Curriculum Guide

RIVER OF GOLD

AMAZON AID FOUNDATION

JOURNEYS IN FILM
educating for global understanding

River of Gold

Curriculum Guide

Journeys in Film

www.journeysinfilm.org

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www.journeysinfilm.org

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JOURNEYS IN FILM™
educating for global understanding

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JOURNEYS IN FILM™
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About *Journeys in Film*

Founded in 2003, ***Journeys in Film*** operates on the belief that teaching with film has the power to prepare students to live and work more successfully in the 21st century as informed and globally competent citizens. Its core mission is to advance global understanding among youth through the combination of age-appropriate films from around the world, interdisciplinary classroom materials coordinated with the films, and teachers' professional-development offerings. This comprehensive curriculum model promotes widespread use of film as a window to the world to help students to mitigate existing attitudes of cultural bias, cultivate empathy, develop a richer understanding of global issues, and prepare for effective participation in an increasingly interdependent world. Our standards-based lesson plans support various learning styles, promote literacy, transport students around the globe, and foster learning that meets core academic objectives.

Selected films act as springboards for lesson plans in subjects ranging from math, science, language arts, and social studies to other topics that have become critical for students, including environmental sustainability, poverty and hunger, global health, diversity, and immigration. Prominent educators on our team consult with filmmakers and cultural specialists in the development of curriculum guides, each one dedicated to an in-depth exploration of the culture and issues depicted in a specific film. The guides merge effectively into teachers' existing lesson plans and mandated curricular requirements, providing teachers with an innovative way to fulfill their school districts' standards-based goals.

Why use this program?

To be prepared to participate in tomorrow's global arena, students need to gain an understanding of the world beyond their own borders. ***Journeys in Film*** offers innovative and engaging tools to explore other cultures and social issues, beyond the often negative images seen in print, television, and film.

For today's media-centric youth, film is an appropriate and effective teaching tool. ***Journeys in Film*** has carefully selected quality films that tell the stories of young people living in locations that may otherwise never be experienced by your students. Students travel through these characters and their stories: They drink tea with an Iranian family in *Children of Heaven,* play soccer in a Tibetan monastery in *The Cup*, find themselves in the conflict between urban grandson and rural grandmother in South Korea in *The Way Home,* watch the ways modernity challenges Maori traditions in New Zealand in *Whale Rider,* tour an African school with a Nobel Prize–winning teenager in *He Named Me Malala,* or experience the transformative power of music in *The Music of Strangers: Yo-Yo Ma & the Silk Road Ensemble.*

In addition to our ongoing development of teaching guides for culturally sensitive foreign films, ***Journeys in Film*** brings outstanding documentary films to the classroom. Working with the Rossier School of Education at the University of Southern California, ***Journeys in Film*** has identified exceptional narrative and documentary films that teach about a broad range of social issues in real-life settings such as famine-stricken and war-torn Somalia, a maximum-security prison in Alabama, and a World War II concentration camp near Prague. ***Journeys in Film*** guides help teachers integrate these films into their classrooms, examining complex issues, encouraging students to be active rather than passive viewers, and maximizing the power of film to enhance critical thinking skills and to meet the Common Core Standards.

Journeys in Film is a 501(c)(3) nonprofit organization.

A Letter from Liam Neeson

Working in films such as *Michael Collins* and *Schindler's List*, I've seen the power of film not only to entertain, but also to change the way audiences see themselves and the world. When I first met Joanne Ashe, herself the daughter of Holocaust survivors, she explained to me her vision for a new educational program called ***Journeys in Film: Educating for Global Understanding***. I grasped immediately how such a program could transform the use of film in the classroom from a passive viewing activity to an active, integral part of learning.

I have served as the national spokesperson for ***Journeys in Film*** since its inception because I absolutely believe in the effectiveness of film as an educational tool that can teach our young people to value and respect cultural diversity and to see themselves as individuals who can make a difference. ***Journeys in Film*** uses interdisciplinary, standards-aligned lesson plans that can support and enrich classroom programs in English, social studies, math, science, and the arts. Using films as a teaching tool is invaluable, and ***Journeys in Film*** has succeeded in creating outstanding film-based curricula integrated into core academic subjects.

By using carefully selected documentary and international films that depict life in other countries and cultures around the globe, combined with interdisciplinary curricula to transform entertainment media into educational media, we can use the classroom to bring the world to every student. Our film program dispels myths and misconceptions, enabling students to overcome biases; it connects the future leaders of the world with one another. As we provide teachers with lessons aligned to Common Core Standards, we are also laying a foundation for understanding, acceptance, trust, and peace.

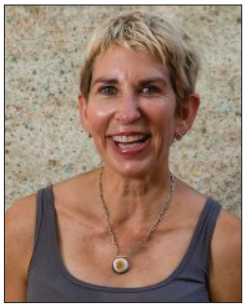
Please share my vision of a more harmonious world where cross-cultural understanding and the ability to converse about complex issues are keys to a healthy present and a peaceful future. Whether you are a student, an educator, a filmmaker, or a financial supporter, I encourage you to participate in the ***Journeys in Film*** program.

Please join this vital journey for our kids' future. They are counting on us. ***Journeys in Film*** gets them ready for the world.

Sincerely,

A Letter from Sarah duPont

President, Amazon Aid Foundation



In the summer of 1999, I journeyed to the Peruvian Amazon, a remote and pristine area, the largest piece of contiguous rainforest left on the planet. There an intrepid group of scientists and I meandered along undulating brown rivers by boat, the best way to traverse this dense and roadless place. Our destination was the research station we had built to study and protect this critical ecosystem. I came to learn firsthand how the Amazon is one of the most important places for the stability of our environment; not only is the Amazon an untapped plethora of important species and indigenous peoples, it also houses countless trees that keep the world's weather pattern steady.

Since that time, I have been fortunate to travel back to the jungles of the Amazon. But it has become a different place. Roads have been built and people have arrived. It has become a new Wild West, a place without law. People driven by poverty and the desire for a better life have come, exploiting the sacred ground. Almost 10 years after my first trip to the once-pristine Amazon, I could no longer travel the rivers without witnessing mass ecological destruction. Out of deep respect for our planet and all living things, I founded the **Amazon Aid Foundation**, with the mission to be the bridge between the scientists and global audiences. Our goal was to educate and to encourage others to protect this critical ecosystem. A team of some of the best scientists, environmentalists, and artists joined Amazon Aid to produce beautiful, relevant, and inspiring multimedia. And the first project that we endeavored to create was a film that would be both beautiful and informative, one that we hoped would affect global audiences so that they too can step forward to protect the Amazon and ensure that the future climate of the world is as we know it today.

But how were we to deliver this message? How could we get people to pay attention in this chaotic time? For me, I knew that it felt like war. A war against the environment. Ecocide. Then a thought was born—why not make a documentary that follows journalists who specialize in war reportage, filming them as they witnessed this broad, far-reaching, and criminal eradication of the Amazon? The film would capture this war against nature.

Narrated by Academy Award winners Sissy Spacek and Herbie Hancock, *River of Gold* is the disturbing account of a clandestine journey bearing witness to the apocalyptic destruction of the rainforest in the pursuit of illegally mined gold. War journalists Ron Haviv and Donovan Webster travel along Peru's Madre de Dios River to reveal the savage unraveling of pristine rainforest. Enrique Ortiz, a Peruvian environmental activist and biologist, guides the team, pointing out the heedless exploitation of the land. Miners rush to the Amazon to scrape together enough money to start a business or to feed their families, while disregarding the catastrophic consequences to their homeland and their own health. Vulnerable trees, over one thousand years old, and countless species of plants, animals, and insects, both those known to science and those yet to be discovered, fall victim to the annihilation as well. Environmental degradation and human degradation are irrevocably intertwined as illegal gold mining is directly tied to corruption, human trafficking, narcotics, and organized crime.

What will be the fate of this critical region as these extraordinarily beautiful forests are turned into a devastated wasteland?

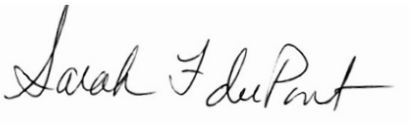
River of Gold reaffirms the right of the rainforest to exist as a repository of priceless biodiversity and not as the toxic remains of man's greed for gold.

I BELIEVE that humans have the capacity for greatness and the ability to create solutions.

I BELIEVE in grace.

I BELIEVE in YOU!

River of Gold was made in the hope for a safe and healthy world. Join Amazon Aid and be part of the voice to protect the world's greatest forests.



Sarah duPont

About Amazon Aid

The Amazon Aid Foundation works to educate and empower people to protect the Amazon through art, science, and multimedia. Our goal is to preserve the rainforest for the health of the planet and for future generations to enjoy.

The goals of AAF are to educate, to activate, and to protect the Amazon region. We develop scientific multimedia platforms to engage students in understanding the significance of the Amazon. Our documentary *River of Gold* and the accompanying curriculum illustrate the direct effect of climate change caused by deforestation and unregulated gold mining.

We bring together scientists, artists, NGOs (Non-Governmental Organizations), global citizens, and governments in a unified alliance to raise awareness for the protection of the rainforest. We recognize the importance of mobilizing individuals and organizations to keep forests standing, to reforest, and to demand responsibly sourced products.

Amazon Aid also connects a network of stakeholders in the Amazon to develop legislation that protects and supports revitalization of the rainforest, including advocacy efforts for clean water and human rights, as well as for the regulation of gold mining and mercury usage.

To the Teacher

Journeys in Film has partnered with the Amazon Aid Foundation to produce a curriculum guide for grades 6-12, so that classes viewing the film can better understand the crisis that is occurring daily in this extremely important region. This curriculum guide to *River of Gold,* like other ***Journeys in Film*** resources, is based on a few fundamental beliefs:

- That a well-made, relevant film is an excellent way to convey information and teach students important critical thinking skills.
- That an interdisciplinary approach will reach students who have different learning modalities (perception, memory, and sensation) and interests.
- That talented teachers interacting with real students on a daily basis are best positioned to write good lesson plans.

Very few teachers will use all the lessons in this guide—to do so would take up most of a quarter in a typical class. Rather, you can choose the lesson or lessons that best support your own curricular goals and the needs of your students. Team teaching with a colleague in another discipline is a great way to reinforce the message of the film and show students that a topic can be studied profitably through different lenses. Admittedly, there is some overlap in a few of these lessons, because students will probably do only one or two, and there are some fundamental understandings that all students should take away, no matter which lessons you choose to use with them.

Lesson 1 introduces the critically important hydrological cycle, the recirculation of water through evapotranspiration and precipitation to sustain life. It includes a hands-on growing experiment that measures how the amount of vegetation affects condensation to simulate the effects of deforestation in the Amazon. A second experiment demonstrates how aquatic organisms are affected when excessive organic material enters bodies of water due to deforestation.

Lesson 2 teaches students about the nature of watersheds and about the uniqueness of the Amazon River Basin—unique thanks to the hydrologic and other forces that created it.

Lesson 3 focuses on the interdependent relationships that have made the Amazon such a rich and biodiverse environment. Students learn how people around the world benefit from the ability of trees in the Amazon to store carbon, thus reducing the greenhouse effect and fighting climate change.

Lesson 4 gives students the opportunity to consider the interplay between biodiversity, habitat loss, and human communities in the Amazon region. It reinforces the film's concerns about the impact of human activity on the Amazon rainforest and the long-term consequences on human health of critical habitat destruction.

Lesson 5 introduces the human inhabitants of the Amazon more thoroughly, asking students to research the lives of the tribes whose welfare and very lives are threatened by the deforestation and destruction of the Amazon by outsiders who come to extract gold and other resources.

Lesson 6 teaches students about the use of satellite photography to track what is happening in the Amazon; it asks students to do individual research using Google Earth to track deforestation over a period of time.

Lesson 7 moves from illegal gold mining to other extractive industries, particularly oil and gas, and examines the impact of these economic activities on the Amazon. Students write essays from the viewpoints of individuals in the region and hold a panel discussion to represent a variety of viewpoints, showing that the issue is complex.

Lesson 8 focuses on activists who have worked to expose environmental injustice and global inequity. Students look at their work and consider ways to use modern techniques to improve awareness campaigns.

Lesson 9 gives students experience in using the ubiquitous smartphone camera to plan and create a photo sequence that can form the basis of an awareness campaign on an important environmental issue or other story in their own neighborhood.

Lesson 10 teaches students about the gold market that is the ultimate driving force behind the illegal gold mining. Students learn about the uses of gold for monetary purposes, for decoration, and for technology, all of which create demand.

Lesson 11 asks the question "What can we do?" Students read a variety of articles about the impacts of illegal gold mining in the Amazon and create a slideshow to present their findings to other classes or to the school. They may develop a plan for fundraising to support the protection of the Amazon and the replanting of trees.

An Amazon Aid Foundation Production

In Association with Über Content

Narrators: Herbie Hancock, Sissy Spacek

Executive Producers: Sarah duPont, James Cavello, Donovan Webster, Margarite Almeida, Phyllis Koenig, Preston Lee

Music: Anthony Marinelli

Directors of Photography: Reuben Aaronson, Hervé Cohen

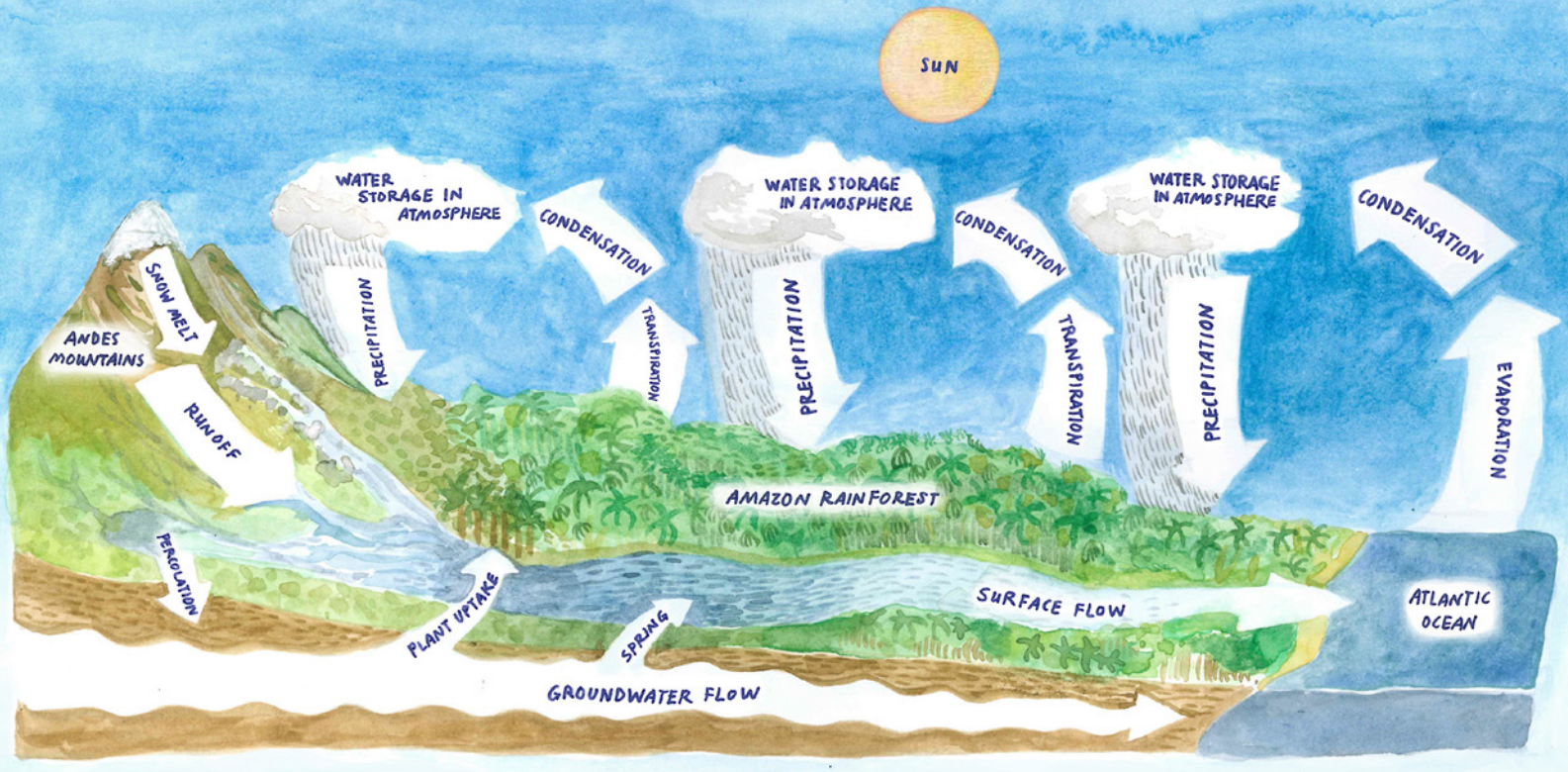
Editors: Esteban Arguello, Matthew Celia, Jon Fine, Hervé Cohen

Produced by: Sarah duPont, James Cavello, Reuben Aaronson

Directed by: Reuben Aaronson

For more information about the film, see http://riverofgoldfilm.com/.

The Hydrological Cycle of the Amazon Rainforest



The Amazon makes its own rainfall, approximately three times, as the weather moves from east to west. Every day the Amazon releases approximately 20 billion metric tons of moisture into the atmosphere, affecting global weather patterns.

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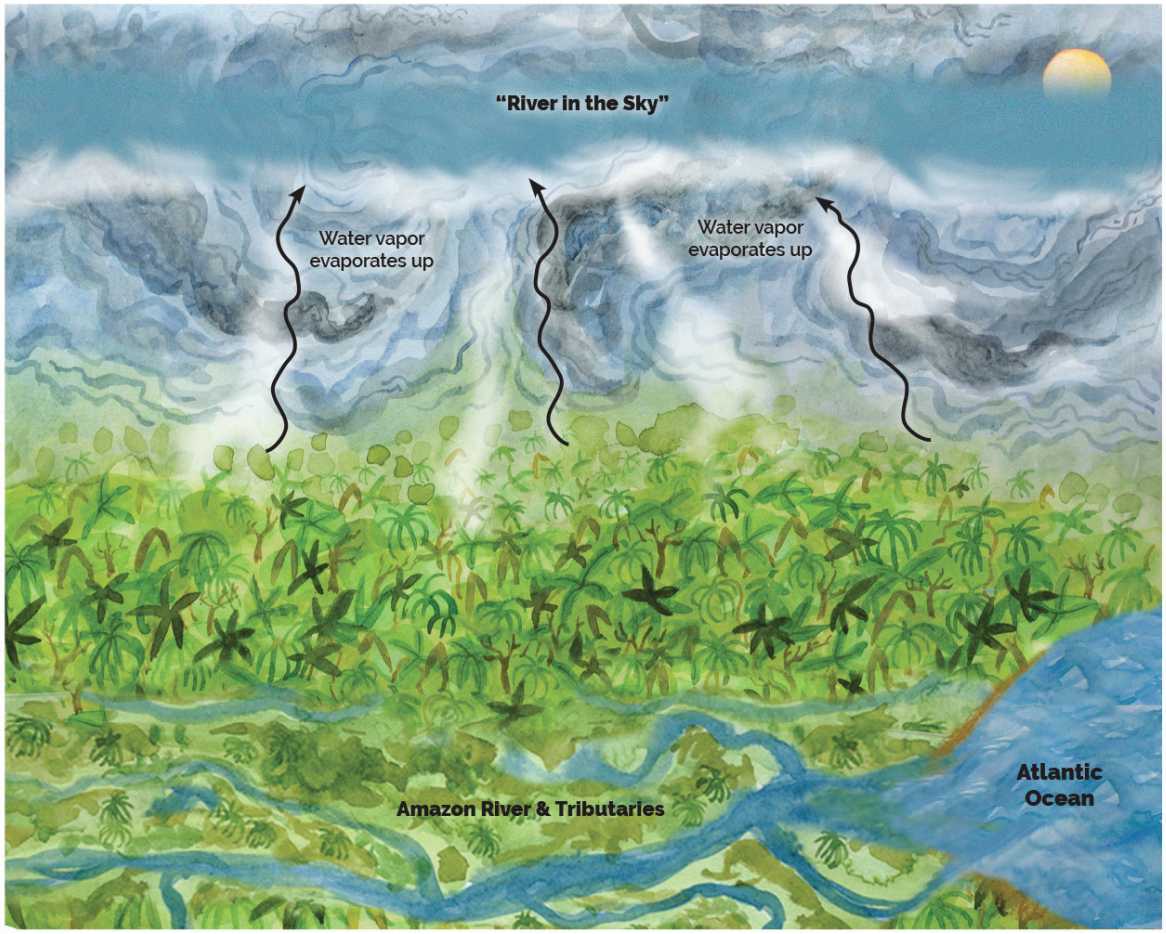
River in the Sky of the Amazon Rainforest



The trees of the Amazon suck up water from the ground and pump approximately **20 billion tons** of moisture into the atmosphere daily to create a ***River in the Sky***. This "flying river" carries more moisture than the rivers of the Amazon which release **17 billion tons** of water daily into the Atlantic Ocean.

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The Hydrological Cycle

Enduring Understandings

- The hydrological cycle is one of the most important ecological functions within the Amazon rainforest.
- The topography of the Amazon allowed for the development of the Amazon rainforest with its great diversity and mass of trees.
- Deforestation of the Amazon's hydrological cycle could affect high-altitude winds (known as Rossby waves) worldwide, leading to global changes in precipitation.
- The Amazon generates on average half of its own rainfall by recycling moisture and forming new clouds, so that rain falls approximately three times as air masses move from the Atlantic across the basin to the west.
- Trees pump so much moisture into the air that this process changes the atmosphere, triggering a shift in wind patterns that brings in more moisture from the ocean.

Essential Questions

- What is the hydrological cycle?
- How does the hydrological cycle function in the Amazon rainforest? How does it function where you live?
- How does deforestation in the Amazon rainforest affect local and global weather patterns?
- What can be done to minimize destruction of the Amazon rainforest while still providing economic benefits for the local population from this rich natural resource?

Notes to the Teacher

In this lesson, it is important to stress that, if the conditions for life on Earth are to be perpetuated, we need to balance the worldwide demand for resources while we maintain a healthy relationship between living organisms and their surroundings. It is also necessary to realize that the complex relationships between organisms and their environment are constantly evolving and can be open to varied interpretations.

The suggested order of activities can be altered depending upon your approach to this unit and the time needed to perform the activities. The lesson has four parts, each taking a minimum of two class periods of 45 minutes to one hour. Each section takes a hands-on approach to learning, followed by group analysis and class discussion of key concepts.

Please note that this lesson uses the term *hydrological cycle*. Let students know that the *hydrological cycle* is also known as the *hydrologic cycle* and the *water cycle*; all terms are acceptable and have the same meaning.

Part 1 focuses on an introduction to the hydrological cycle and deforestation in the Amazon rainforest. Before the first class session, make a copy of **Handout 1: Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest** for each student. Each pair of students needs to have access to the Internet. The activity will take approximately two class sessions of 45 minutes to one hour. During the first session, students will research hydrological cycle terminology and place the terms in the appropriate boxes on the diagram. Each group will discuss and complete the question sheet provided. During the second session, students will review the hydrological diagram and terms and share their answers to the questions with the class. This will

increase their understanding of the important role of trees in the hydrological cycle of the Amazon and how deforestation would affect the cycle.

Here is the basic information about the hydrological cycle to cover with students during these discussions:

- The tropical Atlantic Ocean is a remote source of moisture for the Amazon.
- The hydrological cycle is one of the most important ecological functions within the Amazon rainforest.
- The topography of the Amazon allowed for the development of the Amazon rainforest with its great diversity and mass of trees.
- Water is drawn from the ground into the trees and then is released into the atmosphere by evapotranspiration, leading to the eventual return of water to the forest floor and release of water into the atmosphere.
- The Amazon generates on average half of its own rainfall by recycling moisture and forming new clouds, so that rain falls approximately three times as air masses move from the Atlantic across the basin to the west.
- Trees pump so much moisture into the air that this process changes the atmosphere, triggering a shift in wind patterns that brings in more moisture from the ocean.
- The high leaf area index in the Amazon canopy allows for an increased amount of evapotranspiration.
- Through evapotranspiration approximately 20 billion metric tons of moisture are released into the Amazonian atmosphere daily.
- The Amazonian "river in the sky" carries more moisture than all the rivers of the Amazon combined and is considered by some scientists to be the largest river on Earth.
- Dynamic weather patterns in the Amazon move from east to west because the higher evaporative gradient over the forest draws in the trade winds from the Atlantic Ocean.
- Trade winds lead to tropical conditions on the east side of the Andes (from the equator to 30° N and S) and arid conditions on the west side of the Andes.
- Research models indicate that approximately 80% of the trees in the Amazon need to remain intact to continue the hydrological cycle. At this time, researchers estimate 80% of the trees are still standing.
- Deforestation of the Amazon's hydrological cycle could affect high-altitude winds (known as Rossby waves) worldwide, leading to global changes in precipitation.
- Global changes caused by deforestation could include desertification, drought, and fires leading to disruption and destruction of habitats.

For additional information on the hydrological cycle in the Amazon and deforestation, refer to these websites:

http://advances.sciencemag.org/content/4/2/eaat2340

https://www.weforum.org/agenda/2017/08/how-trees-in-the-amazon-make-their-own-rain/

http://www.sciencemag.org/news/2017/08/trees-amazon-make-their-own-rain

https://www.carbonbrief.org/deforestation-in-the-tropics-affects-climate-around-the-world-study-finds

https://www.sciencedaily.com/releases/2014/12/141218080823.htm

https://climatenewsnetwork.net/loss-of-rainforests-is-double-whammy-threat-to-climate/

http://www.i-sis.org.uk/importanceOfTheAmazonRainForest.php

https://naturalcapitalcoalition.org/amazon-deforestation-nears-tipping-point-study/

https://vtnews.vt.edu/articles/2016/03/030116-cnre-amazonresearch.html

Part 2 simulates the amount of condensation that occurs in areas with varying amounts of vegetation. This simulation can be compared to the effects of deforestation within the Amazon rainforest. Before the first class session, make a copy of **Handout 2: Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest** for each student. Decide whether the simulation will be done as a class demonstration or by individual groups and whether radish seeds or pea seeds will be used for the activity. If using pea seeds be sure to soak them overnight before planting. Gather all supplies listed under **Materials Needed, Part 2,** below; the amounts needed will depend upon whether the activity will be done as a class demonstration or by small groups of students (say three to four per group). If the activity is to be done in groups, all students should wear nitrile gloves, aprons, and goggles. A slideshow for this lesson shows this process step-by-step; you may use it for your own information or share individual slides with your students to guide them.

This activity will take two to three weeks to complete. During the first session, the bowls containing the seeds will need to be prepared. The seeds will take approximately one to two weeks (depending upon seed type used) to be large enough to cover with plastic wrap. Four to five days after covering the bowls, each group will observe and note the amount of condensation on the plastic wrap of each bowl.

If the activity is performed as a class demonstration, place the three bowls in separate areas of the room, divide the class into three groups and have the groups rotate to make observations on each bowl.

No matter how you have divided up the class, in each case the various groups will record their observations, then discuss and complete the question sheet provided. Each group will then share its answers to the questions with the whole class and discuss how varying amounts of condensation could affect the fauna and flora found in the Amazon rainforest.

Note that with an advanced class, more variables can be added to this simulation to increase its complexity, all in the interest of exploring local and global effects of deforestation in the Amazon rainforest.

Part 3 of the lesson focuses on how aquatic organisms are affected when excessive organic material enters bodies of water as a result of deforestation. Before the first class session, make a copy of **Handout 3: Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers** for each student.

You will need to provide some unusual materials for this part, including a LaMotte® TesTab® Dissolved Oxygen/BOD Kit (or similar; BOD stands for Biochemical Oxygen Demand). Gather all supplies listed under **Materials Needed, Part 3**, below; the amounts needed will depend upon whether the activity will be done as a class demonstration or by groups of three to four students. If the activity is to be done in groups,

all students should wear nitrile gloves, aprons, and goggles.

Before the lesson, print out and (and laminate if desired) a sheet with the specific directions and sample calculation information for the DO/BOD kit chosen to perform the experiment. Before the first session, prepare a 600 ml mixture of water, sand, and sugar in a 600–1000 ml beaker or flask. Mix 6 tablespoons of sand with 3 tablespoons of sugar. Add the sand and sugar to the beaker and fill the beaker to the top with water. This will be the first solution students use to test the dissolved oxygen content.

During the first class session, students test the dissolved oxygen content of the water, sand, and sugar mixture, then they add 3 tablespoons of yeast to the mixture. They seal the beaker with Parafilm® and place the beaker in a dark location for a day. The yeast will release gases and the Parafilm® will expand, so place each beaker on a tray to contain any material that may leak. During the second class session, students test the dissolved oxygen content of the water, sand, sugar, and yeast mixture.

Each of the two tests within the activity will take 45 minutes to one hour to complete. During the third class session, each group will discuss and complete the question sheet provided and then share their answers with the class. They then discuss as a whole class how the biochemical oxygen demand, dissolved oxygen content and aquatic organisms are affected by deforestation.

Part 4 is the cumulative assessment and focuses on the types of deforestation that occur within the Amazon and their local and global effects.

Before the first class session, make a copy of **Handout 4** for each student. Each group of students needs to have access to the Internet and to a color printer. Additionally, each group of students will need poster board, markers, colored pencils, pencils, Sharpies, a glue stick, scissors and ruler. Before the first class session, each group will choose a type of deforestation to research from a list provided. During the first two class sessions, have each group research and collect information on the type of deforestation that it has chosen. Two class sessions will need to be dedicated for groups to create their scientific poster. Each group will then present and discuss the type of deforestation researched, the steps or processes involved with this type of deforestation, the specific local and global effects of this type of deforestation, and possible solutions to stop or minimize the effects of this type of deforestation.

A rubric for this activity is on **Teacher Resource 4**. You may wish to use it just for scoring, or you may share it with your students so that they can perform a self-evaluation.

Supplementary multimedia: What does the Amazon look like?

Mercury Uprising

A 12-minute look into the reasons why the Amazon is important, the forces that are destroying it, and the hope for protecting it. *Video by Amazon Aid and ROTU Studios.*

https://vimeo.com/125274209

Tsunami of Clouds

Mesmerizing clouds float across the slopes of the Peruvian Andes. *Video by Edward Hurme.*

https://www.youtube.com/watch?time_continue=21&v=tLtePho5MQE

Amazonia

Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.

https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Amazonia time lapses

From the cloud forests to the lowlands of the jungle, beautiful time-lapse footage from Amazon Aid Artist Dano Grayson.

https://www.youtube.com/watch?v=rNKD8rgQvSE

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.RST.9-10.1
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-Literacy.RST.9-10.2
Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

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

CCSS.ELA-Literacy.RST.9-10.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

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

CCSS.ELA-Literacy.RST.9-10.7
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-Literacy.RST.11-12.2
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CCSS.ELA-Literacy.RST.11-12.3
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CCSS.ELA-Literacy.RST.11-12.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.

CCSS.ELA-Literacy.RST.11-12.7
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CCSS.ELA-Literacy.RST.11-12.8
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

CCSS.ELA-Literacy.RST.11-12.9
Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Next Generation Science Standards

HS-PS1-5 Matter and its Interactions
Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.

HS-ESS2-2 Earth's Systems
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS2-4 Earth's Systems and Weather and Climate
Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.

HS-ESS2-5 Earth's Systems
Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

HS-ESS3-1 Human Sustainability and Earth and Human Activity
Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2 Human Sustainability and Earth and Human Activity
Evaluate competing design solutions for developing, managing and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-4 Human Sustainability and Earth and Human Activity
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

HS-ESS3-5 Weather and Climate and Earth and Human Activity
Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-LS1-5 Matter and Energy in Organisms and Ecosystems
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

HS-LS1-7 Matter and Energy in Organisms and Ecosystems
Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed, resulting in a net transfer of energy.

HS-LS2-3 Ecosystems: Interactions, Energy, and Dynamics
Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.

HS-LS2-5 Ecosystems: Interactions, Energy, and Dynamics
Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

Next Generation Science Standards

HS-LS4-2 Natural Selection and Evolution and Biological Evolution: Unity and Diversity
Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.

HS-LS4-5 Natural Selection and Evolution and Biological Evolution: Unity and Diversity
Evaluate the evidence supporting claims that changes in environmental conditions may result in (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.

