantic Ocean and the Great South Bay. Over time, breaches and inlets naturally close as the longshore current carries sand along the barrier island's ocean front.

Since Hurricane Sandy, the breach at Old Inlet on Fire Island has been a controversial topic. Debates have arisen over the effects of the breach on the Great South Bay – its marine life, water quality, and water levels. Politicians have called for the breach to be mechanically closed, concerned the breach causes flooding in towns along Long Island's South Shore. Environmentalists see the breach as a boon to water quality in the Great South Bay and oppose closure. Some consider powerful storms and their effects, like the breach at Old Inlet on Fire Island, to be a result of human-induced climate change. The question remains: should the breach at Old Inlet be filled in manually or should the breach and the rest of the barrier island shoreline be allowed to evolve naturally, as it has been doing for thousands of years.

There is growing evidence that we are already seeing some of the effects of climate change, such as the increased frequency and intensity of storms. And, because powerful storms are the drivers of barrier island evolution, we may be more likely to see an increase in dramatic landscape change such as the breaching caused by Hurricane Sandy. But impacts to the environment do not stop there. Landscape change – whether terrestrial or aquatic – can result in other changes.

For example, an open breach in a barrier island can influence the movement of sand into the bay; sand deposited on the lee (north) side of the island will eventually become substrate for a new salt marsh. An open connection to the ocean can also affect the salinity, temperature, turbidity, and level of water in the Great South Bay.

This lesson plan entails an inquiry-based AP lab, with pre-labs, activities, and homework designed to be completed before and after the main lab. This also includes an optional field trip to the breach at Old Inlet on Fire Island National Seashore. The overall timeline of this lesson is outlined below.

Timeline:

- **Day 1**
  Assign Pre-Lab Homework
  Understanding Barrier Island Dynamics

  Pre-Lab (Lesson-PowerPoint)
  Hurricane Sandy and Understanding Climate Change

  Follow-Up Homework
  Understanding the health of an aquatic ecosystem: Measuring Dissolved Oxygen and Primary Productivity

- **Day 2 – 4**
  Inquiry-Based Lab (Lesson)
  Measuring the Health of the Bay: Measuring Dissolved Oxygen in an aquatic ecosystem (Setup of lab stations)

  Follow-Up Homework
  "The Impact on Great South Bay of the Breach at Old Inlet" by SoMAS

- **Day 5**
  Post-Lab (Lesson)
  Pros and Cons to keeping the Breach Open

- ***Day 6 (Optional)***
  Field Trip: Visiting the Breach

General Objectives:

The students will

- **Day 1: Pre-Lab Homework**
  Learn about the dynamics of a barrier island through an online animation.

  Day 1: Pre-Lab Lesson
  Understand the effects of the greenhouse effect on Earth and the results of climate change on weather systems.

  Day 1: Follow-Up Homework
  Understand one of the basic principles of measuring the health of an aquatic system by measuring the dissolved oxygen.

- **Day 2 – 4: Inquiry-based Lab**
  Create their own individual labs in which they test the primary productivity of a system by testing DO using variables such as salinity, temperature and introduced nutrients (algal bloom).

- **Day 2 – 4: Follow-Up Homework**
  Learn about the current health of the Great South Bay as researched and documented by SoMAS.

- **Day 5: Post-Lab Lesson**
  Read about various public opinions on the breach and formulate their own opinion based on data.

- **Day 6: Optional Field Trip**
  Explore the Fire Island Wilderness area and breach at Old Inlet.

Day 1: Barrier Islands

On a barrier island, each day is marked by change. As climate change results in higher global mean temperature and subsequently higher ocean temperatures, scientists predict an increase in the frequency and intensity of storms. Hurricane Sandy may be an example of such a storm.

Hurricane Sandy resulted in a drastically different barrier island landscape, virtually overnight. Some of these landscape changes can still be observed, including a breach at Old Inlet. This new landscape feature presents a unique opportunity to assess changes in this region of the Great South Bay, and the chance to consider how change can affect an aquatic ecosystem.

Pre-Lab Homework (prior to lesson):
Understanding Barrier Island Dynamics

Pre-Lab (Lesson-PowerPoint & Worksheet):
Hurricane Sandy and Climate Change

Follow-Up Homework (post-lesson):
Understanding the health of an aquatic ecosystem: Measuring Dissolved Oxygen and Primary Productivity

Barrier beaches are constantly changing. Wind, waves, and currents shape and reshape the shoreline. Powerful storms like Hurricane Sandy are the drivers of what is termed *barrier island evolution* – the landward displacement of sand in response to sea level rise and storm events. Landscape features resulting from storms, such as overwashes (when storm waves overtop or cut through dunes and carry sand to the middle of the island) and breaches, facilitate the landward movement of the island. Overwashing during storms, for example, builds the island's interior and bay side. Breaches and inlets serve as a conduit for sand to move from the beach to the bay side. The sand moved from the ocean side toward the bay side becomes the substrate upon which familiar landscape features like dunes, swale, and salt marshes evolve. What may appear as a "loss" in the dune line, or a "cut" in the island, may actually be the beginning of the next dune or salt marsh.

