Georgia Aquarium

Teacher's Guide

Grades 6-8

Content created by TurnKey Education, Inc. for Georgia Aquarium
TurnKey Education, Inc.: www.turnkeyeducation.net

GEORGIA AQUARIUM

Welcome to Georgia Aquarium!

What to Expect on Your Field Trip

Georgia Aquarium is a must-see field trip destination for students (and teachers!) of all ages. On your class trip, you will experience one of the largest, indoor, aquatic habitats and one of the most abundant collections of marine life in the world.

Georgia Aquarium is dedicated to global leadership in the research and conservation of aquatic animals. Since its founding, Georgia Aquarium has been committed to educating and inspiring current and future generations through the respectful display of marine mammals, fish, invertebrates and many other aquatic species. Aquarium staff, volunteers and partners positively impact the future of our planet by instilling in your students an appreciation for these extraordinary animals and empowering them to become advocates on their behalf.

The seven distinct galleries and more than 100 exhibits within Georgia Aquarium represent aquatic environments ranging from arctic to tropical waters. Your students will discover a diverse assortment of animals sure to amaze, inspire and engage them like never before.

Ocean Voyager Built by The Home Depot is the largest exhibit at Georgia Aquarium and represents our "one world ocean." The habitat holds 6.3 million gallons of water and features the whale shark, which is the largest fish in the world, and the only manta rays in a U.S. aquarium. This is also where you can spot Tank, the 450-pound sea turtle!

In **Cold Water Quest,** you will see animals from arctic regions and temperate seas, including beluga whales, harbor seals, southern sea otters and African penguins. If you are lucky, you may see a penguin waddling by during your visit. Trainers lead several African penguins on a daily **Waddle Walk** across the main Atrium. Students can learn firsthand about the plight of this endangered species and the Aquarium's preservation efforts.

Tropical Diver is the colorful home to more than 300 species of fish and other aquatic animals representing Indo-Pacific reef ecosystems. With 164,000 gallons of water, the Pacific Barrier Reef habitat is one of the largest living reef exhibits in the United States. Look closely. Approximately 25% of the reef wall is live coral.

Southern Company River Scout is an immersive experience showcasing the diversity of freshwater species around the world. In this gallery, students walk amidst the waters of an overhead river to discover the incredible variety of animals found in the lakes and rivers of Africa, South America, Asia and right here in Georgia. Watch out for the piranha!

SunTrust Pier 225 is home to the charismatic California sea lion. These playful pinnipeds (the name for marine mammals that have front and rear flippers) and their dedicated trainers give students the chance to see training activities firsthand while they learn about sea lion conservation and what they can do to help.

Upstairs in **Aquanaut Adventure: A Discovery Zone,** your students will navigate through a series of activities and challenges. Along the way, they will learn about aquatic animals and ecosystems to become a certified Georgia Aquarium Aquanaut!

AT&T Dolphin Tales features an educational presentation that shows your class how the incredible dolphins at Georgia Aquarium are trained and cared for and how to protect dolphins in their natural habitat. In addition, the

newly renovated **4D Funbelievable Theater** employs interactive seats and special effects built into the theater itself. There is a rotating series of 20-minute films based on animated theatrical releases. Your field trip tickets include the theater and all animal galleries and presentations. Please know that presentations are subject to availability and are on a first come, first served basis.

Georgia Aquarium offers your students a unique opportunity to see STEAM (science, technology, engineering, the arts and math) learning at work, both above the ground and under the water. You will find that you can use the topic of aquatic life, along with the enriching experiences at the Aquarium itself, to connect the educational themes of the galleries to your national and local STEAM curricula and content requirements.

Using this Teacher's Guide

As a companion to your experience at Georgia Aquarium, this Teacher's Guide has been created to complement your classroom instruction and make the most of your school field trip. It contains original, assessable, STEAM-related classroom lesson plans for you to use and share.

The Middle School Teacher's Guide includes dynamic activities and assignments for students in grades six through eight. There are also Teacher's Guides for Elementary School and High School. Each Guide is designed to be flexible and used to best meet the needs and capabilities of your class. You know your students better than anyone else!

Following this **Introduction**, you will find **"STEAM Stream,"** a section consisting of five interdisciplinary Classroom Lesson Plans, each featuring a gallery you will visit on your field trip to the Aquarium. The lesson plans begin with instruction pages and answer keys for teachers. These include a list of the appropriate content areas and skills addressed by the activities in the lesson. Rounding out the lessons are ready-to-copy Student Activity worksheets that center on key STEAM topics featured on your tour.

The first lesson plan is "**Cold Water Quest: Penguin Populations.**" Students will complete four classroom activities to understand the importance of the work undertaken around the world to prevent this endangered species from disappearing before the end of this century.

"**River Scout: Tap into the Elements,"** the second lesson plan, challenges students to figure out what has to happen to ordinary tap water before it can become a habitat for cichlids. Then, they will complete the lesson with a map activity that shows just where in the world it is that these cichlids call home.

In the next lesson, "**Pier 225: Sentinels of the Sea,**" students investigate how a single-celled organism—*Pseudo-nitzschia*—can wreak havoc so far up the food web. Students will discover where it comes from and how it explains why sea lions are considered sentinels of the sea.

The student activities in **"Tropical Diver: Calculate and Cultivate"** introduce both the mathematical and the design sides of building artificial reefs.

The fifth lesson plan is **"Ocean Voyager: Turtle Tales and Telemetry."** Students will blend science, art and engineering as they study location data, read ancient folklore and design the "Ultimate Sea Turtle Tag."

Next, in **"Make a Splash,"** games and puzzles relate to themes you encounter on your visit to Georgia Aquarium. Included are a crossword, a word search and Aquarium Jeopardy. These are excellent activities for your bus ride to and from the tour or to assign for extra credit as you see fit. Under **"Beneath the Waves,"** the next section in this Teacher's Guide, you will find facts and figures, a list of Aquarium awareness days and a timeline of Aquarium history.

We know how important it is to justify field trips and document how instructional time is spent outside of your classroom. To that end, this Teacher's Guide is directly correlated to the Common Core State Standards for Mathematics and English Language Arts, the Next Generation Science Standards, the C3 Framework for Social Studies State Standards and the National Core Arts Standards. These correlations are organized by content and grade level. You can readily see how they fit into your required curriculum, making it easy to connect a field trip to Georgia Aquarium with your classroom instruction. Following the national curricula, you will find the Georgia Performance

Standards and Standards of Excellence. In addition, specific requirements are provided for Alabama, Florida, North Carolina, South Carolina and Tennessee.

This Teacher's Guide features a curriculum designed to offer a memorable learning classroom experience that is interdisciplinary and applicable across several grade levels. You can use this Guide before and after your visit to Georgia Aquarium, year after year. It will help prepare students for the teachable moments found throughout Georgia Aquarium. When you get back to school, refer to the Guide as you continue to explore connections between the themes of the field trip and your classroom STEAM instruction.

Ready to get started? Let's blow the trainer's whistle and dive right in!

GEORGIA AQUARIUM

Mathematics, Science, Engineering, Social Studies

Life Science, Earth Science, Lab Design, Primary Sources, Statistics

Lesson Plan 1
Cold Water Quest: Penguin Populations

Teacher Instructions

The African penguins (*Spheniscus demersus*) you see in the **Cold Water Quest** gallery are among the most popular residents at Georgia Aquarium. We think your students will agree! African penguin populations in their natural habitats are in steep decline. Every single bird is critical in the effort to bring this species back from the brink of extinction. Living along the coastlines of South Africa and Namibia, African penguins face extensive environmental threats from humans. Thankfully, people have begun to take steps to preserve their populations. You and your class can join the campaign to save African penguins from peril.

This group of penguins is an excellent example of an "indicator species," which means we can learn about the condition of the ocean in their ecosystems based on the health of these birds. If the African penguins' numbers are declining, it means the populations of the fish they eat are also declining, as is the quality of their natural habitat. Georgia Aquarium helps the African penguin fight for survival through breeding programs and affiliations with organizations like the South African Foundation for the Conservation of Coastal Birds (SANCCOB).

In 2009, the Aquarium began a partnership with SANCCOB, which is one of the groups leading the way in penguin conservation, rescue and rehabilitation. Veterinarians at Georgia Aquarium and SANCCOB share research into the diseases and environmental conditions causing problems within penguin populations. Your students will complete four activities to understand the importance of the work undertaken around the world to prevent this species from disappearing before the end of this century.

Depending on the grade level of your students and your class schedule, these activities can be done as a group (one per day) or in teams at stations set up around your classroom. For a fifth station, you can provide an area with dictionaries for your students to define the "Terms to Know" from the introduction in the Student Activity.

Activity 1: Saving Seabirds

Dr. Alistair Dove is the Director of Research and Conservation at Georgia Aquarium. In 2014, he took a trip to study whale sharks in the South Atlantic Ocean with Rafael de la Parra, a marine biologist and whale shark expert from Mexico. On their way, they stopped in South Africa at SANCCOB. Your students will read Dr. Dove's description of his visit and answer eight questions that follow. They will learn more about the work done in their new chick rearing unit to keep the endangered African penguin from becoming extinct.

This activity can be completed by a group or by individual students. To set it up as a station, print the passage from the Student Activity page in large font for a poster or project it on a screen for the students in the group to read together. The source comes from a Georgia Aquarium blog by Dr. Dove, "Saving Seabirds with SANCCOB," in January 2014: www.georgiaaquariumblog.org/georgia-aquarium-blog/2015/1/13/saving-seabirds-with-sanccob.html. To give your students a behind-the-scenes look at this important work (and some adorable penguins!) at SANCCOB, check out their videos available online at: www.youtube.com/user/SANCC0B.

Answer Key

1. Entanglement, oil spills, overfishing, climate change
2. A handful; no, one hand cannot hold very much
3. New facility for the incubation and hatching of seabird eggs
4. On the verge of a road
5. Answers will vary and might include parents being unable to find the nest after they are relocated
6. 120
7. A tremendous passion for practical, hands-on conservation
8. In partnering with SANCCOB

Activity 2: Penguin Percentages

Your students will perform calculations involving percentages to see how conservation efforts are making a difference in saving the endangered African penguin. Students are instructed to do their work on separate paper and write the answers in the spaces provided, so you may want to provide scratch paper and/or calculators if they do not have their own.

Answer Key

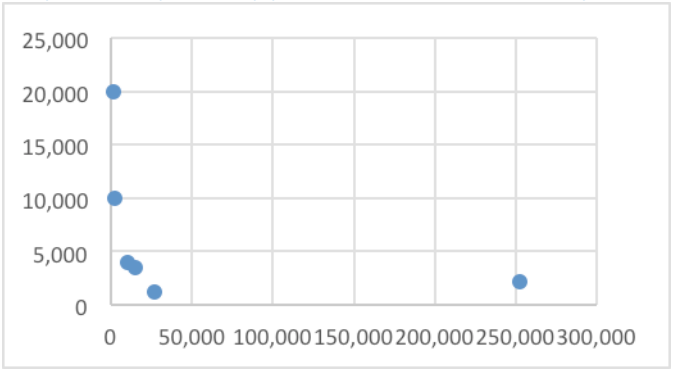
1. 386
2. (a.) 1500/2500 = 3/5 = 3:5; (b.) 0.6 = 60%
3. 18%
4. (a.) 85%; (b.) A majority of the rescued chicks were abandoned by molting parents.
5. Answers will vary but should include the 50% survival rate in 1994 and 84% in 2000, noting that the *Treasure* spill had a much higher survival rate even though there were many more injured birds that time.

Activity 3: Oil Spills vs. Penguins

In 2000, the cargo ship *Treasure* sunk off the coast of Cape Town, South Africa and leaked 1,400 tonnes (metric tons) of oil into the ocean. Your students will use a chart and scatter plot with bivariate data to compare the estimated maximum amount of oil leaked during the *Treasure* spill to five other oil spills in South Africa. The objective is to see what connections there might be between the amount of oil in a spill and the number of birds affected by it. The amount of oil is given in tonnes of crude oil; one tonne of crude oil equals approximately 308 U.S. gallons or 7.3 barrels of oil. At the conclusion, your students will learn that even relatively small oil spills can devastate the environment.

Answer Key

1. Answers will vary but will probably predict that the more oil spilled, the more birds are affected.
2. Scatter plot:



3. (a.) *Castillo de Bellver*/1983; (b.) *Treasure*/2000
4. (a.) *Treasure*/2000; (b.) *Wafra*/1971
5. Answers will vary but should indicate that there doesn't appear to be a strong or obvious relationship, and if there is one, it is inverse.
6. The correlation coefficient shows that the relationship is weak, but it is negative, or inverse.
7. Answers will vary but will most likely be no, because of the slightly negative correlation and inverse relationship. Students probably predicted the spills with more oil affected more birds.
8. Answers will vary and may include factors such as locations of the spill and the penguins' colonies, weather (wind), or tide.

Activity 4: Bird Bath

In this "flipped" laboratory exercise, your students become environmental and chemical engineers looking for the best way to clean birds damaged by an oil spill. Science lessons focused on properties of liquids, oil vs. water, and how to remove oil from water after a spill are plentiful. However, in this version, the process of discovery and the practical realizations of the steps needed to conduct the inquiry are as important as the results of the experiment.

Based on the supplies you provide, each group of students will design and conduct their own experiment to test three cleaners of their own choosing to see which one does the best job at removing oil from feathers. You will provide the class with simulated oil (two recipes are found below), a variety of cleaning solution options and tools for scrubbing.

Supplies

- Feathers, available from craft stores (each group needs four of equal size)
- Aluminum pie pans (three for each group)
- Bowl to hold the "oil" (one for each group)
- Water
- Plastic spoons and small paper cups for adding portions of the chosen cleaners
- Dawn® dishwashing liquid
- Other options to test for cleaning effectiveness such as bar or bath soap, glass cleaner, laundry soap, hydrogen peroxide, shampoo, conditioner, hand sanitizer, bubble bath, vinegar, tonic or seltzer water, baking powder, baby powder, etc.

