YEARS OF LIVING DANGEROUSLY

THE YEARS OF LIVING DANGEROUSLY - EDUCATIONAL COMPANION

Provided to you by the *National Wildlife Federation*

INTRODUCTION

About the Series

This groundbreaking documentary event series explores the human impact of climate change. From the damage wrought by Hurricane Sandy to the upheaval caused by drought in the Middle East, YEARS OF LIVING DANGEROUSLY combines the blockbuster storytelling of top Hollywood movie makers with the reporting expertise of Hollywood's brightest stars and today's most respected journalists.

Purpose

As the educational partner for the *YEARS OF LIVING DANGEROUSLY, National Wildlife Federation*…

How To Get The Most Out Of This Educational Experience

Around the country our schools are providing students with unique, experiential, and applied learning opportunities. The Years of Living Dangerously is one of those opportunities you don't want to miss. As the series unfolds the biggest stories of our time, students become emotionally involved in the lives of those represented and through your instruction and facilitation will become agents of change, empowered by knowledge and evidence to create and solve our problems today and into the future.

EPISODE 3 – LESSON 1

EPISODE SUMMARY: RISING TIDE

In episode two, Harrison Ford continues his investigation into the global effects of the palm oil industry and further explores the corruption that has ravaged the Indonesian landscape resulting in the country being one of the world's largest emitters of greenhouse gases through deforestation. Meanwhile, [former] Governor Arnold Schwarzenegger joins an elite team of wild-land firefighters—known as the "Hot Shots"—as they battle a new breed of forest fires, one made more deadly by climate change. He also discovers another killer wiping out trees at an even faster rate than forest fires.

LESSON SUMMARY

Students will use the stories in episode two to better understand the long term impacts deforestation and longer wildfire seasons have on the environment.

Story 1 – Rising Tide - Tottenville
Correspondent: Chris Hayes
Location: Tottenville, NY, Washington, D.C.,
Greenville, SC – Racine, WI

Story: When Superstorm Sandy killed 24 people on Staten Island, Congressman Michael Grimm worked night and day to help constituents who lost loved ones and were left homeless by the storm. In Sandy's wake, Grimm, a conservative Republican, didn't believe humans have much to do with global warming. Correspondent Chris Hayes follows Grimm for a year to see what he can do for the residents of Staten Island – and what he might learn about climate change.

Story 2- Sanjayan's Journey – Christmas Island
Correspondent: M. Sanjayan
Location: Christmas Island, Kiribati

Story: Even when you are the lead scientist of one of the country's most well respected environmental organizations, that's committed itself to the cause of climate change, you may need to see the proof. M. Sanjayan of The Nature Conservancy travels to the ends of the earth to question some of the top climate scientists in their field as they collect key data unlocking the past and future of our planet's changing climate. In this episode he dives with scientist Kim Cobb to the bottom of the South Pacific looking for answers hidden in fossil corals.

LEARNING OBJECTIVES EPISODE 1: LESSON 1

1. Students will examine evidence and sources of evidence to draw conclusions and make predictions.
2. Students will examine sea surface temperature and sea surface temperature anomalies around Christmas Island
3. Students will consider the impacts of sea surface temperature on corals and analyze trends over time.
4. Students will analyze how both climate change and El Niño weather patterns effect coral ecosystems.

TEACHER BACKGROUND

Climate change is among the greatest threats to coral reef ecosystems worldwide. As seas surface temperatures rise due to climate change, coral bleaching and disease events will occur more often and be more severe. At the same time, carbon emissions from fossil fuel burning are being absorbed by the oceans, causing the ocean waters to become more acidic. The global impacts on oceans are compounded by local environmental degradation from pollution, over use, over fishing, and other human activities.

Bleaching occurs when the colorful algae that corals need to survive become toxic and are expelled, turning the coral white. For milder bleaching events, the algae and coral can recover within a few weeks or months. But, severe bleaching events can kill the coral and have devastating impacts on the marine ecosystems they support. Even a small increase in the sea surface temperature (0.5-1.5° C) over several weeks or a large temperature increase (3-4° C) over a few days can lead to bleaching. Solar irradiance (exposure to the sun's ultraviolet rays), pollution, reef exploitation, and ocean acidification can also lead to bleaching.

The oceans have absorbed about a quarter of the carbon emitted to the atmosphere by burning fossil fuels (half has remained in the atmosphere and the rest has gone into the terrestrial biosphere, mostly forests). The removal of some of the excess carbon from the atmosphere has slowed the pace of global warming. But adding carbon to the oceans is also causing them to become acidic, which makes it difficult for corals and other marine life to form shells and exoskeletons. From the mid-1700s to the 1990s, the sea surface pH decrease from 8.25 to around 8.14. Ocean pH levels are expected to drop even further by 2100 as carbon dioxide emissions continue.

El Niño events are weather phenomenon that, depending on their strength, can have significant impacts on global climate patterns. These events are characterized by large-scale warming of surface waters of the Pacific Ocean and occur every 3-6 years. An El Niño typically last from 6-9 months, but may continue upward of a year or more. The ability to predict El Niño's has only been possible since the 1980's, when computer technology allowed large amounts of complicated ocean-atmospheric interaction data to be collected and analyzed.