HS-LS4-6. Natural Selection and Evolution and Biological Evolution: Unity and Diversity
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity

Duration of Lesson

Part 1 – 2 class sessions

Part 2 – 4 class sessions

Part 3 – 3 class sessions

Part 4 – 5–6 class sessions

Assessments

Completion of handouts

Group discussions

Poster presentation (cumulative assessment)

Materials needed

Whiteboard with whiteboard markers or an interactive board such as a SMART Board

For Part 1:

Copies of **Handout 1: Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest**

Computer, tablet, or phone with Internet access

Teacher Resource 1 (Answer Sheet)

For Part 2:

Handout 2: Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

Slideshow for Lesson 1 (at www.journeysinfilm.org)

3 glass culture bowls or plastic food containers approximately 8"x 8" (minimum)

Potting soil

Pea or radish seeds

Straws or tongue depressors

Sharpie

Pencil

Light source

Nitrile gloves

Goggles

Aprons

Plastic wrap

Teacher Resource 2 (Answer Sheet)

For Part 3:

Handout 3: Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

Nitrile gloves

Goggles

Aprons

600–1000 ml beaker or flask containing water with a sand, sugar, and yeast mixture

Tray to go under the beaker or flask

2 small test tubes

Disposable plastic pipettes

Sharpie

Tablets from LaMotte® TesTab® Dissolved Oxygen/ BOD Kit (or equivalent)

Plastic wrap (Parafilm® works well)

Teacher Resource 3 (Answer Sheet)

For Part 4:

Handout 4: Poster Project

Computer, tablet, or phone with Internet access

Color printer access

Poster board

Markers, colored pencils, pencils, Sharpies

Glue stick

Scissors

Ruler

Teacher Resource 4 (Rubric)

Procedure

Part 1: Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

1. Distribute copies of **Handout 1** and read through the background information and methods. Answer any questions that may arise and then arrange students into pairs.

2. Have each group use the Internet to complete Table 1 and fill in the boxes on the hydrological diagram. Allow sufficient time for them to work while you circulate to supervise and answer any additional questions.

3. After Table 1 and the diagram are complete, have each pair of students discuss the questions at the end of the handout and fill in their answers to the questions; the group work may extend into the next class session.

4. Have a whole-class discussion of their group answers to the questions. See **Answer Sheet for Handout 1** for suggested answers to the questions. You may wish to project the hydrological cycle and "river in the sky" images included in this lesson on a SMART Board at this time to facilitate this discussion.

Part 2: Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

1. Distribute copies of **Handout 2**. Read the background information and review the directions on the handout, answering any questions. Stress safety precautions if completing the activity in individual groups rather than as a demonstration.

2. Arrange students into groups of three to four and give each group the prescribed materials. Suggest that they check to see that the lab setup is complete and that they are familiar with all the materials. Allow students sufficient time to set up the experiment, while you circulate to supervise and answer any additional questions.

3. The seeds will take one to two weeks to reach a testable size. Radish seeds will germinate faster than pea seeds. During this period use a beaker to add water to the bowls; be sure to add an equal amount to each bowl. Spray bottles containing water can also be used to lightly moisten soil as needed.

4. When plants reach a testable size, have each group cut and place ten straws in each bowl to support the plastic wrap. They should use two layers of plastic wrap for each bowl and they should make sure each one is totally sealed.

5. Have students observe the amount of condensation after the first day.

6. After two days have students observe the rate of condensation in each bowl and complete Table 1 on **Handout 2**.

7. After observations are completed, use a razor blade to make one 1" slit in the plastic wrap around Bowl B and open the slit to form a hole in the plastic. Follow the same procedure for Bowl C, but make three slits in Bowl C. The slits will represent the depletion of condensation that occurs in the lower atmosphere when deforestation occurs.

8. After four or five days have students observe the rate of condensation in each bowl and complete Table 1.

9. After the activity is completed, have students discuss the questions at the end of the handout with their partners and fill in their answers to the questions. Finally, have the students discuss their answers with the class as a whole. See **Teacher Resource 2** for suggested answers.

Part 3: Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

1. Distribute copies of **Handout 3**. Read the background information and review the directions on the handout, answering any student questions. Be sure to stress safety precautions.

2. Arrange students into groups with each pair given the necessary materials. Have them check to see that the lab setup is complete and that they are familiar with all the materials. Allow students sufficient time to set up the experiment, while you circulate to supervise and answer any additional questions.

3. Have each student group obtain a sample of the water, sand, and sugar solution and perform the DO/BOD test as specified by the kit.

4. At the end of the class session, add dry yeast and cover the beaker or flask with Parafilm®.

5. On the second day of the activity, have each student group obtain a sample of the water, sand, sugar, and yeast solution and perform the DO/BOD test as specified by the kit.

6. After the activity is completed, have students discuss the questions at the end of the handout and fill in their answers to the questions. Then have the students discuss as a whole class their group answers to the questions. See **Teacher Resource 3** for suggested answers.

Part 4: Types of Deforestation in the Amazon and Their Local and Global Effects (Cumulative Assessment)

1. Distribute copies of **Handout 4.** Have students read the background information from the Amazon Aid Foundation. (This could be a homework assignment the night before.) Review the directions on the handout and answer any questions.

2. Arrange students into pairs. Allow students sufficient time to research their topic and to prepare the poster, while you circulate to supervise and answer any additional questions.

3. After the students have completed making their posters, have them present their posters to the class.

4. After each poster is presented, have students discuss as a whole class the information presented.

Handout 1 ▸ P. 1

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

Background Information:

Water is essential to life and must cycle through all ecosystems. Water is released from the surface of leaves back into the atmosphere, forming water vapor that may eventually condense to form water droplets. The Amazon rainforest is estimated to recycle at least 50% to 80% of the local water in the form of precipitation.

Objectives:

To understand how water flows through the Amazon rainforest and other ecosystems.

To understand how trees affect the hydrological cycle within the Amazon rainforest.

To understand how deforestation would affect the hydrological cycle within the Amazon rainforest.

Materials:

Photocopy of hydrological cycle handout

Computer, tablet, or phone with Internet access

Whiteboard with whiteboard markers or an interactive board such as a SMART Board

Handout 1 ▸ p. 2

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

Hydrological Terms (Table 1)

Directions: Using resources you find on the Internet, define the terms listed in the table below:

Condensation	
Evaporation	
Evapotranspiration	
Groundwater	
Precipitation	
Run-off	
Transport (within hydrological cycle)	
Water table	

Handout 1 ▸ P.3

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

Additional Terms

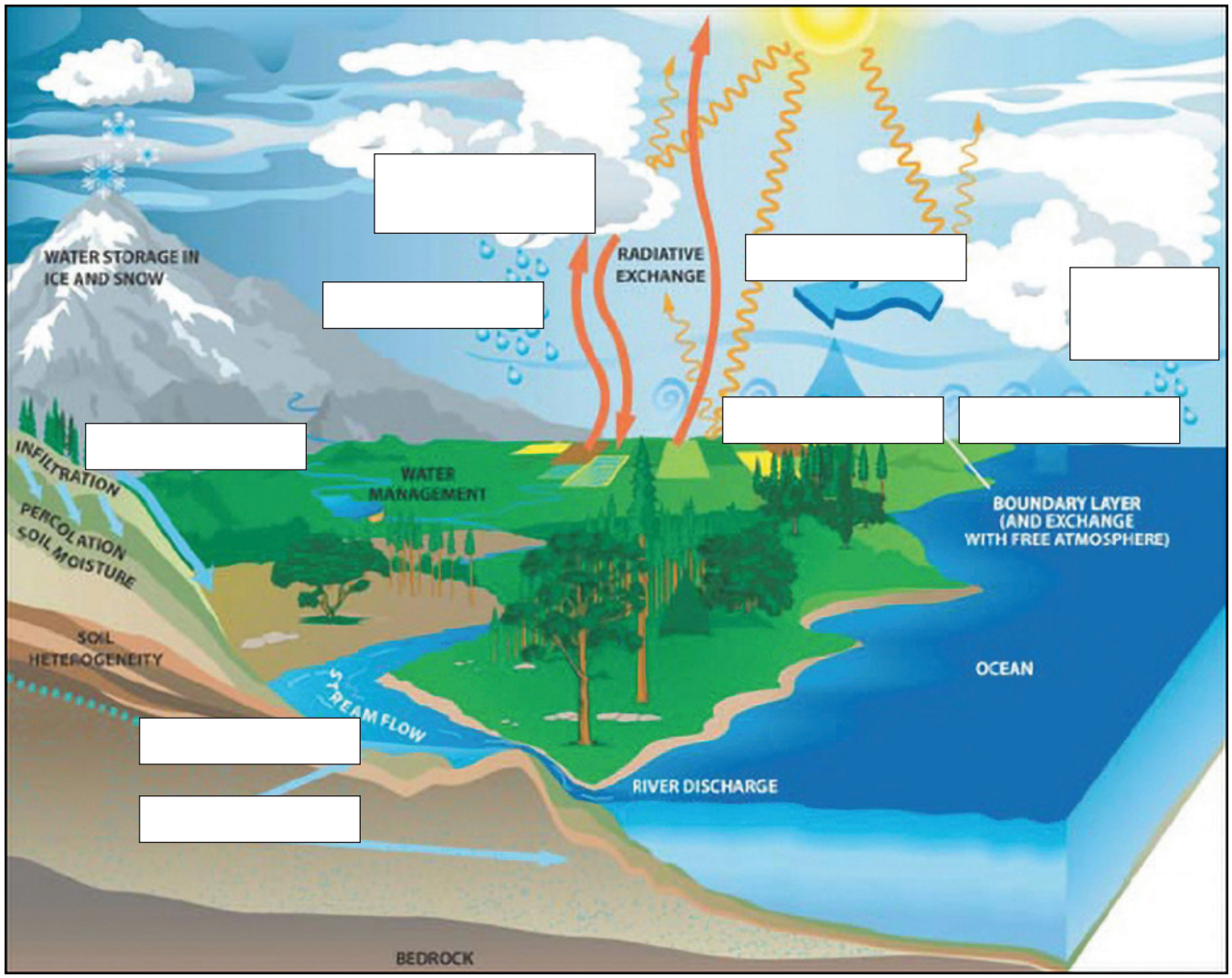
Bedrock	
Infiltration	
Percolation	
River Discharge	
Solar Radiation (from Earth's Surface)	

Handout 1 ▸ P.4

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

Directions:

Fill in the boxes on the diagram below using the terms in Table 1.



Handout 1 ▸ P. 5

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

Conclusion:

Discuss the following questions with your group members and record your answers in the spaces provided.

1. What is the role of trees in the hydrological cycle within the Amazon rainforest? Using some of the terms defined, explain your answer.

2. What causes condensation within the Amazon rainforest? Explain your answer.

3. How does deforestation of 20% or more of the trees in the Amazon rainforest disrupt the hydrological cycle? Explain your answer.

Teacher Resource 1 ▸ P. 1

Answer Sheet for Handout 1

Introduction to the Hydrological Cycle and Deforestation in the Amazon Rainforest

[Note: Students have varying levels of understanding and answers should be discussed and clarified by the teacher.]

Hydrological terms:

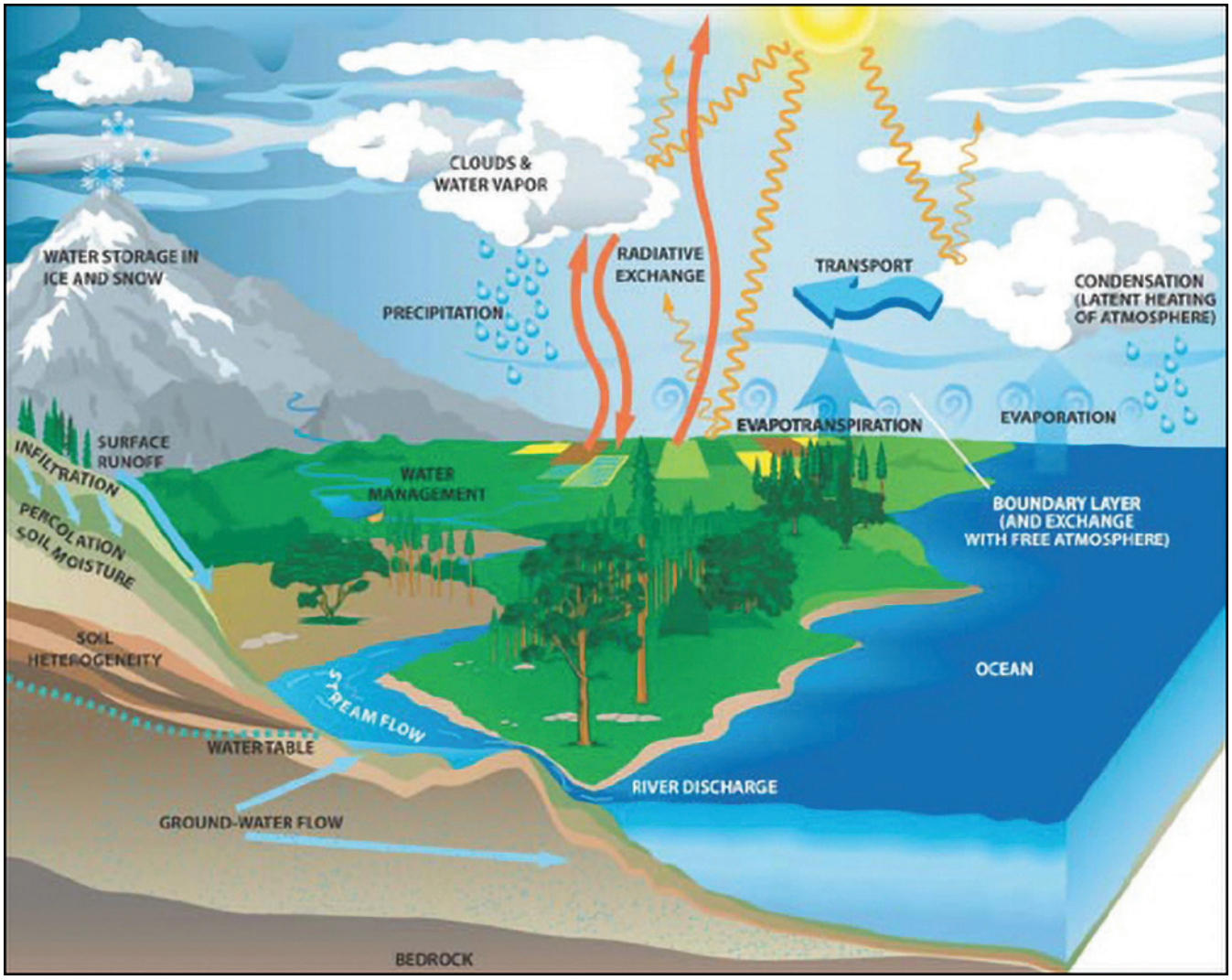
Condensation	Cooling of water vapor resulting in water droplets
Evaporation	Heating of liquid water causing water molecules to move faster resulting in water vapor
Evapotranspiration	Release of water vapor from the openings in leaves, stems, and other plant structures
Groundwater	Water found beneath the Earth's surface
Precipitation	Water that falls from clouds to the Earth's surface
Run-off	Water that flows across the Earth's surface because of (a) soil that is saturated to full capacity, (b) excessive rainfall during a short period of time or (c) an impervious surface
Transport (within hydrological cycle)	Movement of water vapor from over the oceans to over land
Water table	The upper level of an underground surface that is permanently saturated with water

Additional Terms

Bedrock	The solid rock that lies below loosely arranged material in which groundwater can accumulate
Infiltration	The downward flow of water into the Earth's surface
Percolation	The flow of water through soil and porous or fractured rock
River Discharge	Volume of water flowing through a river channel
Solar Radiation (from Earth's Surface)	The amount of heat energy absorbed by the Earth's surface that is reradiated back into the atmosphere

Teacher Resource 1 ▸ p. 2

Answer Sheet for Handout 1



Source: https://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-water-cycle

Teacher Resource 1 ▸ p. 3

Answer Sheet for Handout 1

Conclusion:

1. What is the role of trees in the hydrological cycle within the Amazon rainforest? Explain your answer.

- The root system of rainforest trees absorbs groundwater from deep within the soil, increasing the rate of percolation.
- Tree roots stabilize the soil and help prevent erosion.
- Evapotranspiration from trees in the Amazon allows for approximately 20 billion metric tons of water to be released into the atmosphere daily, causing air to be drawn in from the Atlantic Ocean.

2. What causes condensation within the Amazon rainforest? Explain your answer.

- As the air rises, water vapor in the air cools; condensation forms water droplets.
- Some water droplets fall back to the Earth as rain, while others may form cumulonimbus clouds.
- Approximately 20 billion metric tons of water are released into the Amazon atmosphere daily, forming the Amazonian "river in the sky" that carries more moisture than all of the Amazon rivers combined.

3. How does deforestation of 20% or more of the trees in the Amazon rainforest disrupt the hydrological cycle? Explain your answer.

- El Nino–like changes could take place in the Pacific Ocean, leading to changes in the trade winds, with less rain drawn in from the ocean.
- Reversal of water movement from the Atlantic Ocean to the Amazon rainforest would lead to drought, higher temperatures, and less precipitation, all of which affect aquatic and terrestrial organisms.
- Global terrestrial surface temperatures could rise by as much as 9° Celsius (16° Fahrenheit) and would lead to alterations in precipitation patterns.

Handout 2 ▸ P. 1

Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

Background Information:

Water, essential for photosynthesis, is drawn in through the roots of plants and trees within the Amazon rainforest where it forms clouds. Some water is released from the leaves of plants and trees back into the atmosphere. On average, the Amazon generates half of its own rainfall by recycling moisture and forming new clouds, so that rain falls approximately three times as air masses move from the Atlantic across the basin to the west. The high leaf area index (for broadleaf canopies, the relationship of the total area of one side of leaves compared to the total area of the ground below the leaves) allows for the return of water to the Amazon forest floor and also produces the atmospheric Amazonian "river in the sky."

Objective:

To compare the amount of water vapor that condenses and forms in the atmosphere within the Amazon rainforest with varying amounts of vegetation.

Materials:

Per group or for class demonstration:
3 glass culture bowls or plastic food containers approximately 8" x 8"
Potting soil
Pea or radish seeds
Straws or tongue depressors
Sharpie
Pencil
Light source
Nitrile gloves
Goggles
Aprons
Plastic wrap

Handout 2 ▸ P. 2

Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

Methods:

Day 1

1. Moisten potting soil.
2. Place 2.5"–3"of potting soil in three bowls.
3. In one bowl, cover most of the surface with seeds. If using pea seeds, push the seeds 0.5" down into the soil and cover with a thin layer of soil. Radish seeds can remain on the surface. Label the bowl "A."
4. In another bowl, cover half of the surface with seeds. Repeat step 3, but this time label the bowl "B."
5. In the third bowl, cover one quarter of the surface with seeds. Repeat step 3, but this time label the bowl "C."

Days 2–14

1. Allow the seeds to grow until the seedlings have reached a testable size.
2. Periodically add water and/or spray the seeds with water during the germination process. Be sure to add the same amount of water to each bowl.

Once Seeds Have Reached a Testable Size

1. Add an equal amount of water to each of the bowls.
2. Cut straws to be approximately 2" to 3" above the height of the plants. Uniformly place 10 straws into the soil in each bowl.
3. Carefully cover the bowl with plastic wrap. Make sure the plastic wrap is sealed firmly to the container.
4. Place the bowls under the light source. Make sure the bowls are at the same distance under the light source.

2 Days After Covering Seeds with Plastic Wrap

1. Observe the three bowls.
2. Record your observations in Table 1. Be sure to include a description of the amount of condensation on the plastic wrap, the moisture content of the soil, and the health of the plants.
3. Using a razor blade, your teacher will make one 1" slit in the plastic wrap covering Bowl B and three 1" slits in Bowl C. In each case, use two fingers to widen the slit into a small hole.

4–5 Days After Making Holes in the Plastic Wrap Covering Bowls B and C

1. Observe the three bowls.
2. Record your observations in Table 1. Be sure to include a description of the amount of condensation on the plastic wrap, the moisture content of the soil, and the health of the plants.

Handout 2 ▸ P.3

Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

Table 1: Observations

Bowl A	Observations 2 days after covering with plastic wrap
	Observations 4–5 days after making holes in Bowls B and C
Bowl B	Observations 2 days after covering with plastic wrap
	Observations 4–5 days after making holes in Bowls B and C
Bowl C	Observations 2 days after covering with plastic wrap
	Observations 4–5 days after making holes in Bowls B and C

Handout 2 ▸ p.3

Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

Conclusion:

Discuss the following questions with your group members and record your answers in the spaces provided.

1. Explain why condensation formed on the plastic wrap. Use terms learned in the previous activity (**Handout 1**) within your explanation.

2. Compare the amount of condensation formed in Bowls A, B, and C. Be specific.

3. Make a prediction about what will happen to the rate of condensation if deforestation in the Amazon rainforest continues. Explain how the prediction would affect the plants and animals of the rainforest.

Teacher Resource 2

Answer Sheet for Handout 2

Simulating the Effect of Deforestation on the Rate of Condensation in the Amazon Rainforest

[Note: Students have varying levels of understanding, and answers should be discussed and clarified by the teacher.]

1. Explain why condensation formed on the plastic wrap. Use terms learned in the previous activity within the explanation.

- Heat energy from the light was transferred to the soil and plants. Some water found in the soil and in the plants evaporated into the air and condensed on the plastic wrap.
- Evapotranspiration caused water vapor to condense on the plastic wrap.

2. Compare the amount of condensation formed in bowls A, B and C. Be specific.

- The amount of water droplets on bowl A was the greatest compared to bowl B and C. The plastic wrap on bowl A had a thick film of water droplets across its inner surface.
- The plastic wrap on bowl B had fewer water droplets than bowl A, but more water droplets than bowl C. The plastic wrap on bowl B had a thin film of water droplets across its inner surface, but the entire surface was covered.
- The plastic wrap on bowl C had the least number of water droplets compared to bowl A and B. The plastic wrap on bowl C had scattered water droplets across its inner surface.

3. Make a prediction as to what will happen to the rate of condensation if deforestation in the Amazon rainforest continues. Explain how the prediction would affect the plants and animals of the rainforest.

- The rate of condensation would decrease if deforestation in the Amazon continues.
- Less condensation would result in less rain, resulting in less vegetation.
- Deforestation would also result naturally with decreased amounts of precipitation resulting from less condensation, which could further decrease the vegetation.
- Decreasing vegetation would cause a drastic change in the habitat of many organisms found in the Amazon resulting in decreased diversity.
- Less water needed for life would decrease diversity, which would ultimately affect the food chain within the Amazon.
- Some species in the Amazon could become extinct if their habitat was destroyed owing to a disruption in the water cycle caused by deforestation.

Handout 3 ▸ P. 1

Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

Background Information:

Water can't hold as much oxygen as the atmosphere. Oxygen enters a body of water through photosynthesis and turbulence. Dissolved oxygen (DO) is the amount of oxygen a body of water can hold. As the temperature and the rate of decomposition increase, the amount of dissolved oxygen in a body of water decreases. Deforestation and loss of canopy cover will increase the temperature of a body of water as more solar energy reaches the surface. Deforestation leads to the disruption of root systems, which leads to soil containing organic matter washing into bodies of water. An increase in organic matter will increase the amount of decomposers using oxygen and ultimately decrease available oxygen for other organisms in the water. The demand for oxygen by the decomposers is called biochemical oxygen demand (BOD). As the DO levels drop because of an increase in BOD caused by decomposition, aquatic organisms will die.

Objective:

To understand how soil erosion resulting from deforestation increases the decomposition rate of organic matter in bodies of water, leading to decreased levels of dissolved oxygen.

Materials:

Nitrile gloves
Goggles
Aprons
600–1000 ml beaker or flask containing water with a sand, sugar, and yeast mixture
Tray to go under the beaker or flask
2 small test tubes
Disposable plastic pipettes
Sharpie
Plastic wrap (Parafilm® works well)
Tablets from LaMotte® TesTab® Dissolved Oxygen/BOD Kit (or equivalent)

Methods:

Day 1

1. Using a disposable plastic pipette, obtain a sample of the water, sand, and sugar mixture from your teacher and place it into a small test tube.
2. Measure the DO level of the sample following the instructions in the DO/BOD kit. Record the DO measurement in Table 1.

Your teacher will add yeast to the water, sand, and sugar mixture at the end of the class session.

Handout 3 ▸ P.2

Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

Day 2

1. Using a disposable plastic pipette, obtain a small sample of the water, sand, and sugar mixture (with yeast) from your teacher and place it into a small test tube.
2. Following the instructions in the DO/BOD kit, measure the DO level of the sample. Record the DO measurement in Table 1.
3. Determine the BOD of the water sample.

Table 1: Observations

Initial DO of Water Sample Containing Sand, Water, and Sugar _____
DO of Water Sample Containing Sand, Water, Sugar, and Yeast _____
Calculations See test kit BOD calculation formula to determine the value of the BOD in mg/L

Handout 3 ▸ P.3

Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

Conclusion:

1. What is the importance of dissolved oxygen in a body of water? Explain.

2. When deforestation adds more organic material to a body of water, why does the amount of dissolved oxygen decrease and the biochemical demand increase? Explain.

3. How does the removal of the forest canopy covering a body of water affect its dissolved oxygen content? Explain.

Teacher Resource 3

Answer Sheet for Handout 3

Effects of Deforestation on the Dissolved Oxygen Levels in Streams and Rivers

Note: Students have varying levels of understanding, and answers should be discussed and clarified by the teacher.

1. What is the importance of dissolved oxygen in a body of water? Explain.

- Dissolved oxygen in the water is needed by aquatic organisms for the process of aerobic cellular respiration.
- Cellular respiration provides energy for growth, repair, maintenance, and reproductive processes.

2. When deforestation adds more organic material into a body of water, why does the amount of dissolved oxygen decrease and the biochemical demand increase? Explain.

- An increase in organic material in the water causes a greater number of decomposers, which increases the rate of decomposition.
- Most of the organisms responsible for the decomposition of organic material use oxygen.
- When there is an increase in oxygen-using decomposers, the biochemical oxygen demand increases and results in decreased levels of dissolved oxygen.
- When levels of dissolved oxygen are low, oxygen-using organisms begin to die, which further increases the organic load in the body of water. This leads to more decomposers, a higher rate of decomposition, and even lower levels of dissolved oxygen.

3. How does the removal of the forest canopy covering a body of water affect its dissolved oxygen content? Explain.

- When the amount of leaves over a body of water is decreased, the amount of sunlight (radiant energy) penetrating the water is greater, leading to an increase in the temperature of the water.
- As particles in the water absorb heat energy, they move faster, which lowers their ability to hold oxygen gas, so they release the oxygen to the atmosphere.
- Tree roots hold soil in place. When deforestation occurs, the soil is washed into bodies of water, increasing the turbidity of the water. Because there are more total solids in turbid water that can absorb heat energy from sunlight, the water temperature will increase, causing dissolved oxygen levels to decrease and leading to the death of more aquatic organisms.

Handout 4

Poster Project

Background Information:

Read the article about deforestation at https://amazonaid.org/the-issues/deforestation/

Objective:

To present a poster portraying one cause of deforestation in the Amazon and its local and global effects.

Materials:

Computer, tablet, or phone with Internet access
Color printer access
Poster board
Markers, colored pencils, pencils, Sharpies
Glue stick, scissors, ruler

Methods:

1. Pick one of the causes of deforestation from the list below:

   - Timber industry – legal and illegal
   - Soybean cultivation
   - Coconut cultivation
   - Orange cultivation
   - Palm oil production
   - Road building – legal and illegal
   - Cattle ranching
   - Colonization
   - Agriculture – small and large scale
   - Infrastructure improvements
   - Cellulose ethanol
   - Gold mining
   - Camps of timber companies and miners
   - Crude oil
   - Gas
   - Biofuel

2. Research the process of deforestation resulting from this activity. Be sure to include:

   - the reason for this type of economic activity
   - the steps or processes involved with this type of deforestation
   - the specific local and global effects of this type of deforestation
   - possible solutions to stop or minimize the effects of this type of deforestation

3. Create a poster containing the information from Step 2. The following website can be used as a reference for helpful tips on how to produce a scientific poster. https://www.craftofscientificposters.com/examples.html

   There are some photos you may use at the Amazon Aid Foundation website at https://amazonaid.org/ or you may search for relevant photos on Google Images.

4. Present your poster to the class and discuss its implications.

Teacher Resource 4

Rubric for Cumulative Assessment

The Types of Deforestation That Occur within the Amazon and Their Local and Global Effects

Group Members: _____

Title of Poster: _____

CATEGORY	EXCELLENT (4)	GOOD (3)	SATISFACTORY (2)	NEEDS IMPROVEMENT (1)
Required Content	Poster incorporates all required content along with supplemental information.	Poster incorporates all required content.	Poster incorporates three of the four required content elements.	Poster incorporates two or fewer of the four required content elements.
Accuracy of Content	All content in the poster is accurate.	One content component in the poster is inaccurate.	Two or three content components in the poster are inaccurate.	Four or more content components in the poster are inaccurate.
Effectiveness	Poster provides an excellent understanding of the topic.	Poster provides a good understanding of the topic but lacks one important element associated with the topic.	Poster provides a basic understanding of the topic but lacks two to three important elements associated with the topic.	Poster lacks four or more important elements associated with the topic and does not provide a basic understanding of the topic.
Graphics	All graphics on the poster are labeled, attractive, and support the topic of the poster.	One or two graphics on the poster are not attractive, but all are labeled and support the topic.	All graphics on the poster are attractive and labeled, but a few do not support the topic.	Many graphics on the poster are unattractive and/or are not labeled and/or do not support the topic.
Formatting	All required content components are clearly labeled and easily visible on the poster. Information is sequenced correctly.	All required content components are labeled, but not clearly visible on the poster. Information is sequenced correctly.	One or two required content components are not labeled on the poster. Information is sequenced correctly.	More than two content components are not labeled and/ or information is not sequenced correctly on the poster.
Grammar	Poster has no misspellings and/or grammatical errors.	Poster has one or two misspellings and/or grammatical errors.	Poster has three or four misspellings and/or grammatical errors.	Poster has more than four misspellings and/or grammatical errors.
Citations	Sources of all information and graphics in the poster are properly cited.	Sources of one or two pieces of information and/or graphics in the poster are not properly cited.	Sources of three or four pieces of information and/or graphics in the poster are not properly cited.	Sources of more than four pieces of information and/or graphics in the poster are not properly cited.

Introduction to the Amazon Region

Enduring Understandings

- The Amazon River Basin supplies 20% of the world's freshwater.
- Watersheds or basins extend much farther than the immediate surroundings of a river.
- Watersheds lead to rivers that empty into larger bodies of water.
- Ecological damage to one watershed affects the ecological stability of the entire planet.

Essential Questions

- How do watersheds affect the global ecosystem?
- What is unique about the geography of the Amazon River Basin?
- How does human activity along a river or in a watershed affect that ecosystem?

Notes to the Teacher

In this lesson, students will become familiar with the geography of the Amazon River Basin and learn about watersheds to understand the impact the Amazon River Basin has on global water systems. As the largest watershed in the world, the Amazon River supplies anywhere from 9 to 30 million gallons of freshwater to the Atlantic Ocean each day. This water is then swept around the world on ocean currents. As the film suggests, the dangers of using mercury to mine for gold become obvious when students understand that the same mercury used for mining gold in South America shows up in waters much closer to home.

Part 1 of the lesson uses several websites to introduce students to the watershed concept and then asks them to consider their ecological impact on their own watershed. In which watershed do they live? How do business, government, and human activities affect this watershed? These questions should encourage students to connect more intimately with a place in a different part of the world while beginning to think about the ways in which they affect their own environment.

Before teaching Part 1, you will need to become familiar with the website at https://txpub.usgs.gov/DSS/streamer/web/. Practice zooming in to your geographical area and tracing the rivers upstream, locating the source of each river and identifying the large body of water nearest to you into which each flows. You may also wish to use a wall map or project a map showing the same area; atlases showing the same information could be used instead. For the lesson, you may wish to reserve a computer lab or have students use their own devices to view the websites. You could also project the websites on a screen, whiteboard or SMART Board, but it is better to let students use their own devices.

Part 2 of the lesson focuses on the Amazon River Basin and the nine countries that are responsible for protecting nearly 20% of the world's freshwater supply. Students will use the map of northern South America to trace the Amazon River Basin and identify the countries within its borders. Emphasize to the students that nearly the entire continental United States fits within the Amazon River watershed, to help them gain perspective on the size of this essential ecosystem. If possible, print out copies of the map on **Handout 2** in color to make it easier for your students to use.

