Project A.W.A.R.E.: Stewards for Clean Water

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Introduction

Water is one of the essential elements of life. We wash with it, we drink it, and every living thing depends on it. As the world population continues to grow, so does our need for clean healthy water. Today, our rivers and bays are in trouble. Evidence of poor water quality has been found across the globe. In many areas, regulations and action plans have been established to monitor and decrease the factors that contribute to this dilemma, but there's still a lot of work to do. Today, it is our responsibility as educators to prepare our students to continue to address this global concern. The future will be in their hands, and they need to begin thinking and making ecologically wise decisions that extend beyond the here and now.

A few sayings come to mind as I think about introducing this topic:

What goes up must come down…This is true, as water evaporates *up,* it eventually comes down in one form or another. But what is the definition of *down*? Is it the puddles at our feet? Or does "down" go even further than what we can see?

Another saying, *Out of sight – Out of mind.* What we don't see concretely in front of us, we tend to not be aware or concerned about. This is understandable, but we must continue to study the sources of our consumable water from locations such as sedimentary rock and aquifers, as well as from sites where there are unintended consequences. It is imperative to teach our students to think, observe, consider, make ecological-based decisions, and design innovations that will protect the delicate balance of our natural resources for future generations to come.

The purpose of this unit, *Project AWARE: Stewards for Clean Water,* is to develop a framework for students to become knowledgeable and aware of the interactions and interdependencies between the *A*ir, *W*ater, *A*nimals, and the natural *R*esources that make-up *E*nvironments across the globe (NGSS: atmosphere, hydrosphere, biosphere, and geosphere). The variety of lessons and experiential investigations in this unit help to develop conceptual understanding and knowledge of just how our living planet Earth works. It provides the opportunity to 'stop, observe, and think' about interdependent relationships in nature; within our immediate environment, as well as those areas without boundaries. By directly involving the students with hands-on activities, they will connect, apply, and extend their experiences and understanding to higher complex sustainability issues in the future, such as climate changes and adaptations that occur globally. It is my hope that students will be inspired, as they gain appreciation, acquire knowledge, develop passion, and act as a respectful and responsible individual, to protect the complex yet delicate balance of the environment for a healthier tomorrow.

First, I believe it is necessary to develop the students' awareness of life in the immediate environment. I recommend lessons to begin in the playground, at a nature center, as well a walking trip to the nearby park or stream. This will give students the opportunity to be outdoors experiencing hands-on activities in a familiar location. It is here they can take a closer look at food chains on land and water, and discover how energy is transferred from one source to another. As time goes on, they will understand that the sun is the original source of energy which creates the light energy that is then absorbed and transformed chemically and utilized by the producers, which is then transferred to the consumers (primary and secondary), and eventually 'cleaned-up' by the scavengers and/or broken down by the decomposers. Wow! What a chain of events!

Second, in order to comprehend this chain of events, the students will investigate the process and importance of photosynthesis. Since producers are providers of energy for the rest of the food chain, it's important for them to realize how photosynthesis is all so fascinating, integral, and biologically complex. To experience this process, the students will grow a variety of grasses and plants, in soil and water, under various conditions to see the effects of different amounts of sunlight. Then, they will investigate how and why plant and animal adaptations are influenced by available light and water.

Third, we will take a closer look at a variety of landscapes where the worlds of land, air, water, and animals interact and are interdependent. The students will create their own model by connecting their previously made aquariums and terrariums into an eco-column. At this time, watersheds, geographical mapping, and outdoor lessons - including stream-watch monitoring will further enhance students' conceptual understanding of the relationships between the water and natural resources, along with the plants and animals that live and thrive there. This will then lead to experimenting with polluting the eco-columns with salt, fertilizer, and acid rain. Recognizing that water and oxygen are integral to the system of the life cycle, students will collect evidence from observation and water quality test results. They will then be able to justify and support their hypothesis, and/or predictions.

At this point, students will have an understanding of the interdependencies of food chains within ecosystems, and how water plays a significant role in its delicate balance. They will be given a two-part project to complete. Part one is a biome research project where students pick a location to investigate how the climate and natural resources influence its food chains/webs; and specifically how its water quality issues are impacting animal life. It could also be posed as, "In this biome, describe the interdependencies within the environment and situations that challenge organisms to the point where natural selection forces them to adapt, move, and/or become endangered?" The second part of the investigation will focus on what *they* can do. Students will design and develop an action plan to promote stewardship for clean water to sustain an environmentally healthy community.