- Tools for scrubbing feathers such toothbrushes, paintbrushes, cotton swabs, cotton balls, sponges, gauze pads, paper towels, wash cloths, etc.
- Latex gloves (optional)
- Newspapers or drop cloths to protect the work area
- Additional tools for students to investigate the feathers once they are oiled such as a gram scale, magnifying glass, tweezers, pipette, etc.
- Simulated oil
    - Jar with lid to shake and mix the oil ingredients
    - 1 cup vegetable + 2 tablespoons of cocoa powder
    - **OR** 1.5 cups vegetable oil + 1 teaspoon dark tempura paint powder

Students begin by forming a hypothesis to predict which one of the three substances their group chose to test will be best at removing oil from a feather. Make sure one of the choices available is Dawn® dishwashing liquid. Students who include this cleaner in their experiment will discover that it is the most effective at cleaning oil from the feathers. It includes a company "secret ingredient" that helps break up the oil easily, but is still gentle on the birds. Depending on the grade level of your students, you may want to only offer three choices, or you can offer as many as you can think of! The fourth feather will be used as a control so that students have a baseline to record data from.

Each group will need to determine a plan to measure which cleaner works best, record any general observations during the procedure and keep track of the data in the form of a graph or chart. Once each group works out a plan and conducts the experiment, students will complete the lab report template in the Student Activity pages that follow. If this lesson plan is spread over more than one class period, students can oil their feathers the first day by dipping them in the bowl of oil and laying them to dry in the aluminum pans. Leaving the feathers to dry overnight simulates a more realistic condition of the oiled birds when they are rescued.

At the end of the experiment, all materials may be safely disposed of down the drain. To conclude the activity, consider showing this brief video from National Geographic about another population of endangered penguins, rockhoppers. These birds were affected by an oil spill in the Southern Atlantic Ocean and assisted by SANCCOB in 2011: http://video.nationalgeographic.com/video/nightingale-island-oil-spill.

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Answer Key

Use this rubric to assess each group's lab report. A copy of this rubric is also in the Student Activity pages, following the lab report template. Any section left blank does not earn any points.

	1 POINT	2 POINTS	3 POINTS
QUESTION	Not written in question form AND does not address problem of oiled birds or feathers	Not written in question form OR does not address problem of oiled birds or feathers	Written in question form and addresses problem of oiled birds or feathers
HYPOTHESIS	Not written as complete sentence AND does not include prediction	Not written as complete sentence OR does not include prediction	Written as complete sentence and includes group's prediction for the best cleaning solution
MATERIALS	A few of the items and tools used are listed	Most of the items and tools used are listed	Every item and tool used is listed
PROCEDURE	Key steps in the process are missing	Some steps omitted OR all are included but too many are grouped together.	Individual steps are listed one at a time
OBSERVATIONS and DATA	Results discussed, but no graph or chart included	Includes a graph or chart, but data is not well-identified	Includes a graph or chart with detailed, well-labeled data
CONCLUSION	Not written as a complete sentence; missing results of the experiment and comparison to original hypothesis	Written as complete sentence; includes results of experiment OR comparison to original hypothesis	Written as a complete sentence; includes results of experiment AND comparison to original hypothesis

Total: _____/18 points

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Name Class Date

Cold Water Quest: Penguin Populations

Student Activity

The African penguins (*Spheniscus demersus*) you see in the **Cold Water Quest** gallery are among the most popular residents at Georgia Aquarium. We bet you agree! African penguins in their natural habitat are in steep decline. Every single bird is critical in the effort to bring this species back from the brink of extinction. Living along the coastlines of South Africa and Namibia, African penguins face extensive environmental threats from humans. Thankfully, people have begun to take steps to preserve their populations. Now you can join the campaign to save African penguins from peril.

This group of penguins is an excellent example of an "indicator species," which means we can learn about the condition of the ocean in their ecosystems based on the health of these birds. If the populations of African penguins are declining, it means the populations of the fish they eat are also declining, as is the quality of their natural habitat. Georgia Aquarium helps the African penguin fight for survival through breeding programs and affiliations with organizations like the South African Foundation for the Conservation of Coastal Birds (SANCCOB).

In 2009, the Aquarium began a partnership with SANCCOB, which is one of the groups leading the way in penguin conservation, rescue and rehabilitation. Veterinarians at Georgia Aquarium and SANCCOB share research into the diseases and environmental conditions causing issues within penguin populations. Complete the following four activities to understand the importance of the work undertaken around the world to prevent this species from disappearing before the end of this century.

African penguin

http://www.georgiaaquarium.org/animal-guide/georgia-aquarium/home/galleries/cold-water-quest/gallery-animals/african-penguin

Terms to Know: *affiliation, brink, correlation, hypothermia, imperiled, ingest, invariably, inverse, molt, parasitology, preening, simulated, tonne, untenable, zoology*

Activity 1: Saving Seabirds

Dr. Alistair Dove is the Director of Research and Conservation at Georgia Aquarium. Originally from Australia, Dr. Dove studied Zoology and Parasitology in college. In 2014, he took a trip to study whale sharks in the South Atlantic Ocean with Rafael de la Parra, a marine biologist and whale shark expert from Mexico. On their way, they stopped in South Africa at SANCCOB.

In the paragraphs below, you will read Dr. Dove's description of his visit and learn about the work being done in the new chick rearing unit to keep this penguin from becoming extinct in the wild.

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Saving Seabirds with SANCCOB

South Africa is rich with sea bird diversity, but many birds face difficulties ranging from entanglement to oil spills and the effects of overfishing and climate change, such that they sometimes need a helping hand. This is especially the case for African penguins, which have shown significant declines in recent years and have been reduced to a handful of breeding colonies on islands off the coast of South Africa and Namibia….

We were particularly impressed with the CRU or chick rearing unit, a new facility for the incubation and hatching of seabird eggs that come in from the penguin colonies along the coast. This typically happens when a penguin pair chooses to nest in an untenable location (like on the verge of a road) and colony managers are compelled to relocate the pair, which invariably results in abandonment of the egg. SANCCOB received and hatched over 120 such eggs in the last 12 months, with a release success rate that has more than doubled since the CRU came online….

The overwhelming impression we got from our visit to SANCCOB was that of a group of people unified by a tremendous passion for practical, hands-on conservation. It's always energizing to meet with mission-driven people, and we came away feeling confident that the seabirds of South Africa are in good hands, and that in partnering with SANCCOB for penguin conservation, Georgia Aquarium is helping to make a real difference for the extraordinary imperiled African penguin.

A chick hatched at SANCCOB's chick rearing unit, or CRU.

www.georgiaaquariumblog.org/georgia-aquarium-blog/2015/1/13/saving-seabirds-with-sanccob.html

1. Name four reasons sea birds often need help from humans.

2. What term does Dr. Dove use to describe how many breeding penguin colonies are left in South Africa and Namibia? Does this expression mean there are many left? Why or why not?

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3. Describe the chick rearing unit, or CRU.

4. What example does Dr. Dove give of an “untenable location” for a penguin pair to make a nest?

5. Why do you think relocating a penguin pair causes them to abandon their egg?

6. How many abandoned eggs came into the CRU in one year just from nest relocations?

7. According to Dr. Dove, what unifies the people who work with SANCCOB?

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8. What is one way Georgia Aquarium is helping to make a difference for these penguins?

Activity 2: Penguin Percentages

African penguin population numbers dropped 90% during the twentieth century and 60% in the last 30 years alone. Complete this math activity to see how conservation efforts are making a difference in saving this endangered species from extinction. Perform your calculations on separate paper and write the answers in the spaces provided.

This penguin chick was born at Georgia Aquarium.

www.georgiaaquariumblog.org/georgia-aquarium-blog/2013/3/1/penguin-chicks.html

1. At the end of 2010, SANCCOB had 483 abandoned penguin chicks needing help. Georgia Aquarium sent veterinary staff to provide emergency assistance. If their success rate for the release of these orphaned chicks was 80%, how many chicks were released? (Round to the nearest whole number, or whole penguin!)

2. SANCCOB is best known for its efforts to save penguins, gannets, cormorants and other birds after major oil spills. Even when there are no oil spills, African penguins can account for 1,500 of the 2,500 injured seabirds that need rescuing each year at SANCCOB.

(a.) What is the ratio of penguins to other seabirds in a non-spill year? Write your answer as a fraction and reduce it to find the ratio.

(b.) Based on your answer above, what percent of the total number of seabirds saved each year are African penguins? Write the solution as a decimal before calculating the percentage.

Name Class Date

3. Currently, 39% of the breeding penguin pairs lives in the Western Cape, a province in southwest South Africa and 43% lives in the Eastern Cape, a province on the southeast coast of South Africa. Namibia is the only other country where they live in their natural habitat. What percentage of breeding pairs today lives in Namibia?

4. Some African penguin chicks are at SANCCOB because of a poorly-timed molt. Molting is when a bird's old feathers fall out and new ones grow in. During this time, penguins are not waterproof and cannot swim to catch food for themselves or their chicks. Adults can survive without eating for a while, but the chicks will starve. In the years before their chick rearing unit had even opened, SANCCOB admitted over 2,400 chicks; more than 2,040 of them were from molting parents.

(a.) What percentage of the rescued chicks came from molting parents?

(b.) Based on this percentage, circle the correct statement about the hand-raised penguin chicks.

A minority of the rescued chicks were abandoned by molting parents.

A majority of the rescued chicks were abandoned by molting parents.

5. Oil spills are one of the greatest threats to African penguins and to all coastal animals. Thanks to SANCCOB, the ability to respond and rescue oiled penguins has improved significantly. In 1994, when the *Apollo Sea* ore carrier sank, the spill oiled 10,000 penguins. Only 5,000 could be cleaned and released. In 2000, a spill from the tanker *Treasure* oiled 19,000 penguins. SANCCOB cleaned and released 16,000 penguins. Write a sentence that compares the survival rates for African penguins from the two oil spills. Include the percentages of penguins saved compared to the total number of injured birds from each spill.

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Activity 3: Oil Spills vs. Penguins

In 2000, the cargo ship *Treasure* sunk off the coast of Cape Town, South Africa, and leaked 1,400 tonnes of oil into the ocean. SANCCOB led a major effort to save African penguins and other sea birds threatened by the spill. Compare the amount of oil leaked during the *Treasure* spill to five other oil spills in South Africa to see what connections there might be between the amount of oil in a spill and the number of birds affected by it.

1. First, form a hypothesis to explain what you expect the relationship to be between the amount of oil spilled and the number of oiled birds.

2. Use the information in the chart below to create a scatter plot. Use the "Amount of Oil Spilled in Tonnes" column for your x-axis and the "Number of Birds Affected by Oil" column for your y-axis to plot the spills from the first column. Complete your graph on the grid provided or enter the data into a spreadsheet program on the computer.

Year and Name of Spill	Amount of Oil Spilled in Tonnes	Number of Birds Affected by Oil
1968: *Esso Essen*	15,000	3,500
1971: *Wafra*	27,000	1,200
1972: *Oswego-Guardian/Texanita*	10,000	4,000
1983: *Castillo de Bellver*	252,000	2,200
1994: *Apollo Sea*	2,400	10,000
2000: *Treasure*	1,400	20,000

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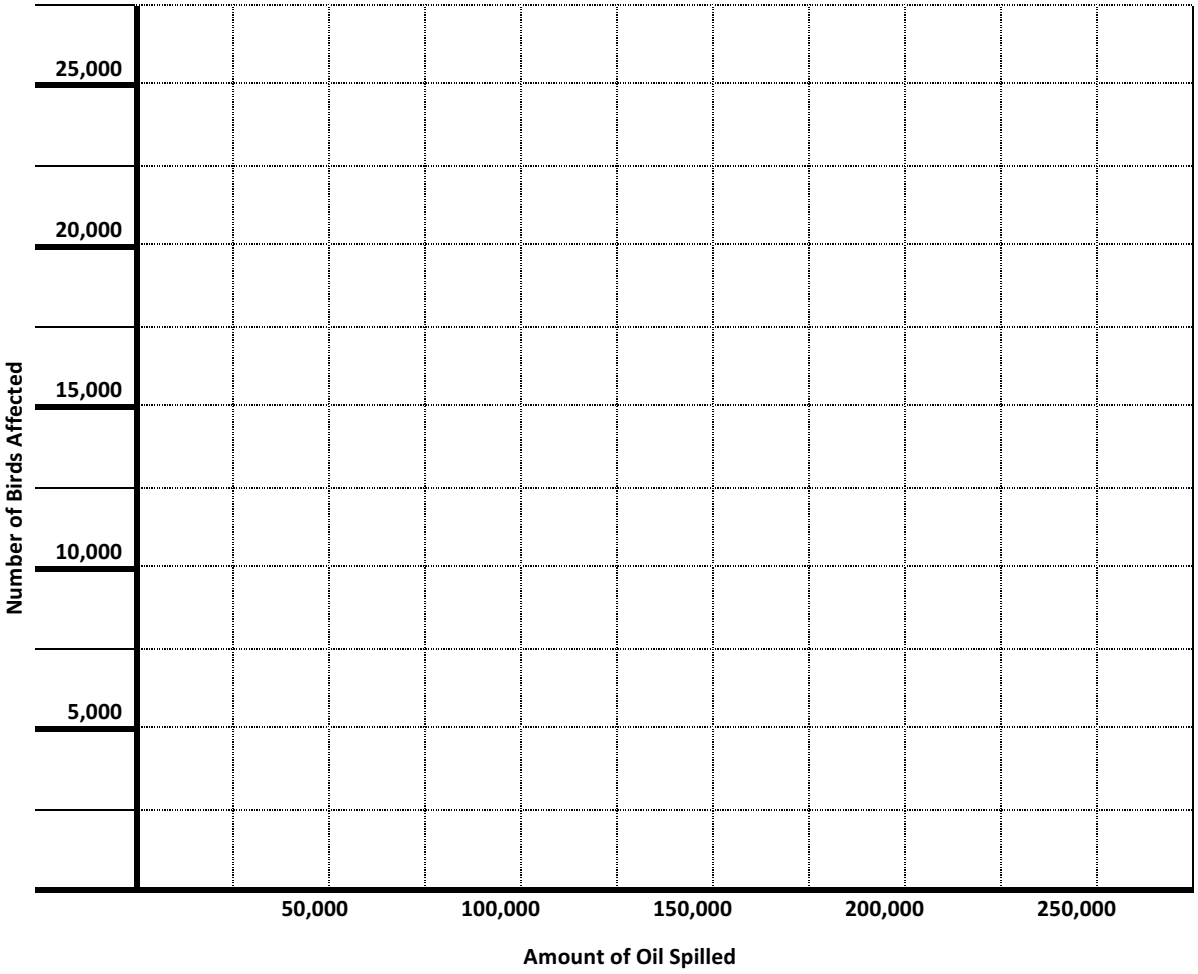
Name Class Date

Oil Spills off the Coast of South Africa



3. (a.) Which ship leaked the most oil? (b.) Which leak oiled the most birds?