In addition to understanding the geography of the Amazon watershed, students should also understand the processes involved in its formation. Initially, the river did not flow from west to east. Only after the formation of the Andes Mountains during the Miocene Epoch (approximately 23 million to 5 million years ago) did the river begin to flow east. The formation of the Andes occurred after the breakup of the massive Gondwanaland supercontinent, when South America split from Africa and the tectonic plates on which it rested began moving west toward the Pacific Ocean. The South American plate eventually converged with the Nazca plate in a process called "subduction." As the Nazca plate pushed eastward against South America, the land along the western edge of the South American plate was pushed up, causing the Andes Mountains to form. As the mountains took shape, sediment from weathering and erosion created deep valleys that carried water from high, inland lakes down the eastern slope of the range and deposited it at the base. This sedimentation largely influenced the shape of the land to the east of the range and topography of the region known today as the Amazon Basin, as well as the movement of the Amazon River east on a new path to the Atlantic Ocean.

This lesson is designed to introduce the Amazon region, as well as the hydrologic factors unique to the creation of the Andes Mountains and shift in the flow of the Amazon River to the east. Please note that it may be helpful to review continental drift, tectonic plate movement, tectonic plate names, and types of plate boundaries prior to the lesson. An understanding of the hydrologic cycle is also essential, and it is covered in detail in Lesson 1, which should be taught in conjunction with this lesson. That lesson provides much more information on the patterns of evaporation, transpiration, and precipitation that govern the weather, not only for the Amazon Basin, but ultimately for the planet.

Here are some additional resources for you and your students:

Amazon ecology:
http://amazonaid.org/

Amazon River source:
http://news.nationalgeographic.com/news/2014/02/140213-amazon-river-length-source-maps-science/

Formation of the Andes Mountains
https://phys.org/news/2015-11-andes-mountains.html

Watershed information:
http://watershedatlas.org/fs_indexwater.html

Map of South America:
http://www.lib.utexas.edu/maps/americas/south_america_ref_2010.pdf

Other maps:
http://ian.macky.net/pat/map/samr/samr.html

A slideshow about the formation of the Amazon Basin
https://www.slideshare.net/nigelcato/amazon-basin-geological-development

Supplementary multimedia: What does the Amazon look like?

Tsunami of clouds:
Mesmerizing clouds float across the slopes of the Peruvian Andes in this video by Edward Hurme
https://www.youtube.com/watch?time_continue=21&v=tLtePho5MQE

Reptiles and amphibians:
Rare footage of reptiles and amphibians from the Peruvian Amazon. Video by Amazon Aid Artist Dano Grayson
https://vimeo.com/78882371

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Amazonia time lapses:
From the cloud forests to the lowlands of the jungle, beautiful time-lapse footage from Amazon Aid Artist Dano Grayson
https://www.youtube.com/watch?v=rNKD8rgQvSE

Common Core Standards addressed by this lesson

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

CCSS.ELA-LITERACY.RH.9-10.4
Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

CCSS.ELA-LITERACY.RH.9-10.3
Analyze in detail a series of events described in a text; determine whether earlier events caused later ones or simply preceded them.

Duration of lesson

2–3 one-hour class periods

Assessments

Homework on watershed terminology

Class discussion

Completion of handouts

Materials needed

Computers with Internet access

Projector with whiteboard or SMART Board

Copies of these handouts:

Handout 1: Watersheds

Handout 2: Amazon River Basin Map

Handout 3: The Amazon River Basin

Colored pencils or markers

Procedure

Part 1: What Is a Watershed?

1. For homework before you begin this lesson, have students define the following terms relating to rivers and bring their definitions to class:

   Watershed
   Tributary
   Source
   Channel
   Riverbank
   Floodplain
   Delta

2. When students arrive for this first lesson, ask them to take out their definitions and review them.

   (*Suggested responses:*

   Watershed: the area of land that contains streams and rivers that all drain into the same, larger body of water

   Tributary: rivulet, creek, or stream that feeds a river

   Source: the start of the tributary that is farthest upstream (Note: There is only one source for a river and it is usually high up in the mountains.)

   Channel: area of land through which a river flows; area where water follows the path of least resistance

   Riverbank: land along the river and home to the "riparian zone" ecosystem that is rich in water-loving plant and animal species

   Floodplain: land around the river that periodically floods

   Delta: place where the river meets a larger body of water; also called the mouth or end of the river

3. Tell your students that they will be focusing on the idea of watersheds in class over the next few periods as they prepare to watch the film *River of Gold*, about the ecological impact of gold mining on the Amazon River Basin and how this industry ultimately affects the global ecosystem. While the film focuses on Peru, it is important that students gain a sense of the scale of the entire Amazon River and Basin.

4. Project the website Watershed Atlas at http://watershedatlas.org/fs_indexwater.html to review with your students the way watersheds work. Allow students time to explore the site and to answer the questions on **Handout 1: Watersheds**. When they have finished, review the responses with the class. (See **Teacher Resource 1** for suggested answers.)

5. Once you feel the students have a good understanding of the importance of watersheds and basins, have them access the U.S. Geological Service Streamer website at https://txpub.usgs.gov/DSS/streamer/web/ on their computers (preferable) or project the website onto a whiteboard or SMART Board. Explain to the students that they will be identifying the watershed where they live. Ask students to find the largest body of water that is closest to them (for example: Maryland would use the Chesapeake Bay, Minnesota students might use the Mississippi River or Lake Superior, Texas students would use the Gulf of Mexico, and students from California would use the Pacific Ocean).

6. Next, have them use the "trace upstream" button to trace each river flowing into the previously identified large body of water back to its source. Ask them to record in which states the river's tributaries are located. Keep a list of the states on the chalkboard as students identify them.

7. Explain that if students were to draw a line that begins at the largest body of water, connects the sources of all the rivers, and returns to the largest body of water without crossing any rivers, they would have outlined the watershed for that body of water. (For the Chesapeake Bay, for example, students will find that they end on either side of the mouth of the bay. For students in the Mississippi River basin, they will cover a huge area that ends on either side of the Louisiana Delta.) Use your wall map or projected map to review the area of the watershed in which your students live.

8. Conduct a group discussion, using the following questions:

   a. Were you aware of your watershed prior to this exercise?
   b. If so, what made you aware? If not, what will you do with this awareness in the future?

   You may wish to assign homework to ask students to research their watershed a bit more. Some questions to consider:

   a. How do people benefit from this watershed?
   b. How do people use it to earn money?
   c. Is the watershed healthy, or is it polluted? How do you know? What resources might be helpful to determine the health of our watershed?

Part 2: The Amazon Basin

1. Distribute copies of **Handout 2: The Amazon River Watershed Map** and **Handout 3: The Amazon River Basin**. You may wish to project the image of the Amazon River watershed on your board or screen for easy reference during discussion.

2. Ask the students to consider the geography of the region and to consider what they learned about rivers and watersheds in yesterday's lesson. Have students work in small groups to answer the questions and label the map as indicated on **Handout 3**. If you have copied the map in black and white, caution them to be careful when they outline the watershed; some of the basin extends slightly into two countries east of Guyana that are not named on the handout, Suriname and French Guiana. Remind them to use what they learned from **Handout 1** to help them with their responses on **Handout 3**.

3. When students have completed this task, have a class discussion in which students take turns identifying the parts of the map they created. (See **Teacher Resource 2** for suggested answers.) You could also project the blank map on to a white board or SMART Board and ask students to add various elements to the board as a class.

4. Spend some time discussing responses to questions 10 and 11. In your discussion of Question 10, use the information in Notes to the Teacher to introduce students to the geologic formation of the Amazon River Basin. In discussing Question 11, have students consider their own environmental impact on the watershed where they live.

5. Begin watching the film at this point.

Handout 1 ▸ P.1

Watersheds

Using the website **Watershedatlas.org**, to answer the following questions:

1. How do small watersheds combine to form large ones?

2. Draw a diagram of the water cycle.

3. How do humans affect the water cycle? (Choose one of the examples from the website and describe the impact.)

4. How do geologic forces affect the flow of rivers and boundaries of watersheds?

5. Choose one natural system and explain how it helps maintain a balanced ecosystem within a watershed.

Teacher Resource 1
P . 1

Watersheds: Answer Key

Using the website: **Watershedatlas.org**, answer the following questions.

1. How do small watersheds combine to form large ones?

A stream begins in the mountains or elevated areas, and the land surrounding that stream becomes part of its watershed. This stream then follows the path of least resistance down to a larger river or body of water. (This website focuses specifically on the path of the Allegheny River as it joins the Ohio River and eventually the Mississippi River in the United States, but similar patterns hold elsewhere.)

2. Draw the water cycle.

Evaporation including Condensation → *Precipitation* → *Infiltration* → *Runoff*

(*Students may have forgotten how transpiration connects plants with the water cycle, but it's an essential process for understanding the complexity of the Amazon River Basin. Be sure to review if necessary.)*

3. How do humans affect the water cycle? (Choose one of the examples from the website and describe the impact.)

Septic fields: If they are poorly maintained, waste can seep into the groundwater and contaminate the area.

Abandoned coal mines: Often the source of AMD (acid mine drainage), these abandoned mines release toxins into the ground and damage the watershed.

Strip mining: This practice removes all vegetation from an area. Once all minerals are extracted, miners today are required to cover the mine with topsoil to allow vegetation to grow again. The regraded lands, however, are frequently less fertile than the original soil and seldom result in more than shrubs or grasses.

Agriculture and livestock: These are often the source of excessive phosphorous and nitrogen introduced to an area from manure and other chemicals. These cause extensive environmental hazards to streams. Livestock can also cause soil displacement and may require cleared land, which allows for more runoff and more silt to enter a stream, altering its makeup.

Pollution: Air pollution from cars and factories is one of the main causes of acid rain. This rain is damaging to new growth. Chemicals that seep into the ground can also alter the water systems for an ecosystem. Most of the water we drink comes from the ground, so it matters what goes in it!

Teacher Resource 1
P . 3

Watersheds: Answer Key

4. How do geologic forces affect the flow of rivers and boundaries of watersheds?

In the film, the Amazon River reversed its flow after a glacier began to recede millions of years ago. On the website, as the glacier receded, it left "till" or gravelly deposits behind, changing the landscape enough to force the Allegheny River away from Lake Erie and down toward the Mississippi. This expanded the watershed tremendously. Tectonic plate movement and changes to the Earth's crust at the boundaries between plates are also important factors in the shaping of land relative to watershed formation.

5. Choose a natural system and explain how it helps maintain a balanced ecosystem within a watershed.

(Answers will vary. Each student should cover the main points for one of the systems listed below. Be sure that all are covered during your discussion.)

Instream: Seasonal water temperature changes related to spawning or migration patterns, provision of food sources like detritus and insects, healthy instream habitats for strong food web interactions, and the ability to buffer chemical changes to the greater watershed if bacterial populations (and the larger food webs) are healthy, water quality is stable, etc.

Riparian forest: Forest adjacent to the river's edge, with extremely important functions for maintaining balance in the ecosystem: filters, transformers, sinks, sources, and stabilizers.

Floodplain: Large flat area above the stream (generally within the riparian forest and wetland), helps to reduce the speed of water entering the stream and to control runoff.

Wetlands: Help control flooding and slowly release water into the ground. This process aids in filtration and maintains a nutrient-rich environment.

Forested slope: Extremely important for underground water storage and the transpiration process that returns water to the air in the form of vapor during photosynthesis. Such slopes help prevent erosion; massive root systems stabilize slopes and lands for animals and other vegetation.

Handout 2

Amazon River Watershed Map

Source: By Kmusser [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons

Handout 3 ▸ p.1 The Amazon River Basin

Using your Amazon River Watershed map and the blank map attached to this handout, work with a partner to answer the following questions. You will need to create a key and title for your map. You may use additional research resources as needed.

1. On the blank map, label the all the countries in the Amazon River Basin (or watershed).

2. Choose a color and draw the approximate course of the Amazon River. Indicate this in your key.

3. Choose a different color and draw the outline of the Amazon River Basin or watershed with a dashed line. Indicate this on your key.

4. Create a scale for your map. Approximately how large an area is the Amazon River Basin? _____

5. Label the mountain range on the west coast of South America. Create a symbol to represent it and add to the key.

6. Where is the approximate SOURCE of the Amazon River? Create a symbol for this physical feature and add it to both the map and your key.

7. Choose another color and circle the MOUTH or DELTA. Indicate this on your key.

8. Label the body of water where the MOUTH or DELTA empties.

9. Use arrows to indicate the direction of the flow of the Amazon River. Add these to your key.

10. Why do you think the river flows in this direction?

11. Consider what you learned yesterday about human impact on the water cycle in a watershed. How might human activity along the Amazon River affect the river itself? How might it affect the global ecosystem?

Handout 3 ▸ p.1 The Amazon River Basin

Source: By TUBS [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0) or GFDL (http://www.gnu.org/copyleft/fdl.html)], via Wikimedia Commons

Teacher Resource 1
P .1

The Amazon River Basin: Answer Key

1. On the blank map, label the countries in the Amazon River Basin (or watershed).

Students should label the following: Brazil, French Guiana, Ecuador, Suriname, Guyana, Bolivia, Peru, Venezuela, and Colombia.

2. Choose a color and draw the approximate course of the Amazon River. Indicate this in your key.

Answers will vary but should be similar to the map on **Handout 2**.

3. Choose a different color and draw the outline of the Amazon River Basin or watershed with a dashed line. Indicate this on your key.

Answers will vary, but should be similar to the map on ***Handout 2***.

4. Create a scale for your map. Approximately how large an area is the Amazon River Basin?

Scales will vary. The Amazon River Basin is approximately 2.77 million square miles (nearly the same size as the continental U.S.)

5. Label the mountain range on the west coast of South America. Create a symbol to represent it and add to the key.

The Andes Mountains. Symbols will vary.

6. Where is the approximate SOURCE of the Amazon River? Create a symbol for this physical feature and add it to both the map and your key.

While this seems debatable, it has recently been suggested that the Amazon's source is the Mantaro River in Peru. Students should use their best judgment when placing this on their maps.

7. Choose another color and circle the MOUTH or DELTA. Indicate this on your key.

Answers will vary, but the Delta is located at the Atlantic Ocean.

8. Label the body of water where the MOUTH or DELTA empties.

The Atlantic Ocean.

9. Use arrows to indicate the direction of the flow of the Amazon River. Add these to your key.

Arrows should point towards the Atlantic Ocean.

Teacher Resource 1
P . 2

The Amazon River Basin: Answer Key

10. Why do you think the river flows in this direction?

Students should deduce from yesterday's work on watersheds that the high elevation of the Andes Mountains, where the Amazon has its source, forces the water to flow toward the lower-lying areas and eventually to the Atlantic Ocean.

11. Consider what you learned yesterday about human impact on the water cycle in a watershed. How might human activity along the Amazon River affect the river itself? How might it affect the global ecosystem?

Answers will vary, depending on how much research students do. Remind them of the title of the film they are about to watch and its focus in Peru. At the most basic level, when lands are cleared, runoff is more prevalent and affects the water flow and nutrients in the river.

Rainforest Ecology

Enduring Understandings

- Interdependent relationships are the foundation for the success of the Amazon. Because of these relationships, the removal or loss of any type of life has an impact on many other species.
- Earth's climate is changing thanks to increased levels of carbon dioxide in our atmosphere, which increases global temperatures in a so-called greenhouse effect.
- Trees in the Amazon are able to store carbon, thereby reducing the amount of carbon dioxide in the atmosphere and fighting climate change.
- People around the world benefit from the resources found in the Amazon rainforest.

Essential Questions

- How do living things rely on one another for survival in the Amazon rainforest? How do we rely on the Amazon rainforest for survival?
- What evidence have scientists used to conclude Earth's climate is changing?
- Why is the Amazon known as a "carbon sink"?
- Why is the Amazon such a unique ecosystem? Why is the Amazon critical in the fight against climate change?

Notes to the Teacher

This lesson dives deeper into the ecology of the Amazon rainforest and looks at the environmental issues that are at play. You may wish to teach this lesson in conjunction with Lesson 1, which provides students with an understanding of the processes of the hydrological cycle that underlies the ecology of the rainforest.

The overarching theme of this lesson is *interconnectedness*; the lesson deals not only with the interconnectedness of plants and animals in the Amazon, but also with the ways our actions in the Amazon have widespread impacts across the globe. The idea that even small actions or changes could have dramatic effects on this rainforest ecosystem is important for students to be able to fully understand the sense of urgency in changing current human practices in the region.

The most pressing environmental issue our planet currently faces is climate change. With the increased rates of carbon dioxide emissions from human activity into our atmosphere, weather patterns are changing and becoming less predictable; extreme weather events are becoming more frequent and increasingly devastating. The loss of parts of the Amazon has caused increased rainfall is some areas to the east of South America, while at the same time causing droughts north of Peru, including California. The destruction of the Amazon itself emits high amounts of carbon dioxide through the machinery used and the burning of the trees. In fact, as noted in *River of Gold*, 20% of all carbon dioxide in the air is from burning trees. This problem is compounded by the fact that the Amazon is arguably the most effective natural resource we have to fight climate change. Through the process of photosynthesis, trees remove carbon dioxide from the air to produce carbohydrates in the form of glucose for the plant to

use. The trees store this carbon for hundreds of years. This is why the Amazon is known as a "carbon sink."

To fight climate change, we need to increase the number of trees in the Amazon, instead of increasing deforestation in countries like Peru. According to *River of Gold*, since 2000, the equivalent of 50 soccer fields of forest are destroyed each minute. If this continues, not only will additional carbon dioxide be added to our atmosphere, but the ability for trees to remove the carbon dioxide will be diminished.

This lesson is divided into five parts; each takes at least one class period to complete. Students should have at least some background knowledge on interactions between species in an ecosystem and food chains. It is important for students to understand that if one species is affected by the destruction of the rainforest, this will lead to a trickle-down effect that can cause the entire ecosystem to collapse. Students should also have some idea of what climate change is, including its causes and effects.

In Part 1, students are asked to tap into both prior knowledge and what they learned from *River of Gold*. They respond to four different statements about the Amazon rainforest, listing facts, explaining key vocabulary, and giving their opinions about these topics. The statements reflect ideas and topics that they will investigate further later on in the lesson. The purpose of this activity is to stimulate student thinking and to have these ideas at the front of their minds as they continue to learn more about the ecology of the Amazon and the threats we face from its destruction.

Before the lesson begins, write the statements below on pieces of construction paper or poster board; feel free to adjust these statements as you wish. Circle key vocabulary words or write them in different colors; this draws attention to this vocabulary and highlights the idea that students should identify what these terms mean during the activity. Post the statements on the wall in different parts of the room.

Statements:

- People living in the United States are directly affected by the health of the Amazon rainforest.
- Forests like the Amazon can help fight climate change.
- Biodiversity and interdependence are critical to the success of the Amazon rainforest.
- Deforestation or forest fragmentation must stop in the Amazon rainforest.

The "Anthem for the Amazon" sets the tone for Part 2. This is a six-minute music video developed by the Amazon Aid Foundation and Rhythm of the Universe. Its purpose is to unite the world in a compelling call to action through the universal language of music to save the world's greatest rainforest. Five hundred children from 50 countries around the world came together to stand up for the Amazon and sing this original global anthem. After viewing the anthem, your students split into small research groups to look more closely at a specific topic about the Amazon to become "experts" in one area. Some students research the ecology of the Amazon by identifying specific species and relationships present there; they also study the importance of biodiversity and forests in general. Some students research natural resources from the Amazon that humans around the world rely on. Finally, another group will look more closely at how humans are currently interacting with the Amazon; they will analyze the costs and benefits of these practices. Before this class session, make enough photocopies of **Handout 1: Research Assignments** and cut the sections apart so that students

will have the appropriate questions for their group. After this period of research, students engage in a jigsaw activity to share what they have found, ending with a whole class discussion of major themes and topics.

Students act as scientists in Part 3 by analyzing the same type of data that adult scientists use to understand climate change. They look more closely at what exactly climate change is and how scientists know it is happening. Students look at NASA satellite data on global temperature and carbon dioxide levels in the atmosphere. They analyze graphs to understand the correlation between increased carbon dioxide levels in the atmosphere and the increase in global temperatures. Students also learn how scientists use ice cores, glaciers, and tree rings to understand past climate trends. Optional: If your students are not familiar with climate change or need further explanation, a brief explanation of what climate change is and its main causes can be found at NatGeo Kids at https://www.natgeokids.com/au/discover/geography/general-geography/what-is-climate-change/.

Finally, in Part 4, when students have a better understanding of climate change and how we know it is happening, they dive more deeply into carbon sequestration and storage, thereby learning how the Amazon can fight climate change and considering the consequences of further destruction of the Amazon. Students read an article from the *Washington Post* that details the increased levels of deforestation of the Amazon and the danger this causes to climate change. Students are introduced to Dr. Thomas Lovejoy and his work on fragmented forests. They watch videos that demonstrate exactly how carbon sequestration works and that explain the importance of reforestation in fighting climate change. The lesson wraps up with a whole class discussion about the implications of the Amazon rainforest, how everything in nature is connected, and the real threat of climate change. An extension activity gives students the opportunity to voice their own opinions, supported by evidence, about deforestation and other topics of the Amazon.

Some additional resources that may be of interest:

Dr. Lovejoy's Project at https://www.amazonbiodiversitycenter.org/about_us. This shows an example of a conservation project that is underway to protect the Amazon rainforest. Additionally, it provides information about the importance of trees and the Amazon in the fight against climate change.

"What is the future of Earth's climate?" at http://authoring.concord.org/sequences/47/activities/278?show_index=true. This web activity uses data from NASA for students to analyze climate trends over past decades to understand what is going on with Earth's climate and what will happen if we don't make any changes.

Supplementary multimedia: What does the Amazon look like?

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Animals of the rainforest:
See 14 species that live in the Amazon, including footage of the unique glass frog. Video by Amazon Aid Artist Dano Grayson.
https://www.youtube.com/watch?v=WrWc2F9VAS4

Amazonia time lapses:
From the cloud forests to the lowlands of the jungle, beautiful time-lapse footage from Amazon Aid Artist Dano Grayson.
https://www.youtube.com/watch?v=rNKD8rgQvSE

Mercury Uprising:
A 12-minute look into why the Amazon is important, the things that are destroying it, and the hope for protecting it. Video by Amazon Aid and ROTU Studios.
https://vimeo.com/125067596

Common Core Standards addressed by this lesson

CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.2
Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

CCSS.ELA-LITERACY.RST.6-8.7
Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

CCSS.ELA-LITERACY.RH.9-10.4
Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

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

CCSS.ELA-Literacy.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-Literacy.CCRA.SL.4
Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.CCRA.SL.2
Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Next Generation Science Standards Addressed in Lesson:

LS2.A: Interdependent Relationships in Ecosystems

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

LS4.D: Biodiversity and Humans

LS1.C: Organization for Matter and Energy Flow in Organisms

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

Duration of lesson

Three to five class periods

Assessment

Classroom discussions and participation

Roundtable discussions

Completion and correctness of activities from handouts

Materials Needed

Construction paper, poster board, or newsprint

Markers of various colors

Copies of **Handouts 1-4**

Student computers with Internet access

Projector for viewing videos listed in the lesson

Copies of or access to the article from *Washington Post* at https://www.washingtonpost.com/news/energy-environment/wp/2016/02/11/the-solution-to-climate-change-that-has-nothing-to-do-with-cars-or-coal/?utm_term=.29a1adc3029d

Procedure

Part 1: What Do We Think?

1. Divide the class into four groups and have each group move to one of the statements you have posted on the wall. Provide students with markers or pencils of different colors.

2. Ask each group to write down their ideas on the statements with the markers. Stress to students that they should think about *River of Gold* and what they viewed in the film to help them. Give them the following prompts:

   a. Do you agree or disagree with the statement? Why?

   b. What information do you already have about the topic?

   c. Can you connect your own ideas to anything other students wrote?

   Give student groups four or five minutes at each statement and encourage them to write as much as they can. Have groups circulate until all groups have had a chance to respond to all the statements.

Part 2: How the Amazon Works

1. Show the "Anthem for the Amazon" music video at https://vimeo.com/143037688 to highlight the importance of the Amazon. Allow time for a brief discussion about the video: What was students' favorite part? Do they feel any personal connections to the "Anthem for the Amazon" video? How effective was it?

2. Have a brief discussion with students about the connections between scientific topics in the music video and scientific topics explored during *River of Gold*. Explain to students that they are going to take a closer look at some of the topics discussed in both the music video and *River of Gold*. Explain that they will be working in small groups to investigate various biological and environmental aspects of the Amazon rainforest in order to understand how the rainforest functions, how we use products from the Amazon, and how humans are affecting these aspects of the Amazon.

3. Divide students into four groups. Assign a topic from **Handout 1: Research Assignments** to each group and distribute the relevant set of questions to each group. Go over your own expectations for research activities, including time, length, and materials to be used.

4. Give students adequate time to research, either during class or for homework. After enough time, explain to students that they will now share their information in **Roundtable Talks** where an "expert" from each group explains the group's findings to a smaller group made up of a member from each of the research topics. Divide the class into these smaller groups. Distribute **Handout 2: How the Amazon Works** and ask them to take notes on the most valuable information presented.

5. As a whole group, discuss the major findings from each of the research groups. During the discussion, make sure to incorporate key ideas:

   - Plants and animals depend on one another for survival. This is not only seen in food chains and food webs, but also in symbiotic relationships, habitats, etc.
   - Forests have unique characteristics that regulate temperature and climate by capturing and storing carbon.
   - Destruction of the Amazon is increasing because of gold mining, logging, building of infrastructure (buildings, roads, etc.). This will increase the amount of carbon dioxide in the atmosphere, increasing the effects of climate change.
   - Humans rely on the natural resources of the Amazon rainforest for a wide variety of products, including freshwater, oxygen, medicine, minerals, and food. With the destruction of the Amazon, we reduce our access to these resources.

Part 3: Evidence of Climate Change

1. Begin a discussion about what the class has learned thus far about the importance of the Amazon rainforest. Students should touch on each of the topics that were investigated in the roundtables. Stress the uniqueness of the Amazon, including biodiversity, numbers of trees, and the reasons the Amazon region is essential in the fight against climate change.

2. Ask the class to share their ideas about climate change and record their comments on the board or chart paper. Students should explain what climate change is, what causes it, and what its effects are now and in the future.

3. Introduce students to the first video, "Bill Nye on Climate Change," at https://www.youtube.com/watch?v=rPqd2otdncg and tell them to take notes to answer these questions:

- What is climate change? (The process of Earth heating up, thanks to human activity, which changes global weather patterns and makes them less predictable)
- How is climate change being increased by humans? (Dramatic increase in population straining resources and creating pollution)
- What does carbon dioxide have to do with global warming? (Increased emissions into the atmosphere that trap heat and therefore increase global temperatures)

Revisit the ideas recorded before viewing the video to see if students can add or correct anything. Discuss why we should care about climate change and draw connections between this, *River of Gold*, and the Amazon rainforest. Now show the video at https://www.youtube.com/watch?v=rPqd2otdncg.

Tell students that as scientists, we have to analyze data to support specific claims, such as climate change. Explain that they are going to analyze various data sets to understand how scientists concluded that the climate is changing.

Pass out **Handout 3: Evidence for Climate Change** to the class, review the directions, and answer any questions students may have. Students can work in groups or independently to complete the handout. As students work, circulate throughout the room to ensure they are finding the data easily and are drawing accurate conclusions.

When the students have finished their research, review their findings as a whole class. Be sure students understand that because of human use of fossil fuels, carbon dioxide levels are rising, which causes global temperature to rise. Scientists use these measurements, as well as information stored in ice cores, tree rings, and sediment to support these findings.

Part 4: Carbon Sequestration

1. Explain to students that, since they now have an understanding of climate change and have seen the evidence scientists have used to prove it is real, they can now further investigate why the Amazon rainforest plays such a critical role in the fight against climate change.

2. Ask students to recall how the Amazon rainforest helps fight climate change. (Forests act as carbon sinks and store excess carbon dioxide emitted by human use of fossil fuels.) Tell students that they will be looking more closely at the role the Amazon, and specifically trees, have in the fight against climate change.

3. Distribute copies of the *Washington Post* article on climate change at https://www.washingtonpost.com/news/energy-environment/wp/2016/02/11/the-solution-to-climate-change-that-has-nothing-to-do-with-cars-or-coal/?utm_term=.29a1adc3029d or have students read the article online. You may choose to read as a whole class, pausing to discuss important ideas; every student can read independently; or you may divide the article into sections and give each section to a group of students. If you choose the small-group option, have each group share the main ideas of their section with whole class.

4. As a class discuss main ideas of the article:

- Why is the Amazon rainforest called a "carbon sink"? (Trees in the rainforest remove carbon from the atmosphere and store it.)
- Why do scientists think stopping deforestation in the Amazon rainforest is so important in the fight against climate change? (Stopping deforestation and restoring forest land could offset as much as one-third of climate emissions,)
- How do plants store carbon? (They absorb carbon dioxide through photosynthesis; this carbon can remain stored in them for decades or even hundreds of years.)
- How does deforestation actually add to the climate change problem? (It can add about 8-15% of global emissions.)
- How does forest fragmentation add to the problem? (Interrupted forests allow more sunlight to reach the rainforest floor, which interrupts normal plant and animal life at these levels.)

5. Pass out **HANDOUT 4** and review the directions on the handout. Explain to students they will need to pay close attention to several short videos to answer the questions on the handout.

6. Show students the following short videos to help them to understand how trees "clean the air," capture carbon, and aid in fighting climate change. [Note: The first video ends with an appeal for the Trillion Trees campaign. If you do not wish to show this, stop the video at 4:03. It is a good idea to pause the video at different times to allow students to take notes.]

How Trees Clean the Air
https://www.youtube.com/watch?v=XVUAgcSCP_U

Capture Carbon with Trees
https://www.youtube.com/watch?v=eDqQ1VdsO3o

After viewing the videos, allow students to share their answers and allow time for students to add details to the answers on their worksheets.

7. Have a class discussion that ties all of the topics together. Have students look back over **HANDOUTS 2–4** and discuss major themes and conclusions. Here are possible discussion topics, or you may use the Essential Questions from the beginning of the lesson.

- Think about *River of Gold* and the research you have done in class. What are some of the ways humans interact with the Amazon rainforest?
- How are these interactions harming the rainforest?
- How are these interactions affecting the rest of the world?
- What is climate change? What is causing climate change?
- How do scientists know Earth's climate is changing? What evidence supports this?
- How can the Amazon rainforest help to fight climate change?
- Do you think gold mining is essential for the economy of Peru?
- What changes could be made to stop deforestation while still allowing Peruvians to support their way of life?

Extension Activity

Do a **Think-Pair-Share**: **Claim, Evidence, Reasoning** activity. Give students or small groups one of the following questions:

- **a)** Why are interdependent relationships between plants, animals, and humans so important to the success of the Amazon?
- **b)** Is the Amazon rainforest essential in the fight against climate change?
- **c)** Deforestation, resulting in forest fragmentation, does provide benefits; however, do these benefits outweigh the costs?
- **d)** Should all human interaction, except observation, be stopped in the Amazon rainforest?
- **e)** Who should make decisions about the use of the Amazon rainforest?

After reading their question, students should write a short claim with evidence in the following format:

Claim: A statement that answers the original question or problem.

Evidence: Scientific data to support the claim. The data should be appropriate and sufficient to support the claim.

Reasoning: A justification that connects the evidence to the claim.

Handout 1 ▸ P.1

Research Assignments

Group 1:

Plant and Animal Interdependence

- What is biodiversity and why is it so important?
- What is interdependence? Why is this important in an ecosystem?
- What are some examples in the Peruvian rainforest?
- How could loss of species and therefore interdependent relationships impact the overall health of the Amazon?

Resources to start with:

The animals of the Amazon rainforest (Flora and Fauna)
https://amazonaid.org/resources/

Ted-Ed video at
https://ed.ted.com/lessons/why-is-biodiversity-so-important-kim-preshoff

"Plants and animals" at
https://simple.wikipedia.org/wiki/Rainforest

Tropical rainforest food web
http://tropicalrainforestscience10.weebly.com/food-web.html

Group 2:

Importance of a Forest

- How big is the Amazon? How many trees and species does it have?
- Why do humans and other species need forests?
- Why are forests known as "carbon sinks"?
- What is the Amazon's canopy structure and how does this support biodiversity?