This lesson includes a pre-lab designed to aid students in understanding the basics of climate change, the impact that Hurricane Sandy had on the barrier beaches and how barrier beaches are ever-changing.

This lesson is broken up into three components:

- **Pre-Lab Homework**
- **Pre-Lab Lesson (PowerPoint with Student Worksheet)**
- **Follow-Up Homework**

Number of Days:
1

Intended Grade/Range:
AP Biology Students
Honors Living Environment
Grades 9 – 12

Content Objective/Outcomes

The students will:

- **Learn about how wind and waves affect barrier beaches.**
- **Describe how climate change is related to the greenhouse effect.**
- **Learn about the impact that Hurricane Sandy had on the barrier beaches of Fire Island National Seashore.**
- **Explain how to gauge the health of an aquatic ecosystem by measuring the dissolved oxygen - one indicator of primary productivity.**

Language Objective/Outcomes

The students will:

- **Obtain information through an online animation and answer questions based on the animation.**
- **Demonstrate the greenhouse effect and ultimately climate change utilizing visual aids.**
- **Hypothesize as to the possible effects the breach may have on the Great South Bay through a PowerPoint presentation.**
- **Understand and use new terminology to demonstrate how to obtain DO levels and primary productivity.**

Day before the Pre-Lab Lesson:

Assign the "Understanding Barrier Island Dynamics" Worksheet to students. The online animation is approximately 11 minutes long. Students need access to the internet via a computer, smart phone, or tablet in order to access and view the animation. Any device used needs to be able to play Flash. Please note that Apple products, such as iPhones and iPads, do not have the capability to play Flash files.

Pre-Lab Lesson:

Show the PowerPoint "Hurricane Sandy and Climate Change." The PowerPoint goes along with a note sheet that allows students to interact with the PowerPoint and to have discussions about climate change and the likelihood of more frequent and more intense storms.

The PowerPoint ends with a discussion of the Great South Bay and how water quality may be affected as there is now increased flushing in this region of the bay. Students can discuss the influence of land-based runoff such as pesticides and seepage from septic tanks on water quality in the Great South Bay, and how an open breach might influence water quality and water levels in the bay.

Follow-Up Homework:

Assign the worksheet "Understanding the Health of an Aquatic Ecosystem: Measuring Dissolved Oxygen and Primary Productivity." Students will be introduced to new vocabulary as well as some

simple math calculations as to how to measure dissolved oxygen (DO) and subsequently primary productivity. The variables that can cause dissolved oxygen to increase or decrease will be introduced as well. Students will be asked to hypothesize what they think the DO of the bay is and how the breach may affect the DO of the bay.

Materials:

Pre-Lab Homework
- **Link to online animation of Barrier Island Dynamics: www.nps.gov/fiis/naturescience/shoreline-dynamics.htm (Click on *Barrier Island Dynamics* link in center of website)**
- **"Understanding Barrier Island Dynamics" Worksheet**

Pre-Lab (Lesson)
- **PowerPoint presentation "Hurricane Sandy and Understanding Climate Change"**
- **"Hurricane Sandy and Understanding Climate Change" Student Notes (to accompany PowerPoint lesson)**
- **Colored pencils, markers or crayons**

Follow-Up Homework
- **"Understanding the Health of an Aquatic Ecosystem: Measuring Dissolved Oxygen and Primary Productivity" Worksheet**

Vocabulary:
Longshore transport
Barrier Island
Swash Zone
Dune/Bluff
Berm
Berm Crest
Bar
Dune Crest
Scarp
Feeder Beach
Storm Surge
Global Warming/Climate Change
Greenhouse Effect
Ocean Acidification
Coral Bleaching

Days 2 – 4: The Great South Bay

Located between the south shore of Long Island and the north shore of Fire Island, the Great South Bay is approximately 151 square miles. Land-based runoff, over-fishing, and changes in habitat conditions in the Great South Bay have nearly devastated the once-famous and commercially valuable shell fishing industry. One method of measuring the health of the bay involves taking measurements of dissolved oxygen levels.