4. (a.) Which ship leaked the fewest tonnes of oil? (b.) Which leak oiled the fewest number of birds?

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5. Based on your graph, does there appear to be relationship between the amount of oil spilled and the number of oiled birds? If so, describe the relationship.

6. A correlation coefficient is a number between -1 and 1. The closer a correlation coefficient is to -1 or 1, the stronger the relationship is among the data in a graph. The positive/negative sign indicates whether the correlation is positive (direct) or negative (inverse). The correlation coefficient for this graph is -0.387. What does that tell you about a connection between the amount of oil spilled and the number of birds oiled?

7. Did the results of this graph support your initial hypothesis? Why or why not?

8. Brainstorm two reasons to explain why the smallest oil spill affected the greatest number of birds.

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Activity 4: Bird Bath

After the *Treasure* oil spill on June 23, 2000, nearly 20,000 oiled birds, mostly African penguins, were caught, cleaned, and rehabilitated. Another 20,000 penguins were relocated to save them from the oil slick heading their way. SANCCOB relied on thousands of volunteers from all over the world to help with these huge tasks. One of the most time-consuming jobs was removing oil from the birds. Toxic oil on feathers poisons birds when they ingest it during preening. Oil also removes the waterproofing on the feathers and can cause hypothermia. It took two volunteers at least an hour to clean just one bird.

Your group will now take on the role of environmental and chemical engineers looking for the best way to clean animals affected by an oil spill. Based on the supplies from your teacher, you will design and conduct a lab experiment testing three cleaners of your own choosing to see which one does the best job at removing the oil from a feather. You will be provided with simulated oil and a variety of possible cleaning solutions and tools.

Before you begin your experiment, form a hypothesis to predict which one of the three substances your group chose will do the best job at removing oil from a feather. You will need to determine how you will measure which cleaner works best, record your general observations during the procedure, and keep track of your data in the form of a graph or chart. Once your group works out a plan and conducts the experiment, complete this lab report form. Attach additional pages as needed. Following the lab report, you will see the point system your teacher will use to assess your work.

A NOAA veterinarian saves an oiled Kemp's Ridley sea turtle after the Deepwater Horizon oil spill in 2010. The largest U.S. oil spill to date threatened more than 400 species of marine wildlife along the Gulf Coast, including fish, coral, dolphins, endangered turtles and birds.
(NOAA and Georgia Department of Natural Resources)

http://oceanservice.noaa.gov/deepwaterhorizon/images/turtle2_b.jpg

Lab Report

TEAM MEMBERS

QUESTION TO BE ANSWERED BY EXPERIMENT

HYPOTHESIS

MATERIALS

PROCEDURE

OBSERVATIONS and DATA

CONCLUSION

Assessment Rubric: Any section left blank does not earn any points.

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Science, Social Studies
Earth Science, Physical Science, Geography

Lesson Plan 2
River Scout: Tap into the Elements

Teacher Instructions

The **Southern Company River Scout** gallery at Georgia Aquarium showcases a wide variety of animals found in the rivers of four continents - Africa, South America, Asia and North America. One group of freshwater fish, cichlids, is found in tropical and subtropical waters on all four! Scientists estimate that there are at least 1,350 species of cichlids worldwide and possibly hundreds more yet to be identified. Most cichlid species are found in three large lakes in East Africa. Called the "African Rift Lakes," they are Lake Malawi, Lake Tanganyika, and Lake Victoria.

These ancient lakes are known for their incredible biodiversity. In fact, they are home to many species of animals found nowhere else on Earth. Lake Malawi contains more than 500 different kinds of cichlids. Lake Tanganyika is the largest lake on the African continent and the second largest lake by volume in the entire world. It has over 400 species of fish including 250 from the cichlid family alone.

Conditions in Lake Victoria are, unfortunately, quite different and serve as a warning to other lakes in the African Rift Valley. Overfished, polluted, and taken over by invasive fish and plants, Lake Victoria barely resembles the lush, diverse ecosystem it once was. The quality and chemistry of Lake Victoria's water is so altered by human activity that its native fish species have been reduced by 80%, which includes at least 200 species of cichlids that have disappeared.

Inside **River Scout**, your students will find habitats devoted exclusively to the colorful cichlids of Lake Malawi and Lake Tanganyika. They will see the incredible variations in the colors, sizes, and behaviors of this fascinating family of fish. Among the Lake Malawi cichlids found in **River Scout** is the parallel striped mbuna (*Melanochromis parallelus*), which is a mouth brooder like many cichlids. This means the young live and take refuge inside their mother's mouth until they are big enough to fend for themselves.

In the **River Scout** habitat devoted to cichlids from Lake Tanganyika, look for the striking five barred cichlid (*Neolamprologus tretocephalus*) and the bright lemon cichlid (*Neolamprologus leleupi*) among its inhabitants. A shell-dwelling species (*Neolamprologus brevis*) makes its home in empty snail shells where it will live and raise its young. Lake Tanganyika has several factors that make it different from the other African Rift lakes. First, it is older and much deeper. It also has fewer rivers and stream exiting the lake, which means the water is "flushed out" far less often.

Could a cichlid from the unique environment of Lake Tanganyika survive in the water that comes out of the tap at your school? After an introduction to the elements and compounds cichlids need in their water, your students will be challenged to figure out what has to happen to ordinary tap water before it can become a habitat for cichlids—which is exactly what the chemists and aquarists at Georgia Aquarium do every day! Your students will then complete the lesson with a map activity that shows just where in the world it is that these cichlids call home.

Part 1: Using the Periodic Table of the Elements

Supplies: One copy of the periodic table of the elements per student

Your students will practice reading the periodic table by identifying elements and compounds essential to cichlid health. If your class science textbook does not have a periodic table, many versions can be found online including this one in the public domain from the National Institute of Standards and Technology: www.nist.gov/pml/data/periodic.cfm.

Answer Key

1. Ca, 20
2. Cu, 29
3. F, 9
4. I, 53
5. Fe, 26
6. Mg, 12
7. Mn, 25
8. K, 19
9. Se, 34
10. Zn, 30
11. (a.) fluorine, iodine, selenium; (b.) fluorine, iodine
12. period 4, 7 elements
13. magnesium and calcium
14. $MgCl_2$
15. KCl
16. $CaCl_2$
17. NaCl
18. $Al_2(SO_4)_3$
19. $MgSO_4$
20. KI

Part 2: From Tap to Tanganyika

Supplies per group: plastic cup, tap water, water quality test kit, internet access

The fresh water at Georgia Aquarium enters the building just as it enters the neighboring homes and schools, from the City of Atlanta's water source. Your students will become chemists as they figure out what would have to be done to that water that in order to make it suitable for Lake Tanganyika cichlids.

Inexpensive water tests are available from a variety of sources including science laboratory supply companies, swimming pool maintenance kits and pet stores. Students will test the water in several different categories, record their results and compare it to five standards given for water in a Lake Tanganyika habitat: pH, temperature, dH (hardness), chlorine/chloramine, and nitrites or nitrates.

Depending on the test kit you are using, students may be able to evaluate additional factors. For this lab, chlorine and chloramine have been combined into one category as they are both disinfectants used to kill pathogens in the water. Your test kit may measure one or both. Nitrates and nitrites enter our water supply as nitrogen contamination from fertilizer run-off. Again, your kit may only measure one or the other or both.

The results of the tap water test will depend on where you live. In general, the pH, temperature, and dH would need to be increased while the chlorine/chloramine and nitrates/nitrites should be reduced. To complete this activity, your students will research and identify ways to change the chemical make-up of your school tap water to make it appropriate for cichlids. Direct their attention to adjustments that can

be made with everyday substances, such as baking soda ($NaHCO_3$) to increase alkalinity, Epsom salts ($MgSO_4$) to increase water hardness, and evaporation to reduce chlorine.

Part 3: Where in the World?

Supplies: political and geographic map of Africa

Georgia Aquarium provides your students with the opportunity to experience species whose native habitats are on the other side of the globe. In fact, the distance between Atlanta, Georgia, and Tanzania (a country that borders Lake Malawi, Lake Tanganyika, and Lake Victoria) is over 8,000 miles! In Part 3, your class will use a map to answer questions about the cichlids' homes in the Rift Valley of eastern Africa.

Answer Key

1. Malawi—Lilongwe; Tanzania—Dodoma; Mozambique—Maputo
2. Burundi—Bujumbura; Democratic Republic of the Congo—Kinshasa; Tanzania—Dodoma; Zambia—Lusaka
3. Tanzania—Dodoma; Uganda—Kampala; Kenya—Nairobi
4. (a.) North = Victoria; (c.) South = Malawi
5. Indian Ocean
6. Shire River
7. Lukuga River
8. White Nile
9. Mount Kilimanjaro
10. Answers will vary and might include transportation/boats, fishing, washing, drinking, watering crops, dumping sewage, or bathing.

GEORGIA AQUARIUM

Name Class Date

River Scout: Tap into the Elements

Student Activity

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Terms to Know: *alkaline, aquarist, biodiversity, compound, contamination, halogen, invasive, isolated, lush, pathogens, tectonic*

GEORGIA AQUARIUM

Name Class Date

Part 1: Using the Periodic Table of the Elements

Trace elements occur in very small amounts but are vitally important nutrients for cichlids and other freshwater fish. These elements are added to a cichlid habitat in food or as a supplement to make the water similar to that of the ecosystems in eastern Africa. Use the periodic table in your science book, or the one provided by your teacher, to identify the symbol and atomic numbers of ten trace elements that cichlids need in order to survive.

1. Calcium: _____

2. Copper: _____

3. Fluorine: _____

4. Iodine: _____

5. Iron: _____

6. Magnesium: _____

7. Manganese: _____

8. Potassium: _____

9. Selenium: _____

10. Zinc: _____

11. (a.) Seven of these elements are metals. Which three are not? (b.) Which two of these three non-metals are halogens from group 17/VIIA?

_____

_____

12. Which horizontal period on the table contains most of the trace elements needed by cichlids? How many are in that period?

_____

_____

Name _____ Class _____ Date _____

13. Which two of the trace elements needed by cichlids are alkaline earth metals in group 2?

_____

_____

Although they are freshwater fish, cichlids need salt compounds in their water. Aquarists add these salts and other minerals to adjust the water chemistry for cichlids, including the pH level, but the water does not become salty like the ocean. Match the following salt compounds, critical for cichlids to survive, to their chemical formulas.

$Al_2(SO_4)_3$	KCl
$CaCl_2$	KI
$MgCl_2$	NaCl
$MgSO_4$	

14. Magnesium chloride _____

15. Potassium chloride _____

16. Calcium chloride _____

17. Sodium chloride _____

18. Aluminum sulfate _____

19. Magnesium sulfate _____

20. Potassium iodide _____

Part 2: From Tap to Tanganyika

The fresh water at Georgia Aquarium enters the building just as it enters homes and schools, from the City of Atlanta's water source. Once inside, habitat water is filtered to remove chlorine or other pollutants that aren't safe for the animals and plants. For example, copper can leak from pipes and poison the water. After water is added to a habitat, its chemistry is constantly checked by Aquarium experts and altered as necessary by adding or removing chemical components, including the elements and compounds you learned about in Part 1.

GEORGIA AQUARIUM

Name Class Date

Become a Georgia Aquarium chemist. Find out what needs to be done to the water that comes out of your school faucet to make it suitable for the Lake Tanganyika cichlids from **River Scout**. Fill a cup with water from the tap in your classroom or nearest water fountain. Use the test kit provided by your teacher to evaluate the tap water in several different categories:

- pH measures acidity and alkalinity. A liquid with a measurement of 0-7 is called an "acid" and 7-14 is known as a "base."
- The temperature of your tap water will depend on the temperature outside.
- dH measures general hardness, which is based on minerals in the water. Hard water has more minerals, such as calcium and magnesium.
- Chlorine and chloramine are added to water as disinfectants to kill pathogens.
- Nitrogen, in the form of nitrites or nitrates, is pollution from fertilizer run-off.

What's in the water? Test it!

	pH	Temperature	dH	Chlorine/ Chloramine	Nitrites/ Nitrates
Tap Water					
Lake Tanganyika	8.6 – 9.5	76 - 82 °F	11.0-17.0	0	0

Next, use the chart below to explain how your results compare to what is acceptable for Lake Tanganyika cichlids. Determine what needs to happen to the tap water and then design a strategy to adjust it as needed. For example, does the pH need to raised or lowered? Does the water need to be warmer or cooler? Consult your science book and research online for ideas on how to make these changes.