Their strength is estimated in surface atmospheric pressure anomalies and anomalies of land and sea surface temperatures. When El Nino's occur people around the world suffer from its effects from severe, record breaking floods and droughts, to the intensification or lack of tornado, cyclone, and/or hurricane storm seasons.

MATERIALS

1. Science notebook
2. One-to-One or paired use of computer with internet access
3. Google Earth
4. Student handout: NOAA Coral Reef Watch Data Set Methodology
5. Student handout: A Look Inside Scientific Articles
6. Student handout: Analyzing Coral Thermal Stress using NOAA's Coral Watch Monitoring System in Google Earth

VOCABULARY

Anomaly, climate, climate change, correlation, credible, currents, drought, El Niño, La Niña emissions, evidence, fact, greenhouse gases, impact, local v. global, natural cycle, opinion, oscillation, paleoclimatology, qualitative data, quantitative data, sea surface temperature, thermal stress, science, trade winds, trend line, weather

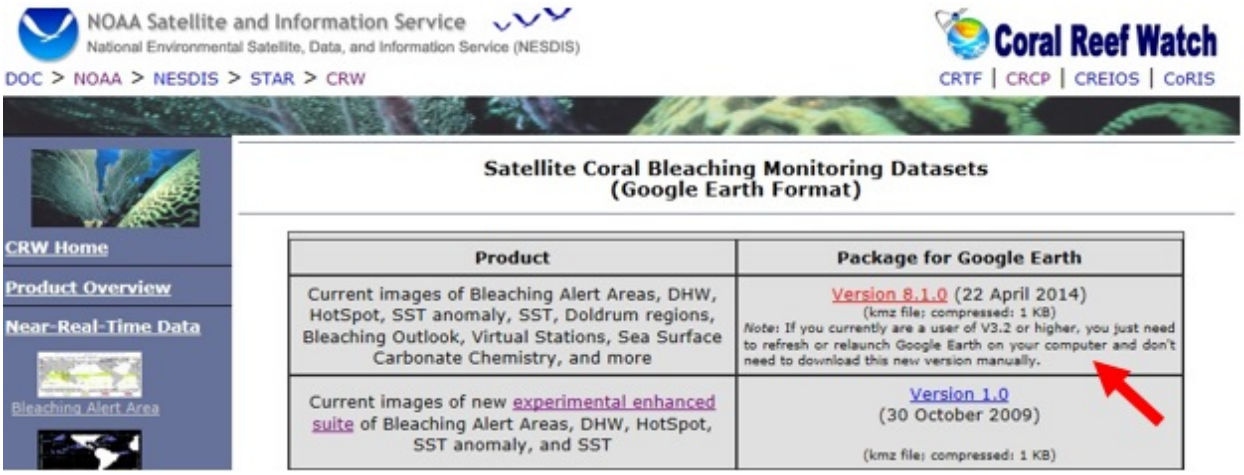
WHAT TO DO

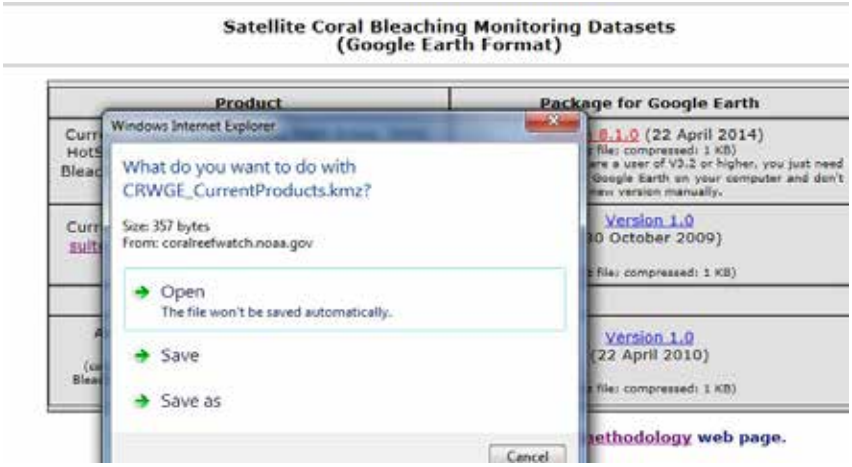
Have students take our online quiz both before and after the lesson. If you'd rather print out a paper copy or project the quiz on your SMART Board see page 6 and 7.

ENGAGE: 30 MINUTES

1. Go to NOAA's Coral Reef Watch: Satellite Coral Bleaching Monitoring Datasets page, http://coralreefwatch.noaa.gov/satellite/ge/index.php
2. Choose, under "Package" for Google Earth", "Version 8.1.0". If there is a newer version (highly likely in the tech world) download the most current version. When prompted, choose "Open". Google Earth will automatically open with the datasets present in the left side navigation. *Special Note* If you do not have Google Earth installed on the computer, students will be prompted to do so.

www.csa.com/discoveryguides/prednino/overview.php





3. Since episode 3 deals with the birthplace of El Niño events, that will be the location students will analyze. In the search field of Google Earth type, "Christmas Island" and then point out to students where the datasets are located in the left navigation, under "Temporary Places".