Audience

The intended audience for this unit is my self-contained, fifth grade class at Brandywine Springs School (BSS), Wilmington, Delaware in the Red Clay Consolidated School District (RCCSD). Red Clay includes the northwestern sections of the City of Wilmington and its suburbs, all the way to the Pennsylvania state line, from the Brandywine Creek to the Pike Creek Valley area, and along the Christina River back to the city line. Red Clay is the 2nd largest public school district in the state. The district serves more than 15,000 students in fourteen elementary schools, six middle schools, and five high schools, four special education schools, and three charter schools.

Brandywine Springs School is unique in that it is the only school in RCCSD to include K-8 with a population of approximately 1,100 students. The student body is comprised of 80% Caucasian, 7% Asian, 7% Hispanic/Latino, 4% African American, and 3% Multi-Racial. Our suburban campus is situated next to the Delcastle Recreational Park which has greenspace, woods, baseball fields, playgrounds, and a small stream. These landforms and landscapes will be utilized in lessons for the students to consider their immediate environment and how natural landforms and man-made structures affect the layout of the land and ultimately affect the water flow and quality of its stream.

Background

The Past is Worth Remembering

As I journeyed through writing this unit, I was reminded of many facets of my childhood and teaching that I seemed to put up on the shelf. Slowly, I took them down, one by one, and as I added them to the broader picture, my thoughts and insights began take focus. As I researched my intuitive beliefs, I also found studies that now validate them with evidence. I believe that as you read this portion of the unit that you will understand and agree.

Think back to the days of colonization when people were establishing towns, with farms, shops, homes, wells, etc. There was always the understanding that we were dependent on nature to water our food supply, fill our buckets, and provide the resources that we needed to establish a safe and comfortable home. Children worked alongside their parents as they did their daily chores. Some walked to a local creek to play or fish.

Now fast forward to the Industrial Age. Think about the changes that occurred, such as the cottage industries starting to disappear as factories became more prevalent and time became a valuable commodity. Children were forced to work long hours in dangerous and arduous conditions, until the Child Labor Law passed to protect our youth from these abusive situations. In addition to the children, businesses were increasingly focused on productivity and profit. Our nation quickly adapted to long hours, more conveniences, and economic prosperity. However, at some point along the way, there were dire unintended consequences, such as polluted rivers from factories and territorial rivalry. The world outside the immediate township became more attractive and meaningful to businesses. Children at this point were encouraged to go to school, be an apprentice to learn a trade , which in turn would bring them success and establish them in good social standing.

Fast forward again, now to the 1950-80's where global businesses were on the rise and people were traveling from coast to coast, country to country. Families moved apart for work and women joined the workforce hoping to break the glass ceiling. Children were often expected to go to college after finishing high school. Computer technology took off as data systems took hold. Conveniences and innovations were still rising rapidly. Now children began watching more and more television. Some children had to wait for their parent(s) to come home from work before they could go out to play (latch-key kids), or perhaps they stayed in an after-school program, or went to organized sports.

Given all this data and technological power, education professionals were expected to prove students' gains in reading, writing, and math through computerized testing. Other subjects in the curriculum, such as science, social studies, physical education, and the other unified arts were being discontinued or threatened.

Now let's consider the present, where digital media is available in so many formats and on a wide array of devices. Data is available and can be cut, manipulated, and transformed to suit individual needs. Computer technology is available for every convenience. Where are the kids? They are using it too! This is their virtual environment. The convenience and comfort of experiencing animals and outdoors in a virtual game attracts children at every age. If you start talking games in class, they won't be the games you once played outdoors as a child, like Spot, or Red Rover; they will be games on-line. Granted, these electronic games are quite thrilling and fast moving – but they are not real.

Recognizing a need for children to have experiences outside of their virtual worlds, members of the educational, medical, and psychological community have come together to bring *awareness* to the fact that children need to be outdoors and have environmental experiences. Research, surveys, and studies have ramped up over the past 10 years revealing that it is not only our country, but countries around the world are facing unprecedented public health and conservation problems. The proliferation of studies all boil down to the fact that reconnecting our youth with the outdoors has become critical for their future health as well as for the future health of our landscapes.

The Outdoor Foundation conducted a nationwide survey, from 2006 to 2009, to examine youth participation in outdoor recreation. After surveying 41,000 individuals, nationwide between the ages of 6 and 25, the results showed declining trends of youth participation in the outdoors, especially for girls 6 to 12 years, dropping from 77% in 2006 to 58% in 2008; 46% of youth reported that lack of time and interest kept them from participating in outdoor activities more often, and 79% of Caucasians participated in outdoor recreation compared to 7.4% for African Americans.[1]

Comparing past to present, in 2011, Planet Ark, an Australian not-for-profit environmental organization, commissioned a study to examine childhood interaction with nature today as compared to a generation ago. They also found a decline of outdoor activity; 73% of respondents reported playing outdoors more often than indoors when they were young as compared to only 13% of their children, 64% of respondents reported climbing trees when they were children as compared to less than 20% of their children, and that 1 in 10 children today play outside once a week or less.[2]