Barrier islands are an example of an ever-changing landscape; one that is driven primarily, by storms. With the advent of climate change, the chances are likely that such storms will increase in frequency and intensity. Hurricane Sandy is an example of such a storm, one that had the power to reshape Fire Island and cause a breach at Old Inlet. However, the breach does not simply represent a change in the shoreline of the barrier island. The breach may lead to environmental changes in the Great South Bay as well as impact the lives of the people living along the south shore of Long Island. The evolution of barrier islands, and of Fire Island in particular, has profound implications to the surrounding environments of the Great South Bay and Long Island –The ecosystems are closely interconnected – changes in one will result in changes to the others. .

As a result of the breach at Old Inlet, colder, more saline and turbulent water is now entering this portion of the bay. The implications of this new landscape feature are not well-understood. Scientists are monitoring water levels, salinity, and temperature, but the impact on the marine ecosystem is not fully understood and will require further study. The impact of the breach on the Great South Bay is a topic of controversy.

Lesson (Inquiry-Based Lab)
Measuring the Health of the Bay: Measuring Dissolved Oxygen in an Aquatic Ecosystem

Follow-Up Homework
"The Impact on Great South Bay of the Breach at Old Inlet" document by SoMAS

Evaluating water quality in the Great South Bay is a complex process that can help us see the consequences of human impact. The water quality of the Great South Bay is diminished by land-based runoff containing contaminants such as fertilizers and outflow from sewage treatment plants and septic systems. In some areas, excessive nutrients entering the bay cause algal blooms. In other areas "dead" zones" occur, where dissolved oxygen levels have fallen so low that life cannot be supported.

Whether or not the breach at Old Inlet on Fire Island National Seashore can positively affect water quality in the bay, remains to be determined, and is a subject of on-going controversy.

This lesson is composed of an inquiry-based AP Biology lab. This constitutes Days 2 – 4 of the overall lesson. Day 5's lesson includes a follow-up homework that is to be assigned on Day 4.

- **Day 2 (Lab Day 1): Setup of Lab**
  Setup of algal bloom
  Salinity and temperature measurements

- **Day 3 (Lab Day 2): Students gather algal bloom data.**
  Salinity and temperature measurements

- **Day 4 (Lab Day 3): Students gather data.**
  Cleanup.
  Analysis and discussion of results.

Follow-Up Homework: "The Impact on Great South Bay of the Breach at Old Inlet" by SoMAS

Number of Days:
3

Intended Grade/Range:
AP Biology Students
Honors Living Environment
Grades 9 – 12

Content Objective/Outcomes

The students will:

- **Learn how to setup individual labs based on variables that can affect dissolved oxygen.**
- **Describe how algal blooms affect dissolved oxygen levels.**
- **Hypothesize as to the general "health" of the Great South Bay from data.**
- **Hypothesize what impact the breach may have on the "health" of the Great South Bay.**

Language Objective/Outcomes

The students will:

- **Obtain data that either proves or disproves student hypotheses as to whether dissolved oxygen levels will increase/decrease in different scenarios.**
- **Demonstrate and obtain data from a controlled algal bloom.**
- **Conclude, using individual results and classmates' results, as to how the health of the bay has come to be what it is today.**
- **Use data, individually as well as combined with classmates, to create a future scenario of the health of the bay.**

Inquiry-Based Lesson/Lab

Measuring the Health of the Bay: Measuring Dissolved Oxygen in an Aquatic Ecosystem
This lab takes approximately 3 days (Days 2 – 4 in the overall lesson). Teachers are to have the salinity and temperature stations set up prior to the beginning of the lab.

Day 2 (Lab Day 1)
Students are to formulate their hypotheses and set up their algal blooms. Demonstration on how to use the equipment can also occur. Initial readings should be taken and recorded. If time permits, students are to begin either the salinity or temperature measurements.

Day 3 (Lab Day 2)
Students are to take measurements of their algal blooms and continue collecting data on salinity and temperature. Students that have completed either salinity or temperature can plot their data.

Day 4 (Lab Day 3)
Students should take final measurements of their algal blooms. Environmentally sound disposal of the water should be demonstrated. Final measurements of the salinity and temperature samples should be taken (for groups that did not have time) and cleanup of stations should be completed. Those groups who have completed their work early can plot data. Exchange of data for the algal bloom, salinity, and temperature should also occur and mean data for the class should be calculated.

Follow-Up Homework:

Assign the document "The Impact on Great South Bay of the Breach at Old Inlet" by Charles N. Flagg and Roger Flood, School of Marine and Atmospheric Sciences, Stony Brook University.

Please note: this document has a brief worksheet to be given the following day (Day 5), in order to emphasize the importance of reading and understanding assigned readings.