4. Provide students with the handout, NOAA Coral Reef Watch Data Set Methodology, found on pages 12 and 13. This page provides students with the "definition" or methodology, for each product or dataset so that students know exactly what they are analyzing. Underneath each methodology is a space for students to jot down phrases or sentences about what they observe. A more thorough analysis will be done later in the lesson.

EXPLORE: 30 MINUTES

1. Watch episode 3. If you are unable to view episode 3 in its entirety then students will need to watch the following segments to support their learning experience. As students watch each segment have them stop and answer each of the questions below in their science notebook. At the conclusion of all segments, encourage students to add to or modify their thinking.

- Minute 3:03 to 5:00
- How does El Nino, a weather event, impact climate around the world?
- Explain how the waters during an El Nino event contribute to sea level rise.
- Minute 15:45 to 17:00
- Explain the evidence corals provide Dr. Kim Cobb?
- Minute 23:07 to 23:54
- Superstorm Sandy occurred during a weak La Niña event (2011-2012) on the heels of a strong La Niña event in 2010-2011 and sandwiched between a moderate El Niño event in 2009-2010. Explain how climate change and these El Niño/La Niña weather events affected Superstorm Sandy.
- Minute 44:49 to 46:44
- What conclusions is Dr. Cobb starting to draw from the corals about the human impact on El Niño's?
- In two generations, Dr. Cobb expects another meter of sea level rise around Christmas Island. How will this impact her research?

EXPLAIN: 60 -75 MINUTES

1. Students are now going to do a more thorough analysis of the datasets within NOAA's Coral Reef Watch within Google Earth.
2. Assuming this section is taking place on a different day than the Engage, you will want your students to again follow steps 1-3 under the Engage section to get to the correct starting point.
3. Provide students with the student handout, Analyzing Coral Thermal Stress using NOAA's Coral Watch Monitoring System in Google Earth found on pages 16 and 17. Once completed, students can tape and fold the handout in to their science notebook.
4. Discuss findings within a small group and then discuss as a class. Use the questions below to guide the discussion.
    - Is there any vocabulary that you need help understanding or clarifying?
    - Is there wording or phrases you don't understand?
    - Turn and explain to your neighbor what an anomaly is.
    - Any observations from the data that caught your attention?
    - Do each of the datasets or products seem to be connected or are they completely unique, their data is not dependent upon other data?

ELABORATE: 30-40 MINUTES

Allow students to choose one of the following articles to read. Provide students with the directions for diving deeper into their reading and the rubric found on pages 14 and 15.

1. Perfect Storm: Climate Change and Hurricanes – featuring Dr. Michael Mann
   www.livescience.com/28489-sandy-after-six-months.html
2. Superstorm Sandy's Link to Climate Change: 'The Case Has Strengthened' – featuring Dr. Joseph Romm
   theenergycollective.com/josephromm/294721/superstorm-sandy-s-link-climate-change-case-has-strengthened-says-researcher
3. 3 Ways Climate Change Made Hurricane Sandy Worse – featuring Dr. Katherine Hayhoe
   stateimpact.npr.org/texas/2012/10/30/three-ways-climate-change-made-hurricane-sandy-worse/
4. Sandy Raises Questions About Climate and the Future – featuring Dr. Radley Horton
   www.npr.org/2012/10/31/164043372/sandy-raises-questions-about-climate-and-the-future
5. El Nino and the 2012 Hurricane Season
   www.accuweather.com/en/weather-news/el-nino-and-the-2012-hurricane/67636

EVALUATE: 10-15 MINUTES

A. Justified True/False – see page 8

B. Online Pre/Post Quiz

Take our online quiz:

1. Corals are a good indicator of temperature changes throughout recorded history. *True/False*
2. El Nino's are natural climate phenomenon that reorganize the entire global circulation. *True/False*
3. The energy sector, led by fossil fuel companies has been strong supporters of combatting the impacts of climate change. *True/False*
4. One out of every four carbon dioxide molecules was put in to the atmosphere by humans. *True/False*
5. Paleoclimatology is the study of climate during the age of dinosaurs. True/False
6. Weather and climate are considered synonyms. *True/False*
7. During El Nino events, typically cool waters brought to the equator as the result of the trade winds stop. *True/False*
8. An extra foot of sea level rise does not impact coastal locations. *True/False*
9. The El Nino of 1997/1998 caused over $30 billion in damage worldwide. *True/False*
10. The two most destructive, deadliest, and costliest hurricanes have occurred in the 21st century. *True/False*

Name: _____

Date: _____

Period: _____

JUSTIFIED TRUE OR FALSE STATEMENTS
EPISODE 101 – DRY SEASON

Justified True or False Statements provide a set of claims or statements that are examined by you. You are meant to draw on evidence from what you have learned to analyze the validity of the statements, and then describe the reasoning used to decide whether each claim is true or false.

NOTE *Ple*ase use grade appropriate spelling and grammar.

	STATEMENT	T	F	WHY I THINK SO…
1.	A tree's rings is to a story of atmospheric and biospheric change as a coral skeleton is to a story of oceanic change.			
2.	Sea surface temperature is the single variable that indicates an El Niño event is taking place.			
3.	When water cools during an El Niño event, it expands, causing sea levels to rise and is in addition to the sea level rise caused by climate change.			

Use this space to include more evidence to support your claim and or to draw a model if applicable.