As a result of this decrease, we are seeing a rise in mental health, obesity, and attention-deficit disorders.[3] Specialists in mental health, Townsend and Weerasuriya, from Melbourne, Australia, report from numerous patients and studies, specifically, that "… positive effects result from the relationship between nature and mental health, including physical activity, social and environmental connectedness."[4]

Dr. Stephen R. Kellert of Yale University, author of "Building for Life: Designing and Understanding the Human Nature Connection," references his personal research as well as well-documented research of others, and states, "Play in nature, particularly during the critical period of middle childhood, appears to be an especially important time for developing the capacities for creativity, problem-solving, emotional and intellectual development." In addition, he continues to recommend that children need to have purposeful and positive contact with nature in their surrounding environment, classrooms, and play areas.[5] This evidence along with the growing trend of studies, continue to prove that nature is important to overall child development in every way - intellectually, emotionally, socially, spiritually, and physically.

Building on this understanding, let's take it a step further to examine the academic effects. As professional educators, we know how much more students are engaged when they learn by doing hands-on activities and how they "love" science labs. Well, the American Institutes for Research actually conducted a study and concluded similar findings. They conducted a weeklong residential outdoor education program with at-risk youth, of whom 56% reported never having spent time in a natural setting. They then ran a program with two groups with and without an outdoor education program. The results were significant: for those with outdoor recreation a 27% increase was measured in mastery of science concepts, enhanced cooperation and conflict resolution skills, gains in self-esteem, positive environmental behavior, motivation, and problem-solving.[6]

In addition to the at-risk population, there have been studies with numerous schools and districts that include a diversity of populations to see how hands-on learning really does benefit students' learning. Janet E. Dyment presented her findings to the Toronto School Board regarding the impact of green initiatives in schools. She found that there was a definite positive impact of green initiatives on a variety of outcomes, including student learning and academic achievement, student behavior, curriculum delivery, and teaching practices.

Specifically, "90% of the study respondents reported that student enthusiasm and engagement in learning increased on green school grounds as compared to teaching indoors and 70% of respondents reported that their motivation for teaching increased on green-school grounds as compared to teaching indoors." We all know that motivation and engagement drives learning. However, there were a few barriers to following through with these findings, and the bottom line is, funding for adequate logistical support, human resources, professional development, physical design, and maintenance is needed. Thus, school boards, administrations and teachers are looking to high policy makers to appropriate funding for school-wide 'green initiatives.'[7]

During this same period of time, in 2005, co-founder of the Children and Nature Network and author, Richard Louv introduced the term "Nature-Deficit Disorder" with the publication of his best-selling book, "Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder**."**[8] He described that this new, non-medical, term "Nature-Deficit Disorder," is caused by a plethora of contributing factors, such as; the massive amount of electronic media and devices, disappearing open space, increased street traffic, diminished importance of hands-on experiences with the natural world, all contributing to diminished use of senses, attention difficulties, conditions of obesity, declining vision,[9] and higher rates of emotional and psychological illnesses.[10] Most importantly, for the focus of this unit, the Nature Deficit Disorder weakens ecological literacy and stewardship of the natural world. Can this be turned around? Yes, it can.

Launched in 2006, The *No Child Left Inside®* initiative was proposed to provide the necessary opportunity for children to unplug from technology and unearth the vast opportunities that nature has to offer. *No Child Left Inside®* also promised to reintroduce children to the wonders of nature – for their own health and well-being, for the future of environmental conservation, and for the preservation of its beauty and character of every community.[11]

In 2007, the *No Child Left Indoors Bill* was written and presented to Congress by Representative John Sarbanes. The bill stated that children need to get outdoors and <u>that</u> would benefit their health, education, and test scores! Since then, there has been an insurgence of organizations and nature centers filling in the gaps and bringing *awareness* back to the fact that children need to be in nature and experience the human-nature connection.

On July 16, 2013, Senator Jack Reed (RI) and Congressman John Sarbanes (MD) reintroduced the bipartisan *No Child Left Inside (NCLI) Act* into the 113th Congress, with 13 Senate cosponsors and 42 in the House. CBF and partners in the NCLI Coalition worked closely with our legislative sponsors in updating the bill language to reflect the fact that many states have already developed plans for environmental literacy and now need support for effective implementation. The intent of the NCLI Act was to amend the Elementary and Secondary Education Act (ESEA) to provide support for environmental literacy programs in public education.

