The Science Behind the Shouting:
Teaching controversial topics in life science
7th Grade Science

Unit Summary:

This unit contains introductory lessons to topics which are commonly misunderstood and/or are controversial within the general public. This unit will give students a scientifically based introduction to the topics of evolution, climate change, bioengineering and wildlife management. Lessons will introduce these topics through evidence, demonstrations and simulations foster understanding of each claim.

These topics intersect and are interwoven both within watershed science and everyday life. Lessons use examples from both watersheds and daily life to illustrate concepts, examples and challenges with each topic. Each of these topics affects both watersheds and our daily lives in a myriad of ways.

The goal of these lessons is to provide the basis of a foundation of knowledge to counter and preempt common misconceptions. The topics included in these lessons are often in the news and social media, these sources are often full of misconceptions, propaganda and outright falsehoods. These introductions are meant to provide students with a basic background of each of these issues to preempt these misconceptions from taking root as they become larger media consumers.

Key Words: Natural Selection, Greenhouse Effect, Biotechnology, Wildlife Management

Next Generation Science Standards:

MS-LS4-2.   Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

MS-LS4-4.   Construct an explanation based on evidence that describes how genetic variations of traits in a population increasesome individuals' probability of surviving and reproducing in a specific environment.

MS-LS4-5.   Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms.

MS-LS1-4.   Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively

MS-LS2-4.   Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations

MS-LS1-6.   Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-ESS3-5.   Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century

MS-ESS3-4.   Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-LS3-1.   Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-LS2-5.   Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

Learning Objectives:

Students will be able to:

- Explain how natural selection causes populations to change.
- Describe the role that carbon dioxide plays in the atmosphere and identify sources and trends of carbon dioxide in the atmosphere
- List different ways biotechnology has shaped the modern world
- Describe the importance that laws play in ecological conservation

Table of Lessons:

Lesson Title- Brief Description	Learning Objectives Students will be able to:	NGSS Addressed	Materials
Evolution: Students learn about evolution and selection then explore how populations change through a fun simulation. This lesson would work well within a unit on Genetics and Inheritance or within a unit about ecology and biological organization	• Define: Evolution, natural selection, artificial selection, population • Give an example of population change • Explain that natural selection is a continuous process occurring in all populations all the time • Describe a mechanism through which populations change through natural selection • Compare and contrast natural and artificial selection • Predict changes in a population given a selection pressure • Provide examples of evolution in the modern world	MS-LS4-2. MS-LS4-4. MS-LS1-4. MS-LS4-5.	1 bag Mini Marshmallows ~2 Tbsp. Salt Class Set: Party Cups Plastic Spoon Plastic Fork
Climate Change: Students will observe the effects of the greenhouse effect, using an in class demonstration then apply the greenhouse effect to planet earth. This lesson would work will within a unit containing nutrient and carbon cycles or	• Explain that energy in the form of heat is transferred as infrared radiation • Identify natural sources of carbon dioxide to the atmosphere • Identify man-made sources of carbon dioxide to the atmosphere • Explain the greenhouse effect using a diagram • Describe carbon dioxide's role in the greenhouse effect	MS-LS2-4. MS-LS1-6. MS-ESS3-5. MS-ESS3-4.	2x 2L Bottles Lamp w/ Incandescent Bulb 2x Stoppers (if available 2x Thermometers Alka Seltzer

an earth sciences unit.	• Analyze the trend within a time series graph • Make predictions about global temperatures using their knowledge of the greenhouse effect		
Biotechnology: Students will extract their own DNA then discuss what bioengineers can do with extracted DNA. Students will learn the about the differences between bioengineering and traditional crop breeding programs. This lesson would work well within a Cell Unit.	• Describe the role of DNA, the cell membrane and the nuclear membrane within the cell. • Explain why cellular membranes must be destroyed to extract DNA • List ways the information in DNA is used by scientists • Define gene • Explain the role of genes within an organism • Define GMO • Explain how a GMO is made • Compare and Contrast genetic engineering with traditional breeding programs	MS-LS4-5. MS-LS3-1.	Class Set 3 oz cups 5 oz clear cups 9 oz cups 100ml Isopropanol/ student Salt Dish soap