TAKING ACTIONS AND DESIGNING SOLUTIONS

Taking actions and/or designing solutions to our local, national, and global problems are a personal journey. Via Facebook and Twitter @YEARSofliving #YEARSproject, share how you are taking action to combat climate change or if you've designed potential solutions share those on Instagram - @YEARSofliving or make a Vine.

Want to engage your school?
Check out these two programs of the National Wildlife Federation, Eco-Schools USA and Schoolyard Habitats *www.eco-schoolsusa.org*, *www.nwf.org/schoolyardhabitats*

Want the opportunity to showcase your investigative reporting skills?
Check out National Wildlife Federation's Young Reporters for the Environment-USA *www.YRE-USA.org*

Are you graduating this year?
Check out our college programs, Campus Ecology and Eco-Leaders *www.CampusEcology.org – www.NWFEcoLeaders.org*

WRITER'S CORNER

Without language there is no science. To be practicing scientists and derive new knowledge, we need language – reading, writing, talking, listening, enacting, and visualizing. Writing is one way to communicate understanding of our learning while allowing us to be creative in our delivery and provide insight and possible solutions to problems.

1. Write a letter to your state and local representatives asking what plans are in place to safe guard the state and its communities against extreme weather events as our climate continues to warm. Think specifically about extreme weather events that impact your state, i.e. flooding, hurricanes, drought, etc. Be sure to provide evidence for your argument based on scientific facts and express why you are concerned, and (depending on your age) you will, in the near future, be a voting member of the community. http://www.usa.gov/Contact/Elected.shtml
2. Creative writing – Using the literary device anthropomorphism, bring the Porites coral to life as you summarize a strong El Nino season and its effect on the Porites community. (need screen grab image requested minute – 24:59 or 25:32) Be sure to include science vocabulary, thought out explanations, the feeling and impact of the experience, as well as, proper spelling and grammar. Have fun with it, be creative and show what you know!
3. If you don't live in a coastal city, why is it important to be concerned about sea level rise beyond just being a concerned citizen or a champion for the environment? Think about the social, economic, and environmental impacts as you craft your response.

CAREERS – AGENTS OF CHANGE

Inspired by episode 3? Thinking about your future? You have the power to make a difference today and in the future. Check out our episode 3 profile on Dr. Charles H. Greene and look into other careers inspired by the issues presented in Episode 3: Rising Tide.

Episode Career Profile
Dr. Kim Cobb

Occupation:
Associate professor in the School of Earth and Atmospheric Sciences at the Georgia Institute of Technology.

Education:
B.A in Biology and Geology – Yale University

M.S. in Oceanography – Scripps Institute of Oceanography, University of California, San Diego

Ph.D. in Oceanography – Scripps Institute of Oceanography, University of California, San Diego

Why She's Involved: "I felt absolutely compelled to do this shoot, as a climate scientist who is deeply invested in science communication, and even more so as a woman in science (and a mother of 4 small children).

While every fieldtrip yields scores of new samples to feed the mass specs, the friendships I made on this one were truly unique. And in a way, that's what the YEARS Project is all about: climate change as a story told by people, from one human to another.

It's always great to share that passion with my students on-site, but this time, in front of the cameras, I felt both the burden and the privilege of being the face of the corals that have reveled so much about climate change in this region, and the island that has offered up these precious time capsules.

I certainly gave it my all. For science, for women, for Christmas Island, for the planet."
Learn more about Dr. Kim Cobb and her work - *shadow.eas.gatech.edu/~kcobb/index.html*

- **Oceanography** – *scripps.ucsd.edu/education/careers* The future of oceanography will require that our nation's brightest minds apply themselves to issues of global concern, the environment, climate change, biodiversity, and sustainable resources.

Disciplines to check out:

  - Physical Oceanographers study the circulation of seawater and the exchange of energy and matter across the surface of the ocean. They examine the transport of sand on and off beaches and the processes of coastal erosion. Physical oceanographers also measure deep currents such as those flowing from Antarctic waters into the Pacific Ocean.
  - Marine Chemists study how the oceans were formed eons ago, and what determines their composition today. They identify ocean resources that may be beneficial, such as natural products with medicinal properties, and investigate means to protect the oceans from the effects of pollution.
  - Marine Physicists develop the means to interact with the oceans. They design and build many specialized research tools, including remotely operated vehicles, sophisticated seafloor instruments, and innovative remove-sensing systems such as acoustic-imaging devices for exploring the oceans. They also develop mechanisms for controlling sand on beaches.

- **Climatologist or Atmospheric Scientist** – *www.bls.gov/ooh/life-physical-and-social-science/atmospheric-scientists-including-meteorologists.htm* Atmospheric scientists study the weather and climate and how it affects human activity and the earth in general. They may develop forecasts, collect and compile data from the field, assist in the development of new data collection instruments, or advise clients on risks or opportunities caused by weather events and climate change.
- **Environmental Journalist** – *www.bls.gov/ooh/media-and-communication/reporters-correspondents-and-broadcast-news-analysts.htm#tab-1* Reporters, correspondents, and broadcast news analysts inform the public about news and events happening internationally, nationally, and locally. They report the news for newspapers, magazines, websites, television, and radio.