July 17, 2015: The U.S. Senate's *Every Child Left Inside*, S.1177, passed the Senate, 81-17. This was a significant symbolic victory that made the case for schools across the nation that the Senate voted overwhelmingly, in a bi-partisan vote, to support Environmental Education. There was dedication across the board to get students outside! Rep. John Sarbanes of Maryland managed to stir up nationwide interest in educating our youth about the environment simply by proposing legislation.

On a video broadcast, Rep. John Sarbanes stated "…the compelling evidence from educators is that when you put environmental education into the curriculum, student achievement grows. It brings the students to life! After book learning for 3 weeks and then experiencing it outside – it brings more understanding back into the curriculum and excitement into the classroom."[12]

On December 10, 2015, a House/Senate compromise bill was passed, *Every Student Succeeds Act*, with a vote of 359-64. Without further delay, on December 11. 2015, President Obama signed the *Every Students Succeeds Act* into law.

This federal funding bill for education largely replaces what was previously known as the *No Child Left Behind Act*, but now includes provisions drawn from the *No Child Left Inside Act*. This represents historic wins for environmental education, such as: (1) Environmental science education would be an allowable subject included in the STEM education grants; (2) Environmental literacy programs would be eligible for funding as part of the 21st Century Community Learning Centers sections of the bill.

Today, we, as educators, are the facilitators who can turn the tide of increasing virtual reality immersion by bringing students outdoors to touch, smell, feel, listen, observe, and reflect. Once these experiences happen, they will 'connect back' and initiate natural play. It will also ignite their natural creative powers to problem-solve and innovate.[13] My hope, along with many other educators, is that this resurgence to realign our students with nature will open their eyes, hearts, and minds. Most importantly, they will embrace being *AWARE* and design future innovations to solve global problems that will protect and maintain harmony in our environment.[14] Our students will be true partners with our living planet.

Next Generation Science Standards Approach

Throughout this unit the major sections will be framed in the three-stage (Phenomenon, Reasoning, and Communicating) lessons of the Next Generation Science Standards (NGSS) model. The first stage is "The Phenomenon," the activating stage of the lesson which leads the students to wonder, explore, discover, research, and reason to a given phenomenon. This is truly an inquiry approach to learning. The students will set off to *gather* information that might lead them to answer their first bank of questions, such as: Why something happened? What happened before? What influenced the event? What will happen after? What are the influencing factors? What are some other influential factors? Can a model or experiment be created to explain this phenomenon? Can I use this model to prove or predict another situation? These are just of few of the questions that will lead students to discover and learn in a multitude of areas, make connections with their personal schema, share both findings and excitement with a peer, and more.

The second portion of the lesson is the Reasoning Stage in which students compile their acquired information and make sense of it. They look for repeating patterns and systems in other environments, thereby justifying their reasoning. This helps them to be able to make sense of the world around them and develops their ability to apply and relate to other situations. These connections are also referred to as NGSS Cross-Cutting Concepts.

The third stage is the Communication Stage. At this point, the students communicate their research-based findings in a presentation which provides evidence-based proof to support their research findings, as well as to argue why it is not something else. In addition, the students communicate this information in writing to further develop their understanding and to assess their learning.

Terminology and Questions

Food Chains/Web Terminology

Food Chain - the interconnected relationships between predators and prey in an ecosystem such that they are all dependent upon each other for food or population control.

Energy Source - the source of capacity and potential for power and activity.

Producer - an organism, such as a plant, that is able to produce its own food from inorganic substances.

Primary Consumer - in the food chain, an animal that feeds on plants; an herbivore.

Secondary Consumer - in the food chain, a carnivore that feeds only upon herbivores.

Predator – The relationship between two organisms where the predator consumes the prey as food and often regulates the population levels of the prey. This evolutionary relationship of prey escape adaptations countering predator prey-acquisition adaptations is very important in maintaining the balance within an ecosystem.

Scavenger - an animal or other organism that feeds on dead organic matter.

Decomposer – the plant or organisms in the food chain that breakdown or decay organic matter.

Photosynthesis - the process through which the green plants use light energy to produce simple sugars and oxygen - using carbon dioxide and water as reactants.

Watershed Terminology

Watersheds are dynamic and unique places where there are complex webs of natural resources, animals, and plants. Its environmental harmony has a very delicate balance. Each day we make many decisions that will ultimately impact this balance.

There are many features that are components of a watershed, such as:

Size – some watersheds can be very small, and can also be part of a larger collection of watersheds, or can be a very large system of streams and rivers – such as the Mississippi River Watershed.

Boundary – The boundary of a watershed can be formed or identified by a large ridge, high bank or cliff from which water drains into or away from the watershed.

Terrain – The terrain describes how flat or steep the land is. This is important because the terrain influences how fast or slow the water drains or floods the land. The speed of the drainage in turn impacts how much erosion or sediment build-up there would be.