Resources to start with:

Important Facts about the Amazon video at
https://www.youtube.com/watch?v=HiwgpA4ReEc

The Importance of Forests video at
https://www.youtube.com/watch?v=gdeBW_Z-6ug

What is a Carbon Sink?
https://www.livescience.com/32354-what-is-a-carbon-sink.html

Handout 1 ▸ P.2

Research Assignments

Group 3:

Human Impact

- What major industries are greatly affecting the Amazon?
- Why is deforestation such a huge problem for Earth?
- How does deforestation lead to drought and climate change?

Resources to start with:

- *Scientific American*: "Amazon Deforestation Takes a Turn for the Worse" at https://www.scientificamerican.com/article/amazon-deforestation-takes-a-turn-for-the-worse/
- Human Impacts website reading at http://tropicalrainforestscience10.weebly.com/human-impacts.html
- Deforestation Impacts video https://www.youtube.com/watch?v=9iJZCXcmsfw

Group 4:

Resources from the Amazon

- What products are made from resources found in the Amazon?
- What are the costs and benefits?
- How would our daily lives be affected by the loss of these resources?

Resources to start with:

- AAF: The Global Importance of Amazon Natural Resources at http://amazonaid.org/global-importance-amazon-natural-resources/
- Section on medicines from the rainforest at http://tropicalrainforestscience10.weebly.com/human-impacts.html
- "What are the Resources of the Amazon Rainforest?" at https://sciencing.com/resources-amazon-rainforest-7214334.html

Handout 2

How the Amazon Works: Roundtable Discussions

Directions:

Listen carefully to the information your classmates share and use the spaces below to take notes. If you need more space, use the back of this page.

Research Topic	Important Facts and Ideas
Plant and Animal Interdependence	
The Importance of Forests	
Human Impact	
Resources from the Amazon	

Handout 3 ▸ P.1

Evidence for Climate Change

Part One: Global Temperature

Directions:

Visit https://climate.nasa.gov/vital-signs/global-temperature/. Read the page, and then study and analyze the graph. View the time-lapse video showing temperature change at the bottom of the page. Then answer the questions below:

1. What trends or patterns did you observe regarding global temperature change over time? Use actual data from the graph to support your answer.

2. Create a graph that predicts what will happen to global temperatures in the next 50 years.

Handout 3 ▸ P.2

Evidence for Climate Change

Part Two: Carbon Dioxide Level in the Atmosphere (Why Earth Is Heating Up)

Directions:

Visit https://climate.nasa.gov/vital-signs/carbon-dioxide/. Read the page, observe and analyze both graphs. View the time-lapse video that shows change in carbon dioxide levels. Then answer the questions below:

1. How is carbon dioxide released into the atmosphere?

2. Describe the patterns and trends shown in the **first graph**. In other words, what story is the graph telling us? Use actual data from the graph to support your answer.

3. Describe the patterns and trends shown in the **second graph**. In other words, what story is the graph telling us? Use actual data from the graph to support your answer.

Handout 3 ▸ P.3

Evidence for Climate Change

4. Create a graph that predicts what will happen to carbon dioxide levels in the next 50 years.

5. Describe the relationship between increased carbon dioxide levels in the atmosphere and global temperatures. In other words, as we emit carbon dioxide into the atmosphere, what happens to global temperature?

Handout 3 ▸ P.4

Evidence for Climate Change

Part Three: Additional Climate Change Evidence

Directions:

Visit https://climatekids.nasa.gov/climate-change-evidence/. Read the information on the page while answering the questions below:

1. How do scientists use **ice cores** to understand what Earth was like long ago?

2. What other things do scientists study to understand what Earth's climate was like long ago?

3. Explain how scientists use **glaciers** to support their understanding of climate change. Give at least one specific example.

Handout 4 ▸P.1

How Do Trees in the Amazon Fight Climate Change?

Directions:

As you watch the videos, take notes to answer the following questions. Your teacher will pause the video periodically to go over the answers and allow you to add any needed details.

1 Why are trees known as "the lungs of the Earth"?

2. How do trees reduce air pollution? What do they remove from the air?

3. How is the Amazon rainforest like a giant air purifier?

Handout 4 ▸p.2

How Do Trees in the Amazon Fight Climate Change?

4. Trees like those in the Amazon can stop dust storms. Why is this important?

5. Opinion: Do you think scientists should still devote time and money researching carbon dioxide levels in the atmosphere? Why or why not?

6. Opinion: Should governments be working to end deforestation? Why or why not? Is ending deforestation more important than jobs in the Amazon rainforest, such as gold mining, logging, cattle herding, etc.? Why or why not?

Teacher Resource 1
P .1

Evidence for Climate Change (Answer Sheet)

Part One: Global Temperature

Directions:

Visit https://climate.nasa.gov/vital-signs/global-temperature/. Read the page, and then study and analyze the graph. View the time-lapse video showing temperature change at the bottom of the page. Then answer the questions below:

1. What trends or patterns did you observe regarding global temperature change over time? Use actual data from the graph to support your answer.

The temperature was fairly steady until the 1930s. There was a temporary increase (up .11° C) in temperature in the early 1940s, and then a steady and rapid climb from 1975 to the present. As the accompanying text points out, 17 of the 18 warmest years have occurred since 2001. The slope of the line from 2009 to 2017 shows a dramatic rise. 2016 was the hottest year on record since 1880.

2. Create a graph that predicts what will happen to global temperatures in the next 50 years.

Graphs will vary, but many will show temperatures climbing steadily and quickly. More optimistic students may predict a slower rise in temperatures due to efforts to combat global warming.

Teacher Resource 1
P . 2

Evidence for Climate Change (Answer Sheet)

Part Two: Carbon Dioxide Level in the Atmosphere (Why Earth Is Heating Up)

Directions:

Visit https://climate.nasa.gov/vital-signs/carbon-dioxide/. Read the page, observe and analyze both graphs. View the time-lapse video that shows change in carbon dioxide levels. Then answer the questions below:

1. How is carbon dioxide released into the atmosphere?

It is released through human activities like deforestation and burning fossil fuels, and natural processes such as respiration and volcanic eruptions.

2. Describe the patterns and trends shown in the **first graph**. In other words, what story is the graph telling us? Use actual data from the graph to support your answer.

The rate of increase in the presence of carbon dioxide in the atmosphere has been steady. On January 16, 2005, carbon dioxide in the atmosphere measured 378.21 ppm. On June 17, 2018, the measurement was 408.47. [Student answers about carbon dioxide measurements will change as NASA continues to add data to the graph.]

3. Describe the patterns and trends shown in the **second graph**. In other words, what story is the graph telling us? Use actual data from the graph to support your answer.

The second graph shows indirect measurements of carbon dioxide based on analysis of ice cores. Carbon dioxide presence was cyclical for hundreds of thousands of years before 1950, with highs approaching 300 ppm and lows around 180 ppm. However, the vertical line at the very end of the graph shows how dramatically it has peaked in the last few decades.

4. Create a graph that predicts what will happen to carbon dioxide levels in the next 50 years.

Graphs will vary. Many students will show a line with a steep upward slope, indicating increasing carbon dioxide levels. Students who believe that carbon dioxide production can be limited may show a graph with a less steep slope.

5. Describe the relationship between increased carbon dioxide levels in the atmosphere and global temperatures. In other words, as we emit carbon dioxide into the atmosphere, what happens to global temperature?

As we emit carbon dioxide into the atmosphere, global temperatures rise.

Teacher Resource 1
P .3

Evidence for Climate Change (Answer Sheet)

Part Three: Additional Climate Change Evidence

Directions:

Visit https://climatekids.nasa.gov/climate-change-evidence/. Read the information on the page while answering the questions below:

1. How do scientists use **ice cores** to understand what Earth was like long ago?

Scientists drill two miles below the surface in Antarctica and bring up samples of ice, called ice cores. They measure the amount of carbon dioxide in the air bubbles trapped inside. They also learn about the Earth's temperature by measuring the amounts of different types of oxygen in the water.

2. What other things do scientists study to understand what Earth's climate was like long ago?

They study cores made of sediment from the bottom of lakes or oceans. They also study tree rings and layers of rocks.

3. Explain how scientists use **glaciers** to support their understanding of climate change. Give at least one specific example.

Glaciers are frozen rivers and they flow like rivers, but more slowly. In recent years, the speed of glaciers has been increasing. In places like Glacier National Park, they are melting because the air is warmer and less snow is falling in winter to replenish the glaciers.

Teacher Resource 2

How Do Trees in the Amazon Fight Climate Change? (Answer Sheet)

Directions:

As you watch the videos, take notes to answer the following questions. Your teacher will pause the video periodically to go over the answers and allow you to add any needed details.

1. Why are trees known as "the lungs of the Earth"?

Trees take in carbon dioxide and release oxygen, which all people and animals need for life. Oxygen produced in one area of the world can be carried on air currents around the globe.

2. How do trees reduce air pollution? What do they remove from the air?

Trees remove pollutants that can cause health problems, like ground-level ozone, sulfur dioxide, nitrogen dioxide, and carbon monoxide, from the air. Then trees convert these pollutants into non-harmful compounds.

3. How is the Amazon rainforest like a giant air purifier?

The trees remove humid hazes, which can cause increased heat, reduced visibility, and health problems. The trees give off water vapor and friendly bacteria, which cause the hazes to collect into clouds, which then bring rain. This brings down pollutants to the ground, where they are converted by the trees into safer compounds.

4. Trees like those in the Amazon can stop dust storms. Why is this important?

Dust storms can travel hundreds of miles. They cause mechanical problems, breathing difficulties, loss of visibility, and the spread of disease.

5. Opinion: Do you think scientists should still devote time and money researching carbon dioxide levels in the atmosphere? Why or why not?

Answers will vary.

6. Opinion: Should governments be working to end deforestation? Why or why not? Is ending deforestation more important than jobs in the Amazon rainforest, such as gold mining, logging, cattle herding, etc.? Why or why not?

Answers will vary.

The Biodiversity of the Amazon Region

Enduring Understandings

- All components of natural systems have a purpose and are interdependent.
- Changes in one part of an ecosystem will affect other parts of the ecosystem.
- Humans benefit from resilient ecosystems.
- Humans can alter the factors in an ecosystem, creating changes to the entire ecosystem.

Essential Questions

- What is biodiversity and why is it important?
- How does species diversity relate to biodiversity?
- How do organisms support each other in food webs?
- How does human activity affect biodiversity?
- What types of human-caused species loss serve as major threats to biodiversity?
- How does biodiversity relate to wellness in human communities?
- How does the disappearance of one species affect other species?
- What steps can be taken to preserve habitats and protect wildlife?

Notes to the Teacher

The activities in this lesson are designed to build upon one another. A thorough review of each activity ahead of time is suggested to best understand how each one scaffolds the ones that follow and to determine the most appropriate use of class time needed. While the recommended lesson duration is between two and five one-hour class periods, the activities can easily be modified to best fit the timeframe available. The activities here are designed to introduce the concept of biodiversity, inviting students to examine the relationship between species diversity in the Peruvian Amazon region, ecosystem resilience, and the health of human communities. Students will explore the impact of human activity on the Amazon rainforest, considering threats to biodiversity from ecological and cultural perspectives. They will also learn more about species that have become endangered in the Amazon region thanks to the gold mining industry and other human-related activities.

In Part 1, students will learn about the concept of diversity through the lens of the Amazon rainforest ecosystem. They will examine the definition of biodiversity, focusing on important vocabulary to help boost their understanding of the more complex natural systems they will encounter later in the lesson. They will consider the importance of biodiversity in a rainforest ecosystem, using evidence from the film *River of Gold* to underscore the environmental and cultural value of ecosystem resilience in the Peruvian Amazon. Students will explore rates of deforestation and biodiversity loss in the Amazon rainforest, and learn how the resulting changes to this ecosystem correlate with the loss of biodiversity. They will also consider the ways in which biodiversity loss affects the health of human communities in the region.

It may be important to review the definition of a rainforest ahead of teaching Part 1 of this lesson, in which case the information found on the National Geographic Online Encyclopedia (https://www.nationalgeographic.org/encyclopedia/rain-forest/) may be helpful. Student knowledge of food webs and energy transfer in ecosystems is also necessary; the Crash Course Ecosystem Ecology: Links in the Chain video lesson (https://www.youtube.com/watch?v=v6ubvEJ3KGM) may serve as an excellent review. This part of the lesson also includes a concept map activity. Lucid Chart's "How to make a concept map" (https://www.lucidchart.com/pages/concept-map/how-to-make-a-concept-map) offers helpful tips on creating a concept map. This portion of the lesson will also require one copy of **Handout 1: Biodiversity: What's the Good Word? (Teacher Copy)** and a class set of **Handout 2: Biodiversity: What's the Good Word? (Student Copy)**. Please note the **Handout 1: Biodiversity: What's the Good Word? (Teacher Copy)** should be cut up for distribution during the biodiversity vocabulary activity. The pieces can be distributed to the class as is, but it may be helpful to adhere them to larger pieces of paper for greater durability and use with the same activity in the future.

Part 2 of the lesson invites students to consider the interplay among biodiversity, habitat loss, and human communities in the Amazon region. They will examine the impact of human activity on the Amazon rainforest and consider the long-term consequences of critical habitat destruction on the health of regional human communities. They will explore the use of the word "health" as it applies to human communities in the Amazon and will learn about the costs of biodiversity loss and deforestation on indigenous Amazon tribes. (It should be noted here that the optional TED video by Dr. Mark Plotkin (What the people of the Amazon know that you don't) at (https://www.ted.com/talks/mark_plotkin_what_the_people_of_the_amazon_know_that_you_don_t/details#t-548806) can easily be adapted as a more formal piece of the lesson.) Students will work in groups to investigate the use of Geographic Information Systems to assess land cover data as way of evaluating biodiversity loss. They will also have the opportunity to learn more about common causes of habitat loss in the Amazon region, with a focus on human activity including the mining of gold. Be sure to underscore the perspective through which the Community Voices writing assignment should be written. This portion of the lesson also requires the use of the Internet and class sets of **Handout 3: Mapping the Amazon** and **Handout 4: Community Voices**.

Part 3 is designed to help students synthesize some of the new concepts they have learned about the interplay between biodiversity and ecosystem resilience, and to begin to think critically about the challenges and concerns facing human communities in the Amazon region relating to habitat loss. Students will be asked to research native Amazon species that are considered threatened or endangered (referred to as "vulnerable" for the purpose of this lesson) and to think innovatively about ways to improve conservation efforts for these populations. This portion of the lesson requires a class set of **Handout 5: We Deserve to Conserve**, noting that the duration of this research project will depend on the amount of class and/or curriculum time available.

Supplementary multimedia: What does the Amazon look like?

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Animals of the rainforest:
See 14 species that live in the Amazon, including footage of the unique glass frog. Video by Amazon Aid Artist Dano Grayson.
https://www.youtube.com/watch?v=WrWc2F9VAS4

Birds of the Amazon:
This rare footage includes video of nesting birds. Video by Amazon Aid Artist Dano Grayson.
https://vimeo.com/78798674

Plants of the Amazon:
The Amazon is dense with plants. Video by Amazon Aid Artist Dano Grayson.
https://vimeo.com/78798436

Insects of the Amazon:
Insects are everywhere in the rainforest. Video by Amazon Aid Artist Dano Grayson.
https://vimeo.com/78882372

Reptiles and amphibians:
Rare footage of reptiles and amphibians from the Peruvian Amazon. Video by Amazon Aid Artist Dano Grayson.
https://vimeo.com/78882371

Common Core Standards addressed by this lesson

English and Language Arts Standards

CCSS.ELA-LITERACY.W.9-10.1
Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCSS.ELA-LITERACY.W.9-10.2
Write informative/explanatory texts to examine and convey complex ideas, concepts, and information clearly and accurately through the effective selection, organization, and analysis of content.

CCSS.ELA-LITERACY.W.9-10.3
Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

CCSS.ELA-LITERACY.W.9-10.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1-3 above.)

CCSS.ELA-LITERACY.W.9-10.7
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CCSS.ELA-LITERACY.W.9-10.8
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation.

CCSS.ELA-LITERACY.SL.9-10.1
Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.SL.9-10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

CCSS.ELA-LITERACY.SL.9-10.5
Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

CCSS.ELA-LITERACY.L.9-10.1
Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCSS.ELA-LITERACY.L.9-10.4
Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 9-10 reading and content, choosing flexibly from a range of strategies.

CCSS.ELA-LITERACY.L.9-10.5
Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

CCSS.ELA-LITERACY.L.9-10.6
Acquire and use accurately general academic and domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Common Core Standards addressed by this lesson

Science and Technical Subjects Standards

CCSS.ELA-LITERACY.RST.9-10.1
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

CCSS.ELA-LITERACY.RST.9-10.2
Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.

CCSS.ELA-LITERACY.RST.9-10.4
Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9-10 texts and topics.

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

CCSS.ELA-LITERACY.RST.9-10.7
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

CCSS.ELA-LITERACY.RST.9-10.8
Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem.

Duration of Lesson

Two to five one-hour periods

Assessments

Completion of the *What's the Good Word* concept map

Group discussion

Presentations

Letter to the Editor assignment

Mapping the Amazon questions

Community Voices environmental campaign project

Materials needed

Whiteboard

Whiteboard markers

Computers with online access

Scissors (optional)

Glue sticks (optional)

Blank 11" x 17" white paper

Handout 1: Biodiversity: What's the Good Word? (Teacher Copy)

Handout 2: Biodiversity: What's the Good Word? (Student Copy)

Handout 3: Mapping the Amazon with answer sheet **(Teacher Resource 1)**

Handout 4: Community Voices

Handout 5: We Deserve to Conserve

Procedure

Part 1: Biodiversity 101

1. Begin by telling the students they will have the opportunity to learn important vocabulary surrounding ecosystem resilience in the Peruvian Amazon. Write the word "biodiversity" on the board and ask students if they have heard of "biodiversity" and, if so, what comes to mind when they think about the term. Record student responses on the board. Briefly discuss, and then distribute the pre-cut biodiversity terms and definitions from **Handout 1: Biodiversity: What's the Good Word? (Teacher Copy)** to individual students (one term and one definition that does not match it per student). If the class size is smaller than the number of terms, give out multiple terms and definitions until they have all been distributed.

2. Invite students to mingle, looking for the individual whose term or definition is a match to the one they were assigned. They may use any resource available in the classroom for help in pairing terms with definitions. When all students have located their counterpart, give the pairs blank 11" x 17" paper and several minutes to discuss the definition of the word. Allow time for the design of a short presentation that articulates in their own words the meaning of the term to the group. Presentations should be oral and include an illustration of the term on the blank paper provided. Each illustration should feature the related term in bold lettering; illustrations can be displayed around the classroom when complete. When all presentations are complete, invite students to list the terms that are most and least familiar. Ask the students why some of these terms are familiar, and why some are not.

3. Tell the students that these terms are all associated with the concept of *biodiversity* and that they will now be given the chance to consider how the terms are related. If in-class time is available, ask student pairs to begin working on a concept map for the entire collection of terms using **Handout 2: Biodiversity: What's the Good Word? (Student Copy)**. An alternative to student pairs working independently might be to create a single map on the board as an entire class. This part of the lesson can also be given as an overnight assignment. When the concept maps are complete, invite students to share the methods they used to create their maps. Ask them to discuss the experience of creating the concept map using these terms. Discussion prompts might relate to terms that were difficult to associate or alternative concept map arrangements.

4. Have students watch the TED video *Why is biodiversity so important?* (https://ed.ted.com/lessons/why-is-biodiversity-so-important-kim-preshoff#watch). See if they can identify any of the terms they reviewed in the first part of the activity. Have them answer the following questions relating the video to the film *River of Gold* in the form of an open group discussion.

- **a.** In your own words, what is *biodiversity*?
- **b.** What three features of a region support biodiversity? Describe examples of these features you remember from the film *River of Gold*.
- **c.** What does it mean if a region has high biodiversity? Low biodiversity? Please explain.
- **d.** The TED video states that a rainforest is a huge system filled with many smaller systems. What does this mean? Describe evidence of "systems within systems" in the Peruvian Amazon that you remember from watching the film *River of Gold*.

e. What does it mean if species are "interconnected"? Describe some of the ways that species in the Amazon region might be interconnected. How is species interconnectedness related to biodiversity?

f. What does it mean if an ecosystem is "resilient"? What does biodiversity have to do with resilience?

g. According to the TED video, what changes to organism populations might result in lower biodiversity in the Amazon region? How would this affect the resilience of the Amazon rainforest ecosystem?

h. What would happen to biodiversity if one species were to be lost? Would the impact be different if multiple species were lost? Please explain.

i. The film *River of Gold* states that an area the size of 50 soccer fields in the Amazon region has been destroyed every minute since 2010. How many acres of forest are equivalent to 50 soccer fields?

j. According to the film *River of Gold*, how long will it take for the rainforest to regenerate? How do you think this will affect the biodiversity in the Peruvian Amazon?

k. Why is biodiversity important to the Peruvian Amazon?

5. For homework, have students create a list of as many environmental costs of biodiversity loss in the Amazon rainforest as they can think of in a 15-minute period. (Suggest that if necessary, they can set a timer for the duration.) For each cost listed, ask them to think of at least one way that the health and/or wellness of human communities in the Amazon region is affected. For example, the loss of trees to deforestation can lead to increased release of stored (sequestered) carbon into the atmosphere. Increased atmospheric carbon, in turn, contributes to climate change and a host of poor human health outcomes (to include cardiopulmonary illness, food- or water-borne disease). Student should be prepared to discuss in the next class.

Part 2: Human Impact on the Amazon Rainforest

1. Begin with a discussion surrounding the homework assignment relating biodiversity loss to human health and/or wellness in Part 1. If time permits, have the students watch the TED video "What the people of the Amazon know that you don't." (https://www.ted.com/talks/mark_plotkin_what_the_people_of_the_amazon_know_that_you_don_t/details#t-548806). Invite students to write their ideas on the board, listing the environmental costs of biodiversity loss on the left-hand side and impacts to human health on the right-hand side. After reviewing the lists as a class, invite several students to come to the board and draw arrows linking each environmental cost to as many of the impacts to human health listed. The board should display many arrows in multiple directions, demonstrating that the relationship between environmental and human health is both vast and complex.

2. Explain to the students that they will now have the opportunity to explore the geography and biological diversity of the Amazon rainforest region as a way of understanding more about the environmentally destructive nature of biodiversity loss. Divide students into pairs. Distribute copies of **HANDOUT 3: MAPPING THE AMAZON** to each group. Instruct the students to complete the activity using the directions provided, paying close attention to the questions. If time is constrained, this activity can be assigned or completed as homework.

3. When students have completed the handout, spend 10-15 minutes reviewing the questions to which they responded during the activity. (See the suggested answers on **Teacher Resource Sheet 1.**) Call on students to describe the relationship between deforestation, biodiversity, and habitat loss. Invite several students to share the additional causes of habitat destruction (to including gold mining) from the film *River of Gold* they included in their answers to Question 9. As students are sharing, generate a list on the board. (NOTE: The final list should include the human activities that appear on **Handout 4: Community Voices**: logging, slash-and-burn, agriculture, dam construction, roadbuilding, industry, and invasive species.)

4. Ask the students if they are familiar with any of the human activities on the list. Challenge the students to share what they know about each based on their existing knowledge and new information from the film *River of Gold*. Choose individual or group brainstorming, a journal prompt, a pair-sharing conversation, or full class discussion.

5. Inform the students that they will have the opportunity to explore the impact of human activity in the Peruvian Amazon by assuming the role of a local community member concerned about the loss of critical rainforest habitat. Tell them they will be writing a "Letter to the Editor" to express their concern about the impact of human activity, biodiversity loss, and regional human health and/or wellness; this is an independent project. Distribute copies of **Handout 4: Community Voices** to each student. Review the instructions with the class, paying close attention to the request that the letter be drafted from the perspective of the community member. (See the example given at the bottom of **Handout 4: Community Voices**.) Inform the students they will each choose one "human activity" to pair with one community voice.

(NOTE: While students ultimately have the choice of the human activity and community voice, you may wish to guide the decision process to ensure that final projects are varied and community voices surrounding the intention of the assignment are diverse. It is also important to note that health and wellness are used synonymously here, giving students the liberty to consider the implications of habitat destruction on such aspects of human communities as disease, safety risks, access to food, poor air or water quality, soil contamination, cultural traditions, or societal constructs.) This assignment can be completed in class over several periods or assigned as a longer-term project.

6. When students have completed the assignment, invite them to read their letters to each other. Students can also be given the option of sharing information about the voice they chose and health impact to their community at the hands of habitat destruction about which they wrote. You may wish to place the assignments on display or compile them electronically to share with the greater community.

7. Once students have submitted their letters, ask them to share any new knowledge they learned from the assignment. Ask the students to consider ways in which the damage to the rainforest ecosystem they addressed in their letters might be reversed. Ask them to discuss the potential steps involved (e.g., alternatives to the human industries about which they wrote, innovative ways to improve biodiversity in the areas affected, ideas for community conservation efforts, etc.). Invite them to discuss what the positive effects of such alternatives might be on the health of the regional community.

Part 3: Amazon Species Conservation

1. Inform the students that, for the final portion of the lesson, they will have the opportunity to learn more about the flora and fauna of the Peruvian Amazon. Tell them they will work in teams to design an environmental campaign dedicated to the conservation of a vulnerable Amazon species of their choosing. Tell them that *vulnerable* species, for purpose of this project, are considered either "threatened" or "endangered." Host a brief discussion about the definitions of these terms. (NOTE: The National Wildlife Federation's Endangered Species Act page at https://www.nwf.org/Educational-Resources/Wildlife-Guide/Understanding-Conservation/Endangered-Species offers a discussion of the difference between *threatened* and *endangered*.)

2. Divide the students into groups of two or three. Distribute copies of **Handout 5: We Deserve to Conserve** to each group. Ask the students why the assignment might be called "We Deserve to Conserve," focusing on what is meant by the words "we" and "deserve." Allow the students time to review the instructions and then discuss the itemized project requirements as a class. Explain that the campaigns each group will design should be informative, exciting, and creative, and that their final product will be shared as part of a five-minute presentation at the project's culmination. Emphasize that, while PowerPoint and Prezi presentations will not be permitted, many creative alternatives exist. Point out the list of suggestions on **Handout 5.**

3. Tell the students that the species choice will be theirs, with the possibility of using either one mentioned in the film *River of Gold* or finding their own. Point out the websites provided at the bottom of **Handout 5: We Deserve to Conserve**.

4. Allow groups class time to begin researching species topics online, reminding groups that the concept of species is not limited to just animals. Groups can work in class or on their own on the remaining project research elements. Be sure to establish and make clear the project length and due date for the final presentation, depending on the amount of time available.

5. While groups are presenting the final version of their campaign, ask the remainder of class to make notes on each presentation. They should record the following:

   a. Name of the presenter
   b. Species name
   c. Conservation status of the species (threatened vs. endangered)
   d. Reason for the conservation status
   e. Two things that stood out about the idea the presenting group has for steps that can be taken to conserve the species

6. When all presentations are finished, host a class discussion that invites students to share their thoughts about other presentations and underscores the ideas for conservation methods that each group has proposed. Ask the students about the feasibility of the projects and how they or the class might be inspired to get involved with a current Amazon conservation project.

Handout 1 ▸ P.1

Biodiversity: What's the Good Word? (Teacher Copy)

Cut apart the following chart, separating terms and definitions. Distribute these to your students during Part 1 of the lesson. You may wish to paste the terms and definitions on larger pieces of paper to prevent loss and to use for later classes.

Ecosystem Diversity	The ecosystem variation unique to a certain geographic location and impact of this variation on human communities and the environment.
Species Diversity	The number of species types that characterize an ecological community.
Genetic Diversity	The sum of genetic characteristics in the hereditary composition of an individual species.
Species Richness	The number of species types unique to an ecological community or region.
Species Evenness	The measure of how close the total numbers of species types in an environment are to one another.
Biodiversity	The variation of life on Earth; evaluated at the molecular, species, and ecosystem levels.
Adaptation	The evolutionary process that genetically tailors an organism population to its environment, thereby enhancing survivability and reproductive success.
Biological Evolution	The changes in genetic characteristics of populations that can be inherited by successive generations over time.
Ecological Niche	The role of a species in its environment relating to the ways in which it addresses needs for food, shelter, survival, and reproduction.
Extinction	The dying out of an individual organism or species (group of organisms).
Keystone Species	A species that helps define an ecosystem, and whose removal would have an extremely large effect on the ecosystem.
Habitat	An ecological area inhabited by a particular species.
Population	Organisms of the same group or species in an area that are capable of interbreeding.
Species	The largest group of organisms in which individuals can interbreed to produce fertile offspring.
Habitat Fragmentation	The process by which habitat loss leads to changes in population dynamics and ecosystem decline.

Handout 1 ▸ P.2

Biodiversity: What's the Good Word? (Teacher Copy)

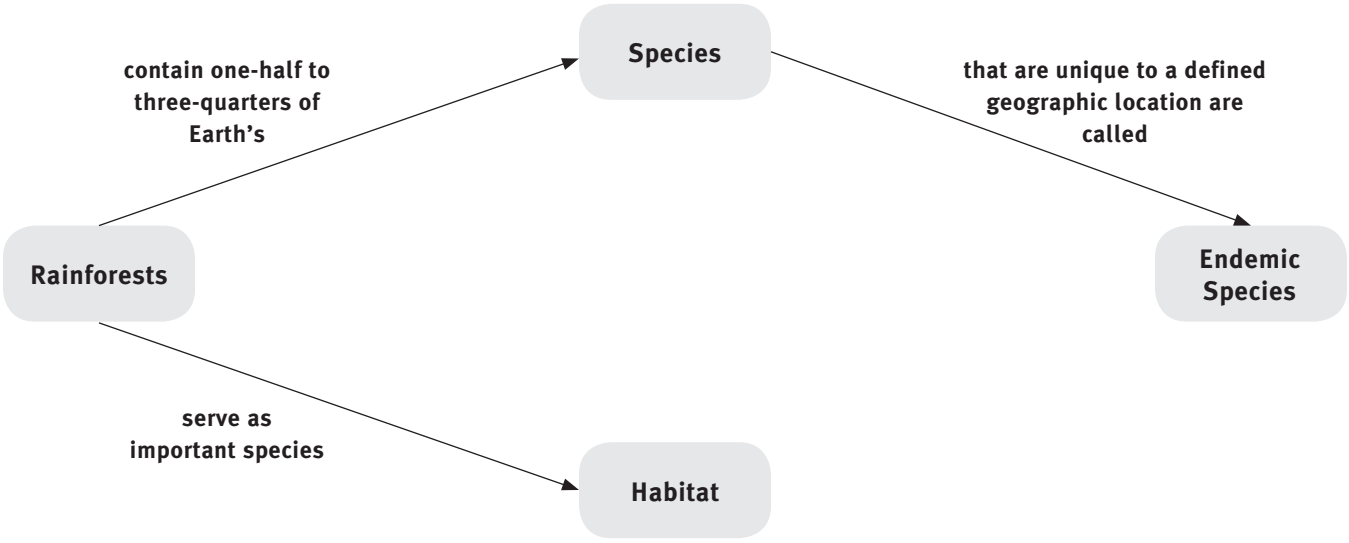
Threatened Species	A species that is likely to become endangered.
Endangered Species	A species that is likely to become extinct.
Herbivore	Organism adapted to eating plant material as a primary dietary component and source of energy.
Carnivore	Organism that derives energy and primary nutrition from consuming other animals.
Conservation	The ethical use of natural resources in such a way as to prevent exploitation and destruction.
Desertification	Land degradation in which a region becomes dry arid and risks loss of water, vegetation, and wildlife.
Deforestation	The process by which forested land is cleared and converted to non-forest use.
Nutrient	Substance in food that organisms acquire from the environment and use for growth and survival.
Endemic Species	Species that are unique to a defined geographic region.
Ecosystem	The collection of biotic (living) and abiotic (nonliving) components in a particular environment.
Food Web	The system of interdependent food chains in an ecological community.
Rainforest	Forest characterized by high rainfall; definitions vary by region.
Producer	Organism that produces its own food (also called an autotroph).
Consumer	Organism that relies on other organisms as a source of food (also called a heterotroph).
Gene Pool	The collection of all genes or genetic information in an interbreeding population.
Species Interdependence	The reliance of two or more species groups on each other.
Humans	Members of the extant genus *Homo* characterized by erect posture, bipedal movement, increased dexterity, tool use, complex brains, and unique ability to form societies.

Handout 2

Biodiversity: What's the Good Word?

Directions:

On a separate sheet of paper, construct a concept map for the terms shown below. The relationships between terms should be displayed with an arrow (→) and a statement that completes a sentence relating the terms to each other. All terms should be used. See the example below and visit https://www.lucidchart.com/pages/concept-map/how-to-make-a-concept-map for tips on designing a strong concept map.