How can the water be changed? Plan a strategy!

	pH	Temperature	dH	Chlorine/ Chloramine	Nitrites/ Nitrates
What changes need to be made to the tap water?					
How can you make these changes?					

GEORGIA AQUARIUM

Name Class Date

Will it work? Dive deeper! Now, put your proposals to the test for your next science fair project! Make the adjustments you recommended in order to make the tap water more similar to the water of Lake Tanganyika and retest. Did your proposed methods work? Why or why not? What can you do differently next time?

Part 3: Where in the World?

Georgia Aquarium provides you with the opportunity to experience species you might otherwise never see since many of their native habitats are on the other side of the globe. In fact, the distance between Atlanta, Georgia, and Tanzania (a country that borders Lake Malawi, Lake Tanganyika, and Lake Victoria) is over 8,000 miles! Use a map of Africa to answer questions about the cichlids' homes in the Rift Valley of eastern Africa.

1. Name the countries that surround Lake Malawi (also called Lake Nyasa) and their capital cities.

2. Name the countries that surround Lake Tanganyika and their capital cities.

3. Name the countries that surround Lake Victoria and their capital cities.

4. (a.) Which of these three lakes is farthest north? (b.) Which lake is farthest south?

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5. Which ocean borders eastern Africa?

6. Which river flows out of Lake Malawi and into the Zambezi River and east to the Indian Ocean?

7. Which river flows out of Lake Tanganyika and eventually to the Atlantic Ocean?

8. Which river flows out of Lake Victoria, north to the Mediterranean Sea?

9. The valleys that filled with water and became lakes were formed by tectonic plates in eastern Africa separating over millions of years. Tectonic movements also form mountains and volcanoes. The tallest mountain in Africa was formed by three volcanoes in Tanzania. What is it called?

10. Many of the people around these lakes live in small, poor, isolated communities with little access to electricity, running water or even roads. List at least three reasons why the lakes are important for the people who live near them.

Lesson Plan 3
SunTrust Pier 225: Sentinels of the Sea

Teacher Instructions

As part of your class field trip, your students will enjoy a presentation called "Under the Boardwalk" in the **SunTrust Pier 225** gallery and meet Georgia Aquarium's charismatic California sea lions (*Zalophus californianus*). Two of the male sea lions, Neptune and Jupiter, are survivors of a recent unusual mortality event, or UME. These two animals, along with thousands more, were found stranded, malnourished, and underweight on the shores of California in 2015. Despite multiple attempts to rehabilitate these two sea lions, they continued to wash ashore and were declared non-releasable by the National Oceanic and Atmospheric Administration (NOAA Fisheries). When an animal can no longer be released into their natural habitat, a home may be found for them in the zoological community.

Georgia Aquarium is proud to provide a caring home to these pinnipeds, the name given to marine mammals that have front and rear flippers. To see how Neptune and Jupiter made their journey from California to Atlanta, show your students this short video: "Caring Together for Sea Lions: Rescue and Arrival," at www.youtube.com/watch?v=29yBPKrJDTA.

Along with other rescued sea lions at **Pier 225**, Neptune and Jupiter help educate the public about the challenges these animals face in their natural habitat in the Pacific Ocean. In "Under the Boardwalk," trainers interact with these social marine mammals and teach students about threats to their environment, including dwindling food sources.

Scientists suspect weather pattern changes and warmer oceans are behind the UME that left so many sea lions stranded. The fish that sea lion mothers usually eat while nursing their young pups prefer to live in cold water. Due to warmer water in the Pacific Ocean, these prey fish are now staying further out at sea. Nursing mothers either have to travel farther to get a good meal, or eat something less nutritional close by. As a result, many pups wean too early, wash ashore, or wander off to search for food themselves.

The Marine Mammal Center in California is one of the world's largest marine mammal rescue and rehabilitation facilities. It has a vital role in the rescue, rehabilitation and release of ill pups during an UME. The Center treats animals for other reasons, too, such as fishing gear entanglement, shark bites or gunshot wounds. Through work done at the Center, researchers know that there is one serious and often fatal condition found in sick California sea lions that is also is a threat to humans: domoic acid. It is poisonous to marine mammals and causes amnesiac shellfish poisoning in humans.

This powerful neurotoxin comes from some species of *Pseudo-nitzschia*. These plants are microscopic, photosynthesizing algae. How does a single-celled organism wreak havoc so far up the food web? Where does it come from? How does it explain why sea lions are considered sentinels of the sea? Your students will investigate these questions and more in the activities below. In Part 1, students will need their science book, a dictionary, or access to search online. Students will use blank paper and art supplies for the activity in Part 2. For Part 3, they will need graph paper and a calculator or access to a computer with spreadsheet software. The 2015 data for Part 3, in which

students compare sea temperatures to numbers of sea lions with domoic poisoning, comes from the Southern California Coastal Ocean Observing System (www.sccoos.org/data/habs/index.php) and The Marine Mammal Center (www.marinemammalcenter.org/patients/released-deceased-patients).

Answer Key

Part 1: 1.d, 2.h, 3.f, 4.j, 5.b, 6.i, 7.e, 8.a, 9.g, 10.c

Part 2: Assess for completion. The completed illustration should be depicted as a web, and not a linear chain. For each component of the explanation, students' drawings should include the following elements:

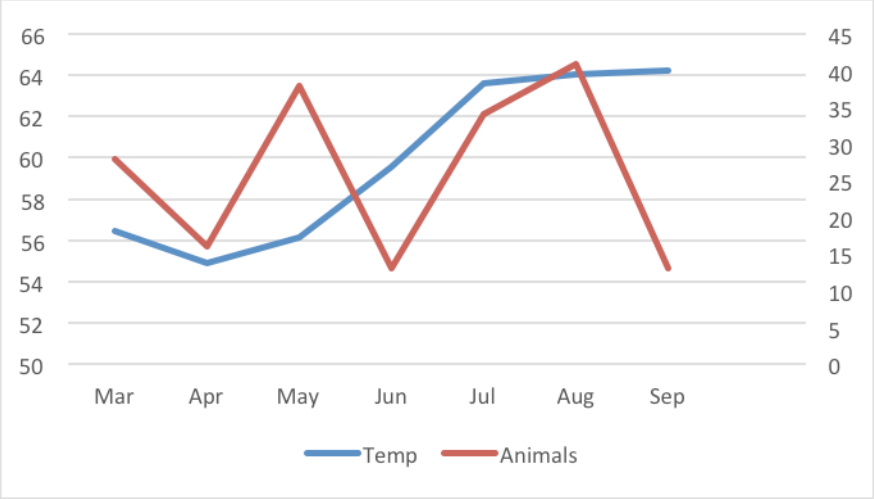
1. *Pseudo-nitzschia* adrift; other phytoplankton
2. Nutrient pollution and/or unusually warmer water; *Pseudo-nitzschia* blooms
3. Copepods and benthic bivalves consume *Pseudo-nitzschia*
4. Larger shellfish and smaller finfish consume copepods
5. Larger crustaceans eat poisoned bivalves
6. Humans eat crustaceans and shellfish, with a range of reactions
7. Sea lions eat sardines, anchovies, and fish with domoic acid; experience lethargy, seizures, paralysis, or death

Part 3

1.

	Mar	Apr	May	June	July	Aug	Sept	Oct
Avg.	56.43	54.88	56.13	59.57	63.56	64.02	64.24	63.88

2.



3. (a.) August, (b.) June
4. (a.) September, (b.) March
5. Students will probably answer no, because the highest months for one factor are not the same as the highest months for the other
6. (a.) both went down, then both went back up, (b.) both increased

7. Answers will vary and might suggest that there was a storm or winds that disrupted or disturbed the bloom, as mentioned in question #1, or perhaps there were fewer sea lions in the area at the time to become ill.
8. (a.) Temperature, because it is closer to a straight line than that for the numbers of animals. (b.) 1.24 degrees/month

GEORGIA AQUARIUM

Name Class Date

SunTrust Pier 225: Sentinels of the Sea

Student Activity

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***Terms to Know**: alga, amnesiac, bioaccumulation, deem, entanglement, gastrointestinal, infographic, lethargy, neurotoxin, pinniped, sentinel, silica, wean*

GEORGIA AQUARIUM

Name _____ Class _____ Date _____

Part 1

Use your science book, a dictionary or an online search to match these life science and earth science terms with their definitions. You will need them to complete the activity in Part 2.

a. benthic
b. bioaccumulate
c. bivalve
d. copepods
e. crustacean
f. diatom
g. krill
h. nutrient pollution
i. phytoplankton
j. zooplankton

1. _____ tiny marine or freshwater crustaceans

2. _____pollution caused by too many agricultural products washing into the water system, including nitrogen and phosphorus fertilizers that lead to excessive algae growth

3. _____a microscopic, single-cell alga with silica in the cell wall

4. _____plankton consisting mainly of tiny animals

5. _____to accumulate, or build up, within the tissues of an organism

6. _____plankton consisting mainly of tiny plants

7. _____invertebrate with a segmented body covered by a shell or crust, that lives in the water

8. _____located at the bottom or lowest level in a body of water

9. _____small, shrimp-like crustaceans eaten by whales and other large marine animals

10. _____mollusk that has two shells hinged together

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Name Class Date

Part 2

Read the explanation below for how domoic acid makes its way into mammals. On separate paper, create an illustrated flow chart or web to show the routes of toxic bioaccumulation in both sea lions and humans. Think of your work as an infographic for the **Pier 225** sea lion gallery!

1. *Pseudo-nitzschia* diatoms drift in the sea with other phytoplankton.

2. Under specific environmental conditions, such as nutrient pollution in the form of agricultural run-off or unusually warmer water temperatures, masses of *Pseudo-nitzschia* become harmful algal blooms.

3. Zooplanktons, including copepods, consume *Pseudo-nitzschia*. The algal bloom is also a food source for benthic bivalves (mussels, oysters, clams, scallops).

4. Copepods are consumed by larger shellfish, including krill, shrimp and small crustaceans as well as small finfish such as anchovies and sardines.

5. Larger crustaceans also eat the poisoned bivalves.

6. Humans eat afflicted crustaceans and shellfish, including crabs, mussels and clams. Reactions range from gastrointestinal distress to short term memory loss to death.

7. Sea lions that eat the sardines, anchovies and other prey with high concentrations of domoic acid experience lethargy, seizures, paralysis, or death.

Part 3

Sea lions are sentinels of the sea because once domoic acid is found in them, scientists know it won't be long before those toxins appear in the seafood that humans eat. In 2015, the same year the UME stranded record-breaking numbers of sea lions, there were also record-breaking numbers of sea lions with domoic acid poisoning. The elevated ocean temperatures contributing to the UME might also have caused the increased poisonings of sea lions at that time. The 2015 algal bloom was the largest and most toxic on record and dangerous enough to close fisheries up and down the coast of California.

The Marine Mammal Center took in over 200 sea lions suffering from domoic acid poisoning in 2015. By September, about 75% of the sea lions under their care were affected. The year before, only a third of the rescued sea lions were affected. Use the data below to compare average ocean temperatures to the number of sea lion patients with domoic acid poisoning admitted to the Center each month.

GEORGIA AQUARIUM

Name Class Date

1. Algal blooms usually break up with cooler temperatures, stronger winds and winter storms. Just like flowers, algae bloom in the spring and thrive in warm weather. Find the average ocean temperature from three locations for seven months in 2015, March through September. The three coastal California locations are where most of the Center's sea lions with domoic acid poisoning were found in 2015: Santa Cruz (SC), Monterey (M), and San Luis Obispo (SLO).

	Mar	Apr	May	June	July	Aug	Sept	Oct
SC	56.26	54.1	54.32	60.17	63.72	63.23	62.24	63.14
M	58.64	54.9	56.8	60.02	62.82	63.55	63.61	63.68
SLO	54.39	55.63	57.28	58.53	64.15	65.27	66.88	64.83
Avg.								

2. Create a combination line graph to compare two data sets. Plot one line for the average temperatures you calculated above and another for the numbers of sea lions admitted to the Marine Mammal Center with domoic poisoning each month. The y-axis on the far left of the graph will be for the water temperatures in Fahrenheit, with a range from 50° to 66°. The y-axis on the far right is the number of sea lions, with a range of 0 to 45. The x-axis is for the months. You will need graph paper to create your graph by hand or enter it into a spreadsheet program on a computer.

	Mar	Apr	May	June	July	Aug	Sept
Sea Lions	28	16	38	13	34	41	13

3. (a.) Which month had the greatest number of sea lions with domoic acid poisoning admitted? (b.) Which month had the fewest sea lions admitted?

4. (a.) Which month had the highest water temperature? (b.) Which month had the lowest temperature?

GEORGIA AQUARIUM

Name Class Date

5. On first glance, does there appear to be a connection between the temperature of the water in a given month and the number of poisoned sea lions admitted that month? Why or why not?

6. Now look at specific sections of time. Explain any similarities or differences you see in the two lines from (a.) March to May and (b) June to August.

7. What do you think could account for the increase in water temperature but decrease in domoic poisoning cases in May?

8. (a.) Which of the two lines is more appropriate for finding a slope? Why? (b.) What is its slope? Express your answer as a rate of change for degrees per month.

GEORGIA AQUARIUM

Mathematics, Science, Engineering

Geometry, Ratio & Proportion, Earth Science, Earth Science

Lesson Plan 4
Tropical Diver: Calculate and Cultivate

Teacher Instructions

When your students visit the **Tropical Diver** gallery at Georgia Aquarium, they will "dive" into one of the most diverse ecosystems in the world. The habitats and exhibits in this gallery provide views into the coral reefs of the Indian and Pacific Oceans. Your class can explore the ways a shipwreck becomes an artificial coral reef, watch garden eels sway in the current, and become mesmerized by flowing, glowing jellies.