Soil Type - The soil type determines the rate of absorbency. If the soil is sandy, then the water will absorb water quickly. If the soil contains clay, then this heavier and tighter soil will not absorb effectively, which then leads to runoff or soil erosion.

Buffer Strips - Buffer strips are areas nearest to the stream or lake where the water drains. These areas are important because they filter, utilize nutrients, and tie-up sediment before it reaches the water. This helps improve the quality of the water Wetlands act as a buffer strip to absorb peak flows of water thus reducing flooding. The plant life in wetlands is also rich in nutrients for many fish, animals, and birds to feed and shelter their young.

Land use – How the land is used impacts the natural resources of the watershed. For example, cities, roads, homes, recreation, farming, mining, and factories all alter and modify the terrain, the drainage, and the buffer areas in the watershed.

Trends – Trends are the common behaviors, likes, preferences as result of economic influences, such as home developments in rural areas. This trend sometimes leads to conflicts over pesticide use, livestock contamination, terrain modifications – all affecting the water quality and property values. Recreation is also influenced by trends, such as motor boating, jet-skiing, fishing, and swimming. Although the water quality is important to the residents, their behavior also influences the water quality and wildlife habitat of the watershed area.

Watershed Management – To balance the activity of people, the economy, wildlife, soil quality, and other natural resources, watershed management is necessary to oversee, manage, and protect the delicate balance to sustain a healthy watershed.

Watershed Questions and Answers

What is a watershed?

A watershed is an area of land where all the water, rain or snow, drains from the highest point or seeps to the lowest point to a large body of water. This area could be as small as the size of a footprint, or as large as the streams and rivers that feed into the Mississippi River. A drainage basin is also used interchangeably to describe watersheds. Since we know that all water is pulled by the force of gravity, whether we physically see it or it is absorbed through the ground, it will all eventually flow downstream carrying sediment or other materials to a common area, such as a reservoir, lake, wetlands, stream, river, bay, or groundwater.[15]

Why is this important?

We all live in a watershed. Watersheds are made up of homes, farms, forests, small towns, and cities. They also have no political boundaries; they cross over counties, states, and even countries.[16] Also, not all watersheds are the same. For example, some are separated, or divided by ridges and hills, while others are smaller and are contained within larger watersheds. This important to realize because what happens upstream has an influence on the outcome downstream. Good or bad, activity from natural forces and/or human manipulations will affect the quality of the water at the outflow point.

Most importantly, everyone relies on water and other natural resources to exist. Clean healthy sources of water in watersheds play an integral role in our safe and sustainable food supply. Healthy watersheds are also vital for our environment and economy. People enjoy the natural beauty of the landscape as they hike, picnic, boat, fish, and swim. The wildlife and plants in a watershed depend on health water for food and shelter. Our challenge is to manage water and other natural resources in an effective and efficient manner whereby the environment and economy can sustain a healthy balance.[17]

Today, scientists and political leaders are researching ways to protect this vital resource. In addition, the agriculture and aquaculture industries are working to supply consumers with safe, wholesome, and sustainable products. To ensure this safety and scientifically-monitored water quality, research and development organizations, such as the Delaware Sea Grant, take the lead in proactive initiatives to protect, renew, educate, infuse economic development, as well as address environmental safety issues.[18] In Delaware for example, Delaware Sea Grant partnered with other environmental and seafood businesses throughout the state to lay the foundation and groundwork for the passage of the Delaware House Bill 160 which states:

"Delaware is the only state on the East Coast of the United States that does not have a shellfish aquaculture industry. Shellfish aquaculture can provide significant economic benefits to coastal communities while improving the water quality and enhancing the habitat value of Delaware's most imperiled estuaries, the Inland Bays. This bill is designed to minimize conflicts with existing uses of the Inland Bays. It authorizes the Department of Natural Resources and Environmental Control to direct and control."[19]

How are pollutants transported into the watershed?

Pollutants are transported into the watersheds in a number of ways. Pesticides used on lawns and agricultural farming seep down into the ground water. Waste products from animal farms, pets, and septic systems also breakdown and seep into the ground water. Oil or petroleum products from factories, roads, cars, and boats also drain or runoff into the tributaries. In addition, home and business development create soil run-off as a result of clearing land and altering the root system of its topography. Asphalt and concrete accelerate the rate at which water collects and transports a wide variety of pollutants, carrying them into the storm drains.

When it rains, all these pollutants flow downstream and end up in water sources that we all depend on. When the rain is not absorbed into the ground, also known as "*run-off*," it goes into a drain and then directly into the streams. This polluted water never has the opportunity to be naturally filtered.