Ecosystem Diversity	Ecological Niche	Endangered Species	Ecosystem
Species Diversity	Extinct	Herbivore	Food Web
Genetic Diversity	Keystone Species	Carnivore	Rainforests
Species Richness	Habitat	Conservation	Producer
Species Evenness	Population	Desertification	Consumer
Biodiversity	Species	Deforestation	Gene Pool
Adaptation	Habitat Fragmentation	Nutrient	Species Interdependence
Biological Evolution	Threatened Species	Endemic Species	Humans

Handout 3 ▸ P.1

Mapping the Amazon

Directions:

Please follow the instructions below regarding the information found on the National Geographic MapMaker Interactive website at http://mapmaker.nationalgeographic.org/. Be sure to answer all questions provided.

1. Go to http://mapmaker.nationalgeographic.org/. Click "OK, Let me get started!" on the first window that pops up. Locate the Amazon region by clicking and dragging the screen of the interactive map.

2. Using the "Zoom" feature in the upper left-hand corner of the map, enlarge the Amazon region so that the names of all rivers that feed into the Amazon are visible.

- **a.** How many smaller, named rivers are shown on the map that flow directly into the Amazon River?
- **b.** How many tributaries do you think might *actually* flow into the Amazon?
- **c.** In which direction does the Amazon flow?
- **d.** Through which countries do the Amazon River and its tributaries flow?
- **e.** In which country does the Amazon River begin?

3. Use the "Draw a polyline" feature in the toolbar on the left-hand side of the map to determine the approximate length of the Amazon River in kilometers (km). Click on "Draw a polyline." Place your first distance marker by clicking on the westernmost point on the Amazon River. Move to the east along the river; place new distance markers at as many bends as possible. When you arrive at the easternmost point, double-click the last distance marker you placed to complete the measurement. Based on your research, how long is the Amazon River?

4. Click on the gray bar to the right of the map. Click "Base Maps" to make sure your map is set to a "NatGeo" filter. Then, click "Layers" and then "Add Layer." On the page that opens, click the "Environment" category and choose "Land Cover" by clicking on the green cross. Read about the "Land Cover" layer using the drop-down menu in the box. In your own words, describe what the "Land Cover" layer will show on the map in the space below.

5. Click "Done." When the interactive map reappears with the new "Land Cover" layer is added, click on the "Legend" tab on the right-hand side. Based on your understanding of rainforests, which Land Cover elements shown in the legend most likely contribute to the Amazon rainforest? Please include colors and land type names.

6. Click the "Layers" tab on the right-hand side of the map. Adjust the transparency in the Land Cover box shown so that the boundaries of all countries within the Amazon region are visible.

- **a.** What tool on your NatGeo Mapmaker Interactive map could you use to determine an accurate measurement of the land area covered by the Amazon rainforest? Please describe the steps involved.
- **b.** The Amazon rainforest covers roughly eight million square kilometers (sq km) of land. Based on a visual observation of your map, approximately what percentage of the rainforest exists in the country of Peru?

Handout 3 ▸ P.2

Mapping the Amazon

c. Using the method detailed in Question 6a, determine the area of the Peruvian Amazon rainforest (in square kilometers) on your map.

7. A study released by the Brazilian government estimated that the rate of Amazon rainforest deforestation increased by 29 percent in 2016, resulting in a net loss of approximately 8000 sq km. Using the area of rainforest in Peru you calculated in Question 6c, determine how many years it will take at this rate for the Peruvian Amazon to disappear completely.

8. Why is deforestation in the Amazon becoming more rapid? What causes of deforestation from the film *River of Gold* can you use to support your response?

9. How does deforestation from the mining of gold lead to habitat loss for species that are critical to the biodiversity of the Amazon rainforest ecosystem? Can you think of other examples of human activity from the film *River of Gold* that lead to decreased biodiversity and habitat loss in this region?

Handout 3 ▸ P.1

Mapping the Amazon (Answer Sheet)

Directions:

Please follow the instructions below regarding the information found on the National Geographic MapMaker Interactive website at http://mapmaker.nationalgeographic.org/. Be sure to answer all questions provided.

1. Go to http://mapmaker.nationalgeographic.org/. Click "OK, Let me get started!" on the first window that pops up. Locate the Amazon region by clicking and dragging the screen of the interactive map.

2. Using the "Zoom" feature in the upper left-hand corner of the map, enlarge the Amazon region so that the names of all rivers that feed into the Amazon are visible.

- **a.** How many smaller, named rivers are shown on the map that flow directly into the Amazon River? *(Approximately 9)*
- **b.** How many tributaries do you think might *actually* flow into the Amazon? *(Thousands)*
- **c.** In which direction does the Amazon River flow? *(West to east)*
- **d.** Through which countries do the Amazon River and its tributaries flow? *(Peru, Bolivia, Venezuela, Colombia, Ecuador, Brazil, Guyana, French Guiana, Suriname)*
- **e.** In which country does the Amazon River begin? *(Peru)*

3. Use the "Draw a polyline" feature in the toolbar on the left-hand side of the map to determine the approximate length of the Amazon River in kilometers (km). Click on "Draw a polyline." Place your first distance marker by clicking on the westernmost point on the Amazon River. Move to the east along the river; place new distance markers at as many bends as possible. When you arrive at the easternmost point, double-click the last distance marker you placed to complete the measurement. Based on your research, how long is the Amazon River? *(Answers may vary depending on student measurement accuracy here. The recorded length of the Amazon is approximately 6400 km or 4000 miles.)*

4. Click on the gray bar to the right of the map. Click "Base Maps" to make sure your map is set to a "NatGeo" filter. Then, click "Layers" and then "Add Layer." On the page that opens, click the "Environment" category and choose "Land Cover" by clicking on the green cross. Read about the "Land Cover" layer using the drop-down menu in the box. In your own words, describe what the "Land Cover" layer will show on the map in the space below. *(While answers may vary here, "Land Cover" in this case refers to imaging of Earth's terrestrial regions to include how the land is covered and/or used.)*

5. Click "Done." When the interactive map reappears with the new "Land Cover" layer is added, click on the "Legend" tab on the right-hand side. Based on your understanding of rainforests, which Land Cover elements shown in the legend most likely contribute to the Amazon rainforest? Please include colors and land type names. *(Most of the green categories shown on the drop-down menu would be included as rainforest land cover: Evergreen Needleleaf, Evergreen Broadleaf Forest, Deciduous Needleleaf Forest, Deciduous Broadleaf Forest, Mixed Forest, Woodland.)*

Handout 3 ▸ P.2

Mapping the Amazon (Answer Sheet)

6. Click the "Layers" tab on the right-hand side of the map. Adjust the transparency in the Land Cover box shown so that the boundaries of all countries within the Amazon region are visible.

- **a.** What tool on your NatGeo Mapmaker Interactive map could you use to determine an accurate measurement of the land area covered by the Amazon rainforest? Please describe the steps involved. *(Answers may vary here. The "Draw a Polygon" tool, however, could first be used to outline the proposed area of the rainforest. The shaded region shown could then be divided into smaller geometric shapes for which the area can be more easily determined. The "Draw a Polyline" tool, in this case, could then be used to measure the length of the sides of the shapes to determine the final area of each shape; the sum of the shape areas together would provide an estimate of the land area covered by the rainforest.)*
- **b.** The Amazon rainforest covers roughly eight million square kilometers (sq km) of land. Based on a visual observation of your map, approximately what percentage of the rainforest exists in the country of Peru? *(Approximately 13 percent.)*
- **c.** Using the method detailed in Question 6a, determine the area of the Peruvian Amazon rainforest (in square kilometers) on your map. *(Approximately 715,000 sq km.)*

7. A study released by the Brazilian government estimated that the rate of Amazon rainforest deforestation increased by 29 percent in 2016, resulting in a net loss of approximately 8000 sq km. Using the area of rainforest in Peru you calculated in Question 6c, determine how many years at this rate it will take for the Peruvian Amazon to disappear completely. *(Approximately 90 years)*

8. Why is deforestation in the Amazon becoming more rapid? What causes of deforestation from the film *River of Gold* can you use to support your response? *(Ineffective legal/political governance and poor environmental policy relating to cattle ranching, subsistence and commercial agriculture, logging, mining, fires, oil and gas development, hydroelectric dams, transportation, and urban infrastructure)*

9. How does deforestation from the mining of gold lead to habitat loss for species that are critical to the biodiversity of the Amazon rainforest ecosystem? Can you think of other examples of human activity from the film *River of Gold* that lead to decreased biodiversity and habitat loss in this region? *(Extremely poor monitoring of gold mining sites can lead to deforestation as land is cleared for soil removal. This process drastically reduces tree cover and vegetation biomass, destroying critical habitat for organism populations that are native to and rely on these areas for survival. Please see the answer to Question 8 above for additional examples of human activity resulting in biodiversity and habitat loss.)*

Handout 4

Community Voices

Directions:

For this activity, you will assume the role of a Peruvian citizen speaking out against the destruction of critical rainforest habitat as the result of human activity. Your voice will appear in the form of a *Letter to the Editor* of a local newspaper expressing concern about the *human health consequences* of rainforest habitat destruction in your community. For your letter, you will choose (1) the type of human activity causing the habitat destruction about which you are speaking out and (2) the community voice you wish to use in your letter. The menu of options for each category is as follows:

Human activity (choose one):

Logging
Slash-and-burn
Agriculture
Roadbuilding
Dam construction
Industry
Invasive species

Community voice (choose one):

Parent
Schoolteacher
Member of an indigenous tribe
Nurse
Tourist
Farmer
Field biologist
Government worker
Chef

Your letter should be thoroughly researched using the film *River of Gold*, the Internet, books, magazines, or any other resources you deem necessary. It should be one page typed and should be written from the perspective of the community member whose voice you chose. *Example: You might be a nurse who is concerned about the construction of a dam near the hospital where you work. The flooding from the altered stream flow has killed off a local fish species known for eating mosquito larvae. You are worried that the increase in mosquitoes will lead to a higher number of Zika virus cases at your hospital, for which you do not have sufficient resources to treat.*

Your letter should address the following questions:

- **Who** are you and **what** is the human activity you are concerned about? (*See above*)
- **How** does the human activity work?
- **Why** are you concerned about this human activity?
- **What** are the environmental impacts of the human activity?
- **What** are the consequences of this human activity on critical rainforest habitat? What species might be involved?
- **What** are the consequences of this human activity on the health of the community with which you work?

Handout 5

We Deserve to Conserve

Directions:

The Peruvian Amazon is one of the most biologically diverse areas on Earth, housing the largest number of bird species and third-largest population of mammals in the world. According to the film *River of Gold*, 30 percent of the Earth's species reside in the Peruvian rainforest, with new species having been discovered every three days for the past ten years. Unfortunately, a growing number of native Amazon species are vulnerable (either threatened or endangered) from critical habitat destruction caused by human activity. For this project, you and your team will research one such species and design a nonprofit campaign dedicated to its conservation. Your task is to create an exciting and informative way to advertise your campaign to help spread awareness about the critical need to protect your species and its habitat. Be creative!

Your marketing concept should be completely original. Your group might consider a poster, television ad, school lesson plan, public service announcement, website, brochure, children's book, documentary, or other format. (PowerPoints and Prezis are not allowed.) Your final product will be shared with the class as part of a five-minute presentation, and should include the following information:

1. Name and logo of the organization launching the campaign (should be original)

2. Common and scientific name of the species you chose

3. Two photos of the species

4. Information about the habitat in which the species resides

5. Level of species vulnerability (threatened vs. endangered)

6. Role of the species in the local Amazon ecosystem (e.g. what would happen to the ecosystem if the species were to disappear)

7. Impact on human communities resulting from the species' vulnerability

8. Explanation of why the species is threatened or endangered

9. Steps that could be taken to protect the species and preserve its habitat

Ideas for vulnerable species might include those featured in the film *River of Gold* like the harpy eagle, golden lion tamarind, jaguar, or poison dart frog. You may also choose your own, in which case you may find the sites below helpful.

Animal species profiles (Amazon Aid Foundation)
https://amazonaid.org/?s=species

Threatened and endangered species profiles (World Wildlife Fund)
https://www.worldwildlife.org/places/amazon

Indigenous Amazonia

Enduring Understandings

- The Amazon is home to a diverse population of indigenous peoples who have lived in isolation.
- "Uncontacted" (isolated) tribes are affected by modern economic and political developments.
- Leadership and policymakers can play a significant role in the future existence of indigenous tribes in the Amazon.

Essential Questions

- What cultural characteristics shape the indigenous tribes of Peru, Colombia, and Brazil?
- How will increased industrial development throughout the Amazon affect indigenous tribes in the future?
- How can policy decisions shape the economic development of the Amazon to protect indigenous peoples?

Notes to the Teacher

Many pre-Columbian indigenous peoples remain deep in the Amazon, still living as if Europeans had never arrived hundreds of years ago. But such isolated tribes can no longer depend on the Amazon as a refuge; in the very recent past, throughout Peru, Colombia, and Brazil, tribe members have begun to emerge into settled areas and to increase their contact with the modern world. More and more, tribes have been accused of raiding several modern villages, taking goods and food; and violence by and against the once-isolated people is on the rise. In some ways, these conflicts are the last, lingering reminders of the collision of cultures that began in 1492, when Christopher Columbus landed in the New World. Since then, the Amazon countries have seen the loss of millions of native lives.

The world's largest and most diverse uncontacted or isolated cultures are centered in the Amazon, primarily in Peru and Brazil. They still lack immunity from many Western diseases. They do not have modern weapons to defend themselves from the modern unknown. Although not forgotten, they also have no voice in national politics. Experts and aid groups warn that modern industries such as mining, oil drilling, and deforestation are contributing factors to the crisis facing many tribes today.

For decades, the governments of Amazon nations showed little interest in protecting these tribes. In the 1960s and 1970s, Brazil tried to assimilate and relocate uncontacted groups, but their efforts were unsuccessful, largely because of selfish motives. Later, in 1987, Brazil developed the Department of Isolated Indians, which saw some success but ultimately faced budgetary challenges. Colombia set up a national park in 2002 as a way of safeguarding uncontacted

tribes, but their exact location is unknown in many cases, so government-sanctioned protection has been increasingly challenging. Peru's national park has protected land for several tribes. In 2011 the Colombian President Juan Manuel Santos signed legislation guaranteeing preservation of the rights of uncontacted indigenous groups.

However, the reality of the success of government actions is sometimes illusory. There is the constant threat of illegal miners invading the territory designated for isolated tribes, the threat of violence imposed on both isolated groups and modern, settled villages, and the government's less-than-subtle nudge toward ecotourism. It is clear that more must be done if the true and genuine goal of Amazon governments is to preserve and protect the rights, histories, and autonomy of these isolated tribes.

In this lesson, students will explore the complex relationship between indigenous Amazonia and modern South America. They will begin by learning more about the uncontacted tribes of Peru, Colombia, and Brazil such as the Mashco-Piro, the Ticuna, and the Tupi peoples. **Handout 1: Research Assignments** contains URLs for five articles to be read and annotated by student groups before the lesson begins. (The handout also has an SDQR chart as a graphic organizer to help them with thoughtful note-taking. If some of your students do not have computer access at home, make copies of the articles and give them to the students discreetly or provide time for the reading and note-taking to be done at school.) In class, students share information gleaned from their readings and look for commonalities and differences among the indigenous societies. Then they discuss larger questions about culture shock and government policies with respect to indigenous groups.

Next, students will employ creativity to produce a "culture collage" of each of the indigenous tribes covered. Encourage students to be ambitious, creative, and thorough while working on completing this assignment; ideally, they should have access to magazines, glue or tape, a computer and printer, markers, and other creative materials.

Lastly, students will exercise their research skills and write a report that outlines the emerging threats to uncontacted peoples and offer policy suggestions to move toward solutions that amplify voices and validate all people and experiences.

Some additional resources are:

https://www.survivalinternational.org/tribes/uncontacted-brazil

https://www.nytimes.com/2017/09/10/world/americas/brazil-amazon-tribe-killings.html?mcubz=0

http://science.sciencemag.org/content/348/6239/1061.full

http://www.sciencemag.org/news/2015/06/feature-deep-peru-s-rainforests-isolated-people-emerge

Supplementary multimedia: What does the Amazon look like?

Peoples of the Amazon:
The local peoples of the Amazon love their home. Video by Amazon Aid Artist Dano Grayson.
https://vimeo.com/78854295

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.

https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.RH.9-10.1
Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

CCSS.ELA-Literacy.RH.9-10.2
Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.

CCSS.ELA-Literacy.RH.9-10.4
Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.SL.9-10.1
Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-Literacy.SL.9-10.4
Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

CCSS.ELA-LITERACY.SL.9-10.1.B
Work with peers to set rules for collegial discussions and decision-making (e.g., informal consensus, taking votes on key issues, presentation of alternate views), clear goals and deadlines, and individual roles as needed.

CCSS.ELA-LITERACY.SL.9-10.1.C
Propel conversations by posing and responding to questions that relate the current discussion to broader themes or larger ideas; actively incorporate others into the discussion; and clarify, verify, or challenge ideas and conclusions.

Duration of the Lesson

Three class periods

Assessments

Group participation

Completion of **Handouts 1–2**

Culture collage

Research and reflection written response

Materials needed

Handout 1: SDQR Chart

Handout 2: Indigenous Amazonia

Poster board or large construction paper and markers

Tape or glue

Magazines and paint (if available)

Computer access to or copies of articles listed below

Procedure

Part 1: A close look at the uncontacted Indians of Indigenous Amazonia

1. The day before the lesson, divide the class into five groups. Distribute **Handout 1: Research Assignments** and assign each group to read and annotate one of the following articles at home. Each group member should come to class the next day prepared to discuss the article with the group.

Group 1: "An Isolated Tribe Is Emerging From Peru's Amazonian Wilderness" at https://news.nationalgeographic.com/2015/10/151013-uncontacted-tribes-mashco-nomole-peru-amazon/

Group 2: "Ticuna Rites of Passage" at http://www.amazon-indians.org/page23.html

Group 3: "Photos emerge of an uncontacted Amazon tribal community in Brazil threatened by illegal gold miners" at http://www.independent.co.uk/news/world/americas/photos-uncontacted-tribe-community-village-amazon-yanomami-illegal-gold-miners-a7426651.html

Group 4: "The Lost Tribes of the Amazon" at http://www.smithsonianmag.com/innovation/the-lost-tribes-of-the-amazon-22871033/?all

Group 5: "The Amazon's indigenous people: The other Brazil" at http://www.economist.com/node/12641796

2. On the day of the lesson, give student groups time to meet to review their reading and clear up any questions.

3. Distribute **Handout 2: Indigenous Amazonia**. Have each group in turn share the key information from their article using their completed SDQR handout. While each group shares, instruct students in the audience to take notes using the handout.

4. Conduct a whole-class discussion about the differences and commonalities discovered among indigenous groups.

5. Then conduct an extended discussion using the following questions:

- **a.** Did anything you found surprise you? Had you learned anything about indigenous peoples of the Amazon previously in your years in school? If not, why were they not included in the curriculum?
- **b.** What did you find missing in the articles that you read? What additional questions did you have?
- **c.** What do we mean by the term "culture shock"? (*Confusion, uncertainty, and anxiety when one is confronted with a different culture without adequate preparation.*) If you were a member of one of these isolated groups, what elements of modern society would give you culture shock? Why? If you were to visit one of these societies, would you experience culture shock?
- **d.** Is it possible for members of isolated groups to remain in isolation today? If so, what are the benefits of isolation and how could such isolation be safeguarded? If not, what strategies would you use to introduce them to modern society?
- **e.** What policies should the countries of the Amazon adopt with respect to their more isolated societies? What are the reasons behind your policy recommendations?

6. Conclude the class by giving students time to write in their journals about what they have learned through their reading and discussion on this subject and what questions are still unanswered.

Part 2: The Culture Collage

1. Distribute poster board or large construction paper to each student. Instruct students to draw an outline of South America. They may draw it free-hand but should use a map found on the Internet or a classroom textbook as a reference.

2. Ask students to brainstorm elements for a collage that serves as a visual representation of the history and culture of uncontacted/indigenous Amazonia, using their outline as the outer edges of their collage. What information stands out from their completed handouts? What aspects of culture will they focus on? Food? Language? Social classes? What histories will they visualize?

3. Give students computer time to search for appropriate images to convey their ideas and to print them out.

4. Provide students with the materials they will need for the collage. (See Notes to the Teacher.) Encourage them to be ambitious, creative, and thorough while working on completing this assignment. Tell them they may draw images if they have not been able to find a particular one that they want for the collage.

5. Display completed work around the classroom and conduct a gallery walk for students to see one another's collages.

Extension Activity

Ask students to recall the rich cultures and histories they explored during the previous class period. Have them think about the implications of chosen isolation from the modern world, as well as circumstances that may call for increased interactions with the modern world. Arrange for students to use a library, computer lab, or resource center to research documented interactions between indigenous peoples of the Amazon and those of modern Peru, Colombia, and Brazil. They should also research the government efforts to either protect or restrict the rights of indigenous peoples. Then have them use their research to write a report of their findings and include at least one policy suggestion to address the threat that indigenous peoples are facing.

Handout 1 ▸ P. 1

Research Assignments

Directions:

Find the article that your group is supposed to read as an assignment. Read carefully and use the next page to take clear, concise notes on information you find about the indigenous peoples of the Amazon region.

Your group _____

Group 1: "An Isolated Tribe Is Emerging From Peru's Amazonian Wilderness" at https://news.nationalgeographic.com/2015/10/151013-uncontacted-tribes-mashco-nomole-peru-amazon/
Group 2: "Ticuna Rites of Passage" at http://www.amazon-indians.org/page23.html
Group 3: "Photos emerge of an uncontacted Amazon tribal community in Brazil threatened by illegal gold miners" at http://www.independent.co.uk/news/world/americas/photos-uncontacted-tribe-community-village-amazon-yanomami-illegal-gold-miners-a7426651.html
Group 4: "The Lost Tribes of the Amazon" at http://www.smithsonianmag.com/innovation/the-lost-tribes-of-the-amazon-22871033/?all
Group 5: "The Amazon's indigenous people: The other Brazil" at http://www.economist.com/node/12641796

Handout 1 ▸ P.2

Research Assignments

SDQR Note-Taking Chart

Name: _____ **Date:** _____

Text Author(s): _____

Text Title: _____

S	What does the text <u>say</u>?	
D	What <u>doesn't</u> the text say? What seems to be missing?	
Q	What <u>questions</u> do you have after reading?	
R	What <u>reflections</u> do you have after reading?	

Handout 2

Indigenous Amazonia

Name: _____ **Date:** _____

Indigenous Tribes of Peru
Indigenous Tribes of Colombia
Indigenous Tribes of Brazil

Teacher Resource

Answer Key to Handout 2: Indigenous Amazonia

Indigenous Tribes of Peru

- increased contact with settled villages, led to murder via arrow of 22-year-old Leo Perez
- population of 600-800
- have asked to barter for food, clothes, tools
- not strong swimmers but can climb trees well
- name themselves after flora and fauna of the forest
- government protection agents patrol Alto Madre de Dios River to meet Mashco people
- old and modern Yine language is shared
- Mashco = wild ones/savages, they call themselves Nomole = brothers/countrymen

Indigenous Tribes of Colombia

- Yuri and Passé tribes originated near the Amazon River during pre-Columbian times
- Yuri and Passé tribes retreated from major rivers and ventured deep into the jungle, choosing to avoid contact in an effort to escape massacres, enslavement, and infections
- Ticuna Pelazon ceremony:
  - four-day ceremony practiced only during full moon
  - when a girl has her first menstrual cycle, she is placed into isolation and taught about the myths, heroes, and history of the Ticunas as well as her future responsibilities
  - her body is painted black with *huito*; all of her hair is removed; she is dressed with eagle feathers and a crown; snail shells are hung from her belt
  - music, singing, dancing, and purification by fire over four days without sleep

Indigenous Tribes of Brazil

- 35,000 Yanomami population
- able to make use of 500 different plants
- at risk of being destroyed by illegal gold miners
- 9.6 million hectares of Yanomami territory is legally protected by the government (in theory)
- shaman leads spiritual ceremonies
- violent contact in the past (attacks by miners)
- 1000 gold miners are 35 km from community
- Brazil's budget cuts have weakened the protections of uncontacted tribes

Satellite Technology and the Rainforest

Enduring Understandings

- Real-world problems around the globe such as deforestation and gold mining in Peru can be understood today through the use of technology (remote sensing, video, etc.).
- Satellite imagery provides a historical record and provides data for monitoring changes in land use, such as the measurement of deforestation in the Peruvian jungles caused by gold mining. Such technology can lead to meaningful changes at the national, local, and individual level.
- The loss of the Amazon habitat is critical for all people.

Essential Questions

- How can remote sensing technology reveal what is happening in the Madre de Dios River Valley in Peru?
- What is the calculated area of Peruvian jungle loss per year over time?
- How can Google Earth be used to document habitat alteration over time?
- How has the powerful tool of remote sensing technology changed in terms of purpose and use?

Notes to the Teacher

This lesson is designed to teach students the power of satellite imagery in understanding the changes in the Amazon rainforest over the past several decades. The lesson is divided into three parts: a pre-documentary brainstorming activity and two follow-up activities involving the exploration of satellite images of the region discussed in the film and a student-driven research activity. After completing the lesson, you may wish to design an optional extension activity to explore land use changes in your students' hometown, or the impact of fracking on forested land in northwestern Pennsylvania or other areas.

Before the lesson, familiarize yourself with the information about remote sensing technology and satellite imagery provided on **Teacher Resource 1: What Is Landsat?** and **Teacher Resource 2: A Timeline of Earth-Orbiting Satellites.** (These handouts may become a student's optional research assignment in Part 3.)

The first part of the lesson will take approximately one to two class periods to allow students time to study two satellite images of the region, one from 1984 and the other from 2016, and to brainstorm possible reasons for the colors and color changes in the area. In addition to generating their own ideas, teams create a list of possible questions they have related to the images. Before the lesson, be sure that you have a way to give students access to the 1984 and 2016 Landsat images on pp. 133–134; you may wish to project them from your computer or copy them to put on student computers, for example. You may also wish to print out copies of these images and laminate them so that each group can have a set to use. Photocopy **Handout 1** for each team to record their ideas and questions and to be used afterwards for reporting to their classmates. This activity should be completed prior to viewing the film *River of Gold*.

The second part will take one or two class periods to allow students to work with Google Earth Pro images from the Madre de Dios region of Peru and to use this technology to understand the images presented to them Part 1. Prior to teaching this part of the lesson, access the following link: https://www.google.com/earth/resources/ or use **Teacher Resource 3: Using Google Earth Teaching Guide** and run through the teacher guide protocol. Make photocopies for students of **Handout 2**, which includes instructions for working with Google Earth Pro and tasks to complete. Refer to the accompanying Google Earth PowerPoint to locate the mining area that students will be measuring. For instance, slides 10 and 11 can provide a helpful visual for students to see what area they will be measuring.

Part 3 will take several class periods for students to research a relevant topic of interest. You may choose to have students do this culminating activity independently or in small groups. (See the menu on **Handout 3: Research Proposal Planning Sheet** for recommended choices.) The research component may be assigned as homework, or you may provide time in class or the library. To ensure equitable collaboration among team members, you may want to request a minimum of one annotated bibliography from each student. If so, a team of four may need to provide a total of four annotated bibliographies. Individual students or teams of students will need to research their chosen topic, provide a mini-proposal to the teacher, and present their final result to the class. Audience members also participate in providing questions and meaningful feedback to each presenter or group.

Supplementary multimedia: What does the Amazon look like?

Mercury Uprising:
A 12-minute look into why the Amazon is important, the things that are destroying it, and the hope for protecting it. Video by Amazon Aid and ROTU Studios.
https://vimeo.com/125067596

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Amazonia time lapses:
From the cloud forests to the lowlands of the jungle, beautiful time-lapse footage from Amazon Aid Artist Dano Grayson
https://www.youtube.com/watch?v=rNKD8rgQvSE

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.RST.9-10.1
Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions

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

CCSS.ELA-Literacy.RST.9-10.7
Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

Next Generation Science Standards (NGSS) addressed by this lesson

HS. Interdependent Relationships in Ecosystems;

Students who demonstrate understanding can:

HS-LS2-6.
Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. [Clarification Statement: Examples of changes in ecosystem conditions could include modest biological or physical changes, such as moderate hunting or a seasonal flood; and extreme changes, such as volcanic eruption or sea level rise.]

HS-LS2-7.
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. [Clarification Statement: Examples of human activities can include urbanization, building dams, and dissemination of invasive species.]

HS-LS4-6.
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity. [Clarification Statement: Emphasis is on designing solutions for a proposed problem related to threatened or endangered species, or to genetic variation of organisms for multiple species.]

Next Generation Science Standards (NGSS) addressed by this lesson

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.

- Design, evaluate, and refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-LS2-7)

Disciplinary Core Ideas

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. (HS-LS2-2), (HS-LS2-6)
- Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. (HS-LS2-7)

LS4.D: Biodiversity and Humans

- Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). (Secondary to HS-LS2-7)
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, introduction of invasive species, and climate change. Thus, sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. (Secondary to HS-LS2-7), (HS-LS4-6)

ETS1.B: Developing Possible Solutions

- When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts. (Secondary to HS-LS2-7), (Secondary to HS-LS4-6)
- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. (Secondary to HS-LS4-6)

Next Generation Science Standards (NGSS) addressed by this lesson

Crosscutting Concepts

Cause and Effect

- Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-LS2-8), (HS-LS4-6)

Scale, Proportion, and Quantity

- The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. (HS-LS2-1)
- Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale. (HS-LS2-2)

Stability and Change

- Much of science deals with constructing explanations of how things change and how they remain stable. (HS-LS2-6), (HS-LS2-7)

Duration of the Lesson

Part 1 - One to two class periods

Part 2 - One to two class periods

Part 3 - Three to five class periods

Assessments

Brainstorming notes handout

Class discussions

Google Earth Activity/Challenge, Research, etc.

Student or group projects and presentations

Materials needed

Images/Figures 1984 vs. 2016 (on pp. 133–134)

Google Earth Screen Savers Slideshow

Teacher Resource 1: What is Landsat?

Teacher Resource 2: Timeline for Earth-Orbiting Satellites

Handout 1: Satellite Image Brainstorming Notes

Teacher Resource 3: Using Google Earth Teacher Guide

Handout 2: Using Google Earth

Handout 3: Research Proposal Planning Sheet

Whiteboard or overhead to record and display class ideas and questions

Computers with Internet access

River of Gold documentary

Procedure

Part 1: Satellite Image Brainstorming Activity

1. Begin class by sharing the Landsat before (1984) and after (2016) images at the end of this lesson (pp. 133–134) via projection on a screen or on student computers or personal devices (e.g., Chromebooks). Explain to students that the two images are satellite images of the same Amazon rainforest taken on two different dates. Using the information in **Teacher Resources 1** and **2**, tell them about the Landsat program in as much detail as you desire.

2. Divide the class into teams of three or four students and distribute **Handout 1: Satellite Image Brainstorming Notes** to each team. Ask each team to use the handout to record their ideas and the questions they have concerning the images.

3. Ask each team to consider the following questions as you write them on the board:

   - *What do you think the different colors on the images represent?*
   - *Can you identify any particular geological features (mountains, rivers, etc.) or physiographic structures (roads, urban areas, etc.) in the images?*
   - *How are the two images similar and how are they different? What could account for these differences?*
   - *What do you think has happened in this region over the past several decades? What questions do you have concerning these images?*

4. While brainstorming for 10–15 minutes, circulate around the room to offer suggestions to teams that are stuck. Students may get hung up on being "right" about what they are seeing, but remind them this is an exercise in making their "best guesses" and the goal is to collaborate with others on generating ideas and questions.

5. After brainstorming as teams, lead them in a discussion. Ask each team to report their ideas orally and to record their answers either on an overhead or on the board. Look for overlapping ideas (e.g., dark green areas may represent vegetation) and outliers to foster good discussion among the teams.

6. Follow up with a round of sharing their questions and again look for overlapping or redundancy, but also look for interesting or unique questions. Record these questions along with their ideas. Possible student questions that may arise prior to watching the film include:

   - *What are those bright tan spots that show up and why are they there?*
   - *Do the dark green areas represent forests?*

Possible student questions after watching the documentary may include:

- *How do they know the forest they are destroying contains gold?*
- *When did the gold mining begin? Has the mining continued since then?*
- *Have the areas of mining increased in size?*
- *Where else in Peru are they mining?*

Part 2: Exploring a Satellite Image Using Google Earth

1. Distribute copies of **Handout 2: Using Google Earth** to students. This handout includes instructions on how to use some basic features of Google Earth and a series of tasks (questions and data collection) relating to the mining areas discussed in the film.
2. While students work through the student activity, you may wish to display figures and images from the slideshow to help guide them.
3. The ultimate goal is to provide a frame of reference for students to understand the magnitude of deforestation and mining activities.