At the center of this colorful gallery is one of the largest living reef exhibits in the United States, the Pacific Barrier Reef. Often called the "rainforests of the ocean," coral reefs occupy only 1% of the marine environment and yet are home to over 25% of all marine life. They are disappearing at an alarming rate largely because of human behavior, such as water pollution and dangerous fishing practices. Once the coral disappears, so do all the organisms that make their homes on, under, around, and in the reefs — from microscopic plankton to apex predators like sharks.

Georgia Aquarium has worked with coral reef experts around the world—from Florida to Fiji—to help protect and regrow damaged reefs. Here in Atlanta, the Aquarium's aquaculture laboratory cultivates corals for the Pacific Barrier Reef exhibit. Some of the jellies on display in the **Tropical Diver** gallery were also raised in the lab. These research and breeding programs align with the commitment of Georgia Aquarium to preserve biodiversity and support conservation efforts.

Scientists research both short- and long-term solutions to the destruction of coral reefs. One option is to build artificial reefs. Sometimes, artificial reefs are created to increase fish populations and prevent overfishing on already stressed reefs. Other times, they are used to repair a damaged reef. They can even be established in areas where there were no reefs before in an attempt to redirect divers, boats and fishermen away from a damaged habitat. The activities in this lesson plan introduce both the mathematical and the design sides of building artificial reefs.

For the math questions in Part 1, students will need scratch paper and/or a calculator. Students should work in pairs or groups for Part 2. You will need a large collection of Lego® or other interlocking toy bricks in the "2x4" size to simulate cinder blocks. Students will use them to design and build a model of an artificial reef. Be sure they view the images at the two websites listed below to help visualize how cinder blocks are used to calculate and cultivate artificial reefs.

- https://condofish.wordpress.com/media/galleries/adrian-stacey-gallery
- https://appliedecology.cals.ncsu.edu/absci/2014/07/the-final-reef-is-complete

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Answer Key

Part 1

1. 2000 gallons = 267.38 cubic feet, therefore the breadth and width are both approximately 5.78 feet: 8 ft x 5.78 ft x 5.78 ft
2. 114,552 ft^2
3. a. 13.333 tires per $mile^2$
4. 0.24 lbs/gal
5. 1520 gallons, total volume
6. (a.) 16 in = 406.4 mm and 8 in = 203.2 mm (b.) Both 32:406.4 and 16:203.3 = 12.7 mm. The scale is 1:12.7 mm

Part 2: Answers to design questions will vary but should be written for review. Artificial reef must be able to stand freely, supported only by its own bricks yet with enough space for both prey and predators to feel at home.

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Tropical Diver: Calculate and Cultivate

Student Activity

When you visit the **Tropical Diver** gallery at Georgia Aquarium, you will "dive" into one of the most diverse ecosystems in the world. The habitats and exhibits in this gallery provide views into the coral reefs of the Indian and Pacific Oceans. You can explore the ways a shipwreck becomes an artificial coral reef, watch garden eels sway in the current and become mesmerized by flowing, glowing jellies.

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Scientists research both short- and long-term solutions to the destruction of coral reefs. One option is to build artificial reefs. Sometimes, artificial reefs are created to increase fish populations and prevent overfishing on already stressed reefs. Other times, they are used to repair a damaged reef. They can even be established in areas where there were no reefs before in an attempt to redirect divers, boats, and fishermen away from a damaged habitat. The activities in this lesson plan introduce both the mathematical and the design sides of calculating and cultivating artificial reefs.

Terms to Know: *aggregate, aquaculture, breadth, decommissioned, interlocking, leach, polyp, scuttled, silica, simulate, substrate*

Part 1: Calculate

As you solve these math problems and answer the questions, you will learn more about the habitats in the **Tropical Diver** gallery at Georgia Aquarium as well as efforts to create artificial reefs in the natural environment. Use scratch paper and/or a calculator and write your answers below.

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1. The Shipwreck display you see in **Tropical Diver** demonstrates how a ship can become an artificial reef. It is home to various species of eel, cleaner shrimp and bigeye fish. This Shipwreck habitat is eight feet tall and holds 2,000 gallons of water. Assuming that the width and the breadth are equal, use the height and volume to calculate the dimensions of this rectangular prism. (Hint: There are 7.48 gallons in 1 cubic foot.)

2. While many shipwrecks are accidental, some artificial reefs have been created by purposefully sinking cleaned, decommissioned military ships. The *USS Oriskany* is a former U.S. Navy aircraft carrier that was scuttled off the coast of Florida in 2006. She was commissioned in 1950 and served mostly in the Pacific Ocean, in both the Korean and Vietnam wars. So far, she is the largest ship purposefully sunk for an artificial reef. The *Oriskany* was 888 feet long and 129 feet wide. If her top deck were completely flat, what would the surface area have been?

3. During the 1970s, two million tires were dumped into the Atlantic Ocean in an attempt to make an artificial reef. The project, the Osborne Reef, seemed like a good idea at the time but has since become an environmental disaster. We now know that the untreated tires and materials used to bind them together can leach chemicals into the water. Plus, the tires were not anchored properly. They have spread out, washed ashore, and smashed into existing (and previously healthy) marine habitats. The original site covered 150,000 m^2. What was the density of tires per square mile in the Osborne Reef?

a. 13.333 tires per $mile^2$

b. 0.075 tires per $mile^2$

c. 13.333 $miles^2$ per tire

d. 0.075 $mile^2$ per tire

4. When Georgia Aquarium was built, the habitats were filled with water from the City of Atlanta—the same water that goes into homes, schools and businesses. However, the water went through many treatment and filtering phases before it became suitable for marine life. After the water was purified, a product called "Instant Ocean®" was added to make it salty. At the initial salting of the Pacific Barrier Reef in **Tropical Diver**, 40,000 pounds of Instant Ocean® were added to the 164,000-gallon tank. How many pounds of Instant Ocean® per gallon of water did the Reef habitat require when it was first filled?

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5. To provide enough oxygen for the corals living in the Pacific Barrier Reef, an overhead wave machine simulates the motion of the ocean by regularly dumping water into the habitat. In each wave cycle, four buckets dump 380 gallons each. What is the total volume of the gallons dumped to create each "wave?"

6. Cinder blocks are often used to build artificial reefs. In Part 2 of this activity, you will design your own artificial reef using interlocking toy building bricks in place of cinder blocks. The standard "2x4" Lego® brick is 32 mm long and 16 mm wide. Cinder blocks are 16 inches long and 8 inches wide.

(a.) Convert the block's inches into millimeters to match the Lego® brick measurement system.

(b.) Calculate the scale of the cinder block reef model you will build with the Lego® bricks. (Hint: 1 inch = 2.54 centimeters)

Part 2: Cultivate

An artificial reef provides a surface upon which coral polyps and other marine animals establish their homes. After a hard coral polyp attaches itself to a substrate, it secretes a substance that hardens into a skeleton of calcium carbonate. The aggregate reef grows slowly as other corals attach to the existing skeleton. It can take up to 10,000 years for a small coral reef to form.

Cinder blocks are a suitable building material for artificial reefs partly because they already contain a form of calcium carbonate. They are made by mixing concrete with other ingredients including sand, gravel, and silica. The blocks are inexpensive, easy to find, and safer for the marine environment than many other objects than have been used in the past.

One popular form of cinder block artificial reef is the igloo-shape. Blocks are staggered atop each other in circles, getting smaller as they go up. Visit the image gallery at https://condofish.wordpress.com/media/galleries/adrian-stacey-gallery to see how one community in Costa Rica has used this design to build an artificial reef near the beach town of Playa Hermosa.

A group of scientists in the Bahamas uses anywhere from 30 to over 80 blocks to create the different reefs they need for their research. You can see one under construction here: https://appliedecology.cals.ncsu.edu/absci/2014/07/the-final-reef-is-complete. Other designs include stacking the blocks into tall pyramids or keeping them low and long, like a short wall.

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As you can imagine, the design possibilities are practically endless but there are certain factors to consider with your group during the planning stages of this challenge. Discuss and record answers to the following design questions:

- Will your artificial reef stand alone or be one in a group?
- How will the structure encourage marine life? For example, are there vertical surfaces for polyps to attach to or crevices where small fish can hide?
- Could an animal become trapped or entangled?
- Since you would be paying for each brick in real life, how can you strike a balance between stability and economy?

Your team should begin by making a sketch before you build your model with the Lego® or other interlocking toy bricks provided by your teacher. The final design needs to be able to stand freely, supported only by its own bricks yet with enough space for both prey and predators to feel at home. You may need to revise your plan along the way as you discover ways to improve it. When all groups have built their models, arrange them together to create a miniature artificial coral reef in your classroom.

Science, Social Studies, Fine Arts

Engineering Design, Earth Science, Geography, Culture, Visual Arts

Lesson Plan 5
Ocean Voyager: Turtle Tales and Telemetry

Teacher Instructions

At 6.3 million gallons, the **Ocean Voyager Built by The Home Depot** gallery at Georgia Aquarium is one of the world's largest indoor aquatic habitats. Some of the biggest animals in the Aquarium live here, including four whale sharks (*Rhincodon typus*) and four manta rays (*Manta spp.*). One of the newer residents your students will see in **Ocean Voyager** is Tank, the 450-pound green sea turtle (*Chelonia mydas*). He came from the Aquarium's partner facility in Florida, Marineland Dolphin Adventure. Tank was rescued and rehabilitated after a shark attack. He now serves as an ambassador to his species, educating everyone about green sea turtles and the dangers they face in their natural habitat.

In addition to caring for Tank, Georgia Aquarium plays an important role in the conservation of loggerhead sea turtles. The Aquarium has worked with the Georgia Sea Turtle Center on Jekyll Island and Georgia Aquarium Conservation Field Station in Marineland, Florida, to ensure these animals are safely returned to the ocean after rescue and rehabilitation. Thanks to the efforts of the Aquarium's researchers and expert veterinarians, loggerhead sea turtles (*Caretta caretta*) have been released in Georgia, Florida and North Carolina. Before they are released, the turtles are fitted with non-invasive satellite tags in order to learn more about protecting them in their natural habitat. Show your students photos of sea turtles—with satellite tags attached—from one of the releases here: www.flickr.com/photos/georgiaaquarium/sets/72157624378077487/with/4797183252/.

Because sea turtles spend most of their life at sea, long phases of their lifecycle remain a mystery. Most of our knowledge centers on the nesting females who come ashore every year to lay their eggs. However, new technologies like satellite tags can provide data during the time that the turtles are at sea. Satellite tags use an automated information processing system called "telemetry" to relay measurements and locations of sea turtles and many other animals.

Your students will use location data collected from real telemetry tags on green sea turtles in Part 1 of this lesson. The information is collected and provided by a group called OBIS-SEAMAP (Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations), which also has databases for marine mammals, seabirds, other kinds of sea turtles, and rays and sharks: http://seamap.env.duke.edu. Students will need a map or atlas and a blank world map with lines of latitude and longitude. If your social studies textbook does not already provide blackline master maps for you to copy for your class, there are many options online including:

- www.eduplace.com/ss/maps
- www.worldatlas.com/webimage/testmaps/maps.htm
- www.clickandlearn.cc/FreeBlacklineMaps/FreeBlacklineMaps.htm.

In Part 2, your students will explore the important role the nomadic green sea turtle plays in the folklore of one ancient culture. This section features the story of Kauila from an ancient Hawaiian myth. Kauila is a green sea

turtle goddess who lived on a beach, Punalu'u, with black volcanic sand on the Big Island. The tale provides a mythological explanation for a freshwater spring and the stream of fresh water that really flows under the black sand at Punalu'u. After reading the tale, students will need black construction paper and pastels or chalk to illustrate it.

In addition to telemetry, there are other ways to tag and track sea turtles, which your students will investigate while working in teams to design the "Ultimate Sea Turtle Tag" in Part 3. A reclusive philanthropist (you!) who loves sea turtles (who doesn't?) has decided to donate money to whomever can develop the most technologically advanced data collection system ever. In a presentation to the class, each team must convince "the mystery philanthropist" and a group of investors (the rest of the class) that their design is the best option. This section may be completed easily as a hypothetical proposition within one class period or extended into an inquiry-based project over several days. Students will need access to the internet to conduct their research.

Answer Key

Part 1

1. Check for accuracy for the locations on the list
2. Check for accuracy: Tropic of Capricorn ~ 23°N, Tropic of Cancer ~ 23°S
3.

	Latitude	Longitude	Location
1.	21°S	177°W	southern Pacific Ocean, between Fiji and Tonga
2.	7°S	40°E	Indian Ocean, coast of Tanzania
3.	4°S	40°E	Indian Ocean, coast of Kenya
4.	5°N	104°E	Malaysia, NE of Singapore, Gulf of Thailand/South China Sea
5.	9°N	84°W	Southwest coast of Costa Rica, Pacific Ocean
6.	12°N	67°W	North of Venezuela, Caribbean Sea
7.	13°N	91°W	Coast of Guatemala, Pacific Ocean
8.	14°N	124°E	East coast of Philippines, Philippine Sea/Pacific Ocean
9.	15°N	118°E	South China Sea between Japan and Philippines, closer to Philippines
10.	15°N	146°E	east of Northern Mariana Islands, Pacific Ocean
11.	18°N	78°W	SW coast of Jamaica, in Caribbean Sea
12.	20°N	87°W	east side of Mexico's Yucatan Peninsula, Caribbean Sea
13.	21°N	157°W	coast of Hawaii, south of Moloka'i, in Pacific Ocean
14.	32°N	129°E	southwest Japan, in the East China Sea
15.	33°N	79°W	Atlantic Ocean, coast of SC
16.	36°N	55°W	Northern Atlantic Ocean, northeast of Bermuda
17.	37°N	76°W	Mouth of the Chesapeake Bay/Atlantic Ocean, coast of VA
18.	40°N	73°W	Atlantic Ocean, coast of NY/NJ
19.	44°N	68°W	coast of Maine, Atlantic Ocean near Bay of Fundy mouth
20.	56°N	1°W	North Sea, east coast of Scotland

4. Use locations from chart

5. Answers will vary but may focus on those found farther north, such as the coasts of Maine and Scotland
6. 13
7. They are in the Atlantic Ocean
8. The warmer waters of the Gulf Stream

Part 3: You can assess the team's written responses to Step 2 and the quality of their presentation.