Materials:
- **Samples of pond water, Great South Bay water and Atlantic Ocean water**
  [Please note: for those who cannot obtain samples, the setup instructions include instructions on simulating the bay and ocean waters]
- **DO meter (portable)**
- **Hot plate**
- **Ice Bath**

Lab
- **Student Lab:**
  "Measuring the Health of the Bay: Measuring Dissolved Oxygen and Primary Productivity"
- **Teacher Setup Instructions**

Follow-Up Homework
"The Impact on Great South Bay of the Breach at Old Inlet" by Charles N. Flagg and Roger Flood, School of Marine and Atmospheric Sciences, Stony Brook University

Day 5/6: The Breach

Breaches and inlets are natural landscape features on barrier islands. A breach is a break in the island, or natural channel, through which water can flow freely between the ocean and bay. Three breaches resulted from Hurricane Sandy on two adjacent barrier islands, Fire Island and Westhampton Island. Of the three breaches, all but one were artificially closed by the Army Corps of Engineers in November, 2012.

Breaches are an example of the ever-changing landscape of barrier islands. Storms, such as Hurricane Sandy, are the driving force behind such changes – changes that may be more frequent, with the possible increase in the number and intensity of storms due to climate change. Though the breach may have seemed to only impact Fire Island, it has proven to have implications upon the surrounding ecosystems, that being the Great South Bay. The influx of water from the ocean may have an impact on the water quality of the Great South Bay as well as the lives of the residents along the towns of the south shore of Long Island. The breach represents an important example of how the evolution of a barrier island can affect surrounding ecosystems.

The one remaining breach, located at Old Inlet in the Otis Pike Fire Island High Dune Wilderness, provides a unique opportunity to better understand how these dynamic features influence landscape change and water quality.

The breach at Old Inlet has been a controversial topic because of its potential impact on water quality and water levels in the Great South Bay.

Follow-Up Homework
(Worksheet to Day 4 Homework)
Impact on Great South Bay of the Breach at Old Inlet

Post-Lab (Lesson):
Breach Evolution: Pros and Cons• Optional: Visit to the Breach (Day 6)

Determining whether breaches in barrier islands along Long Island's south shore are a benefit to the Great South Bay, a potential risk to Long Island residents, or that they pose both benefits and risks, is difficult. There is no simple answer.

This lesson is composed of a post-lab lesson that involves a discussion of the current breach at Old Inlet on Fire Island National Seashore.

- **Day 5 (Post Lab Lesson):**
  Follow-Up Homework (assigned on Day 4)

  NY Times Article "Breach Through Fire Island Also Divides Opinions" by Lisa W. Foderaro
  Wall Street Journal Article "The Kindest Cut of All" by Will James

- **Day 6: Optional Field Trip**
  Visit to the Breach

Number of Days:
1 – 2
(Optional Field Trip)

Intended Grade/Range:
AP Biology Students
Honors Living Environment
Grades 9 – 12

Content Objective/Outcomes

The students will:

- **Learn about the current data collection being conducted by scientists in an effort to monitor the breach and its impact on the Great South Bay**

- **Learn of the current opinions about the breach – those in support of allowing it to evolve naturally (in which it may remain open or close on its own) and those in favor of closing the breach through man-made means**

- **Generate their own opinion as to whether the breach should evolve naturally or be closed through human intervention**

Language Objective/Outcomes

The students will:

- **Understand various methods in which data is collected by scientists and how to extrapolate conclusions from the data**
  - **Extrapolate fact from fiction when reading about various opinions, those based on scientific data versus those that are not based on facts.**

- **Draw conclusions from individual and group data in conjunction with readings and data from Stony Brook scientists**

Day 5: Post-Lab (Lesson)

Breach Evolution: Pros and Cons
This portion of the mini-unit uses the information gathered from the first four days (lesson on climate change as well as inquiry-based lab) to aid students in creating their own opinion as to the fate of the breach at Old Inlet on Fire Island National Seashore.

Follow-Up Homework Worksheet
On the previous day (Day 4), students were assigned a reading on the data and conclusions made by SUNY Stony Brook scientists Charles N. Flagg and Roger Flood in regards to the impact the breach has had on the Great South Bay. This worksheet is a follow-up, allowing students to formulate ideas from the reading and from scientific data.

Post-Lab Lesson: Breach Evolution: Pros and Cons
Students will read the NY Times article, "Breach Through Fire Island Also Divides Opinions."

During the reading, students will be asked to find two pieces of information within the article that support allowing the breach to change naturally and two pieces of information that support mechanically closing the breach.