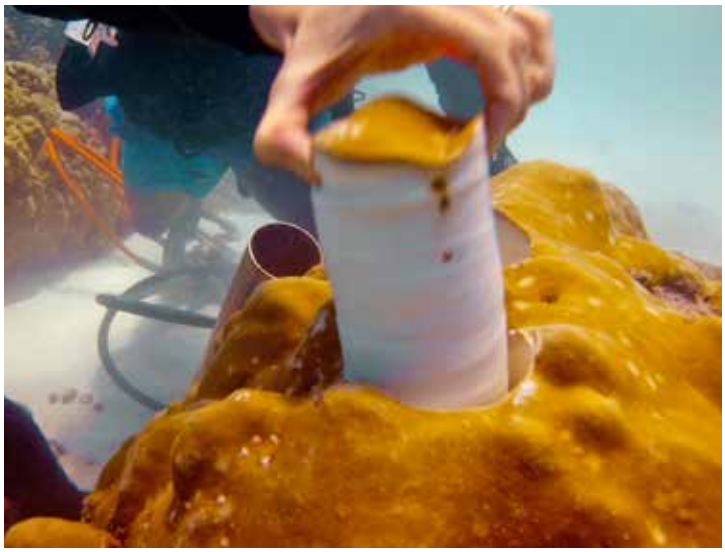
NOAA CORAL REEF WATCH DATA SET METHODOLOGY

Special Note Product is another name for dataset.

1. **Sea Surface Temperature (SST)**
   The near real time SST is produced from nighttime-only data, to eliminate the effect of solar glare and reduce variability caused by heating during the day. SST data come from NOAA's polar-orbiting satellites, which measure infrared radiation from the ocean surface across the entire globe every day. This SST product is updated twice-weekly.

2. **HotSpot**
   Corals are vulnerable to bleaching when the SST exceeds the temperatures normally experienced in the hottest month. This is shown in the Coral Bleaching HotSpot product, which highlights regions where the SST is currently warmer than the highest climatological monthly mean SST for that location. The HotSpot value of 1° C is a threshold for thermal stress leading to coral bleaching. To highlight this threshold, HotSpot values below 1.0 C are shown in purple, and HotSpots of 1.0° C or greater range from yellow to red. Global images are updated twice weekly.

3. **Degree Heating Weeks (DHW)**
   Mass coral bleaching has been shown to be caused by prolonged periods of thermal stress. The DHW product accumulates any HotSpots greater than 1° C over a 12 week window, thus showing how stressful conditions have been for corals in the last three months. It is a cumulative measurement of the intensity and duration of thermal stress, and is expressed in the unit ° C weeks. DHWs over 4° C-weeks have been shown to cause significant coral bleaching; values over 8° C-weeks have caused widespread bleaching and some mortality (death). The global data is updated twice a week.



4. Sea Surface Temperature (SST) Anomaly

SST Anomaly is produced by subtracting the long-term mean SST (for that location in that time of year) from the current value. A positive anomaly means that the current sea surface temperature is warmer than average, and a negative anomaly means it is cooler than average. The images are updated twice weekly.

5. Bleaching Alert Area

These global maps summarize the current DHW (Degree Heating Weeks) and HotSpot values. At a glance, this product outlines the location, coverage, and potential risk level of the current bleaching thermal stress. Alert levels are defined below. The global data are updated twice weekly.

LEVEL	DESCRIPTION
NO STRESS	**No Color:** Corals are not currently experiencing any thermal stress
WATCH	**Lime Green:** Temperatures are above normal summer maximums, but corals are not yet stressed.
WARNING	**Orange:** Corals are experiencing a low-level buildup of thermal stress.
BLEACHING ALERT 1	**Red:** Corals are currently stressed, accumulating to a level where bleaching is expected.
BLEACHING ALERT 2	**Maroon:** Corals are currently stressed, accumulating to a level where widespread bleaching and some coral mortality is expected.

6. Bleaching Outlook

Currently in the experimental or beta phase, this product is based on SST forecasts from the NOAA operations Climate Forecast System (CFS). Displayed here are the most recent seasonal outlooks at probabilities of 60%-90%, thereby identifying the lowest thermal stress levels that 60% and 90% of all the ensemble members predict, respectively. Four potential bleaching thermal stress levels are color coded (see the color legend in Google Earth) in this bleaching outlook layer. In a normal year, the prediction system will forecast no potential for bleaching thermal stress. When sea surface temperature forecasts exceed bleaching thresholds and continue long enough to cause bleaching, the outlook products display the bleaching potential during the upcoming warm season. Actual conditions may vary due to subsequent changes in climatic conditions or weather patterns.

A LOOK INSIDE SCIENTIFIC ARTICLES

DIRECTIONS

REQUIREMENTS

1. Using the Student Reading Resources or articles that you allow students to use related to the topic; write a summary meeting the following guidelines.
    - **a.** Whole page
    - **b.** Double spaced
    - **c.** 12pt font size
    - **d.** Times New Roman/Calibri/Arial font
2. Do not print out the article. At the end of your summary write an endnote with the correct bibliographic information (http://www.easybib.com/) for your article.