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Name Class Date

Ocean Voyager: Turtle Tales and Telemetry

Student Activity

At 6.3 million gallons, the **Ocean Voyager Built by The Home Depot** gallery at Georgia Aquarium is one of the world's largest indoor aquatic habitats. Some of the biggest animals in the Aquarium live here, including four whale sharks (*Rhincodon typus*) and four manta rays (*Manta spp.*). One of the newer residents you will see in **Ocean Voyager** is Tank, the 450-pound green sea turtle (*Chelonia mydas*). He came from the Aquarium's partner facility in Florida, Marineland Dolphin Adventure. Tank was rescued and rehabilitated after a shark attack. He now serves as an ambassador to his species, educating everyone about green sea turtles and the dangers they face in the wild.

In addition to caring for Tank, Georgia Aquarium plays an important role in the conservation of loggerhead sea turtles. The Aquarium has worked with the Georgia Sea Turtle Center on Jekyll Island and Georgia Aquarium Conservation Field Station in Marineland, Florida, to ensure these animals are safely returned to the ocean after rescue and rehabilitation. Thanks to the efforts of the Aquarium's researchers and expert veterinarians, loggerhead sea turtles (*Caretta caretta*) have been released in Georgia, Florida and North Carolina. Before they are released, the turtles are fitted with non-invasive satellite tags in order to learn more about protecting them in their natural habitat.

Because sea turtles spend most of their life at sea, long phases of their lifecycle remain a mystery. Most of our knowledge centers on the nesting females who come ashore every year to lay their eggs. However, new technologies like satellite tags can provide data during the time that the turtles are at sea. Satellite tags use an automated information processing system called "telemetry" to relay measurements and locations of sea turtles and many other animals.

You will use location data collected from real telemetry tags on green sea turtles in Part 1 of this lesson. In Part 2, you will explore the important role the nomadic green sea turtle plays in the folklore of one ancient culture. In addition to telemetry, there are other ways to tag and track sea turtles, which you will investigate while designing the "Ultimate Sea Turtle Tag" in Part 3.

***Terms to Know**: chlorophyll, ectotherm, Gulf Stream, herbivore, investors, philanthropist, plight, Polynesian, reclusive, telemetry, Tropic of Cancer, Tropic of Capricorn, tropical zone*

Part 1

The green sea turtle is one of seven species of endangered sea turtles. Its name comes from the color of its fat tissue. As adults, they are herbivores. Chlorophyll found in the plants they eat imparts a greenish hue. All sea turtles live in tropical and subtropical waters around the world. Because they are ectotherms, they rely on the environment to maintain their body temperature. Warm water in the tropics, as well as that flowing in currents like the Gulf Stream, bring sea turtles to the coasts of six of the seven continents.

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The chart below lists latitudes and longitudes for locations where green sea turtles, like Tank, have been recorded. The data comes from tagged green sea turtles and includes twenty areas frequented by them in the decade before Tank found his home in Atlanta. This is just a sample from hundreds of thousands of locations where the turtles have been seen or detected. To complete this chart, you will need an atlas or globe and a blank world map from your teacher.

1. Locate and label the following on your world map: Atlanta, all seven continents, Pacific Ocean, Atlantic Ocean, Indian Ocean, Arctic Ocean, Caribbean Sea, Gulf of Mexico, South China Sea, Arabian Sea, Bay of Bengal, Gulf of Thailand, Coral Sea, Philippine Sea, Gulf of St. Lawrence, Mediterranean Sea, and North Sea.

2. Label the latitude lines representing the Tropic of Capricorn and the Tropic of Cancer. Draw them on your map if they are not already included.

3. Identify these absolute locations based on their latitudes and longitudes. Include the name of the nearest land and body of water. The first one has been done for you.

	Latitude	Longitude	Location
1.	21°S	177°W	southern Pacific Ocean, between Fiji and Tonga
2.	7°S	40°E	
3.	4°S	40°E	
4.	5°N	104°E	
5.	9°N	84°W	
6.	12°N	67°W	
7.	13°N	91°W	
8.	14°N	124°E	
9.	15°N	118°E	
10.	15°N	146°E	
11.	18°N	78°W	
12.	20°N	87°W	
13.	21°N	157°W	
14.	32°N	129°E	
15.	33°N	79°W	
16.	36°N	55°W	
17.	37°N	76°W	
18.	40°N	73°W	
19.	44°N	68°W	
20.	56°N	1°W	

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4. Put all 20 locations from the chart on your map.

5. In your opinion, which location was the most unexpected place to find a sea turtle? Why?

6. Of the 20 places listed, how many are within the tropical zone?

7. Identify one factor that most of the places north of the Tropic of Capricorn have in common.

8. What geographic phenomenon accounts for the presence of so many sea turtles in a northern ocean?

Part 2

Turtles appear in as many ancient stories as they do on coastlines around the world. Several Native American creation myths say the earth is actually the back of a giant turtle. The turtle is often a very clever creature in African folktales. In Hawaii—one of the places on your map from Part 1—the green sea turtle is called "honu." Legends claim that the original Polynesian settlers found the islands by following the honu. Also in Hawaii, you will hear about the story of Kauila. Kauila is a green sea turtle goddess who lived on a beach, Punalu'u, with black volcanic sand on the Big Island. The tale provides a mythological explanation for a freshwater spring and the stream of fresh water that really flows under the black sand at Punalu'u.

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Keiki and Kauila

> *Long ago, a mother sea turtle named Honupo'okea ("turtle with white head") came out of the ocean, as all sea turtle mothers do at nesting time. Honupo'okea arrived on the black sands of Punalu'u and dug a large hole with her strong front flippers. She placed one beautiful egg in the hole and carefully covered it back up. Before she returned to the sea, she dug another hole in the sand near the nest with the help of her husband, Hon'ea ("turtle with red-brown shell"). That hole became a freshwater pond. Soon a beautiful baby girl green sea turtle, Kauila, hatched.*
>
> *Kauila lived on the beach, returning often to her freshwater pond. She loved playing with the local children (keiki) and was known to transform herself into a girl occasionally to join them. The keiki knew she was resting in the pond when they saw bubbles rising in it. Kauila also shared the fresh drinking water from her pond with the children. As she grew up, she became the keiki's guardian. The people were forever grateful to her for taking care of their children by providing water and watching over them as they played.*

Today, honu and keiki still share the beach of black sand at Punalu'u. Nearby, a bronze plaque telling the story of Kauila stands to honor her. The plaque contains an engraving of a child sleeping on the shell of a large sea turtle. What kind of image would you choose to illustrate Kauila's legend? Using black construction paper to represent the black sand, illustrate the story by drawing with the chalk or pastels. Your illustration may be a literal or artistic interpretation of Kauila's tale.

Part 3

Satellite tags can collect a wide range of information but they require a power source. Simple plastic or metal tags on a sea turtle's flippers are less expensive, but they rely on people to find and report sightings. Another option involves a small microchip—like your pet cat or dog might have—inserted into a turtle's flipper. However, it requires the right scanner to read the chip. These are only three methods commonly used to track animals. Each of them has their own advantages and disadvantages.

If you were in charge of tagging and tracking an endangered species, what information would you want to collect? Environmental conditions? Location? Health readings and body chemistry? How would the data be used by you or other researchers? Without today's technological limits, what might the turtle tag of tomorrow look like? How would it function?

What if there were inexpensive, non-invasive techniques that gathered any kind of data imaginable and did not run out of power? A reclusive philanthropist (your teacher!) who loves sea turtles (who doesn't?) has decided to donate money to whomever can develop the most technologically advanced data collection system. In a presentation to your class, your team must convince "the mystery philanthropist" and a group of investors (the rest of your class) that your design is the best option.

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Step 1: Learn more about tagging turtles. Currently, creative engineers are experimenting with different kinds of sensors, solar power, GPS, photography, 3D printing and even drones in an attempt to come up with new ways to gather information about sea turtles. Begin your research on these sites.

- www.seaturtle.org/tagging/satellite.shtml
- www.conserveturtles.org/seaturtletracking.php?page=satwelc
- www.seaturtlestatus.org/sites/swot/files/report/SWOT10_Report_Final.pdf (pp. 8-13)
- www.sprep.org/marine-turtles/turtle-tagging
- www.worldwildlife.org/initiatives/tracking-turtles-via-satellite
- www.actionbioscience.org/biodiversity/costa.html

Step 2: Time for your engineering challenge, "The Ultimate Sea Turtle Tag!" Include all of the following information on separate paper for your design.

Plan

1. What is the name of your new sea turtle tracking system?
2. Describe what it will look like. Include a sketch.

Research and Development

1. Identify three tracking tags or systems already in use that your invention will improve upon. Explain why your new tagging system is better.
2. In addition to the websites already given, list two more resources (online or books) your team used while working on this design challenge.

Data Collection

1. What kind of information will your new tracking system collect?
2. Is the information stored by the device to be retrieved later, or is the data sent as it is gathered? How?
3. What will scientists use the data to learn?
4. Does it provide images as well as data?
5. How will this information help the plight of an endangered species?

Design

1. What are three tools or technologies (real or invented by your team) that your design uses?
2. Does your device require a power source? If so, what is it? Does it stay "on" all the time?
3. Does it need to be waterproof or safe at deep depths? Why or why not?
4. Does it passively observe the animals or is it attached to them?
5. What materials are used to make it?

Step 3: Prepare your presentation. Remember, you need to convince the philanthropist and the investors that your team's idea for a new sea turtle tracking system is the most practical and useful.

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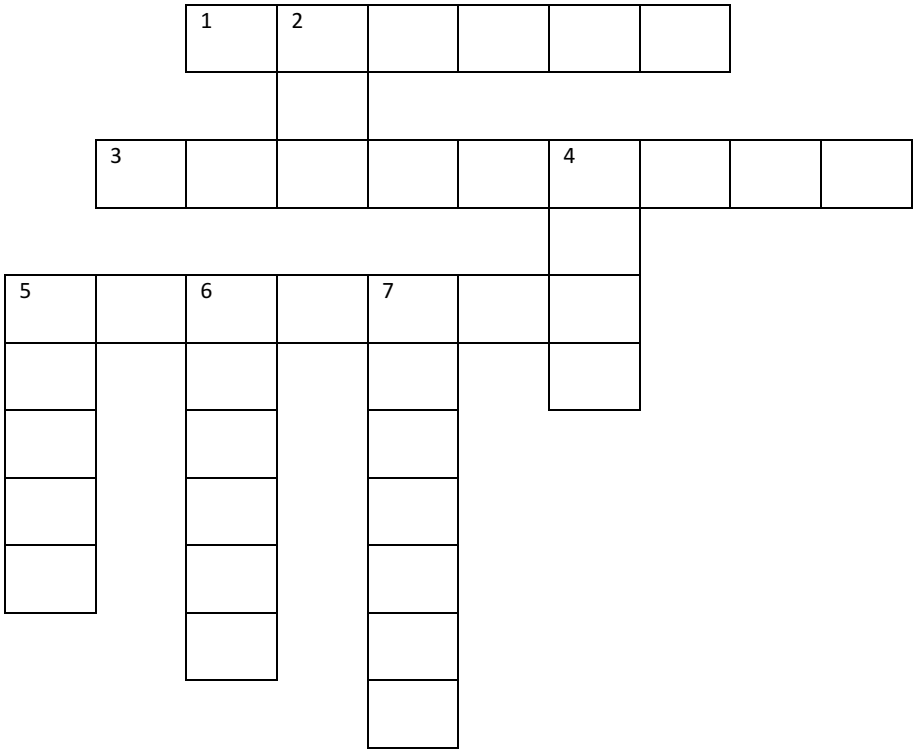
Crossword: Animal Offspring

Match the name of an animal that resides at Georgia Aquarium listed in the word bank with the term used for its baby or youngster in the clues. Did you know you saw a fry and a pup on your field trip?

Across
1. calf
3. ephyra
5. larva

Down
2. elver
4. fry
5. pup
6. hatchling
7. chick



BELUGA	OCTOPUS
EEL	OTTER
FISH	PENGUIN
JELLYFISH	TURTLE

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Word Search: Oceans, Seas and Bays

An **ocean** is one of the five major bodies of salt water that surround the continents. A **sea** is a division of an ocean or a large body of salt water mostly enclosed by land. A **bay** is part of a large body of water that extends into a shoreline. Search below for the names of these four oceans, four seas and two bays.

ARCTIC Ocean
ATLANTIC Ocean
BERING Sea
CARIBBEAN Sea
HUDSON Bay
INDIAN Ocean
MEDITERRANEAN Sea
MONTEREY Bay
PACIFIC Ocean
RED Sea

M	J	F	I	L	G	C	A	L	C	O	H	F	T
G	E	M	A	N	L	T	I	W	A	Z	D	T	E
B	F	D	I	R	L	R	D	F	R	I	K	L	D
V	N	R	I	A	C	L	L	D	I	A	C	K	P
V	E	Y	N	T	W	T	B	N	B	C	J	U	R
B	O	T	E	K	E	J	I	W	B	Z	A	H	N
H	I	X	R	W	O	R	S	C	E	N	Z	P	A
C	R	C	U	O	B	R	R	A	A	G	F	C	I
Y	E	R	E	T	N	O	M	A	N	E	Z	Q	D
F	X	E	S	F	Q	T	K	T	N	H	W	P	N
N	D	Q	R	M	R	I	J	Y	Q	E	U	Y	I
G	B	P	E	U	W	J	N	K	F	G	A	X	T
B	H	U	D	S	O	N	E	I	T	L	F	N	K

GEORGIA AQUARIUM

Answers are Questions: Aquarium Jeopardy!