Students should then be asked to review their own data gathered from the previous three days on the inquiry-based lab involving algal blooms, salinity, and temperature. Using the reading, the document from the SUNY Stony Brook scientists, and their own data, students are to formulate an opinion whether to allow the breach to evolve naturally (in which it may remain open or close) or to close it manually. This opinion needs to be supported by scientific data as well as secondary sources (provided).

The "going further" section asks students to read additional articles pertaining to the breach. Students are to find, within the articles, information that either supports or refutes their opinion.

Materials:
- **Follow-Up Homework Student Worksheet**
- **NY Times article "Breach Through Fire Island Also Divides Opinions"**
- **Student worksheet "Breach Evolution: Pros and Cons"**
- **Additional articles (for going further section)**

Follow-Up Homework Student Worksheet
- **Day 4 "The Impact on Great South Bay of the Breach at Old Inlet" by Charles N. Flagg and Roger Flood**
- **Follow-Up Homework Worksheet**

Post-Lab (Lesson)
- **NY Times article, "Breach Through Fire Island Also Divides Opinions"**
- **"Breach Evolution: Pros and Cons" Worksheet**
- **Additional articles (for going further portion of worksheet)**

Day 6: Optional Field Trip: Visit to the Breach

For schools that have the opportunity, visiting the breach at Old Inlet within the Otis Pike Fire Island High Dune Wilderness area gives students an opportunity to visit a national park site, see the only federally designated wilderness area in New York State and to experience the breach that they have been studying for the past week.

With climate change possibly increasing the number and intensity of storms, storms that are the driving force behind barrier island evolution, it is important to understand that landscape change can affect the barrier island ecosystem as well as the estuarine ecosystem.

Prior to the visit, encourage students to go online and read about up-to-date information about the breach at www.nps.gov/fiis/naturescience/post-hurricane-sandy-breaches.htm. Class visits to the breach and other sites on Fire Island National Seashore must be arranged through the Division of Interpretation which can be reached by phone at (631) 687-4780.

Students can bring their worksheets with them on the class visit to the Fire Island Wilderness and the breach. If possible, teachers are encouraged to walk with their students through stretches of the wilderness area and from the ocean side to the bay side in order to allow students to experience federal wilderness and appreciate the narrow width of the island. Be sure to adhere to safety precautions with regard to ticks and mosquitoes.

Due to safety concerns, teachers should contact the park in advance before visiting the breach.

Materials:

Optional Field Trip: Visit to the Breach

- **Breach Visit Worksheet**
- **Fire Island National Seashore Website www.nps.gov/fiis/naturescience/post-hurricane-sandy-breaches.htm**
- **Portable DO meter (if available)**
- **Clip boards (optional)**
- **Pens/Pencils**

Education Standards:

Common Core Standards

- **Reading Standards for Literacy in Science and Technical Subjects 6 – 12**
  - **RST Grades 9-10 #1**
    - **Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.**
  - **RST Grades 11-12 #1**
    - **Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.**
  - **RST Grades 9-10 #2**
    - **Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.**
  - **RST Grades 11-12 #2**
    - **Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.**
  - **RST Grades 9-10 #3**
    - **Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, performing technical tasks, attending to special cases or exceptions defined in the text.**
  - **RST Grades 11-12 #3**
    - **Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.**
  - **RST Grades 9-10 #4**
    - **Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 9 – 10 texts and topics*.**
  - **RST Grades 11-12 #4**
    - **Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to *grades 11–12 texts and topics*.**
  - **RST Grades 9-10 #6**
    - **Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.**
  - **RST Grades 11-12 #6**
    - **Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, identifying important issues that remain unresolved.**
  - **RST Grades 9-10 #7**

        - Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
    - RST Grades 11-12 #7
        - Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

    - RST Grades 9-10 #8
        - Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.
    - RST Grades 11-12 #8
        - Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

    - RST Grades 9-10 #9
        - Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.
    - RST Grades 11-12 #9
        - Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 6 – 12

    - WST Grades 9-10 #8
        - Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.
    - WST Grades 11-12 #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.

    - WST Grades 9-10 #9
        - Draw evidence from informational texts to support analysis, reflection, and research.
    - WST Grades 11-12 #9
        - Draw evidence from informational texts to support analysis, reflection, and research.

Next Generation Science Standards (NGSS)

- HS-LS2 Ecosystems: Interactions, Energy, and Dynamics

- **HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.**
- **HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.**

- **HS-ESS2 Earth's Systems**
  - **HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.**
  - **HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.**

- **HS-ESS3 Earth and Human Activity**
  - **HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influences human activity.**
  - **HS-ESS3-5. Analyze geoscience data and the results form global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.**
  - **HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.**