ARTICLE SUMMARY FORMAT

1. Name, date, class, and period
2. Paragraph #1-Introduction
    - **a.** What is the title of the article (should be in quotes or italics)?
    - **b.** Who is the author?
    - **c.** What source or publication did the article come from?
    - **d.** What is the date of the article?
    - **e.** Write one to two sentences about what the article is about
3. Paragraph #2-Summary (Abstract) of Article
    - **a.** Give a summary of the article; what is the article about?
    - **b.** If necessary, you can write more than one paragraph summarizing the article
4. Paragraph #3- What did you think of the article (critique)
    - **a.** Do you agree or disagree with the author(s)?
    - **b.** Did it support or change your opinion of the topic; if not, why or if so, how?
    - **c.** Did the writer demonstrate that he/she did sufficient research?
    - **d.** What were some of the facts? Opinions? Any bias?
5. Paragraph #4-Conclusion
    - **a.** What are your reasons for choosing your particular article and how does it relate to what we are studying now?

ARTICLE SUMMARY RUBRIC				
CATEGORY	**4**	**3**	**2**	**1**
Requirements	All written requirements completed accurately and turned in on time.	4 of the 5 requirements were met	3 of the 5 requirements were met.	Only 1 or 2 requirements met.
Spelling, Grammar, and Punctuation	There are no spelling, grammar, or punctuation errors in the summary. ***Run spell check before printing!***	There are no more than 2 spelling, grammar, or punctuation errors in the summary.	There are 3-4 spelling, grammar, and punctuation errors in the summary.	The summary has 5 or more spelling, grammar, and punctuation errors in the summary.
Summary of Article	The summary covers all the main points of the article.	The summary covers all but one of the main points of the article.	The summary covers all but 2 of the main points of the article.	The article is not well summarized. Most main points are missing.
Critique	All four questions under "Critique" are answered clearly and completely.	Three questions under "Critique" are answered clearly and completely.	Two questions under "Critique" are answered clearly and completely.	One or none of the questions under "critique are answered.
Overall Paragraph Construction	All paragraphs include introductory sentence, explanations or details, and concluding sentence.	Most paragraphs include introductory sentence, explanations or details, and concluding sentence.	Paragraphs included related information, but were typically not constructed well.	Paragraphing structure was not clear, and sentences were not typically related within the paragraphs.

Self-Assessment: _____ **Grade Equivalent:** _____

Teacher Assessment: _____ **Grade Equivalent:** _____

Student and/or teacher comments:

_____

_____

_____

_____

Total Rubric Points	Grade Equivalent
16-20	A
11-15	B
6-10	C
1-5	F

ANALYZING CORAL THERMAL STRESS USING NOAA'S CORAL WATCH MONITORING SYSTEM IN GOOGLE EARTH

IMPORTANT INFORMATION –

1. Use the information from the work you did on the handout, NOAA Coral Reef Watch Data Set Methodology

2. For conversions from Celsius to Fahrenheit

$$\frac{C^\circ\ (9)}{5} + 32 = F^\circ$$

3. Reminder: An anomaly is something different from the norm or from the usual.

DATA COLLECTION

Latitude and longitude for Christmas Island: _____

Date of collection? _____

Is the planet currently experiencing and El Niño or La Niña weather event? _____

1. Click on "Sea Surface Temperature", by clicking in the box and record the following information.

- Using the key, what is the temperature of the waters surrounding Christmas Island? _____
- Convert this temperature to degrees Fahrenheit. _____

2. Click off "Sea Surface Temperature", by clicking in the box and click on "Sea Surface Temperature Anomaly", by clicking in the box.

- Using the key, what is the SST anomaly surrounding Christmas Island? _____
- Convert this temperature to degrees Fahrenheit. _____
- In words describe what this SST anomaly means. _____

3. Click off "Sea Surface Temperature", by clicking in the box, and turn on "Degree Heating Weeks", clicking in the box.

- Record the number of Degree Heating Weeks, DHW. _____
- At this time are the corals surrounding Christmas Island experiencing thermal stress based on this data? _____ Explain your response _____

_____

4. Click off "Degree Heating Weeks", by clicking in the box, and turn on "HotSpot", by clicking in the box.

- Record the degrees Celsius for Christmas Island. _____
- Convert this temperature to degrees Fahrenheit. _____
- What does this reading tell us about corals at this point in time?

_____

_____

_____

_____

_____

_____

5. Click off "HotSpot", by clicking in the box, and click on "Bleaching Alert Area", by clicking in the box.

- What is the current thermal stress for the corals surround Christmas Island? _____
- Is this what you expected to see based on your understanding so far? _____

  Explain _____

_____

_____

_____

_____

_____

_____

6. Click off "Bleaching Alert Area", by clicking on the box, and click on "Bleaching Outlook", by clicking in the box.

- What is the current outlook period? (looking for a 3-month time frame) _____
- What is the current "potential stress level" for this 3 month period? _____
- Based on the time of year, do you predict an increase or decrease in the alert levels?

  Explain _____

_____

_____

_____

_____

_____

ANALYSIS

7. Turn off "Bleaching Outlook", by clicking in the box. Near Christmas Island on the Google Earth map is a NOAA symbol in yellow and blue. Click on it.

- Here you will have a breakdown of the data you just collected. Fill in the chart with the data you now see on the screen.