- Point values in ascending order from 100-500
- Answers must be in the form of a question

Water	Elasmobranches	Life History	Physiology	Georgia Aquarium	Conservation
The percentage of the Earth's water that is freshwater	The protective covering over sharks' skin	The name of the southern super continent after the Pangaea split	One challenge faced by organisms in the intertidal zone	The Correll Center for Aquatic Animal Health was created in this year	The reason a species would be a non-sustainable seafood choice
The depth at which colors begin to disappear	The shark to which the largest shark tooth fossil belongs	The currently accepted approximate age of the Earth	The primary source of fresh water for marine mammals	The amount of water in Ocean Voyager	A natural substance that can be used in place of fossil fuels to make plastic
The ideal water temperature for coral reefs	The common name for *Rhincodon typus*	The era to which the earliest animal fossils can be dated	An adaptation found in mangroves allowing them to grow directly in seawater	The name of the species of penguin found at Georgia Aquarium	The number of years it takes for a plastic grocery bag to decompose
The salinity of ocean water	A difference between sharks and rays	The oldest region on the world ocean (which "ocean")	Adaptations in the gills of bony fish allowing them to live in freshwater	The name of Georgia Aquarium's first manta ray	Pollution resulting from the actions of the general population
The temperature of the water in the deepest areas of the ocean	One of the differences between skates and rays	The number of years (in millions) that horseshoe crabs have been on Earth	The process that follows glycolysis when oxygen is not present	The smallest species of shark found in Georgia Aquarium	The characteristics of amphibians that make them indicator species

Final Jeopardy Category: Georgia Aquarium

- Name three species of rays found in the Seaside Touch Pool. *(black blotched fantail, cownose, Atlantic)*

Final Jeopardy Category: Research and Conservation

- What is the conservation status of the California sea lion on the IUCN Red List? *("Least Concern")*

GEORGIA AQUARIUM

Answer Keys

Crossword: Across 1. Beluga, 2. Jellyfish, 3. Octopus; Down 2. Eel, 4. Fish, 5. Otter, 6. Turtle, 7. Penguin

Word Search

M	J	F	I	L	G	C	A	L	C	O	H	F	T
G	E	M	A	N	L	T	I	W	A	Z	D	T	E
B	F	D	I	R	L	R	D	F	R	I	K	L	D
V	N	R	I	A	C	L	L	D	I	A	C	K	P
V	E	Y	N	T	W	T	B	N	B	C	J	U	R
B	O	T	E	K	E	J	I	W	B	Z	A	H	N
H	I	X	R	W	O	R	S	C	E	N	Z	P	A
C	R	C	U	O	B	R	R	A	A	G	F	C	I
Y	E	R	E	T	N	O	M	A	N	E	Z	Q	D
F	X	E	S	F	Q	T	K	T	N	H	W	P	N
N	D	Q	R	M	R	I	J	Y	Q	E	U	Y	I
G	B	P	E	U	W	J	N	K	F	G	A	X	T
B	H	U	D	S	O	N	E	I	T	L	F	N	K

(Over, Down Direction)

ARCTIC (4, 2, SE)
ATLANTIC (8, 1, SW)
BERING (1, 6, NE)
CARIBBEAN (10, 1, S)
HUDSON (2, 13, E)
INDIAN (14, 11, N)
MEDITERRANEAN (1, 1, SE)
MONTEREY (8, 9, W)
PACIFIC (13, 7, NW)
RED (4, 11, S)

Aquarium Jeopardy: What is/are…?

Water	Elasmobranches	Life History	Physiology	Georgia Aquarium	Conservation
3%	Dermal denticles	Gondwana	Extreme temperature changes, water vs. air cover, salinity, waves	2006	Consumed faster than they can reproduce/farming methods harmful to environment
30 ft.	Megalodon	4.5 billion years	Food	6.3 million gallons	Corn
77°F or 25°C (answer can vary by a degree)	Whale shark	Precambrian	Salt excretion on leaves, “sacrificial leaf”	African	60
3.5% or 35 ppt (answer may vary from 33-36ppt/3.3-3.6%)	Placement of gill slits	Indo-Pacific	Ion pumps	Nandi	Non-point source pollution
4°C or 39°F	Spines, extra set of fins, lay eggs/live birth	350 million (accept 300-450 million)	Fermentation	Epaulette shark	Absorption of contaminants through skin (population levels indicate pollution levels)

GEORGIA AQUARIUM

Go Figure!

Teachers: Let numbers (and maybe a little math) tell the story of Georgia Aquarium to your students. Swim around this list to locate information you can use as reference material in your classroom. *Please note*: this data is subject to change.

PEOPLE

- More than **24 million** guests have visited Georgia Aquarium since it opened in 2005.
- Guests from all **50 states** and **143 countries** on **six continents** have visited the Aquarium.
- Volunteers have served more than **1.6 million** hours since 2005.

SIZE

- **One-and-a-half White Houses** could fit into the 84,000 square-foot AT&T Dolphin Tales gallery.
- The Dolphin Tales Theater's impressive viewing window is the length of **two school buses**.
- Georgia Aquarium is one of the world's largest aquariums with more than **10 million gallons** of water in more than **100 habitats**.
- Tropical Diver's Pacific Barrier Reef habitat is one the largest reef exhibits in the United States, at about **164,000 gallons**.
- Georgia Aquarium is the only aquarium in the United States that is home to manta rays and the only aquarium in North America that is home to whale sharks, the **largest fish** in the world.
- Ocean Voyager is one of the world's largest indoor aquatic habitats at **6.3 million gallons**.

FOOD (Per Year!)

- The Georgia Aquarium commissary prepares more than **600,000 pounds** (272,158 kg) of food for its animals.
- Collectively, the four whale sharks in Ocean Voyager eat more than **91,500 pounds** (41,504 kg) of krill, fish and gel.
- Penguins are offered **18,500 pounds** (8,391 kg) of diet items.
- Beluga whales are offered more than 70,000 lbs. (31, 751 kg) of fish.
- Sea otters are offered more than 18,500 lbs. (8,391 kg) of clams, squid, crab, shrimps, scallops and other assorted seafood.
- The commissary handles enormous amounts of seafood including **76,500 pounds** (34,700 kg) of krill, **250,000 pounds** (113,399 kg) of capelin, and **8,700 pounds** (3,946 kg) of fish-based gel.

WATER

- Each minute, the Aquarium's life support system filters more than **170,000 gallons** of water.
- The building uses about **70 miles** of pipes...enough to circle the city of Atlanta along I-285.
- Georgia Aquarium's Life Support Systems are able to recover and reuse **99.5%** of all exhibit water each week.
- Georgia Aquarium has **reduced water usage by about 24%** each month through a combination of condensation recaptured from cooling units, waterless urinals and operational improvements to life support systems.

GEORGIA AQUARIUM

Aquarium Awareness Days

This month-by-month list includes key dates that readily connect your students to the STEAM themes found within Georgia Aquarium. Be creative, have fun—go deep!

For example,

- For African Penguin Awareness Day in October, research the *MV Treasure* Oil Spill. Morty Waddlesworth, the elder statesman of the Aquarium spokespenguin family, is a survivor of this historic event.
- Ask students to compare the effects of climate change and the environmental characteristics of the North Pole to their hometown for International Polar Bear Day, February 27.
- On World Oceans Day in June, make a school-wide commitment to take a pass on disposable bottles, utensils and wrappers, as these items often end up as plastic trash in our ocean.

Note: Dates in **bold** are observed at Georgia Aquarium

January
- **17: National Dolphin and Whale Protection Awareness Day**
- **20: Penguin Awareness Day**

February
- 2: World Wetlands Day
- 14: World Whale Day
- 27: International Polar Bear Day

March
- 3: World Wildlife Day
- 22: World Water Day
- 28: Earth Hour

April
- 16: Dolphin Day
- **17: Autism Awareness Day**
- **22: Earth Day**
- 25: World Penguin Day

May
- **16: Endangered Species Day**
- **21: Armed Forces Day**
- 22: World Biodiversity Day
- 23: World Turtle Day

June
- 5: World Environment Day
- **8: World Oceans Day**
- 24: Catfish Day

July
- 14: Shark Awareness Day
- 16: World Snake Day

August
- **30: International Whale Shark Day**

September
- **18: Sea Otter Awareness Week**
- 18: World Water Monitoring Day
- 27: World Rivers Day

October
- 4: World Animal Day
- 5: World Habitat Day
- 8: World Octopus Day
- **8: Cephalopod Awareness Days**
- **13: African Penguin Awareness Day**
- 21: Reptile Awareness Day

November
- 3: Jelly Day

GEORGIA AQUARIUM

Georgia Aquarium: Through the Years

These significant moments in the history of Georgia Aquarium, from Bernie Marcus's initial dream to the Aquarium's 10-year anniversary celebration, connect to themes, events, people and topics featured in this Teacher's Guide and within the galleries you visit on your field trip.

2001	Bernie Marcus, co-founder of The Home Depot, and his wife, Billi, give a gift of $250 million through the Marcus Foundation to build Georgia Aquarium.
2003	Coca-Cola generously donates the nine and a half acres on which the Aquarium sits. Construction begins on Georgia Aquarium.
2005	Bernie Marcus's dream is fulfilled and the world's largest aquarium at the time is open to the public.
2006	A.D. "Pete" and Ida Correll gift $2.5 million to build the Correll Center for Aquatic Animal Health, a state-of-the-art animal care facility within Georgia Aquarium.
	The three millionth guest visits Georgia Aquarium within its first nine months of opening.
2007	The five millionth guest visits Georgia Aquarium.
2008	Georgia Aquarium announces the "Journey with Gentle Giants" swim and dive immersion program.
	Georgia Aquarium makes a $1.5 million contribution to establish Georgia Aquarium Conservation Field Station, a new marine animal rescue and research facility in Marineland, Florida.
2009	The 10 millionth guest visits Georgia Aquarium.
2010	Three rescued southern sea otter pups find a home at Georgia Aquarium in the Cold Water Quest gallery.
2011	The Aquarium acquires the world's first oceanarium, now known as Marineland Dolphin Adventure, near St. Augustine, Florida.
	AT&T Dolphin Tales, Georgia Aquarium's $110 million dolphin exhibit, opens to guests.
	Ocean Mysteries with Jeff Corwin from Georgia Aquarium premieres on television.
2012	Georgia Aquarium's Volunteer department reaches one million hours of contribution.
2014	The Georgia Pacific Penguin Nursery is unveiled to aid in enhancing the Aquarium's already successful African penguin breeding program.
	The 20 millionth guest visits Georgia Aquarium.
2015	Georgia Aquarium opens its new interactive gallery, Aquanaut Adventure: A Discovery Zone.
	Georgia Aquarium researchers and Emory University successfully sequence the first full shark genome using DNA from the whale sharks in Georgia Aquarium's collection.
	Georgia Aquarium concludes its 11th year with the Health and Environmental Risk Assessment (HERA) and researchers discover a major link between human health, dolphin health and the health of our ocean.
	Georgia Aquarium kicks off its year-long 10th anniversary celebration.
2016	A new, educational dolphin presentation, AT&T Dolphin Celebration, replaces the original presentation in the AT&T Dolphin Tales theater.
	Georgia Aquarium's 4D Funbelievable Theater reopens following renovations with a screening of *Happy Feet*.

GEORGIA AQUARIUM

Deeper Dive: Curriculum Correlations

Grades 6-8

We know how important it is for you to justify field trips and document how instructional time is spent outside of your classroom. With this in mind, both the activities in this Teacher's Guide and the experiences your students have during their field trip to Georgia Aquarium are correlated to the Common Core State Standards for Mathematics, Common Core State Standards for English Language, the Next Generation Science Standards, the C3 Framework for Social Studies State Standards, and the National Core Arts Standards. These standards are arranged by content area and then by grade.

Following the national curricula, you will find the Georgia Performance Standards and Standards of Excellence. In addition, specific requirements are provided for Alabama, Florida, North Carolina, South Carolina, and Tennessee.