Part 3: Student Research & Presentation

1. If desired, divide the class into groups of three or four. Distribute **Handout 3: Research Proposal Planning Sheet** and review with students the menu of research activities. If students are working in groups, give them time to discuss their choices.
2. Have students generate a mini-proposal including the following components:

   Topic selection
   Project format
   Reasons for their topic and format choice
   Annotated bibliography for three to four resources

3. Provide adequate time for student research; announce deadlines for research and presentations. Remind students that more questions may arise as they get deeper into their research.
4. Have each individual or group make a presentation on the research project to the class. At the end of each presentation, provide the opportunity for feedback in the form of questions, strengths, and areas for improvement. For example, audience members must ask at least two questions about the project (e.g., Why is the Landsat program coming to an end?) and provide one strength (e.g., I really liked your creative ideas on how to conserve what is left of the Peruvian rainforest.) and one area of improvement (e.g., You may want to use index cards next time to help you hit all of your talking points effectively.).

Teacher Resource 1
P .1

What is Landsat?

Landsat History, 1972–the Present

The term *remote sensing* refers to the study of something without coming in contact with it. We will use an Earth-orbiting satellite called Landsat to conduct a remote sensing study of deforestation and mining for gold in the Peruvian jungles of the Amazon Basin. What follows is a brief history of the Landsat Program, developed by NASA (National Aeronautics and Space Administration) and operated by NOAA (National Oceanic and Atmospheric Administration).

The Landsat Program

The Landsat satellite program began with the launch of the Earth Resources Technology Satellite (ERTS-1) on July 23, 1972. ERTS-1 (later named Landsat 1) had the mission to acquire reflectance data in the visible and near-infrared (NIR) wavelengths from the Earth's land surfaces. By mapping the land surfaces, Landsat 1 was designed to detect and document changes over time, such as volcanic eruptions, wildfires, patterns of seasonal changes in vegetation, etc. Landsat 1 became the first civilian Earth-orbiting satellite to gather such data from an orbit approximately 500 miles high. Because it covered the same point on the ground every 18 days (later shortened to 16 days), it has proved to be one of the most valuable sources of change-over-time environmental data for scientists the world over.

The first three Landsats carried a sensor called the Multispectral Scanner (or MSS), which acquired reflectance data in the green, red, and two near-infrared spectral bands. Each band produced pixels that were approximately 79 meters (259 feet) on a side, creating a single scene that is approximately 110 miles x 110 miles (177 km x 177 km) in area. As the Earth rotates beneath Landsat, a new 110-mile scene is imaged. As noted above, every 18, now 16 days, the entire Earth is mapped. Since Landsat collects reflected data, pixel-by-pixel, clouds are imaged along with land surface features (urban areas, rivers, lakes, forests and crops, ice and snow, etc.). Because Landsat cannot "see" through clouds, Landsat scenes aren't useful if clouds block the view—in our case, the Madre de Dios area of the Amazon Basin. Landsat images from many days provide us with the extent and progression of deforestation and mining practices over time, telling us when the practices began, how they have spread, and if they are continuing today.

Beginning with the launch of Landsat 4 in July 1982, a new sensor system called Thematic Mapper (or TM) was carried into orbit along with the MSS. The TM collected additional data in the blue, green, and red visible bands, NIR, and two short-wave infrared bands (SWIR). Each of these bands acquired data in 30m pixels (approximately 90 feet square or the size of a baseball diamond). Images with sharper resolution, better color and more-accurate moisture detection have resulted. TM and MSS sensors were carried on Landsats 4, 5, and 7. Unfortunately, Landsat 6 failed to achieve orbit.

Teacher Resource 1
p .2

What is Landsat?

The most recent Landsat (Landsat 8) was launched in 2013. After almost 50 years, the Landsat program has become the longest continuous source of Earth-observation data for the scientific community. Because many of the remote areas of the world are not accessible in any other way, much of what we know about tropical deforestation, pollution effects on forest ecosystems, hurricane damage, rising sea levels, loss of polar ice and mountain glaciers, etc., can only be detected and characterized through the use of satellite data supplied by systems such as Landsat.

Landsat uses *multispectral* sensors, so-called because they acquire reflected sunlight in a few broad spectral bands in the visible, near-infrared and shortwave infrared regions of the electromagnetic spectrum. Landsat Thematic Mapper acquires single broad spectral bands in the blue (band 1, at 0.45–0.515 micrometers, or μm, green (band 2, at 0.525–0.605 μm), and red (band 3, at 0.65–0.69 μm), as well as in the near infrared (band 4, at 0.77–0.90 μm) and the shortwave infrared (band 5, at 1.55–1.75 μm and band 7, at 2.09–2.35 μm). If you are wondering what happened to band 6, it is in the thermal infrared, located at 10.40–12.50 μm. Each of these Thematic Mapper bands was carefully selected to allow Landsat to map specific themes, such as forests and crops, urban areas, water depth, barren lands, etc.

More advanced sensor systems that acquire solar reflectance data in a large number of very narrow spectral bands are called *hyperspectral* sensors. By collecting reflectance data across the same spectrum as the Landsat TM, but in hundreds of narrow bands, a more precise detection of diagnostic spectral features can be made. Such diagnostic spectral features may then be used to detect and identify vegetation species, specific types of stress in vegetation, identification of soil and bedrock mineralogy, etc. Other orbital sensors use radar pulses to see through clouds and at night, and Light Detection and Ranging (LiDAR) to map the height of forests and collect elevation data. Using such orbital systems provides us with remote sensing methods to monitor changes on the Earth's surface.

Teacher Resource 2
p .1

A Timeline of Earth-Orbiting Satellites

It has always been the dream of humankind to be able to fly, to look down on the Earth from the sky. Early attempts included hot-air balloons, like those used in the US Civil War to spy on enemy troops, and the first flight of a heavier-than-air craft by the Wright brothers in 1903. The birth of the Space Age was ushered in by Robert Goddard, the inventor of the first liquid-fuel rocket, in 1926. In the Second World War, such rockets as the German V-2 became the first long-range ballistic missiles.

The Space Age became the Space Race with the launch of Sputnik 1 by the Soviet Union on October 4, 1957; it was the first artificial satellite to orbit the Earth. The United States launched its first successful satellite, Explorer 1, on January 31, 1958. What follows is a brief listing of significant events in the development of Earth-observing satellites such as Landsat and other environmental orbital monitoring systems.

Timeline:

Name	Launch Date	Details
Sputnik 1	Oct. 4, 1957	Sputnik 1 was 23 inches in diameter, with four external radio antennas that broadcast a radio pulse. It made no measurements.
Sputnik 2	Nov. 3, 1957	Sputnik 2, launched one month after Sputnik 1, was much larger and carried a dog named Laika into orbit. Largely a propaganda tool, Sputnik stayed in orbit for 162 days, but Laika died a few hours after launch.
Explorer 1	Jan. 31, 1958	With Explorer 1, the United States entered the Space Race. Designed to measure characteristics of the upper atmosphere, its 900-mile-high orbit allowed it to detect the Van Allen radiation belt surrounding the Earth for the first time.
Yuri Gagarin	April 12, 1961	Gagarin, a Russian pilot and cosmonaut, became the first man to orbit the Earth, intensifying the Space Race.
John Glenn	Feb. 20, 1962	Glenn, one of seven Mercury astronauts, became the first American to orbit the Earth in his one-man spacecraft, Friendship 7. One of the Mercury program's purposes was to photograph the Earth from orbit, with a special focus on the tropical forests of the Amazon.

Teacher Resource 2
p .2

A Timeline of Earth-Orbiting Satellites

Name	Launch Date	Details
Project Gemini	1961–1969	NASA's Gemini program involved the development and operation of a two-man orbital spacecraft, in preparation for longer space flights and eventual travel to the Moon.
Project Apollo	1968–1972	NASA's Apollo program was designed to carry three astronauts to and from the Moon. The astronauts took the first images of the entire Earth, seeing our home as a planet and dubbing it the "Blue Marble." Their photographs resulted in the establishment of the first Earth Day in April 1972.
Neil Armstrong	July 20, 1969	Apollo 11 made the first lunar landing, on a dark, basaltic area called Mare Tranquillitatis (Sea of Tranquility). The spacecraft carried three astronauts to the Moon, two of whom walked on the surface (Neil Armstrong and Buzz Aldrin).
Key Hole (Corona)	1959–1972	Nine or more secret reconnaissance satellites named Key Hole were launched starting in 1959 but were classified. Code-named "Corona," these secret spy satellites, similar in design to the Hubble space telescope, looked down at the Earth instead of out into the Universe. This is a good example of military tools also being used for science.
NASA Space Shuttle Program	1981–2011	The Space Shuttle program actually began in 1972, with its first flight in 1981. Four Shuttle spacecrafts flew low orbits for a total of 133 successful missions, with two disastrous failures—Challenger in 1986 and Columbia in 2003—resulting in 14 fatalities. Spacecraft in the program were designed to be reusable and to "shuttle" between Earth and the International Space Station. Many of the Shuttle missions were focused on Earth observations and served as test beds for new remote sensing systems.
Landsat	1966–present	Conceived in 1966 as the first civilian Earth observation satellite, ERTS-1 (Earth Resources Technology Satellite) was launched in July 1972. It and its followers, renamed Landsat, acquire images of the same spot on the Earth every 16-18 days. A total of seven Landsats have orbited the Earth, supplying almost 50 years of continuous coverage of our home planet in visible and infrared spectral bands. Landsats 5, 7, and 8 have provided images used in Google Earth.

Handout 1

Satellite Image Brainstorming Notes

In the box below, answer the questions posed to you regarding the two Landsat images of the Amazon:

Team-Generated Ideas

In the box below, record at least three questions your team has concerning the two Landsat images of the Amazon:

Team-Generated Questions

Teacher Resource 3
P .1

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity Teacher's Guide

1. Download Google Earth Pro from the Google Earth Website at https://www.google.com/earth/download/gep/agree.html.

2. To save Google Earth on your computer, drag the Google Earth icon down to your icon bar at the bottom of your screen. Double-click on the icon to open the program. You should see the globe centered on the Western Hemisphere.

3. Click and rotate the globe to center on Peru in South America. You can also type in "Madre de Dios, Peru," or enter the Lat/Lon coordinates for the area at (70° 14' 12" S, 12° 57' 23" W). The outline of Peru is seen, along with Equator to the north, Bolivia to the south, and Brazil to the east. A screenshot of this orientation of the globe is provided as Figure 1 on the slideshow.

   Notice the coastal Andes mountain chain in the western portion of the country, and the green expanse of the Amazonian tropical forest to the east. All of the Google Earth images have been acquired with the Landsat Thematic Mapper (TM) sensor and are shown in "true color," where the forests are dark green, exposed soil (river banks, mining areas, etc.) is tan, and exposed rocks are gray.

4. Zoom in on Peru, using the + button on the right-hand portion of the image. You may also use the slider function between the + and – buttons. Figure 2 demonstrates this initial zoom-in. Note that the names of each country are now displayed.

   Figure 3 has been added to indicate where the Madre de Dios (Spanish for "Mother of God") gold mining areas are located in Peru. Note that this area is to the east of the Andes, important because the weathering of these mountains over time has resulted in the deposit of gold-rich sediments into the rivers that are tributaries of the Amazon. "Placer-style" gold mining on these rivers has led to the extensive deforestation in the Huaypetue and Madre de Dios areas of the Peruvian Amazon.

   Zooming in further (Figure 4), we begin to see more surface details in the Peruvian state of Madre de Dios, including the Andes chain, multiple rivers (light tan in color) and roadways. The small rectangles along the roadways and in the forests represent ground photos acquired at the spots indicated. Click on these to see the photos. The "Christmas tree" icons indicate photos taken at protected areas.

   Figure 5 shows the same image as in Figure 4, but with the location of the gold mining areas indicated. (You may wish to ask your students to locate these areas before you show them Figures 3 or 5.)

5. Zoom in further until you have an image similar to Figure 6. In this Landsat TM image, you see the two major areas of active gold mining, the Huaypetue region (Figures 7 and 8) and the Madre de Dios region (Figure 9). In the Huaypetue region the deforestation and mining area is somewhat spoon-shaped, while in the Madre de Dios region consists of four or five linear patterns of deforestation and mining. **Up to this point, all of the images shown are of the most recent Landsat TM, acquired on 12/30/2016.**

Teacher Resource 3
P .2

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity Teacher's Guide

6. Now you can begin to compare this 2016 image with earlier Landsat scenes acquired on previous dates. Remember that the Landsat Thematic Mapper acquires a new image every 16 days, going all the way back to 1982. This provides an invaluable source of change-over-time data on the state of the Madre de Dios tropical rainforests of Peru.

Staying at the zoom level in Step 5, go to the icons at the top of your screen. Find the icon of a clockface with a backward arrow (the seventh one to the right) and click on it. A black horizontal scale will appear, with 12/2016 indicated on the right end and 1969 on the left end. Note the scale units. By clicking on the scale unit near the left end, you can display the 12/1984 image. Now click on the next unit and see the image acquired in 12/1985. Then on to 1986, 1987, 1988, etc. When did the mining activities begin in the Madre de Dios area? In the Huaypetue area?

Note that the 1985 image has some clouds. The 1988 image has even more clouds, as do the images of 1992, 1994, 1995, etc. Also note that no Landsat images before 1984 are available. If you click on any earlier dates e.g., 1969), only the most recent image (2016) is displayed. Warn your students of this idiosyncrasy in the Google Earth software.

7. You have learned how to navigate the Google Earth images, and to study change-over-time images to see when the mining activities began in both the Huaypetue area (do this on your own) and the Madre de Dios area. Now you will learn how to have your students compute the actual area of each deforestation and mining operation, and the changes since 1984. Go again to the upper icons and find the ruler function. Click on it and then select the "polygon" option. Outline each mining area using this function (see Figures 10 and 11). Have your students measure each of the mining areas to determine how many square miles of tropical forests have been lost over time. How many soccer fields have been lost each year since the mining began?

8. Your students are now using exactly the same research tools as NASA and university research scientists.

Handout 2 ▸ p.1

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity

Step 1. Download Google Earth Pro from the Google Earth Website at https://www.google.com/earth/download/gep/agree.html.

Step 2. To save Google Earth on your computer, drag the Google Earth icon down to your icon bar at the bottom of your screen. Double-click on the icon to open the program. You should see the globe centered on the Western Hemisphere.

Step 3. Click and rotate the globe to center on Peru in South America. You can also type in Madre de Dios, Peru, or enter the Lat/Lon coordinates for the area at (12° 57' 23" W, 70° 14' 12" S). The outline of Peru is seen, along with Equator to the north, Bolivia to the south, and Brazil to the east.

Notice the coastal Andes mountain chain in the western portion of the country, and the green expanse of the Amazonian tropical forest to the east. All of the Google Earth images have been acquired with the Landsat Thematic Mapper (TM) sensor and are shown in "true color," where the forests are dark green, exposed soil (river banks, mining areas, etc.) is tan, and exposed rocks are gray.

Step 4. Zoom in on Peru, using the + button on the right-hand portion of the image. You may also use the slider function between the + and – buttons. Note the names of each country are now displayed.

Find the Madre de Dios (Spanish for "Mother of God") gold mining areas located in Peru. Note that this area east of the Andes is where large deposits of gold-rich sediments are found and where gold mining operations on these rivers has led to extensive deforestation. Call your teacher over to verify your location before moving on.

_____ Teacher Initials

Zooming in further, you begin to see more surface details in the Peruvian state of Madre de Dios, including the Andes chain, multiple rivers (light tan) and roadways. The small rectangles along the roadways and in the forests represent ground photos acquired at the spots indicated. Click on these to see the photos. The "Christmas tree" icons indicate photos taken at protected areas. Select two photos that are of interest to you and summarize your observations. *What do you notice?*

Handout 2 ▸ P.2

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity

Photo #1

Photo #2

Step 5. Zoom in further until you see the two major areas of active gold mining, the Huaypetue region and the Madre de Dios region. In the Huaypetue region the deforestation and mining area is somewhat spoon-shaped, while the Madre de Dios region consists of four or five linear patterns of deforestation and mining. Up to this point, all of the images are of the most recent Landsat TM, acquired on 12/30/2016. Call your teacher over to verify that you have found both regions.

_____ Teacher Initials

Handout 2 ▸ P.3

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity

Step 6. Now you can begin to compare this 2016 image with earlier Landsat scenes acquired on previous dates. Remember that the Landsat Thematic Mapper acquires a new image every 16 days, going all the way back to 1982. This provides an invaluable source of change-over-time data on the state of the Madre de Dios tropical rainforests of Peru.

Staying at the zoom level in Step 5, go to the icons at the top of your screen. Find the icon of a clockface with a backward arrow (the seventh one to the right) and click on it. A black horizontal scale will appear, with 12/2016 indicated on the right end and 1969 on the left end. Note the scale units. By clicking on the scale unit near the left end, you can display the 12/1984 image. Now click on the next unit and see the image acquired in 12/1985. Then on to 1986, 1987, 1988, etc. When did the mining activities begin in the Madre de Dios area? In the Huaypetue area?

Madre de Dios _____ Huaypetue_____

Note that the 1985 image has some clouds. The 1988 image has even more clouds, as do the images of 1992, 1994, 1995, etc. Also note that no Landsat images before 1984 are available. If you click on any earlier dates (e.g., 1969), only the most recent image (2016) is displayed.

Step 7. You have learned how to navigate the Google Earth images, and to study change-over-time images to see when the mining activities began in both the Huaypetue area (do this on your own) and the Madre de Dios area. Now you will learn how to compute the actual area of each deforestation and mining operation, and the changes since 1984.

Using the most recent image (2016) of both mining areas, go to the upper icons and find the ruler function. Click on it and then select the "polygon" option. Outline each mining area separately as best as you can using this function, and measure how many square miles of tropical forests have been lost over time. Record the square miles that have been calculated for you. Call your teacher over to verify your calculations.

2016 Madre de Dios mining area _____ (square miles)

2016 Huaypetue mining area _____ (square miles)

_____ Teacher Initials

Handout 2 ▸ P.4

Using Google Earth in the Madre de Dios/*River of Gold* Remote Sensing Activity

Congratulations! You are using exactly the same research tools as NASA and university research scientists. Continue using these skills to complete your task.

Step 8. For both mining areas, find images related to your birth year. Draw polygons and determine the square miles of deforestation and mining and record below:

Date: _____

Madre de Dios mining area _____ (square miles)

Huaypetue mining area _____ (square miles)

Step 9. Based on your data in steps 7 and 8, calculate how deforestation and mining has increased over the course of your lifetime.

Change from _____ to 2016

Madre de Dios mining area _____ (square miles)

Huaypetue mining area _____ (square miles)

Step 10. Challenge Problem: How many soccer fields have been lost each year since your birth year? *(Hint: Find a local soccer field on Google Earth to determine its area in square miles.)*

Handout 3 ▸ P.1

Research Proposal Planning Sheet

You are going to do some additional research and design a presentation for your class on one of these topics.

Timeline Activities

Create either a hard copy or a digital timeline that demonstrates your understanding of one of the topics listed below or a topic of your own that is approved by your teacher. You might include important dates, descriptions, pictures, and images. Be sure to confer with your teacher as you plan your timeline. Discuss the number of dates and events. Topics to choose from are:

- Landsat history (see your teacher for resources)
- Timeline of Earth-orbiting satellites (see your teacher for resources)
- Tropical deforestation in the Amazon or specifically in the Madre de Dios river system
- Global demand for gold
- Nixon administration decision to separate the dollar from the gold standard
- Poverty in Amazonia
- Overpopulation (either global or Amazonian)
- Your own timeline idea with teacher approval

Conservation Plans

Begin by researching existing conservation plans from nonprofit organizations such as the Nature Conservancy. You should also review the website at https://extension.unh.edu/resources/files/resource001227_rep1568.pdf (published by the University of New Hampshire Cooperative Extension Service) to learn more about the components of a conservation plan. Topics to choose from are:

- Protecting biodiversity
- Identifying largest carbon reserves to combat climate change with limited resources (See Gregory P. Asner's work at the websites listed on the next page.)
- Mining areas (identifying and protecting, helping with enforcement, etc.)
- Promotion of ecotourism

Solution to the Problem

- Write a letter to your local representative, state senator, member of Congress, or NASA Jet Propulsion Laboratory (JPL) supporting the need to continue the Landsat program
- Explore ways to educate people on the long-term value of the Amazon rainforest
- Raise awareness on how the Amazon rainforest affects everyone on a global scale (climate change, air quality, carbon reserves, etc.)
- Design a solution and present it in whatever medium you choose

Handout 3 ▸ P.2

Research Proposal Planning Sheet

Some Resources that May Be of Help to You:

Mercury in Peru
https://www.researchgate.net/project/Carnegie-Amazon-Mercury-Project

Mercury poisoning in Peru
https://amazonaid.org/interview-carnegie-amazon-mercury-project-director-luis-fernandez/

Airborne laser-guided imaging spectroscopy for mapping

https://www.researchgate.net/publication/313476749_Airborne_laser-guided_imaging_spectroscopy_to_map_forest_trait_diversity_and_guide_conservation

Greg Asner's work.
https://www.researchgate.net/publication/316502845_Conservation_assessment_of_the_Peruvian_Andes_and_Amazon_based_on_mapped_forest_functional_diversity

Predicting tropical tree growth rates
http://onlinelibrary.wiley.com/doi/10.1002/eap.1436/abstract;jsessionid=B85710C62A3848E6BE788EE7EA1FF538.fo4to1

Forest disturbance and recovery
http://onlinelibrary.wiley.com/doi/10.1029/2008JG000911/full

Greg Asner's TED talk.
https://ted.com/talks/greg_asner_ecology_from_the_air?utm_source=tedcomshare&utm_medium=email&utm_campaign=tedspread

Greg Asner's *LA Times* article
http://www.latimes.com/science/la-sci-sn-forest-diversity-hotspots-20170127-story.html

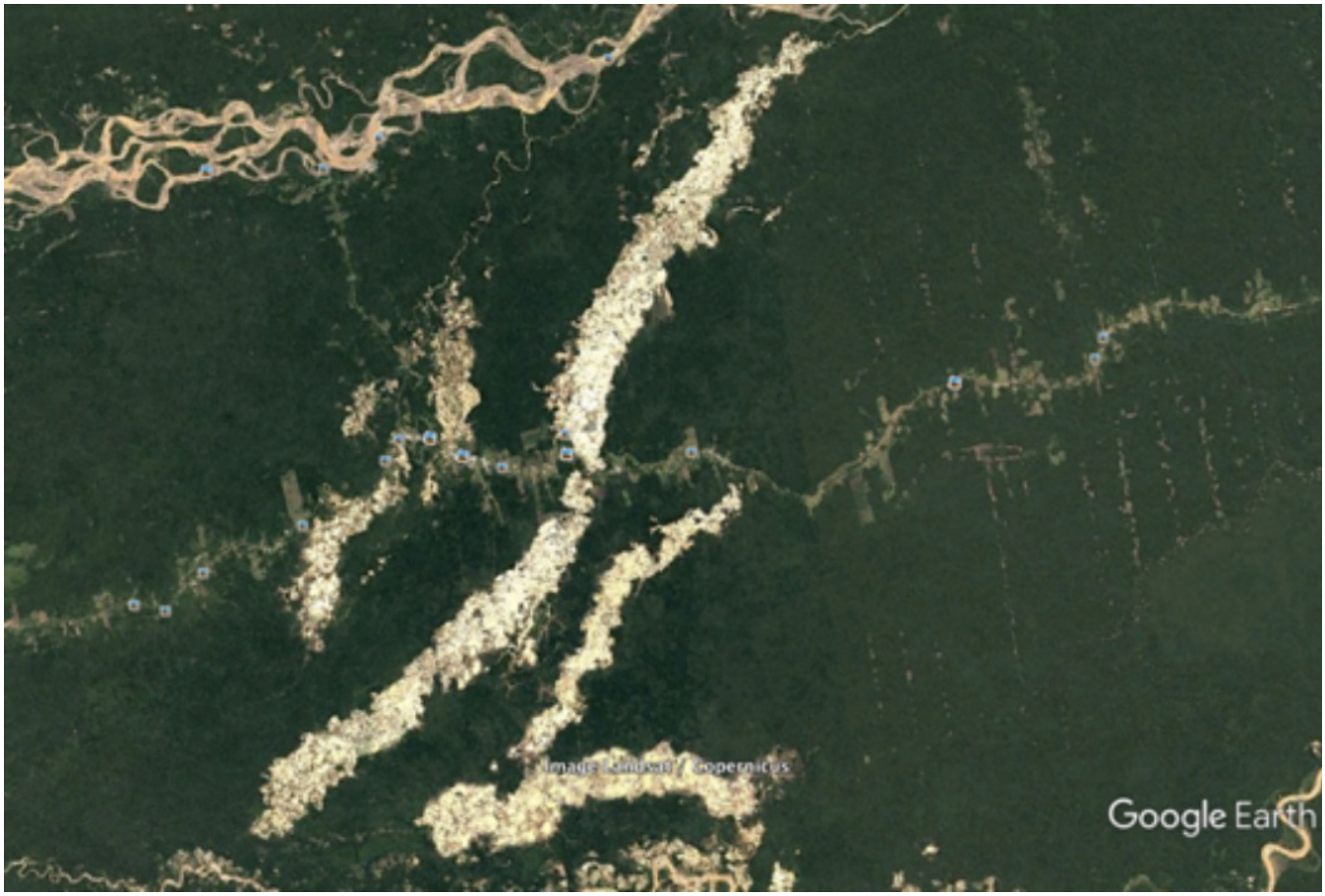
The following article from *Scientific American* quotes Amazon researcher Thomas Lovejoy, who states that the tipping point for deforestation in the Amazon is 20 percent. We are almost there. Further deforestation would render the Amazon unable to maintain the current climate system. He also says that the Amazon releases 20 billion tons of moisture into the atmosphere daily.
https://www.scientificamerican.com/article/amazon-deforestation-takes-a-turn-for-the-worse/

Landsat images, 1984 and 2016

Image 1: The Madre de Dios Gold Mining Area, acquired 12/1984

Landsat images, 1984 and 2016

Image 2: The Madre de Dios Gold Mining Area, acquired 12/2016



Extractive Industries and Environmental Costs

Enduring Understandings

- The rainforest of the Amazon is being degraded by illegal gold mining with negative impacts for the world as a whole as well as for the region.
- Extraction of oil and gas in the Amazon is also causing severe environmental problems.
- Immediate steps should be taken to prevent further damage to the Amazon Basin.

Essential Questions

- How does illegal gold mining affect the wildlife, vegetation, and human inhabitants of the Amazon Basin?
- What are the effects of oil and gas extraction in the Amazon?
- What can be done to prevent additional damage?

Notes to the Teacher

This lesson should be taught after the class has viewed *River of Gold*. It gives students an opportunity to review the issues with illegal gold mining explored in that film, and then allows students to learn more about other types of industries that are damaging to the Amazon environment, particularly oil and gas exploration.

The first part of the lesson begins with a very short film called *Mercury Uprising*, a recapitulation of *River of Gold* in about 11 minutes. After watching the film, students answer a series of questions to consolidate their understanding of the consequences of illegal gold mining. Then they tackle a challenging reading excerpt from a report on oil and gas production in the western sector of the Amazon Basin; some initial vocabulary work will help them to understand the passage. The report describes in summary form the effects of these industries on the rainforest—the destruction of habitat for diverse animal species, the building of roads that then encourage colonization and lumbering, the introduction of disease to isolated populations, and more.

After reading the report, students, working in pairs, make a graphic that illustrates the consequences of gas and oil extraction. They can use a flowchart, a mind map, or original student design. Depending on your students' needs, you may wish to spend some time reviewing these techniques. If your class is highly computer-literate, you may wish to use Inspiration, SmartDraw, the SmartArt feature in Word, or another program to make the graphic. Finally, students are given the assignment to find out more up-to-date information, to decide if the situation is improving or getting worse.

Part 2 of the lesson begins with students providing

information that they have found in their research. Since the report in 2008 excerpted on the handout, oil and gas production have struggled for several reasons: the worldwide drop in the price of oil, the difficulties involved in running a pipeline through the Andes and the rainforest, the conviction of several executives for bribery, resistance by indigenous peoples who have taken control of some oil platforms, and competition from other suppliers, including the United States. Gas production seems to be more successful, while oil production is declining.

After discussing the current situation briefly, students use RAFT strategies to write an essay from the viewpoint of a hypothetical stakeholder with interests in the Amazon. **Handout 2** explains the strategy, which uses the concepts of role, audience, format, and topic to narrow the focus of the essay. For more on the RAFT strategy, see these websites:

http://www.readwritethink.org/professional-development/strategy-guides/using-raft-writing-strategy-30625.html

http://www.adlit.org/strategies/19783/

Part 3 of the lesson uses the ideas that students generated for their essay when they participate in a panel discussion such as you would find on a television news program, with a moderator and a set of panelists. Each panelist will play the role of the persona in his or her essay, guided by the student moderator. After five to ten minutes, you will call new members to replace the first panel. The purpose is to recognize the complexity of the economic situation in the Amazon, so that students don't think only in terms of victims and villains.

Supplementary multimedia: What does the Amazon look like?

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Amazonia time lapses:
From the cloud forests to the lowlands of the jungle, beautiful time-lapse footage from Amazon Aid Artist Dano Grayson.
https://www.youtube.com/watch?v=rNKD8rgQvSE

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-Literacy.CCRA.R.2
Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCSS.ELA-Literacy.CCRA.R.4
Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCSS.ELA-Literacy.CCRA.R.7
Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words.1

CCSS.ELA-Literacy.CCRA.W.2
Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

CCSS.ELA-Literacy.CCRA.W.3
Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details and well-structured event sequences.

CCSS.ELA-Literacy.RST.11-12.2
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CCSS.ELA-Literacy.RH.11-12.4
Determine the meaning of words and phrases as they are used in a text, including analyzing how an author uses and refines the meaning of a key term over the course of a text (e.g., how Madison defines faction in Federalist No. 10).

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

Duration of the Lesson

Three to four class periods

Assessments

Class discussions

Mind map, flowchart, or other graphic showing consequences of oil and gas production

RAFT essays

Panel discussion

Materials needed

Access to video of *Mercury Uprising* at https://vimeo.com/125274209

Projector

Large sheets of paper

Markers

Copies of **Handouts 1 and 2**

Procedure

Part 1: The Effects of the Extraction Industries

1. Although students have already seen the film *River of Gold*, show them the short film *Mercury Uprising* to refresh their memory of its main points. Stop briefly at the one-minute mark to ask what has happened to the landscape in the film. (Lush rainforest filled with wildlife has given way to a barren desert.) Ask them to find out why as they watch the rest of the film.

2. Discuss the short film with the class. Some possible recall questions are:

   a. Why is the Amazon called "the lungs of the Earth"? What would happen if it didn't exist? (Far more carbon would be present in the atmosphere, leading to global warming.)
   b. What role does the Amazon rainforest provide in maintaining a suitable climate? (It releases freshwater, which regulates and moderates the climate.)
   c. How close is the Amazon rainforest to a "tipping point" for irreversible damage? (The tipping point is 80%; the Amazon now is at 81%.)
   d. What causes deforestation? (Cattle ranching, logging, extraction of oil and gas, farming, dams, roads, fires, and illegal gold mining)
   e. Why is illegal gold mining the most devastating source of deforestation? (Miners use mercury.)
   f. What is the process by which individuals mine gold in the Amazon? (They add mercury to the sands and sediment to consolidate the gold.)
   g. How does mercury affect the food chain? (It is absorbed by plants, fish, and animals. The larger the fish, the greater the concentration of mercury.)

h. How widespread is artisanal gold mining? (It is done by 20 million people in more than 70 countries.)

i. Why is mercury so dangerous to humans, especially pregnant women and young children? (It affects the brain, leading to birth defects, lower IQ, impaired motor function, and complications with hearing, sight, and taste.)

j. What other problems tend to appear with illegal mining? (Violence, drug trafficking, organized crime, corruption, child slavery.)

k. How has Peru tried to limit the effects of illegal gold mining? (Soldiers have shut down mining operations; the government has been regulating mining and following illegal gold to markets.)

l. What can be done to help? (Develop better methods for mining and agriculture, promote sustainable economic alternatives like ecotourism, and engage in reforestation.)