All of these sources of pollution affect the quality of the water, water which we consume, use in business and industry to drive our economic growth, and that is taken up through and integrated into the environment's food chains, affecting all forms of wildlife. Since it is very difficult to determine the exact sources of pollution and measure the levels of pollutants as they course through the environment, sources of pollutants are divided into two main categories, point and non-point sources.

The point sources are a single identifiable source where the pollution can be measured and directly altered and monitored. The non-point sources describe pollution coming from unidentifiable sources such as acid rain, fertilizer, and/or pesticides.

What are the contaminants in the water?

There are three main elements that contribute to water pollution in the watersheds; nitrogen, phosphorus, and sediment. While each of these elements by themselves are not harmful and naturally present in the natural environment, they are now appearing in excess, and this is what causes the imbalance and creates a chain reaction of "unintended consequences."

Both nitrogen and phosphorus are necessary for plant growth, but when there is an overabundance, they fuel the growth of too much algae, creating dense algae blooms that block sunlight and reduce dissolved oxygen available to fish, crabs, oysters, and other organisms. Sources of nitrogen and phosphorus include fertilizers (animal manure is used in agricultural farming), household septic systems, and municipal and industrial wastewater, and storm water run-off.

Excess sediment is one of the leading causes of the declining health of watersheds. Too much sediment clouds the water, blocking the sunlight that aquatic plant life and grasses need to grow. Grasses provide food and shelter for juvenile fish, oysters, and fowl. The run-off of sediment comes from eroding land from construction sites, and impervious surfaces such as roadways and parking lots. 15% of urban storm water is responsible for the impaired rivers in the United States.[20]

How is water pollution in a watershed measured?

The U.S. Geological Survey (USGS) has been measuring water conditions for decades. Some measurements, such as temperature, pH, specific conductance, and dissolved oxygen are taken almost every time water is sampled and investigated, no matter where in the U.S. the water is being studied.

The four main tests commonly used to determine water pollution in a watershed give specific information about the water quality; (1) Dissolved Oxygen (DO) shows if there is enough oxygen in the water to sustain life. (2) Temperature of the water, because every organism needs a specific temperature range in which it can exist and survive, (3) Turbidity reflects the clarity of the water, because if there are too many particles in the water, the amount of sunlight that can penetrate the water and be absorbed by the underwater plants will be reduced, and (4) pH of the water measures the acidity or alkalinity of the water which indicates the environment which certain organisms and plant life require to exist and flourish.

What is dissolved oxygen?

Although water molecules contain oxygen, this oxygen (DO) is what is needed by aquatic organisms living in natural waters. A small amount of oxygen, up to about ten molecules of oxygen per million of water, is actually dissolved in water. Oxygen enters a stream mainly through its surface from the atmosphere, and from groundwater discharge. Just as we take oxygen from the air for our metabolic activities, dissolved oxygen is taken from the water by fish and zooplankton.

How does dissolved oxygen affect water quality?

Rapidly moving water, such as in a mountain stream or large river, tends to contain plenty of dissolved oxygen, while stagnant water contains very little. If there is an excess of organic material in lakes and rivers, then the water becomes oxygen-deficient, or eutrophic. This can be seen often in smaller bodies of water during the summertime where there is a large amount of rotting, organic material. Bacteria in water consume oxygen as organic matter decays, leaving little oxygen for fish and other living organisms.

How does water temperature affect water quality?

Water temperature is not only important to swimmers and fisherman, but also to industries and even fish and algae. A lot of water is used for cooling purposes in power plants that generate electricity. They need cool water to start with, and they generally release warmer water back to the environment. The temperature of the released water can affect downstream habitats. Temperature also can affect the ability of water to hold oxygen as well as the ability of organisms to resist certain pollutants.

How do dissolved oxygen, temperature, and aquatic life relate together?

The concentration of dissolved oxygen in surface water is controlled by temperature and has both a seasonal and a daily cycle. Cold water can hold more dissolved oxygen than warm water. In winter and early spring, when the water temperature is low, the dissolved oxygen concentration is high. In summer and fall, when the water temperature is high, the dissolved-oxygen concentration is low.

Dissolved oxygen in surface water is used by all forms of aquatic life; therefore, this constituent typically is measured to assess the "health" of lakes and streams. Oxygen enters a stream from the atmosphere and from ground-water discharge. The contribution of oxygen from ground-water discharge is significant, however, only in areas where ground water is a large component of streamflow, such as in areas of glacial deposits. Photosynthesis is the primary process affecting the dissolved-oxygen/temperature relation; water clarity and strength and duration of sunlight, in turn, affect the rate of photosynthesis. Dissolved-oxygen concentrations fluctuate with water temperature seasonally as well as diurnally (daily).