Christmas Island, Australia Thermal Stress Level: Date:	
DHW (C-weeks)	
HotSpot (C)	
SST (C)	
SST Anomaly (C)	
Max Month SST Climatology	

- Taking this complement of data under consideration what is the current health of the corals surrounding Christmas Island? _____

- What evidence leads you to believe coral health will remain the same, decline, or improve over the coming months? _____

- Click on the blue hyperlink, Time Series Graph and Data. There are several Australian locations on this page, be sure you are always looking at the data for Christmas Island. The data on these graphs only go back to 2000. The strongest El Nino event in the time span available was during 2002-2003 and was categorized as a "moderate" event. The strongest La Nina was in 2010-2011 and was categorized as "strong".

  Take a moment to digest the graph. Look carefully at labels and the key to help you make sense of the data. In the space provided below summarize the comparison of data between years 2002-2003, 2010-2011, and the most current calendar year.

- What's the point? Why is coral health important? Is it a variable that helps us better understand global warming and the impacts of climate change?

- Connect this problem, climate change, to you, specifically coral health. Remember, we are all connected in this web of life; where are you connected?

21st CENTURY SKILLS	NGSS SCIENCE AND ENGINEERING PRACTICES
LEARNING & INNOVATION	**1** Asking Questions & Defining Problems
Critical Thinking and Problem Solving	**2** Developing & Using Models
Communication and Collaboration	**3** Analyzing & Interpreting Data
INFORMATION, MEDIA, &TECHNOLOGY SKILLS	**4** Using Mathematics & Computational Thinking
• Information Literacy	**5** Constructing Explanations & Designing Solutions
• Media Literacy	**6** Engaging in Argument from Evidence
• ICT (Information, Communications, and Technology Literacy	**7** Obtaining, Evaluating, & Communicating Information
LIFE & CAREER SKILLS	
Flexibility and Adaptability	
Social and Cross-Cultural Skills	

NGSS HIGH SCHOOL
ECOSYSTEMS: INTERACTIONS. ENERGY, AND DYNAMICS
Students who demonstrate understanding can:
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-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.
EARTH'S SYSTEM
Students who demonstrate understanding can:
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's 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.
EARTH AND HUMAN ACTIVITY
Students who demonstrate understanding can:
HS-ESS3-5. Analyze geoscience data and the results from 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.

CCSS – ELA/LITERACY – HIGH SCHOOL – SCIENCE AND TECHNICAL SUBJECTS AND SOCIAL STUDIES

KEY IDEAS AND DETAILS

RST.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.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.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.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.9-10.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks, attending to special cases or exceptions defined in the text.

*RST.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.

RH.9-12.1 Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

CRAFT AND STRUCTURE

RST.9-12.4 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 9–12 texts and topics.

*RST.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.9-10.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., force, friction, reaction force, energy).

RH.9-12.4 Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

RH.11-12.4 Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text.

INTEGRATIONS OF KNOWLEDGE AND IDEAS

RST.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.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.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.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.

CCSS – ELA/LITERACY HIGH SCHOOL *Continued*

RST.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.

RH.9-10.7 Integrate quantitative or technical analysis (e.g., charts, research data) with qualitative analysis in print or digital text.

RH.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, as well as in words) in order to address a question or solve a problem.

RH.9-10.8 Assess the extent to which the reasoning and evidence in a text support the author's claims.

RH.11-12.8 Evaluate an author's premises, claims, and evidence by corroborating or challenging them with other information.

WRITING

Text Types and Purposed

*WHST.9-12.*1 Write arguments focused on discipline-specific content.

*WHST.9-10.*2 Write informative/ explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.

PRODUCTION AND DISTRIBUTION OF WRITING

*WHST.9-12.*4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

RESEARCH TO BUILD AND PRESENT KNOWLEDGE

*WHST.9-12.*7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

*WHST.9-12.*9 Draw evidence from informational texts to support analysis, reflection, and research.

RANGE OF WRITING

*WHST.9-12.*10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline- specific tasks, purposes, and audiences.

NCSS – HIGH SCHOOL

CULTURE

Learner will understand:

- That behaviors, values, and beliefs, of different cultures can lead to cooperation or pose barriers to cross-cultural understanding;
- That awareness and knowledge of other cultures is important in a connected society and an interdependent world;
- That the cultural values and beliefs of societies influence their analysis of challenges, and their responses to these challenges.

NCSS HIGH SCHOOL *Continued*

Learners will be able to:

- Construct reasoned judgments about specific cultural responses to persistent human issues;

TIME, CONTINUITY, AND CHANGE

Learners will understand:

- The importance of knowledge of the past to an understanding of the present and to informed decision-making about the future.

PEOPLE, PLACES, & ENVIRONMENTS

Learners will understand:

- The theme of people, places, and environments involves the study of the relationships between human populations in different locations and regional and global geographic phenomena, such as landforms, soils, climate, vegetation, and natural resources;
- Concepts such as: location, physical and human characteristics of national and global regions in the past and present, and the interactions of humans with the environment;
- Consequences of changes in regional and global physical systems, such as seasons, climate, and weather, and the water cycle;
- The causes and impact of resource management, as reflected in land use, settlement patterns, and ecosystem changes;
- The social and economic effects of environmental changes and crises resulting from phenomena such as floods, storms, and drought;
- The use of a variety of maps, globes. Graphic representations, and geospatial technologies to help investigate spatial relations, resources, and population density and distribution, and changes in these phenomena over time.