3. Remind students that gold mining is not the only problem facing the Amazon; another big problem is the extraction of oil and gas. Distribute **HANDOUT 1: OIL AND GAS PROJECTS IN THE WESTERN AMAZON**. Point out the underlined words and ask students to skim the reading, underlining any other words that they find that are unfamiliar. Then lead a discussion of these words and others they have found:

Biodiverse — having a wide variety of plants and animals. (Point out that breaking a word down into its roots, in this case "bio" and "diverse," is a way to figure out the meaning of a word.)

Taxa — plural of taxon, a group within the taxonomic classification system of biology, such as a family, species, phylum, or order. (Point out that students might be able to guess an approximate meaning from the examples given after the word.)

Indigenous — originating in and typical of a particular region or country.

Blocks — specific geographic areas set aside by governments for gas or oil exploration. (Point out that the definition may sometimes be contained right in the sentence. Most students will think of building blocks or city blocks with this word; point out that sometimes common words have unusual meanings depending on context.)

Contamination — making something impure or unsuitable for use by contact with something bad or unclean.

Seismic — related to earthquakes or earth tremors, whether natural or manmade.

Contentious — eager to argue or fight; causing or characterized by arguments or fights.

Morbidity — the presence of disease in a population.

Mortality – the relative frequency of deaths in a population.

4. Ask students to read the excerpt on the handout carefully, annotating as they read. Discuss, summarizing the negative effects that these economic activities have on the environment and on the people living there. Ask how this compares to the illegal gold mining. Is one worse than the other?

5. Tell students that you would like them to make a graphic that illustrates the effects of gas and oil production in the Amazon. It can be a flowchart, a mind map, or other type of diagram. Review how to make these if necessary. Then arrange students in pairs and give them markers and large

sheets of paper to construct their flowcharts, basing them on the information from the handout. When they are finished, post the flowcharts and discuss.

6. Point out that the effects summarized in the flowcharts are all negative. Ask: What would motivate people to engage in such an economic activity when they know it causes harm? Ask if anyone can think of any positive outcomes from these extractive industries. (More employment, fuel for use nationally, fuel to sell overseas to earn money for other needs)

7. Point out that this article was written in 2008. Ask students if they think the situation has gotten better or worse since then. How could they find out? Assign them to use the Internet for homework to learn about conditions in the oil and gas industries in the Amazon today.

Part 2: Creative Writing with RAFT Strategies

1. Begin class by asking students what they have learned about the extractive industries in the Amazon today. Supplement what they have found with the information from Notes to the Teacher.

2. Distribute **Handout 2: RAFT Planning for Writing about the Amazon.** Review the first chart, making sure that students understand these terms. The directions call for fiction or nonfiction; you may add poetry if that suits the nature of your class.

3. Have students work with a partner or small group to generate ideas for their RAFT writing and think about the ramifications of possible choices. Then have them work as individuals to fill in their choices on the chart.

4. Follow your usual writing procedure: tell the students the expected length of the paper, set intermediate and final deadlines, plan individual writing conferences, and hold peer editing sessions.

5. When the papers are finished, arrange to publish the papers in a classroom blog or on a bulletin board to give students the opportunity to see the work of all others in the class.

Part 3: Sharing Views

1. Arrange the classroom as if for a panel discussion on a typical news program. Ask for volunteers who are willing to participate in a discussion about the Amazon, with each assuming the role of the persona created for the RAFT essay. Choose four students whose papers reflected very different roles. Cast one student as the moderator of the panel discussion.

2. Give the moderator several starter questions: What is the state of the Amazon today? What can be done to improve the economic use of the Amazon without negative consequences? Would you be willing to support such a plan (or plans)? Encourage the student playing the moderator to ask follow-up questions.

3. After five minutes, change the roles to give other students a chance to speak. Continue until every student has had a turn as either panelist or moderator.

4. To conclude the class, have students write their own opinions, not the ones of their role-playing character, in response to the question about what can be done to improve the economic use of the Amazon.

Handout 1 ▸ P.1

Oil and Gas Projects in the Western Amazon: Threats to Wilderness, Biodiversity, and Indigenous Peoples (Excerpt)

Directions:

Read and annotate the following excerpt from a report on industry in the Amazon region compiled by scholars in 2008.

The western Amazon includes parts of Bolivia, Colombia, Ecuador, Peru, and western Brazil. It is one of the most biodiverse areas of the planet for many taxa, including plants, insects, amphibians, birds, and mammals. The region maintains large tracts of intact tropical moist forest and has a high probability of stable climatic conditions in the face of global warming. By contrast, the eastern Amazon in Brazil, where much of the global attention has focused, has a high probability of continued massive deforestation and drought risk in the coming decades. The western Amazon is also the home to many indigenous ethnic groups, including some of the world's last uncontacted peoples living in voluntary isolation.

Underlying this landscape of extraordinary biological and cultural diversity are large reserves of oil and gas, many yet untapped. Record oil prices and growing global demand are now stimulating unprecedented levels of new oil and gas exploration and extraction. It is the nations of the region, and not the indigenous peoples who live on much of the land, who assert their constitutional ownership of subsoil natural resources. National governments delimit specific geographic areas or "blocks" that are zoned for hydrocarbon activities, which they may lease to state and multinational energy companies for exploration and production….

Oil and gas development in the western Amazon has already caused major environmental and social impacts. Direct impacts include deforestation for access roads, drilling platforms, and pipelines, and contamination from oil spills and wastewater discharges. The technologies of the 1970s-era oil operations caused widespread contamination in the northern Ecuadorian and northern Peruvian Amazon. Even the much newer Camisea pipeline, which began operations in the fall of 2004, had five major spills in its first 18 months of operation. A 1990s-era oil operation experienced a major spill in Ecuador's Yasuní region as recently as January 2008. There are also direct impacts associated with seismic testing activities during the exploration phase of projects.

Indirect effects arise from the easy access to previously remote primary forest provided by new oil roads and pipeline routes, causing increased logging, hunting, and deforestation from human settlement. For example, much of the extensive deforestation in the northern and central Ecuadorian Amazon followed colonization along the oil access roads.

Social impacts are also considerable. The national representative organizations of indigenous peoples in Ecuador (CONAIE) and the Peruvian Amazon (AIDESEP) have opposed new oil and gas projects, citing the widespread

Handout 1 ▸ P.2

Oil and Gas Projects in the Western Amazon: Threats to Wilderness, Biodiversity, and Indigenous Peoples (Excerpt)

contamination from previous and current oil projects. In both countries, local residents and indigenous peoples have taken legal actions against U.S. oil companies for allegedly dumping billions of gallons of toxic waste into the forests. Intense opposition from indigenous peoples has stopped exploration in two leased blocks in Ecuador (Blocks 23 and 24) for over seven years. Deforestation and colonization following road building has affected the core territory of several indigenous groups in Ecuador. Oil and gas projects in the territories of indigenous peoples in voluntary isolation have become highly contentious. These peoples, so named due to their decision of avoiding contact with the outside world, inhabit remote parts of the western Amazon and are extremely vulnerable because they lack resistance or immunity from outsiders' diseases. First contact results in high rates of morbidity and mortality, with mortality estimates ranging between a third and half of the population within the first several years.[1]

1 Finer M, Jenkins CN, Pimm SL, Keane B, Ross C (2008) Oil and Gas Projects in the Western Amazon: Threats to Wilderness, Biodiversity, and Indigenous Peoples. PLoS ONE 3(8): e2932. doi:10.1371/journal.pone.0002932. http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0002932

Handout 2

RAFT Planning for Writing about the Amazon

You are going to write about the effects of the extractive industries (gold, oil, gas, timber, etc.) in the Amazon River Basin. Your writing can be fiction based on facts or nonfiction. Use the following elements to plan your composition.

ROLE	Assume the role of a person who has a vested interest in what happens in the Amazon region. You could be a biologist, a gold miner, a worker on an oil platform, a shareholder in a gas company, a government executive, a teenager from an isolated tribe, an environmentalist from an international organization, etc. Use your imagination.
AUDIENCE	Once you have assumed your role, to whom would you write? To a government official? To a newspaper audience? To a fellow environmentalist? To someone whose viewpoint is in opposition to yours? Just to yourself?
FORMAT	What format should your writing take? An editorial? A letter? A diary? A report? What is most appropriate for the role and audience you have chosen?
TOPIC	The effects of the extractive industries (gold, oil, gas, timber, etc.) in the Amazon River Basin. Which aspects of this topic will you focus on?

Make your choices below:

YOUR ROLE	
YOUR AUDIENCE	
YOUR FORMAT	
YOUR TOPIC	The effects of the extractive industries (gold, oil, gas, timber, etc.) in the Amazon River Basin. Specific aspect you will write about: _____ _____

Faces of Activism

Enduring Understandings

- From the time of the Industrial Revolution to the present, environmentalists have worked to expose environmental injustice and promote equity in global communities.
- As with other social movements, environmental activists come from diverse backgrounds and use a variety of techniques.
- Modern technologies provide the opportunity for future activists to modify traditional techniques to increase their impact.
- Throughout history, activists have used art and especially music to inspire positive change
- There are many ways for activists to affect the world around them in both large and small ways.

Essential Questions

- How do social movements create positive change for the environment?
- What methods do environmental activists use to create change? How successful are these techniques?
- How do activists use art and music to create change?
- Are there ways to adapt these techniques to be more successful, so they create a larger impact?

Notes to the Teacher

As the Industrial Revolution dawned in Europe and beyond, both landscapes and cityscapes began to change rapidly. These changes were recognized by citizens who urged communities and governments to protect precious natural resources. As industrialization and its necessary infrastructure spread, so too did environmental activism. Early environmental activists were concerned with issues such as how air quality affected health and how natural resources would be preserved. Over time, activists began to recognize that environmental issues didn't affect all communities equally, as more economically stable areas were least likely to be affected by attempts to make money quickly at the expense of the environment.

The current state of environmental activism recognizes the importance of both providing a living and a life in vulnerable communities. Once natural resources are depleted, they are sought from more remote locations. The by-product of this expansion is that infrastructure like roads and bridges is required to move goods more efficiently. Developing land in these undeveloped areas creates a struggle for local economies, which usually benefit monetarily in the short term, but are devastated environmentally in the long term. *River of Gold* shows how these local changes can also affect entire ecosystems and continents.

In this lesson, students will be introduced to well-known environmental activists who focused on local, regional, national, and international issues. Students will learn more about these activists, evaluate the methods that these activists used as they worked to accomplish their goals, and prepare a plan that they believe would have a wider impact than one that has already been used. It is designed to be used after students have watched *River of Gold* and have been introduced to Ron

Haviv, Donovan Webster, and Victor Zambrano, who serve as examples of modern environmentalists with differing motivations, methods, and backgrounds.

Prior to teaching the lesson, reserve library and computer lab space if required, photocopy handouts, make name placards (use regular sheets of paper folded lengthwise), and talk with your school librarian about any resources that students may use to complete their handouts and prepare for their presentations.

You may wish to structure the roundtable in Part 2 as either a report or as a role-play. Students should be expected to speak and respond to ideas and comments made by other activists as the activist they researched. Activists who were contemporaries should recognize one another and should be able to comment on one another's work. Teachers who choose this option should include a second research day in part 1 to ensure that students have sufficient time to do the additional research this extension activity requires.

Supplementary multimedia: How can you use art and music to tell the story?

***Anthem for the Amazon*:**
A stunning call to action by 500 children from around the world, singing to protect the Amazon. Footage includes indigenous children from Peru. Video by Amazon Aid and ROTU Studios.
https://vimeo.com/143037688

***Beauty and Destruction*:**
This split-screen video artistically combines footage of the destruction and the beauty to be found in the Amazon, with music by legendary jazz great Wayne Shorter. Video by Julia Sharpe.
https://vimeo.com/146904761

Common Core Standards addressed by this lesson

CCSS.ELA-LITERACY.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-LITERACY.CCRA.SL.4
Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSS.ELA-LITERACY.CCRA.W.8
Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

CCSS.ELA-LITERACY.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

Duration of the Lesson

This is a three-part lesson, designed to take three to four hours of class time.

Assessments

Class discussions

Handouts

Presentations

Optional writing exercise

Materials needed

Access to library or devices with Internet connection for research

Handout 1: Environmental Activists, Then and Now

Handout 2: Activist Profile

Handout 3: Creating an Awareness Raising Plan

Placard with each activist's name for the roundtable

Procedure

Part 1: Who are environmental activists?

1. After viewing *River of Gold*, discuss what it means to be an activist. (Someone who vigorously supports a cause) Explain that while activism has existed for a long time, environmental activism gained strength when the Industrial Revolution began to bring change to societies at a faster pace. Since then, environmental activists have taken on a variety of roles in their local, regional, and national communities. Ask students to brainstorm reasons people may become environmental activists.

2. Ask students who the activists are in the film. Discuss how Ron Haviv and Donovan Webster became activists using their existing skill sets as war journalists. Discuss Victor Zambrano's role as a local activist after he retired from the military. Are there other occupations that require skill sets that could be used by activists? Ask students to think of one example and then to share with a neighboring classmate.

3. Assign or allow students or pairs of students to choose an environmental activist from **Handout 1: Environmental Activists, Then and Now** for further research. This list includes historical and contemporary activists from a variety of countries and with different interests and experiences that led them to activism. No activist should be chosen more than once. This list will be used again in Part 2, so ask students to hold on to it.

4. Once everyone has a person assigned, ask students to use their devices to research the activist whom they have chosen. Direct them to complete **Handout 2: Activist Profile** using the information that they learn during their research.

5. Ask students to consider what they have learned about their activists, then ask them to prepare a short presentation (one to two minutes) for the next class on the identity of their activists, what they did, and how they did it. (If students need additional time, the work in steps 4 and 5 can be completed as homework, or another class day may be devoted to research and preparation of the presentations.)

Part 2: Activist Roundtable — How Have Environmental Activists Created Change?

1. Before class, make a placard with each activist's name on it to put in front of each student or pair of students during the Activist Roundtable.

2. Each student or pair of students should be prepared to make a short presentation. Ask students to refer to **Handout 1** to help identify the activist presented by their classmate(s).

3. As they listen to their classmates' presentations, ask students to make a list of methods used by successful activists. Students may also ask questions of their peers if they need clarification.

4. Once all students have made their presentations, discuss the methods that seemed to have been used most successfully. Would these methods work today? Ask students to consider this question for homework.

Part 3: What Would You Do to Improve the Impact of Environmental Activists?

1. Divide students into small groups. Ask each group to think about the presentations and discussions from the previous class. Did any of the activists use art or music to create change? If so, how?

2. Direct each group to develop a plan that improves the methods used by one (or more) of the activists. They should discuss how these methods would work today. Did the skills of the activist limit them in any way? If the students were to become activists, what would they do differently? How might they use technology in a way that would make it easier for them to meet their goals? Did they see any of these methods used in *River of Gold* by Ron Haviv, Donovan Webster, or Victor Zambrano? How might these methods also promote equity in the region where the activist works? Using **Handout 3: Creating an Awareness-Raising Plan**, students should consider how they would enhance or change the methods they have learned about in order to be more successful.

3. Have the members of each group present their ideas to the class. Wrap up by asking students if there has ever been a change they wanted to make in their local community. Discuss whether the plan they developed would help them make that change.

Writing Prompt (Optional)

At the completion of the three-part lesson, teachers may wish to require students to respond to the following prompt: Write a letter to the activist whose model you modified, explaining what changes you proposed and why.

Extension activities

1. You may wish to ask students to reformat the information they have gleaned from their research into a résumé to provide an opportunity for building life skills. Templates are easily found on a variety of web pages, including the Purdue Online Writing Lab (OWL) at https://owl.english.purdue.edu/owl/resource/927/1/.

2. Challenge students to adapt their Awareness-Raising Plan and present it to their student government to improve engagement in schoolwide programs like recycling.

3. Suggest that students post their ideas and activities on the Amazon Aid Voices portal at http://voices.amazonaid.org/.

Handout 1 ▸ P.1

Environmental Activists, Then and Now

Directions:

Use this list of environmental activists to identify the subjects of your classmates' presentations. If it helps you remember, put the name of each student presenter in the space below the subject's name.

Edward Abbey	American author (1927–1989) who wrote the nonfiction narrative *Desert Solitaire*.
Ansel Adams	American photographer (1902–1984) who is known for his black-and-white photos of the American West.
John James Audubon	American ornithologist and painter (1785–1851) who created detailed illustrations of birds in their natural habitat.
Wendell Berry	American writer and farmer (1934–) who has been an outspoken proponent of sustainable agriculture.
Erin Brockovich	American legal clerk (1960–) who helped build a case against Pacific Gas and Electric for contamination of drinking water.
Harvey Broome	American lawyer (1902–1968) who was a founding member and early president of The Wilderness Society.
David Brower	American mountaineer (1912–2000) who served as the first executive director of the Sierra Club and founded several environmental organizations.
Kevin Buzzacott	Indigenous Australian (1947–) who campaigned for land rights for Aboriginal people and against uranium mining.
Berta Cáceres	Indigenous Lenca leader from Honduras (1971?–2016) who founded the Council of Popular and Indigenous Organizations of Honduras (COPINH) and led the fight against the building of dams that would threaten traditional ways of life.
Rachel Carson	American conservationist and author (1907–1964) who wrote *Silent Spring*, which launched the modern environmental movement in the U.S.
Al Gore	American statesman, author, and Nobel Peace Prize winner (1948–) who founded the Alliance for Climate Protection.
Julia Butterfly Hill	American (1974–) who lived in a California redwood tree for 738 days to protest clear-cutting.

Handout 1 ▸ P.2

Environmental Activists, Then and Now

Aldo Leopold	American author (1887–1948) who was a director of the Audubon Society and founder of the Wilderness Society; he wrote *A Sand County Almanac*.
James Lovelock	English scientist (1919–) who proposed the Gaia hypothesis.
Wangari Maathai	Kenyan Nobel Peace Prize winner (1940–2011) who founded the Green Belt Movement.
Chico Mendes	Brazilian trade union leader (1944–1988) who fought for rainforest preservation and the rights of indigenous people.
John Muir	Scottish-American naturalist (1838–1914) was an early advocate for wilderness preservation and who is known as "Father of the National Parks."
Olaus Murie	American wildlife biologist (1889–1963) whose field research on large mammals changed wildlife management practices.
Gifford Pinchot	American forester (1865–1946) who was the first chief of the United States Forest Service.
José Cláudio Ribeiro da Silva	Brazilian (1957–2011) who campaigned against logging and clear-cutting in the Amazon rainforest.
William Blake Richmond	British artist (1842–1921) who founded the Coal Smoke Abatement Society.
Theodore Roosevelt	American statesman and naturalist (1858–1919) who made conservation a priority during his presidency, as he designated national parks, national monuments, national forests, and numerous bird and game preserves.
John Ruskin	English art critic (1819–1900) who spread his own naturalist theory of visual representation in art, which encouraged conservation of buildings and environments.
Henry David Thoreau	American author (1817–1862) who wrote *Walden* and followed the doctrines of transcendentalism.

Handout 2 ▸ P.1

Activist Profile

Provide answers that are as specific as possible.

Name: _____

Country(ies) where activism occurs: _____

Time when activism occurs (Be as specific as possible): _____

Background (Include information about the activist's family and education):

Work experience (include paid and unpaid work experience):

Event or events that trigger activism:

Handout 2 ▸ P.1

Activist Profile

Goal(s) of activist:

Methods used by activist:

Were activist's methods successful and were goals met? Why or why not?

Was this activist inspired by others? Did he or she work with any other activist to achieve their goals?

Handout 3 ▸ P.1

Creating an Awareness-Raising Plan

Directions:

Develop a plan that improves the methods used by one of the activists you have studied. Discuss each method as a group and prepare to present your ideas when you have finished.

Describe the method(s) used that you feel could be more effective (a) if they were modified to include innovative ideas or (b) if they were combined with methods used by other activists:

What modifications would you make? Why?

What materials or skills would be needed?

Handout 3 ▸ P.2

Creating an Awareness-Raising Plan

Does your plan rely on the use of technology to make it easier for you to meet the activist's goals? If this technology existed when your activist was working, why do you think it wasn't used?

How might these methods also promote equity in the region where the activist works?

What other outcomes would you hope to accomplish if your plan was implemented?

Smartphone Photojournalism

Enduring Understandings

- Photography is a form of journalism.
- Research prior to the event to be photographed is crucial.
- Photojournalism not only evokes emotion but also provides evidence for needed change.

Essential Questions

- What is photojournalism?
- How can photojournalists effect change?

Notes to the teacher

From as early as the American Civil War, photography has held the power to capture the horror, complications, and celebrations of history at the moment they happen. In a world where many of the perceptions people have about events come from commentary and arguments on cable television, photography still manages to be a medium that needs no explanation beyond the picture itself. While the well-worn axiom that a picture is worth a thousand words holds true, being in a moment to capture one at 1/250 of a second takes practice and some basic techniques. This lesson challenges students to think in terms of visual representation as a way to communicate.

This lesson can be completed either before or after viewing *River of Gold*. It provides students with simple techniques that can be used on a smartphone as a way to get started in visual storytelling. The lesson is divided into five parts. An optional extension activity uses interviews with Ron Haviv, the photojournalist whose work forms the basis for the film, to gain further understanding of the risks and responsibilities of a photographer attempting to represent important eras, events, and problems. After the assignment, the students will have a better understanding of the nature of photojournalism and the role that Mr. Haviv played in *River of Gold*.

Part 1 of the lesson will take two class periods. It exposes students to the basics of photojournalism and its importance in telling compelling stories. Before the lesson, students will have researched assigned topics in world history. After a general discussion of photojournalism on the first day of the lesson, students view some examples of outstanding news photos from Reuters and consider what makes a photo worthy of selection as one of the "best." Then, using Ron

Haviv's gallery, students find photos of the topics they have researched, choosing one to analyze using **Handout 1**. In the next class period, they present their ideas about Haviv's photos. Finally, they brainstorm local events that might make good subjects for a photojournalism narrative and decide what needs to be known prior to the photo shoot.

Before Part 1 of the lesson, you will assign student groups to research one recent world event; see "Procedure" for specific topics. Prepare a PowerPoint slideshow of carefully selected photographs from the article "56 of the most powerful Reuters photographs ever taken" at http://www.businessinsider.com/the-56-best-reuters-photographs-in-its-30-year-history-2015-2. Choose as many photos as you wish to discuss in class; avoid those that your class may find upsetting or too gruesome. Include the captions for each photo if you wish; if you choose not to include the captions, keep a list for yourself so that you can provide context during the class discussion.

The second part of the lesson will introduce the students to their smartphone's camera and ways to get the most out of it. You will need a computer and projector for this part of the lesson. (Most students will have a smartphone of their own or will be able to borrow one for a class period, but allow students who don't have one to work with a camera instead.) Students will practice some basic photo techniques to gain a familiarity with their cameras and to learn how to create a variety of images. They will also prepare for the actual shoot they are planning with a new understanding of visual goals. Before this section of the lesson, you will need to view the videos referenced in the lesson procedure. You will also need to make a slideshow of half a dozen close-ups you find effective and interesting; they can be found by Googling "close-up pictures." Make another slideshow of right time/right place photos in a lighter mood from http://www.kickvick.com/right-time-photos/. This guide on improving your photography is also helpful: https://petapixel.com/2016/09/14/20-composition-techniques-will-improve-photos/. After a discussion of basic techniques, students create questions for research on their own subject and make a list of possible shots using **Handout 2.**

The third part is the actual photo shoot, which will most likely occur outside of the school. In the digital era, students will be encouraged to shoot as many photos as possible using the methods learned. They try to apply the techniques that have been discussed in class. It may be wise to give the students several weeks for completing the assignment, as their chosen subjects may not be scheduled conveniently. Require the students to take a minimum of 40 shots (perhaps ten from each extreme camera angle). This can be assessed by having the students upload the photos on a photo program like Flickr or Photobucket or put them in a folder on Google Drive that they then share with you.

Part 4 is the selection and captioning process; the students scrutinize all of their photos and choose the best ones to tell the story. The hardest part of creating a photo exhibit is choosing the right shots. They will create a simple slideshow of eight to ten photos to present to the class. Then they should write captions for each slide. This could be tricky, because the caption should give context for the photo without blatantly stating the photographer's opinions about the subject. For instance, a shot of a mayor speaking at a podium should have a caption that reads: *At the town meeting, Mayor Harry Johnson discusses the upcoming proposal for land development*. The caption should not read: *Mayor Johnson, who has significant ties to certain land developers, makes excuses on how he is about to get rich.*

Finally, the students present their own work and describe why they chose certain images; student peers can evaluate each photo shoot constructively and make suggestions. This critical eye towards their own and their peers' work will make them better photographers as well as better witnesses to history. A rubric for scoring is available on **HANDOUT 3**.

There is an optional extension activity that requires students to watch interviews of some photojournalists and write an essay responding to a prompt about photojournalism.

Supplementary multimedia:
What is the power of the image?

Amazonia slide show:
The stunning sounds and images of the Peruvian Amazon through the lens of photojournalist and Amazon Aid Artist Jon Golden
https://vimeo.com/268859073

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.CCRA.R.2
Determine central ideas or themes of a text and analyze their development; summarize the key supporting details and ideas.

CCSS.ELA-Literacy.CCRA.R.3
Analyze how and why individuals, events, or ideas develop and interact over the course of a text.

CCSS.ELA-Literacy.CCRA.SL.2
Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Duration of lesson

Five to six class periods plus time for photo shoot

Assessment(s)

Analysis of Ron Haviv photo

Planning sheet for photojournalism project

Photographs uploaded to Flicker or another photo site

Slideshow presentation

Class discussion

Materials needed

Access to library or computers for research

Student smartphones or cameras

Classroom computer with projector

Access to Internet

Access to PowerPoint, Prezi, or similar program

PowerPoint of Reuters photos

Handouts 1–3

Procedure

Part 1: Introduction to Photojournalism

1. For homework before starting this lesson, divide students into six groups and have each group research one recent topic in world history to an extent that they can explain it to their classmates. Suggested topics are the Syrian refugee crisis; Black Lives Matter protests in Ferguson, Missouri; the school shooting in Newtown, Connecticut; poverty in Haiti; drug violence along the border with Mexico; the Arab Spring in Egypt; the crisis in Darfur.

2. Begin class by writing the words "Photo + Journalism = Photojournalism" on the board. Discuss what it means to be a journalist. Why might someone wish to become a journalist? What are a journalist's responsibilities? How does one prepare for a career as a journalist? What would be the rewards and disadvantages of being a journalist overseas? Then focus on the word "Photo." Discuss: What does a photojournalist do? How is the work of photojournalists similar to and different from the work of print journalists?

3. Explain to the class that they are now going to look at some photos that are considered excellent examples of photojournalism, from one of the best-known news agencies. Show class the slideshow you have made from the Reuters photos. Pause at each photo and discuss:

   a. What is happening in the photo? What is the context for this photo?
   b. What emotions does the photo arouse in the viewer?
   c. How difficult was it to take the photo? Did the photojournalist have to take any risks?
   d. What elements (color, composition, the use of light, distance of the photographer from the subject, camera angle, originality, an interesting subject, technical skill) make this photo considered one of the "best"?

4. Give each student a copy of **Handout 1: Analyzing Photos**. Review the directions on the handout to be sure students understand the assignment. Then let the student groups meet to select the photos that each student will analyze for homework. Tell students that they will be presenting their photos to the class the next day. Explain that they may use **Handout 1** for notes, but they should not just read from it; they should use the information to give an informal talk about what they see in the photo.

5. The next day, have students give their presentations, showing the chosen photo while they speak. Then ask students if they think that Ron Haviv was just trying to record the facts or if his photos convey a particular opinion or emotion. Have students refer to specific photos in the discussion.

6. For homework, have students choose a subject (in their school, neighborhood, or town) that might make a good photo series, something that needs to be improved or someone who is working to improve the area. Suggest that a student service learning project might be a good subject, or they might find a topic by asking adults or by reading the local newspaper. Also ask them to bring smartphones or cameras to the next class.

Part 2: Introduction to Smartphone Photojournalism

1. Ask students to share the subjects that they have chosen for their photo series and conduct a class discussion in which students evaluate the potential of each topic and suggest possible lines of research about it. Tell them that their next homework assignment will be to formulate research questions about the subject they have chosen.

2. Explain that for smartphone photojournalism, there are four techniques that students should employ: the rule of thirds, close-ups, extreme angles, and right place/right time. Write these terms on your board.

3. Ask students to hypothesize the meaning of the *rule of thirds*. Then show the students examples from the websites at https://www.youtube.com/watch?v=4UrNBzhcyAM and https://www.youtube.com/watch?v=IpEuYp4_iSg. The first explains the rule of thirds with portraiture, the second with landscapes. Ask them to restate the rule of thirds in their own words and have write down a simple definition in their notebooks.

4. Have them shoot portraits, candid shots, and objects in the classroom using the rule of thirds. Mention that some of their phone cameras might have an option for gridlines, but it is not necessary. After shooting, give students time to share their photos with a partner and critique each other's work.

5. Tell students that a *close-up* is a good way for the students to get used to the focal capabilities of their smartphone. Tell the students they are going to take close-up photos of as many objects (including each other) as possible. As an example, have the students take a shot of a pencil with only one end of it in focus. Mention that some students' cameras have an option for selective focus, but it is not necessary. Share your slideshow of close-ups and discuss what the technique adds to each photo.

6. Now give students an opportunity to shoot close-ups of objects in the classroom and to share their photos with their partner and critique one another's work.

7. Tell students that the use of *extreme angles* can convey an attitude toward the subject. Photographing a person from a low angle can make that person seem more powerful. A high-angle shot may make the subject seem isolated, vulnerable, or powerless.

8. This is a chance to get physical. With safety in mind, have the students get on the floor and shoot upwards at each other and stand on desks to shoot downwards. Provide time for students to share with their partner and critique one another's work.

9. Ask students what they think is meant by the phrase "Right Place/Right Time" that you wrote on the board. Have the students brainstorm about an event at school such as a sports event, assembly, lunchtime, or any other activity. Create a list on the board of possible shots that could be captured. Remind them that it is important to pay particular attention to the reaction of spectators of the event as well as the event itself. For instance, it is great to get a shot of the home run at the baseball game, but also important to get one of the crowd cheering. Tell them that it is important for a photojournalist not to stage photos; they should capture a moment, not create one. Show students examples of this from the 9/11 portfolio of award-winning Stephen Shames at https://stephenshames.com/projects/9-11-ground-zero/ and from your right place/right time slideshow.

10. Review the class by having students define the terms *the rule of thirds, close-ups, extreme angles,* and *right place/ right time* in their own words.

Part 3: The Photo Shoot

1. Distribute and read through **HANDOUT 2: YOUR PHOTOJOURNALISM SHOOT** with the class. Take sufficient time to answer student questions thoroughly.

2. Assign deadlines for the research, the shoot, and the upload, and have student fill them in on the handout.

Part 4: Editing and Captions

1. Tell students that they are now going to create a PowerPoint presentation of the eight to ten photos that they consider their best, arranged in a logical way to tell a story.

2. Ask them to define the word *caption* (sometimes called a *legend*, a title or brief description to accompany a photograph). Discuss with them what qualities a good caption should have:

- **a.** The first sentence of a caption describing the photo should be in present tense. The next sentences, if any, should be in past tense.
- **b.** The caption should not merely tell what the photo is; it should give information that cannot be gathered from the photo itself.
- **c.** A caption should not begin with a name. If names are used, state "from left," not "from left to right."
- **d.** Vary the way the way the sequence of captions begins, just as a writer should do with sentences in an essay.
- **e.** Remind the students that the photos themselves should tell a story.

3. Give students time to make a PowerPoint or use a similar program to create a slideshow of their eight to ten pictures with captions. Have them review what they learned in their research and think about why they chose particular photos for the slideshow.

Part 5: Presentation

1. Have individual students present their slideshows and discuss:

- **a.** Why the subject was important enough to them to use for this project
- **b.** Why they chose certain photos
- **c.** What the shoot was like
- **d.** What they hope viewers' reactions will be
- **e.** What changes they hope might come about because of these photos.

2. When all the slideshows have been viewed, hold a class discussion on what students have learned from this lesson, what they enjoyed about it, and what they found difficult.