What is pH?

pH measures the acidic/basic levels of the water. The range goes from 0 - 14, with 7 being neutral. pH of less than 7 indicates acidity, whereas a pH of greater than 7 indicates a base or an alkaline condition. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. pH is reported in "logarithmic units," like the Richter scale, which measures earthquakes. Each number represents a 10-fold change in the acidic/basic levels of the water. For example, water with a pH of 5 is ten times more acidic than water having a pH of six.

Pollution can change the water's pH, which in turn can harm animals and plants living in the water. For instance, water coming out of an abandoned coal mine can have a pH of 2, which is very acidic and would definitely affect any fish crazy enough to try to live in it! By using the logarithm scale, this mine-drainage water would be 100,000 times more acidic than neutral water -- so stay out of abandoned mines. The water in the Cheat River in West Virginia looks pristine and clear. However, this is because nothing can exist due to the excessive acidity caused by the mine run-off.

What is turbidity?

Turbidity is the amount of particulate matter that is suspended in water. Turbidity measures the scattering effect that suspended solids have on light: the higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid include: clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, plankton, microscopic organisms.

Turbidity makes the water cloudy or opaque. Turbidity is measured by shining a light through the water and is reported in cephalometric turbidity units (NTU). During periods of low flow (base flow), many rivers are a clear green color, and turbidities are low, usually less than 10 NTU. During a rainstorm, particles from the surrounding land are washed into the river making the water a muddy brown color, indicating water that has higher turbidity values. Also, during high flows, water velocities are faster and water volumes are higher, which can more easily stir up and suspend material from the stream bed, causing higher turbidities.

Unit Design

This unit, *Project AWARE* will be a problem-based unit. This means that the over-arching question of how can we restore, utilize, and protect our natural resources for our future, will thread throughout the content areas. It will also align with Common Core State Standards as well as the Next Generation Science Standards:

- CCSS in reading and numerous strategies, such as close reading are applied to both fiction and non-fiction environmentally-based texts and research.

- The CCSS of writing are addressed by the students as they cite evidence from multiple sources as they write in formats such as; narrative, informational, as well as persuasive/argumentative points of view.

- Challenging math concepts and Math Practices are reinforced when the students collect/measure/calculate data from the stream, and draw meaning from metric measurements.

- Historical timelines of United States politics, economics, and population growth are considered as they discuss the various reasons for the pollution and health hazards that have occurred over time.

- GIS and Google Earth applications will also be threaded throughout the unit to enhance content and digital/technology learning.

- The Ecosystem science kit will be the modified core curriculum that will guide students, in small groups, through discovery-based, hands-on labs to explore what makes up a food chain and the intricacies of an ecosystem.

Lesson Performance Expectations and Objectives

With the completion of Project AWARE, students will be able to:

- Construct a model explaining how energy and matter transfers through a food chain and food web. (Lesson 1)

- Construct an explanation, supported by evidence, to communicate that organisms in an ecosystem are interdependent. (Lesson 1)

- Construct a model explaining how energy from the sun is converted by the plant through the process of photosynthesis. (Lesson 2)

- Construct an explanation, with supporting evidence, to communicate how producers play a significant role in the food chain. (Lesson 2)

- Use models to describe how energy in animals' food (used for body repair, growth and to maintain warmth) was once energy from the sun. (Lesson 2)

- Explain the make-up of a watershed and how water flows within it. (Lesson 3)

- Diagram the structure and topography of a watershed. (Lesson 3)

- Describe the relationship between water and various soils and surfaces. (Lesson 3)

- Describe the relationships between ecosystems and its watershed. (Lesson 3)

- Explain the effects of high and low levels of oxygen, nitrogen, and phosphates in the water. (Lesson 3)

- Explain and support with evidence forecasted potential ecological effects of poor and healthy water in our streams, bays, and oceans. (Lesson 3)

- Design a brochure for the community to advocate for the need for clean water and what action(s) each individual can take to contribute a healthier environment.

Classroom Activities

The format of the lessons will include:

Teacher-centered activities will include instruction of specific content, teacher modeling of specific practical skills for students, research guidance and troubleshooting, and modeling how to conduct a presentation of research.

Student-centered activities will provide Team/Peer-led discussions, hands-on and inquiry based lab and stream-watch activities, practical skills practice and evaluation, formative and summative assessment of content knowledge, research opportunities and collaborative group work on research portion of curriculum

Vocational Tasks

Sampling Protocols
- Stream-Watch Sampling and Analysis
- In-Class Aquarium Sampling and Analysis

Habitat Evaluation
- Collect qualitative and quantitative information through observation and technology apps (GIS/Google Earth)
- Analyze maps and aerial photographs
- Analyze data and prepare a technical report

Strategies

This unit will be taught in a constructivist manner. Students will be given concrete information, yet expected to transfer to independent and conclusive thinking. Students will be working in groups by interest, mixed abilities, and teaching teams throughout the unit. Videos, video clips and web based instruction will also be an integral portion of the classes. Google Earth and GIS systems will be introduced and applied to demonstrate watersheds with no political boundaries and the impact of our human footprint.