Learners will be able to:

- Acquire, organize, and analyze geographic information from data sources, geographic tools and geospatial technologies such as aerial photographs, satellite images, geographic information systems (GIS) to determine patterns;
- Evaluate the consequences of human actions in environmental terms.

INDIVIDUAL DEVELOPMENT AND IDENTITY

Learners will be able to:

- Discuss the nature of stereotyping, bias, altruism, and conformity in societies, and their implications for personal, group, and national relationships.

INDIVIDUAL, GROUPS, AND INSTITUTIONS

Learners will understand:

- How various forms of groups and institutions change over time;
- The impact of tensions and examples of cooperation between individuals, groups, and institutions, with their different belief systems;

NCSS HIGH SCHOOL *Continued*
• How the beliefs of dominant groups tend to become norms in a society;
• How groups and institutions work to meet individual needs, and can promote the common good and address persistent social issues.
POWER, AUTHORITY, AND GOVERNANCE
Learners will understand:
• Mechanisms by which governments meet the needs and wants of citizens, regulate territory, manage conflict, establish order and security, and balance competing conceptions of a just society.
Learners will be able to:
• Analyze and evaluate conditions, actions, and motivations that contribute to conflict and cooperation among groups and nations.
SCIENCE, TECHNOLOGY, AND SOCIETY
Learners will understand:
• Science and technology have had both positive and negative impacts upon individuals, societies, and the environment in the past and present;
• That the world is media saturated and technologically dependent;
• Consequences of science and technology for individuals and societies;
• Decisions regarding the uses and consequences of science and technology are often complex because of the need to choose between or reconcile different viewpoints;
• Prediction, modeling, and planning are used to focus advances in science and technology for positive ends;
• Developments in science and technology may help to address global issues.
Learners will be able to:
• Use diverse types of media technology to access, analyze, evaluate, create, and distribute messages;
• Identify the purposes, points of view, biases, and intended audience of reports and discussions related to issues involving science and technology;
GLOBAL CONNECTIONS
Learners will understand:
• The solutions to global issues may involve individual decisions and actions, but also require national and international approaches (e.g. agreements, negotiations, policies, or laws);
• The actions of people, communities, and nations have both short – and long-term effects on the biosphere and its ability to sustain life;
• Individuals, organizations, nations, and international entities can work to increase the positive effects of global connections, and address the negative impacts of global issues.

NCSS HIGH SCHOOL *Continued*

Learners will be able to:

- Analyze the cause and consequences of persistent, contemporary, and emerging global issues, and evaluate possible solutions;

CIVIC IDEALS AND PRACTICES

Learners will understand:

- The theme of civic ideals and practices helps us recognize where gaps between ideals and practices exist, and prepares us to work for social justice;
- That seeking multiple perspectives is required in order to effectively grasp the complexity of issues involving civic ideals and practices;
- The importance of becoming informed as the basis for thoughtful and positive contributions through civic action.

Learners will be able to:

- Ask and find answers to questions about how to become informed and take civic action;
- Research primary and secondary sources to make decisions and propose solutions to selected civic issues in the past and present;
- Identify assumptions, misconceptions, and biases in sources, evidence, and arguments used in presenting issues and positions;
- Develop a position on a public policy issue and defend it with evidence.

Resources and Links

- Bell, Gerald. "Climate Diagnostic Bulletin: March 2014." U.S. Department of Commerce, 2014. Wed. 28 Apr. 2014.
- Climate Prediction Center. Publications: Monthly Climate Diagnostics Bulletin. Wed. 28 Apr. 2014. ***www.cpc.ncep.noaa.gov/products/outreach/publications.shtml***.
- "Climate at a Glance." National Climatic Data Center (NCDC). N.p., n.d. Web. 15 Apr. 2014. ***www.ncdc.noaa.gov/cag/***.
- Coral Bleaching. ***www.noaawatch.gov/themes/coral_bleaching.php***
- Department of Labor Statistics. ***www.bls.gov/ooh/home.htm***
- El Niño and La Niña Years and Intensities. Golden Gate Weather Service. Wed. 28 Apr. 2014. ***http://ggweather.com/enso/oni.htm***.
- Glebushko, Yerkaterina. "The El Niño Phenomenon: From Understanding to Predicting." The El Niño Phenomenon: From Understanding to Predicting. CSA, 2004. Web. 28 Apr. 2014. ***/www.csa.com/discoveryguides/prednino/overview.php .***
- NOAA Coral Reef Monitoring Methodology. *http://coralreefwatch.noaa.gov/satellite/methodology/methodology.php#sst*
- Pielke, Roger A., Jr., and Christopher W. Landsea. La Niña, El Niño, and Atlantic Hurricane Damages in the United States. NOAA, 6 Apr. 1999. Web. 28 Apr. 2014. ***www.aoml.noaa.gov/hrd/Landsea/lanina/figures.html***.
- Scripps Institution of Oceanography. ***https://scripps.ucsd.edu/education/careers***
- Weather Impacts of ENSO. The Jetstream. National Weather Service, 11 Apr. 2014. Wed. 28 Apr. 2014. ***www.srh.noaa.gov/jetstream/tropics/enso_impacts.htm***.