3. Use the rubric on **HANDOUT 3** to give students feedback on their work on this project.

Extension activity:

1. Have students view one or more of the following interviews:

   Interviews with Ron Haviv:

   https://www.youtube.com/watch?v=67HuNFFf8Ek

   https://www.youtube.com/watch?v=VGklM8Sofu4&list=PL32EB7E7F0321E2E1

   Interviews with National Geographic photographers

   https://www.youtube.com/watch?v=6tVlMaBNkpg

   Photojournalism from a woman's perspective: Lynsey Addario

   https://www.youtube.com/watch?v=n9y0406879Y

   Then have them write an essay on the following prompt: Using one or more of the interviews above, write an essay entitled *Being a Witness: How Photojournalism Can Create Change.*

2. Invite students to post their photography on the Amazon Aid Voices portal at http://voices.amazonaid.org/.

Handout 1 ▸ p.1

Analyzing a Photograph

Directions:

Use the Internet to find the website of photojournalist Ron Haviv at www.ronhaviv.com/. Then using the headings at the top of the page, locate the correct collection of photographs for your group

Topic	Heading	Photo collection
The Syrian refugee crisis	New Editorial	Exodus
The protests in Ferguson, Missouri	New Editorial	A Winter's Day of Discontent
The school shooting in Newtown, Conn.	New Editorial	Newtown
Poverty in Haiti	New Editorial	Haiti's Children Today
Drug violence along the Mexican border	New Editorial	Invisible Lines: Death in Juarez
The Arab Spring in Egypt	New Editorial	Arab Spring on the Nile
The crisis in Darfur	Projects	Children of Darfur

Each member of your group should choose a different photo, one that strikes you as particularly interesting. Analyze the photo according to the elements you discussed in class for the Reuters photos.

Your group_____

Caption of your photo_____

What is the subject of the photo?

Handout 1 ▸ P.2

Analyzing a Photograph

Who is in the photo?

What objects are in the photo?

Why did you select this photo above the others? What appealed to you?

What emotion does this photo arouse in the viewer?

How does Haviv use each of these elements?

a. Color

Handout 1 ▸ P.3

Analyzing a Photograph

b. Composition

c. Light

d. Distance of the photographer from the subject

e. Camera angle

What else do you want to say about this photo?

Handout 2 ▸ P.1

Your Photojournalism Shoot

Name _____

What is the subject of your photo shoot? _____

Explain why you think this is an appropriate subject for a photojournalism shoot.

What story do you want your photographs to tell?

What difficulties do you anticipate in taking these photographs? How will you overcome them?

What are five research questions you should answer to understand more about your subject?

a.

b.

Handout 2 ▸ P.2

Your Photojournalism Shoot

c.

d.

e.

Then spend time researching and taking notes on your subject to answer these questions. As you research, on a separate sheet of paper, list at least 20 shots you plan to take to tell the story of your subject.

Research deadline _____

After this planning, go on your photo shoot. Take at least 40 photos, including ten close-ups, ten from a low camera angle, and ten from a high angle. Try to follow the rule of thirds and to be at the location of your subject at an optimal time.

Shoot deadline _____

When you have finished, upload your photos according to your teacher's directions.

Upload deadline _____

Handout 3

Smartphone Photojournalism Presentation: Scoring Rubric

Criteria	Score 1–10
The subject chosen for the photojournalism project was significant and appropriate.	
The list of research questions was thoughtful and relevant.	
Questions were adequately answered by research.	
40+ photos were posted by the deadline on the site specified by your teacher..	
At least one photo chosen for the slideshow used a close-up for dramatic effect.	
At least one photo chosen for the slideshow used an extreme camera angle for dramatic effect.	
The photographer generally followed the rule of thirds.	
Captions for the photos in the slideshow were informative and well-written.	
The student showed his or her photographs and explained his or her process for the project.	
The student contributed positively to the discussions of other students' slideshows.	
TOTAL SCORE	**/100**

Additional comments:

The Market for Gold

Enduring Understandings

- Knowledge of world economics and the social construction of monetary value is essential to understanding the argument for and against protecting the Amazon rainforest and its peoples from gold-mining operations.
- The global demand for gold and the economic principle of supply and demand are key concepts to understanding the motivation of small-scale gold-mining operations.
- Understanding the concepts of intrinsic vs. extrinsic value is essential for students to grapple with their own sense of morality and ethics.
- Personal choices affect environmental destruction and market values.

Essential Questions

- In what ways does gold have value?
- What products are made with gold?
- Is the value of the rainforest higher than the value of the gold?
- How can our personal choices affect the destruction of the Amazon rainforest?

Notes to the Teacher

Gold has been used since antiquity as a measure and symbol of wealth and power. Gold holds both extrinsic and intrinsic value, as its unique properties are useful as well as beautiful to behold. As a metal, gold does not tarnish, conducts electricity, and is malleable; it can be melted and cast into detailed shapes. It is gold's beauty, however, that has given it a special place in the human mind, which assigns value to gold beyond its usefulness. Thus, even before global exploration and globalism, gold was held in the highest esteem by cultures spanning the globe.

Gold's beauty and rarity made it the perfect metal to symbolize wealth. Around 605 BCE, the first coin currency, *electrum trite*, was made of an alloy of silver and gold. Soon after, this alloy was replaced by solid gold. By 293 CE, Romans were using gold as a backing for their coin currency made of bronze and copper. Each *nummus* coin was assigned a value that symbolized a fraction of an amount of gold. This system of gold-backed currency, referred to later as the gold standard, evolved and spread across the globe, lasting as our basic economic principle until the Great Depression of the 1930s.

Gold was also used as jewelry and as a way of showing the power of royalty. Perhaps the funerary mask of Tutankhamun, dating from 1323 BCE, is the best-known example. The "gold of Troy" treasure dates back more than 1000 years earlier. In medieval times, gold discoveries and mining increased, and gold was highly sought after. So humans have worked with and valued gold for a very long time.

This lesson traces the history of gold and teaches the basic economic principles needed to understand the value of gold. This lesson could be taught in segments or in full after viewing

River of Gold. Each part provides essential supplemental knowledge and challenges students to connect the film to their own personal choices as consumers. The lesson is divided into five parts, each taking one or two class periods to complete. Each part ends with a homework activity that could be used for extensions in class. Most parts of this lesson require computers and Internet access for students, a whiteboard or chart paper to display the writing prompts, and printed handouts.

For homework before beginning Part 1, students think through their personal definitions of "value" and define what they value. Students share their responses to a prompt, making a word web to help visualize responses, and then deepen their thinking about value by categorizing items into extrinsic and intrinsic value categories. Class discussion will explore what we personally value and whether that is based on the item's function or fashion.

Next, students will extend their understanding of value by looking at the system of supply and demand that give items economic value. With **Handout 2,** students take notes on a short video, "Crash Course Economics," and then show their understanding of supply and demand by trying to predict market responses to various scenarios. Finally, using **Handout 3**, students will explore the current value of gold and the implications of global events on gold prices. Students will reflect on this knowledge by debating whether we hold some items at a higher value than we should.

Part 2 asks students to examine how gold came to be the most valued metal by human societies across the globe. This will help students understand the events that shaped gold into a symbol of wealth and a standard for currency, in addition to its use as a component in products today. Next, students explore the quest for gold in the Americas and how it affects the local environment and peoples. This exploration is through Howard Zinn's *A People's History of the United States,* Chapter 1. Students will listen to part of this chapter read aloud and will be asked to reflect on whether Columbus and his men valued gold over human life—and if we continue to do so today.

Part 3 asks students to research the current use of gold in jewelry, medicine, and electronics, and to discuss the implications of their own consumerism. They will present their findings to one another and share resources for awareness and conscious consumerism. **Handout 4** details the questions and suggested resources for this assignment and provides space for initial notes.

In Part 4, students are challenged to wrestle with the question posed by the filmmakers: Is the value of this forest higher than that of the gold or not? Through a "circle of viewpoints" discussion, students look at the perspectives of multiple stakeholders, from the miners themselves to peoples living around the Amazon. The class will then share this information and reflect on the importance of becoming more conscious consumers. **Handout 5** asks students to reflect on the lesson as a whole, refine their beliefs and values, and think deeply about their own values, how their personal choices affect the environment, and what they can do to change that.

Here are a few additional websites that you may find useful:

Teaching Economics As If People Mattered
http://www.teachingeconomics.org/

Buycott
https://www.buycott.com/

Fairphone
https://www.theguardian.com/sustainable-business/2016/apr/29/fairphone-smartphone-company-search-conflict-free-gold

National Geographic, "The Quest for Gold" DVD
https://shop.nationalgeographic.com/products/the-quest-for-gold-dvd

Trailer at
https://www.youtube.com/watch?v=pB2f2Thct10

"Why We Left the Gold Standard"
http://www.npr.org/sections/money/2011/04/27/135604828/why-we-left-the-gold-standard

Bitcoin vs. Gold's Value on NBC News
http://www.nbcnews.com/business/economy/bitcoin-value-surpasses-gold-first-time-currency-s-history-n728456

Supplementary multimedia: What does the Amazon look like?

Mercury Uprising:
A 12-minute look into why the Amazon is important, the things that are destroying it, and the hope for protecting it. Video by Amazon Aid and ROTU Studios.
https://vimeo.com/125067596

Amazonia:
Take a journey through the lens of Amazon Aid Artist Torben Nissen. See rare footage of the Amazon's flora and fauna, including a three-toed sloth and its baby.
https://www.youtube.com/watch?v=ucvMRxzor_w&sns=em

Amazonia slide show: The stunning sounds and images of the Peruvian Amazon through the lens of photojournalist and Amazon Aid Artist Jon Golden.
https://vimeo.com/268859073
https://vimeo.com/268859073

Amazon Aid Foundation presents
Photojournalism and the World's Forests
Photography to inspire change
https://amazonaid.org/ photojournalism

Amazon Aid Foundation presents
Using your smartphone to become a Citizen Journalist
https://amazonaid.org/citizen- journalism/

Common Core Standards addressed by this lesson

CCSS.ELA-Literacy.RH.9-10.4
Determine the meaning of words and phrases as they are used in a text, including vocabulary describing political, social, or economic aspects of history/social science.

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

CCSS.ELA-Literacy.CCRA.R.1
Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCSS.ELA-Literacy.CCRA.SL.4
Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSS.ELA-Literacy.CCRA.SL.1
Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSS.ELA-Literacy.CCRA.SL.2
Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

Duration of lesson

Five to six class periods

Assessment(s)

Class discussions

Homework writing prompts

Activities on handouts

Persuasive essay

Materials needed

Handouts 1–5

Chart paper, chalkboard, or whiteboard and markers

Computer with projector

Video clip from "Crash Course Economics" at https://www.youtube.com/watch?v=g9aDizJpd_s

Computers with Internet access

Howard Zinn, *A People's History of the United States* (Chapter 1) online at http://www.historyisaweapon.com/defcon1/zinncol1.html)

Procedure

Part 1: Value

1. Before starting this lesson, assign this prompt for homework:

   Directions: For homework, write a detailed one-page expository essay outlining your answer to this question: What do I value? There is no single right answer; however, you should be descriptive and detailed in your response.

   Explain that you want them to think through their personal definitions of "value" and identify what they value and why.

2. Begin class the following day by writing "Our Class Values" in the middle of the board or chart paper. Draw a bubble around the phrase to start a word map around it and give students **Handout 1: Values** so they can do the word map activity with you.

3. Next, allow students to share their responses to their homework about values. Chart the things they value on the board in a word map around your bubble. Put duplicates or closely related items together. Remind students to chart along with you on **Handout 1**.

4. After ten minutes, summarize what students shared by reviewing the chart. Have students deepen their thinking about values by looking at and discussing the definitions of extrinsic and intrinsic value on the next page of the handout, and then working through the activity on the back of **Handout 1**. (This should take students 10-15 minutes, working independently.) Have a short class discussion afterwards to make sure students understand these concepts.

5. (You may wish to start this part of the lesson on a second day.) Prepare the clip from *Crash Course Economics* by fast-forwarding through any ads before turning on the projector. Give students copies of **Handout 2: Supply and Demand** and instruct them to listen for the answers to the questions as they watch the video.

6. Show the ten-minute video clip on supply and demand from "Crash Course Economics" and prompt students to answer the first three questions on the handout. Stop the video as needed, allowing students time to take notes; discuss concepts that need clarification. Then test their understanding of supply and demand by having them predict the market's responses to scenarios on **Handout 2**. Discuss the scenarios and allow students to ask questions as needed.

7. Students will need access to computers and the NASDAQ website link to do the next activity, exploring the current value of gold and the implications of global events on gold prices. Give them copies of **Handout 3: The Price of Gold.**

8. After they have determined the price of gold and written their answers for the first three questions, brainstorm some world events that could cause the price of gold to go up or down. (In general terms, some factors are wars and other political crises, the actions of central banks in buying or selling gold, rising or falling demand for jewelry and technology, costs of gold production, the inflation rate, uncertainty about world events. Try to find specific events that trigger changes in gold prices.)

9. For homework, ask students to read and take notes on the first three sections of the history of gold at https://geology.com/usgs/gold/.

Part 2: The History of Gold

1. Ask students what they know about the use of gold in ancient and medieval times. Tell students briefly about the early history of gold for jewelry and currency, using the information in Notes to the Teacher.

2. Ask: What about early modern times? How valuable was gold in the eyes of those who sailed on voyages of discovery?

3. Explain to students that you are going to read aloud part of a chapter from a book about Columbus, Howard Zinn's *A People's History of the United States*, Chapter 1. Go to http://www.historyisaweapon.com/defcon1/zinncol1.html and read from the beginning to "A report of the year 1650 shows none of the original Arawaks or their descendants left on the island."

4. Ask students if they learned anything new about Columbus from this passage. Ask if the information about gold and slaves was covered in what they had previously learned in school about Columbus. Then ask, "Did Columbus and his men hold the value of gold above human life?"

   Ask students to compare Columbus's attitudes towards gold's value with those you saw in the film *River of Gold.* Is the value of gold still being put above the value of human life? If the miners are risking their lives, what does that say about what they value? If the government hasn't seriously invested in stopping the mining operation until recently, what might that say about what it values?

Part 3: Uses of Gold and Informed Consumerism

1. Give students **Handout 4: Gold Use Today**. Break the class into three groups and assign each a topic (gold in jewelry, medicine, and electronics). Read the directions to the students, emphasizing the two outcomes that should be in their presentation. Be sure students understand these topics.

2. Have students research their topics for homework. Then allocate a class period for student groups to meet, share their research, and plan and create their presentations.

3. Have each of the groups present about their findings to the class at the beginning of the next class period.

Part 4: The Value of the Forest vs. the Value of Gold

1. Give out **Handout 5: Circle of Viewpoints Discussion**. Explain that the goal of this discussion is to get students to think deeply about opposing perspectives on an issue. If your students aren't familiar with this type of discussion, you may want to go over the guidelines:

   a. Speak only from the point of view of your assigned role.
   b. Be respectful and allow others to speak for their assigned role.
   c. Remember that you may be saying things you do not personally believe, just like your classmates. Do not take the debate personally or carry it outside of this class.

2. Split the class into groups of six. Either assign a role to each student or allow students to choose their own role within the group.

3. Time each round with one minute for each member to speak and one minute for the rest of the group to respond; use a timer and prompt students to engage and take their turn. Walk around the room to hear conversations. Sample prompts: "It is the gold miner's turn; everyone else please listen. You have one minute. Begin." Then "The gold miner's time is up, and the rest of the group has one minute to respond." Remind students to take notes on the responses, as they may help later with the reflection assignment.

4. After the discussion, ask students to look at the writing prompt on **HANDOUT 5** and read through the directions with them. Allow students to ask questions and discuss the prompt as necessary.

5. Give students a class period or two to write their persuasive essays; offer individual writing conferences to help any students who have difficulty.

6. Share the essays in class or publish them to your school community or larger audience if available.

Handout 1 ▸ P.1

Values

Part 1: Values Word Map.

Directions:

As your classmates share their "value" essays from homework, create a word map of what the class seems to value. As students share what they value, connect each idea to the bubble below.

Our class values

Handout 1 ▸ p.2

Values

Part 2: Intrinsic and Extrinsic Value

Directions:

After you have completed the word map of class values, read the definitions from http://www.dictionary.com below. Then complete the activity that follows.

Value *(noun)*
1. relative worth, merit, or importance.
2. monetary or material worth, as in commerce or trade.
3. the worth of something in terms of the amount of other things for which it can be exchanged or in terms of some medium of exchange.

Intrinsic *(adjective)*
1. belonging to a thing by its very nature.

Extrinsic *(adjective)*
2. being outside a thing; outward or external; operating or coming from without.

For each of the following items, decide it if has intrinsic value, extrinsic value, or both, and explain your choice in complete sentences.

Clean water

Handout 1 ▸ P.3

Values

A dollar bill

A $400 pair of sneakers

A gold wedding ring

An iPhone

Handout 2 ▸ p.1

Supply and Demand

Part 1. Directions:

As you watch the Crash Course Economics *episode on "Supply and Demand," answer the questions below. You may have to pause or rewatch this short video to complete the activity. Link:* https://www.youtube.com/watch?v=g9aDizJpd_s

What is meant by the economics term "market"?

How does a system of voluntary exchange work?

Explain how the law of supply and demand works to set prices.

Handout 2 ▸ P.2

Supply and Demand

Part 2:
Using your understanding of supply and demand, predict how prices will change in the following scenarios:

Scenario 1: A historic drought causes the strawberry crop to die off in most areas of the world.

How would the price of strawberries change? Why?

Scenario 2: Strawberry shortcake becomes a trending dessert on Pinterest and starts an international frenzy for this delicious treat. How would the price of strawberries change? Why?

Handout 2 ▸ p.3 Supply and Demand

Scenario 3: A huge deposit of gold is found off the coast of Africa, doubling the amount of available gold in the market. How would the price of gold change? Why?

Scenario 4: South American environmental agencies create an effective task force to stop small-scale gold mining across the continent. How would the price of gold change? Why?

Handout 3 ▸ P.1

The Price of Gold

Directions:

Go to the NASDAQ website at http://www.nasdaq.com/markets/gold.aspx?timeframe=1oy *to analyze the changes in gold prices over the last ten years, one year, and last six months. You will see a chart like the outdated one below, but with today's updated information. Use the online chart and the timeframe selection device under it to answer the questions on the next page.*

End of day Commodity Futures Price Quotes for Gold (COMEX)

Select Timeframe: 10 Years Refresh

Handout 3 ▸ P.2

The Price of Gold

How has the price of gold changed over the past ten years?

How has the price of gold changed over the past year?

How has the price of gold changed in the last six months?

After you have analyzed the chart, think of three world events, political changes, or economic circumstances that might have caused the price of gold to change. Explain why each might have affected the market.

1.

2.

3.

Handout 4

Gold Usage Today

Directions:

Each group has been assigned a topic to research and present to the rest of the class. Use the resources below to research your topic and possible solutions. Create a PowerPoint or other visual presentation that addresses the following questions:

1. How is gold used in your topic?

2. How can you as a consumer be sure that you are not buying these products with gold mined through unsustainable practices?

Circle the topic for your group:

Gold in Jewelry **Gold in Medicine** **Gold in Electronics**

Suggested web resources

(You may need to explore other resources on your own)

Amazon Aid
http://amazonaid.org/

Solidaridad Network
https://www.solidaridadnetwork.org/supply-chains/gold

Geology.com
http://geology.com/minerals/gold/uses-of-gold.shtml

Fairmined
http://www.fairmined.org/

Handout 5 ▸ p.1

Circle of Viewpoints Discussion

Directions:

Each of you will be assigned to a small group and given the role of one of the stakeholders involved in small-scale gold mining. Your job is to represent your person's point of view in a conversation about the questions below. Each member of the group must listen and respond to other members in a respectful manner. Take notes on the responses, as they may help you later with a reflection assignment.

Role	Student Assigned	Notes
Small-scale gold miner		
An official from an environmental clean-up agency		
Small-scale mine owner		
A Peruvian living near the Madre de Dios River		
A member of the Peruvian government		
You (a student in this class)		

Handout 5 ▸ P.2

Circle of Viewpoints Discussion

How do you define the value of the gold vs. the value of the forest? Which has more long-term value?

How would your answer differ if you had a different perspective? Whose perspective is the most important in this case?

Circle of Viewpoints Reflection

In the film, the narrator asks, "Is the value of this forest higher than the gold or not?"

In a persuasive essay, answer this question. Be sure to include details and evidence from the film, class activities, and your research to support your answer.

Next Steps: What Can We Do?

Enduring Understandings

- Knowledge of the environmental, social, and economic impacts of small-scale gold mining in the Amazon is essential in understanding the need to solve the global problem documented in the film *River of Gold*.
- Governments and industry try in good faith to help with certain environmental problems (such as by banning the sale of ivory to save endangered elephants) but are often hindered by the environmental, social, and economic realities of the local area.
- The poor are often the least capable of solving any of the problems caused by small-scale mining because they have few economic resources or employment options.
- Awareness campaigns are an excellent tool to inform people about a cause and to inspire action.

Essential Questions

- What are the environmental and human impacts of small-scale gold mining in the Amazon?
- Who are the people using small-scale mining to extract gold, and why is it so difficult for them to cease that practice?
- How can an awareness campaign help alleviate the problems in the Amazon?
- What can students in other countries do to save the Amazon rainforest?

Notes to the Teacher

The documentary film *River of Gold* teaches us about the true cost of small-scale gold mining in the Amazon. Deforestation and toxic chemicals draining into the water supply have threatened the present and future survival of all living things in that area. The people who engage in these practices are just trying to feed their families and literally cannot afford to join the battle for the environmental health of the Amazon. Students need to be as aware of this simple fact as much as they need to be aware of the environmental devastation. Students' empathy for the untenable situation of these small-scale miners will drive the lesson forward.

What is needed is not only an awareness of the dangers posed by small-scale gold mining, but also an alternate means to make a living. Many people currently engaged in mining would gladly give it up for something else that would pay the same as gold. At the present time, for gold miners so far from cities and unaccustomed to urban living, this dangerous form of mining seems like the only way they can earn a living and feed their families. Students need to understand this concept, rather than viewing the miners as environmental villains.

After viewing the documentary film *River of Gold*, student research groups will use **Handout 1: Amazon Research** to record what they learned from the film about the problems associated with small-scale mining. There are a number of ways for you to have students conduct research. You can use four large groups or eight small ones, depending on the number of students in the class. You can assign all research for homework, do all research during class time, or combine the approaches. You can require younger students to read just one article, require older or more gifted students to read all of them, or require students to add websites and articles that

they find independently. Run off a copy of the first page of the handout for each student and enough copies of page 2 to meet your research requirements. **Teacher Resource 1** has a list of possible websites you could give to students to get their research under way. You can just photocopy it a few times and then cut the sections apart to give to individual groups.

In Part 3 of the lesson, students learn the meaning of the term "awareness campaign" and discuss several examples to understand how the issues are being addressed and to learn what is effective.

You may find some vivid examples at http://www.topdesignmag.com/30-examples-of-awareness-campaigns/, but choose carefully and put them on a slide presentation of your own; some are too graphic for classroom display. The anti-drug commercial from the 1980s can be seen at https://www.youtube.com/watch?v=3FtNm9CgA6U. A vivid anti-smoking commercial from the Centers for Disease Control is at https://www.tobaccofreekids.org/press-releases/2013_09_09_cdc.

Students then plan a set of PowerPoint (or other presentation program) slides to convey their findings about their issue to the rest of the class. You may need to teach the basics of PowerPoint to the class if they are not familiar with it. You should choose a few effective backgrounds and fonts to use and give the class a chance to vote on the one background and font to use; you want the slideshow to be unified even though students are contributing slides on different topics. Student groups create slides about their research, and then you synthesize the group slides into one presentation. Student presenters then show their work to the class and, if you choose, to the school at an assembly. They may also wish to share it by social media, so give them access to the whole slideshow when it is completed.

There is an optional Part 4, if students express a desire to work to alleviate the situation in the Amazon. The organization Amazon Aid, which produced *River of Gold*, works with a science group called CINCIA that partners with Wake Forest University and others. They hire local workers to replant acres of rainforest, thus combating the effects of illegal gold mining and providing an alternative source of income to miners in a region where options are scarce. Students can plan a fundraiser and collect money to donate to plant a tree symbolically or protect an acre of rainforest. Information about the reforestation program can be found at https://amazonaid.org/.

You may wish to enlist the aid of your student government to make this a schoolwide project. Some schools have done bake sales or car washes; others have encouraged students to do chores like mowing the lawn or babysitting and then to donate the proceeds; some have just collected spare change. Of course, be sure that you clear everything in advance with your administration and keep parents and guardians of your students well-informed.

Supplementary multimedia: How to tell the story through media

Mercury Uprising:
A 12-minute look into why the Amazon is important, the things that are destroying it, and the hope for protecting it. Video by Amazon Aid and ROTU Studios
https://vimeo.com/125067596

60 Seconds:
What can you lose in 60 seconds? Too much! Video by Elizabeth Webb
https://www.youtube.com/watch?v=MwmtltBjq84&sns=em

If you could save the greatest forests in the world, would you?
Thirty seconds to ask yourself why. Video by ROTU Studios
https://vimeo.com/268435432

Anthem for the Amazon:
A stunning call to action by 500 children from around the world singing to protect the Amazon. Footage includes indigenous children from Peru. Video by Amazon Aid and ROTU Studios
https://vimeo.com/143037688

Amazon Aid Overview:
Why the Amazon, and why Amazon Aid? Video by Johnny Saint Ours
https://www.youtube.com/watch?v=aj-okRWVjjs&sns=em

Common Core Standards addressed by this lesson

CCSS.ELA-LITERACY.RH.9-10.1
Cite specific textual evidence to support analysis of primary and secondary sources, attending to such features as the date and origin of the information.

CCSS.ELA-LITERACY.RH.9-10.2
Determine the central ideas or information of a primary or secondary source; provide an accurate summary of how key events or ideas develop over the course of the text.

CCSS.ELA-LITERACY.RH.11-12.2
Determine the central ideas or information of a primary or secondary source; provide an accurate summary that makes clear the relationships among the key details and ideas.

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

CCSS.ELA-LITERACY.RH.11-12.9
Integrate information from diverse sources, both primary and secondary, into a coherent understanding of an idea or event, noting discrepancies among sources.

Duration of lesson

Five class periods plus time for research and making the slide presentation

Assessment(s)

Class discussions

Handout 1

Slideshow presentation

Materials needed

Classroom wall map of South America

Access to the Internet for research

Handout 1: Amazon Research

List of research websites from **Teacher Resource 1**

Access to PowerPoint, Prezi, or similar presentation software

Procedure

Part 1: Viewing the Film

1. Point out the location and size of the Amazon on a classroom map, and ask students what they know about it. Put keywords on the board. (Sample answers: jungle, rainforest, river, names of animals the students associate with the Amazon) Explain that they are going to see a movie, *River of Gold*, that will show them what is happening to the Amazon River today.

2. Show the documentary film *River of Gold*, stopping it occasionally to discuss what is happening in the film and to answer student questions. Let students discuss their emotional reactions to the film as well.

3. At the end of the film, ask students what other key words they would now add to the words on the board. (Sample answers: mercury, pollution, health problems, desert, barrenness) Ask students why they might be concerned about the Amazon when it is so far away. (Destruction of the Amazon will increase the presence of carbon dioxide in the air, and thus contribute to global warming everywhere.)

Part 2: Research

1. Divide students into four groups (or eight groups if your class is very large) and assign the research topics: illegal gold mining, deforestation, climate change, and mercury.

2. Distribute **Handout 1: Amazon Research** and ask each student to fill in the topic to be researched. Then have student groups meet to share what they remember about the topic from the film *River of Gold,* recording the information in notes on the first part of the handout.

3. Explain to students the procedure you have chosen for research, your expectations, and the deadline for the research. (See Notes to the Teacher.) Distribute the lists of websites for each group that you have made from **Teacher Resource 1**. Explain to them that as they read, they should record a short version of the title of the website, enough so that you can tell which one it is; don't require them to write the whole URL unless they are adding websites they found independently. Tell them that much information will be repeated in several readings; they need to record only new information as they proceed through the readings.

4. Let them meet briefly to assign websites to each member of the group so that each listed website is read and annotated by at least one student.

5. When sufficient research time has elapsed, assemble the students in their groups and ask them to share information. They should highlight significant points about their topic that they wish to share with the class.

Part 3: An Awareness Campaign

1. Ask students if they know what an awareness campaign is. (An effort to alert the general public about the importance of an issue, with the goal of getting the audience to respond.) Ask students if they can name an awareness campaign that they have seen. Project a few images from sample awareness campaigns and discuss what issue each is addressing and how effective it is. (See Notes to the Teacher for some examples.)
2. Tell students they are going to make a PowerPoint campaign about the Amazon, using what they have learned in class and their research. Give them a choice of backgrounds and allow them to vote on the one they want; do the same with fonts. Then have student groups work together to design the slides they want, combining text and images.
3. Remind them that a PowerPoint slide should have key words and bullet points, but the speaker presenting the slideshow should have more information to add; watching a PowerPoint when the speaker is just reading from it seems like wasted time. Point out the place for notes on a PowerPoint slide and explain that you want students to fill it in with what they think should be said while the audience is viewing the slides.
4. Give them adequate class time to design the slides, locate images, write the text for the slides, and write the additional information in the notes section. Tell them to email you the slide presentation when it is finished. Then have each group select a presenter.
5. Combine the slides into one presentation and have the presenters share the slideshow with the class as a whole.
6. Ask students to write an "exit ticket" reflecting on what they have learned through this lesson. (See https://www.edutopia.org/practice/exit-tickets-checking-understanding for more about exit tickets.)

Part 4: A Fundraising Campaign (Optional)

1. If students express frustration about not being able to do anything about conditions in the Amazon, you might remind them of the story of Malala Yousafzai, who at 13 was advocating for girls' education and who at 16 won the Nobel Peace Prize. You can also bring up the students at Marjory Stoneman Douglas High School, who have made gun control a top issue.
2. Using the information in Notes to the Teacher, tell them that Amazon Aid has a program for reforestation,
3. Guide the group in planning and carrying out a fundraiser.

Extension Activity

Suggest that students post about their actions to save the Amazon on the Amazon Aid Voices portal at http://voices.amazonaid.org/.

Handout 1 ▸ P.1

Amazon Research

Your topic_____

What do you and your research team remember about your topic from the film *River of Gold*?

First reading_____

What new information about your topic did you learn from this reading?

Handout 1 ▸ P.2

Amazon Research

Additional reading _____

What new information about your topic did you learn from this reading?

Additional reading_____

What new information about your topic did you learn from this reading?

Teacher Resource 1 ▸ p. 1

Suggested Websites for Research

Illegal Gold Mining

https://amazonaid.org/the-issues/gold-mining/

https://www.reuters.com/article/us-brazil-environment-mining/brazilians-toil-for-gold-in-illegal-amazon-mines-idUSKCN1BP269

https://www.smithsonianmag.com/travel/the-devastating-costs-of-the-amazon-gold-rush-19365506/

https://www.theguardian.com/environment/2011/sep/26/amazon-gold-rush-prices-soar

https://www.sapiens.org/culture/amazon-gold-mining/

Deforestation

https://amazonaid.org/the-issues/deforestation/

https://www.scientificamerican.com/article/amazon-deforestation-takes-a-turn-for-the-worse

http://www.nature.com/nclimate/journal/v5/n1/full/nclimate2430.html

https://amazonaid.org/global-impact-amazon-deforestation/

http://wwf.panda.org/about_our_earth/deforestation/deforestation_fronts/deforestation_in_the_amazon/

https://www.worldwildlife.org/threats/deforestation

Teacher Resource 1 ▸ p. 2

Suggested Websites for Research

Mercury Poisoning

https://amazonaid.org/the-issues/mercury-poisoning/

https://www.wfdd.org/story/going-gold-sends-mercury-down-river

http://www.nature.com/news/peru-s-gold-rush-prompts-public-health-emergency-1.19999

http://pubs.rsc.org/en/content/articlelanding/2014/em/c4em00567h#%21divAbstract

http://www.miamiherald.com/news/nation-world/world/americas/article196933579.html

Climate Change

https://amazonaid.org/the-issues/climate-change/

http://climate.org/deforestation-and-climate-change/

http://wwf.panda.org/what_we_do/where_we_work/amazon/amazon_threats/climate_change_amazon/

https://www.nationalgeographic.org/news/ask-amazon-expert-why-we-cant-afford-lose-rain-forest/

https://phys.org/news/2015-04-amazon-rainforest-losses-impact-climate.html

Educating for Global Understanding | www.journeysinfilm.org

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https://amazonaid.org/

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