NATIONAL STANDARDS

Common Core State Standards for Mathematics

Standard for Mathematical Practice: CCSS.Math.Practice.MP1, CCSS.Math.Practice.MP2, CCSS.Math.Practice.MP4, CCSS.Math.Practice.MP5, CCSS.Math.Practice.MP6

Grade 6: CCSS.Math.Content.6.RP.A.1, CCSS.Math.Content.6.RP.A.2, CCSS.Math.Content.6.RP.A.3, CCSS.Math.Content.6.NS.B.2, CCSS.Math.Content.6.EE.A.1, CCSS.Math.Content.6.EE.A.2, CCSS.Math.Content.6.EE.B.6, CCSS.Math.Content.6.G.A.2, CCSS.Math.Content.6.SP.A.2, CCSS.Math.Content.6.SP.B.4, CCSS.Math.Content.6.SP.B.5

Grade 7: CCSS.Math.Content.7.RP.A.2, CCSS.Math.Content.7.RP.A.3, CCSS.Math.Content.7.NS.A.3, CCSS.Math.Content.7.EE.A.1, CCSS.Math.Content.7.EE.A.2, CCSS.Math.Content.7.EE.B.4, CCSS.Math.Content.7.G.B.6, CCSS.Math.Content.7.SP.B.3

Grade 8: CCSS.Math.Content.8.EE.A.2, CCSS.Math.Content.8.EE.B.5, CCSS.Math.Content.8.EE.C.7, CCSS.Math.Content.8.SP.A.2, CCSS.Math.Content.8.SP.A.3

Common Core State Standards for English Language Arts

Grade 6: CCSS.ELA-Literacy.RI.6.1,CCSS.ELA-Literacy.RI.6.7, CCSS.ELA-Literacy.SL.6.1

Grade 7: CCSS.ELA-Literacy.RI.7.1, CCSS.ELA-Literacy.SL.7.1

Grade 8: CCSS.ELA-Literacy.RI.8.1, CCSS.ELA-Literacy.SL.8.1

Literacy in History/Social Studies: CCSS.ELA-Literacy.RH.6-8.1, CCSS.ELA-Literacy.RH.6-8.4, CCSS.ELA-Literacy.RH.6-8.7

Literacy in Science and Technical Subjects: CCSS.ELA-Literacy.RST.6-8.1, CCSS.ELA-Literacy.RST.6-8.4, CCSS.ELA-Literacy.RST.6-8.7

Next Generation Science Standards: MS-LS1-4, MS-LS1-5, MS-LS1-6, MS-LS2-1, MS-LS2-2, MS-LS2-3, MS-LS2-4, MS-LS2-5, MS-LS4-2, MS-LS4-4, MS-ESS2-6, MS-ESS3-3, MS-ESS3-4, MS-ESS3-5, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-PS1-3

C3 Framework for Social Studies Standards: D2.Geo.1.6-8, D2.Geo.2.6-8, D2.Geo.3.6-8, D2.Geo.4.6-8, D2.Geo.9.6-8, D2.Geo.12.6-8, D2.His.1.6-8, D2.His.14.6-8, D3.1.6-8, D4.1.6-8

National Core Arts Standards: Visual Arts
Grade 6: VA:Cr2.3.6a, VA:Pr5.1.6a
Grade 7: VA:Cr2.3.7a, VA:Pr5.1.7a
Grade 8: VA:Cr2.3.8a

GEORGIA

Mathematics
Standards for Mathematical Practice: 1, 2, 4, 5, 6
Grade 6: MGSE6.RP.1, MGSE6.RP.2, MGSE6.RP.3, MGSE6.NS.2, MGSE6.EE.1, MGSE6.EE.2, MGSE6.EE.6, MGSE6.G.2, MGSE6.SP.2, MGSE6.SP.4, MGSE6.SP.5
Grade 7: MGSE7.RP.2, MGSE7.RP.3, MGSE7.NS.3, MGSE7.EE.1, MGSE7.EE.2, MGSE7.EE.4, MGSE7.G.6, MGSE7.SP.3
Grade 8: MGSE8.EE.2, MGSE8.EE.5, MGSE8.EE.7, MGSE8.SP.2, MGSE8.SP.3

English Language Arts
Grade 6: ELAGSE6RI1, ELAGSE6RI7, ELAGSE6SL1
Grade 7: ELAGSE7RI1, ELAGSE7SL1
Grade 8: ELAGSE8RI1, ELAGSE8SL1
Literacy, History/Social Studies: L6-8RH1, L6-8RH4, L6-8RH7
Literacy, Science and Technical Subjects: L6-8RST1, L6-8RST4, L6-8RST7

Science
Grade 6: S6E3a, S6E3c, S6E6b, S6E6c
Grade 7: S7L1b, S7L4a, S7L4b, S7L4c, S7L4d
Grade 8: S8P1a, S8P1f

Social Studies
Grade 6: SS6G1a, SS6G1b, SS6G4a, SS6G7a, SS6G11a
Grade 7: SS7G1a, SS7G1b, SS7G2a, SS7G5a, SS7G9a, SS7G9b
Grade 8: SS8G1a
Map and Globe Skills: 1, 2, 7, 8, 9
Information Processing Skills: 2, 3, 6, 7, 9, 11, 12

Fine Arts: Visual Arts
Grade 6: VA6MC.1b, VA6MC.2c, VA6PR.1a, VA6PR.1b, VA6PR.2a, VA6C.1b, VA6C.2b, VA6C.3a
Grade 7: VA7MC.1a, VA7MC.2c, VA7PR.1a, VA7PR.1d, VA7PR.1e, VA7PR.2a, VA7C.1a, VA7C.1b, VA7C.2b
Grade 8: VA8MC.1a, VA8PR.1b, VA8PR.2a, VA8C.1a, VA8C.1c

ALABAMA

Mathematics
Standard for Mathematical Practice: 1, 2, 4, 5, 6
Grade 6: 1, 2, 3, 5, 12, 13, 17, 22, 25, 28, 29
Grade 7: 2, 3, 6, 7, 9, 10, 16, 19

Grade 8: 4, 7,9, 26, 27

English Language Arts

Grade 6: 11, 17, 31
Grade 7: 1, 30
Grade 8: 1, 30

Science

Grade 6: 10, 14, 15, 16
Grade 7: 5, 6, 7, 8, 9, 11
Grade 8: 1, 5

Social Studies

Grade 7 Geography: 1, 2, 3, 9

Arts Education, Visual Arts: 1, 6

FLORIDA

Mathematics

Grade 6: MAFS.6.RP.1.1, MAFS.6.RP.1.2, MAFS.6.RP.1.3, MAFS.6.NS.2.2, MAFS.6.EE.1.1, MAFS.6.EE.1.2, MAFS.6.EE.2.6, MAFS.6.G.1.2, MAFS.6.SP.1.2, MAFS.6.SP.2.4, MAFS.6.SP.2.5
Grade 7: MAFS.7.RP.1.2, MAFS.7.RP.1.3, MAFS.7.NS.1.3, MAFS, 7.EE.1.1, MAFS.7.EE.1.2, MAFS.7.EE.2.4, MAFS.7.G.2.6, MAFS.7.SP.2.3
Grade 8: MAFS.8.EE.1.2, MAFS.8.EE.2.5, MAFS.8.EE.2.7, MAFS.8.SP.1.2, MAFS.8.1.3
Mathematical Practice: MAFS.K12.MP.1.1, MAFS.K12.MP.2.1, MAFS.K12.MP.4.1, MAFS.K12.MP.5.1, MAFS.K12.MP.6.1

English Language Arts

Grade 6: LAFS.6.RI.1.1, LAFS.6.RI.3.7, LAFS.6.SL.1.1
Grade 7: LAFS.7.RI.1.1, LAFS.7.SL.1.1
Grade 8: LAFS.8.RI.1.1, LAFS.8.SL.1.1

Science

Grade 6: SC.6.E.6.2, SC.6.E.7.3, SC.6.E.7.3 SC.6.E.7.5, SC.6.L.15.1, SC.6.N.1.1, SC.6.N.1.5, SC.6.N.3.4,
Grade 7: SC.7.E.6.6, SC.7.L.15.3, SC.7.L.17.1, SC.7.L.17.2, SC.7.L.17.3, SC.7.N.1.1, SC.7.N.1.4
Grade 8: SC.8.L.18.1, SC.8.N.1.2, SC.8.N.1.6, SC.8.N.3.1, SC.8.P.8.5, SC.8.P.8.6
Grades 6-8: SC.68.CS-CP.3.1, SC.68.CS-CS.1.4, SC.68.CS-CS.2.2, SC.68.CS-CS.2.4

Social Studies

Grade 6: SS.6.G.1.1, SS.6.G.W1.1, SS.6.W.1.3
Grade 7: SS.7.G.1,2, SS.7.G.1.3, SS.7.G.2.2,
Grade 8: SS.8.A.1.2, SS.8.A.1.3, SS.8.G.3.1, SS.8.G.5.2

Visual Art: VA.68.C.1.1,VA.68.C.2.1, VA.68.F.1.1, VA.68.H.3.3, VA.68.S.1.3

NORTH CAROLINA

Mathematics
Grade 6: 6.RP.1, 6.RP.2, 6.RP.3, 6.NS.2, 6.EE.1, 6.EE.2, 6.EE.6, 6.G.2, 6.SP.2, 6.SP.4, 6.SP.5
Grade 7: 7.RP.2, 7.RP.3, 7.NS.3, 7.EE.1, 7.EE.2, 7.EE.4, 7.G.6, 7.SP.3
Grade 8: 8.EE.2, 8.EE.5, 8.EE.7, 8.SP.2, 8.SP.3
Standards for Mathematical Practice: 1, 2, 4, 5, 6

English Language Arts
Grade 6: RI.1, RI.7, SL.1
Grade 7: RI.1, SL.1
Grade 8: RI.1, SL.1

Science
Grade 6: 6.P.2.1, 6.E.2.4, 6.L.2.1, 6.L.2.3
Grade 7: 7.E.1.5, 7.E.1.6, 7.L.2.3
Grade 8: 8.P.1.2, 8.P.2.1, 8.P.2.2, 8.E.1.1, 8.E.1.2, 8.E.1.3, 8.E.1.4, 8.L.3.1, 8.L.3.2, 8.L.3.3

Social Studies
Grade 6: 6.H.1.1, 6.H.1.3, 6.G.1.3, 6.C.1.1
Grade 7: 7.H.1.1, 7.H.1.3, 7.G.1.1, 7.G.1.3, 7.G.2.2
Grade 8: 8.H.1.1, 8.H.1.3, 8.G.1.2, 8.G.1.3

Arts Education: Visual Arts
Grade 6: 6.V.2.1, 6.V.3.2, 6.CX.2.2
Grade 7: 7.V.2.1, 7.V.3.2, 7.CX.2.2
Grade 8: 8.V.2.1, 8.V.3.2, 6.CX.2.2

SOUTH CAROLINA

Mathematics
Mathematical Process Standards: 1, 2, 4, 5, 6
Grade 6: 6.NS.2, 6.RP.1, 6.RP.2, 6.RP.3, 6.EEI.1, 6.EEI.2, 6.EEI.6, 6.GM.2, 6.DS.4, 6.DS.5
Grade 7: 7.NS.3, 7.RP.2, 7.RP.3, 7.EEI.1, 7.EEI.2, 7.EEI.4, 7.GM.6, 7.DSP.3
Grade 8: 8.EEI.2, 8.EEI.5, 8.EEI.7, 8.DSP.2, 8.DSP.3

English Language Arts
Grade 6: RI.5.1, RI.7.1, C.1.2
Grade 7: RI.5.1, C.1.2
Grade 8: RI.5.1, C.1.2

Science
Grade 6: 6.S.1A.2, 6.S.1A.3, 6.S.1A.4, 6.S.1A.5, 6.S.1A.6, 6.S.1A.7, 6.S.1B.1, 6.E.2B.3, 6.E.2B.4, 6.L.4A.2, 6.L.4B.1, 6.L.4B.2, 6.L.4B.5

Grade 7: 7.S.1A.2, 7.S.1A.3, 7.S.1A.4, 7.S.1A.5, 7.S.1A.6, 7.S.1A.7, 7.S.1B.1, 7.P.2A.2, 7.P.2A.3, 7.P.2B.3, 7.P.2B.4, 7.EC.5A.1, 7.EC.5A.3, 7.EC.5B.1, 7.EC.5B.2, 7.EC.5B.3
Grade 8: 8.S.1A.2, 8.S.1A.3, 8.S.1A.4, 8.S.1A.5, 8.S.1A.6, 8.S.1A.7, 8.S.1B.1, 8.E.6B.2

Social Studies
Grade 7: 7-6.6
Social Studies Literacy Skills for the Twenty-First Century:

- Identify and explain the relationships among multiple causes and multiple effects.
- Select or design appropriate forms of social studies resources to organize and evaluate social studies information.
- Identify the location of places, the conditions at places, and the connections between places.
- Compare the locations of places, the conditions at places, and the connections between places.
- Cite specific textual evidence to support the analysis of primary and secondary sources.
- Integrate information from a variety of media sources with print or digital text in an appropriate manner.

Visual Arts
Grade 6: VA6-1.3, VA6-6.2
Grade 7: VA7-1.3, VA7-6.2
Grade 8: VA8-1.3, VA8-6.2

TENNESSEE

Mathematics
Standards for Mathematical Practice: 1, 2, 4, 5, 6
Grade 6: 6.RP.1, 6.RP.2, 6.RP.3, 6.NS.2, 6.EE.1, 6.EE.2, 6.EE.6, 6.G.2, 6.SP.2, 6.SP.4, 6.SP.5
Grade 7: 7.RP.2, 7.RP.3, 7.NS.3, 7.EE.1, 7.EE.2, 7.EE.4, 7.G.6, 7.SP.
Grade 8: 8.EE.2, 8.EE.5, 8.EE.7, 8.SP.2, 8.SP.3

English Language Arts
Grade 6: RI.1, RI.7, SL.1
Grade 7: RI.1, SL.1
Grade 8: RI.1, SL.1

Science
Grade 6: GLE 0607.Inq.1, GLE 0607.Inq.2, GLE 0607.Inq.3, GLE 0607.Inq.5, GLE 0607.T/E.2, GLE 0607.2.1, GLE 0607.2.2, GLE 0607.2.4, GLE 0607.8.3
Grade 7: GLE 0707.Inq.1, GLE 0707.Inq.2, GLE 0707.Inq.3, GLE 0707.Inq.5, GLE 0707.T/E.2, GLE 0707.3.2, GLE 0707.7.6
Grade 8: GLE 0807.Inq.1, GLE 0807.Inq.2, GLE 0807.Inq.3, GLE 0807.Inq.5, GLE 0807.T/E.2, GLE 0807.5.1, GLE 0807.5.3, GLE 0807.5.5, GLE 0807.9.4, GLE 0807.9.9

Visual Arts: 1.3, 6.1