Wildlife Management:
This lesson is an introduction into wildlife management and endangered species. Students will learn how management is the intersection of science, human wants and needs, and philosophy. Students will then participate in a case study focused on the recovery of bald eagles in the US. This lesson would fit well within an Ecology unit
	1. Identify and explain how human activities like habitat loss, over-hunting and pesticide use led to population declines of bald eagles.
	2. Explain what DDT is, why it was used, and how it accumulates in a food chain and why it banned.
	3. Identify how management activities alleviated the threats of habitat loss, over-hunting and pesticide to bald eagles.
	4. Explain the importance to wildlife conservation of:
	    a. Population monitoring)
	    b. Threat Identification
	    c. Management Action
		MS-LS2-5	Internet Access

Safety Considerations:
Small risk of ingestion of saline solution in the biotechnology lesson.

Evaluation Plan:
- Evolution:
  - Formative Evaluation
    - Students complete a worksheet as they perform the simulation.
  - Summative Evaluation
    - Students apply their knowledge to a real world scenario in a written response.
- Climate Change
  - Formative Evaluation
    - Students answer questions to assess their ability to identify trends in global CO_2 concentration.
  - Summative Evaluation
    - Students apply their knowledge of the greenhouse effect to make predictions about trends in global temperature.
- Biotechnology
  - Formative Evaluation
    - Students provide written response to a real world scenario involving biotechnology and then share their responses in a mini town hall meeting.
    - Students complete a KWL.
- Wildlife Management
  - Formative Evaluation
    - Students write a paragraph compiling their research about the successful recovery of the bald eagle.
    - Students apply this knowledge by working together to devise a very basic management plan for a threatened species of their choosing.

Resources (websites):
Climate Change
> http://www.esrl.noaa.gov/gmd/ccgg/trends/graph.html
> http://www.skepticalscience.com/graphics.php?g=7
Biotechnology
> https://www.youtube.com/watch?v=DaaRrR-ZHP4
Wildlife Management
> http://www.fws.gov/Midwest/eagle/recovery/biologue.html
> http://www.fws.gov/contaminants/Info/DDT.html
> http://www.fws.gov/Midwest/eagle/recovery/biologue.html
> http://www.fws.gov/Midwest/eagle/recovery/qandas.html

Brief description of how this unit relates to your graduate research. (1 page):

My inspiration for this unit stems from my experiences studying coaster brook trout. Coaster brook trout are a Brook Trout that live their lives very differently from normal Brook Trout. Normal Brook Trout spend their entire lives in streams or rivers, whereas coaster brook trout are born in the stream, grow to a certain size and then migrate to Lake Superior for several years before returning to reproduce. Coaster brook trout were once commonly found in tributaries of Lake Superior, but they began disappearing about 100 years ago, and today there is only a single known natural remnant population on the south shore of Lake Superior. When I started my research one of my first tasks was to learn about the management decisions that caused the sharp decline in the coaster populations. Since then I also have been an engaged citizen speaking with my friends and family, writing letters to managers and law makers and attending public input meetings about brook trout regulations. These interactions led me to believe that many people, even people who are enjoy brook trout do not fully understand natural resources management and its impacts. I felt that these misconceptions about what constituted good natural resources management was leading to much of the controversy and acrimony surrounding various management proposals.

I have used my experiences and background knowledge gained through extensive study of biological sciences to craft this unit to try and address and preempt common misunderstandings and misconceptions surrounding many of the most controversial topics within the natural sciences. My goal is to provide students with enough background knowledge to recognize the propaganda and pseudoscience that surround many of these topics.