Students will be placed into research groups that will research biomes and present their physical characteristics and current environmental issues to the class. The students will also write a report based on research from journal articles, websites, and other specialized resources.

Cross-curriculum content applications will support project-based learning. This will increase engagement as they will have multiple opportunities to demonstrate application of their knowledge and understanding throughout the unit. Current events will also encourage interest, application of subject matter, and facilitate the power of questioning, point of view, and further research.

Field work and labs will also be the norm in the unit. Students will be gathering stream-watch data on a regular basis throughout the unit from the stream in the abutting county park. This information will be uploaded to the Delaware Nature Center Stream-Watch Program. Class Skyping will occur with a fifth and seventh grade class in other Delaware schools outside the Red Clay District to compare data and analysis.

Students will make aquariums and terrariums to see interdependencies within the ecosystems. They will then add pollutants to purposely disturb the balance of the ecosystem and record the results. In groups, the students will also investigate pollutants such as road salt, acid rain, and fertilizer. They will create a presentation and model of one of these pollutants as it affects the water supply. This presentation will address the questions of what the pollutant is, what harm is causes, why it matters, and what should or can be done to rectify the situation.

Unit: Ecosystems - Project A.W.A.R.E.

Lesson 1: Mysterious Animal Remains

To establish the foundation of this unit, I recommend that you think about your population of students and how their time inside and outside of school is structured. Allow them time to slowly become *aware* of their surroundings, both man-made and natural. Explore the man-made innovations or modifications that surround them. Perhaps take a trip to your playground and take a good close look at what type of structures are there. The man-made structures are there because..? The natural features are there because….? What are their purposes? How do we enjoy them? How do we protect or take care of them? Then, to follow-up, experience the same location with the senses. What do you see, hear, feel, and smell? Allow them to share with a partner and then with the class.

Lead the class discussion from individual interdependent observations such as a squirrel and acorns, butterflies and flowers, birds and worms to think about food chains. You may want to pick an animal, such as a bird, and start asking questions about where they live, what they eat, etc. Videos clips at this point are up to your discretion. This will create a good background for the students to have a sense of the roles of plants and animals (producers, consumers, decomposers) before beginning the first NGSS lesson.

Phase 1:

<u>Phenomenon:</u> After establishing a basic foundation of the food chain concept, begin the first lesson with a phenomenon. I used a picture of deer bones and teeth in the grass, and asked the questions whose bones are these, how did they get there, and where does this animal fit in the food chain? The students have to draw clues from the photo and start

researching and reading articles about the food chain and teeth formations of prey versus predator, or carnivore, herbivore, and omnivores (See Figure 1).

Figure 1

Gathering (Obtaining Information)

Ask questions from clues in the picture. Encourage them to make connections with the clues that will lead to determining; what animal the bones belong to, infer what happened previously, and predict what will happen next. This questioning strategy (cause and effect) guides students to define the situation in the photo. (Teacher hint: The students should discuss in small groups and then share out in class discussion.)

Plan a strategy to explain and describe the organisms/plants/animals that belong to the food chain. Their investigations should draw evidence from content articles, non-fiction books, picture cards, and websites. (Teacher hint: This investigative work should work in pairs. Students take turns reading and taking notes. Resources can be set-up as centers. Differentiated materials can be made available at this time as well.)

Phase 2: Reasoning

Model: Create a model of the food chain to explain what happened to the deer.

Students analyze and create a model, or diagram, according to the sequence of the food chain. It should also include labels, habitat details, and a caption describing each phase of the food chain. (Teacher hint: Students can use index cards so they can arrange and rearrange them in the proper sequence. Then repeat the sequence on a strip of paper folded in fourths – Producer/Primary Consumer/Secondary Consumer/Decomposer. Students label, add detail, and color to each frame of the food chain model).

Ask Questions: Students investigate to answer the following questions as a result of their research:

- Why is an energy source important in a food chain?
- Explain the role of the producers in a food chain?
- What is the difference between primary and secondary consumers?
- Explain the role of a decomposer? How do they influence the nutrients in the soil?

Construct Explanation: use evidence to explain your reasoning.

Students will turn and talk with a partner to describe the food chain and why each phase of the food chain is important and interdependent with specific evidence from the investigation. Writing their explanations as well as their partners is very helpful for students to enhance their conceptual understanding of this food chain/web process.

Develop Arguments from Evidence: Students defend their position by recognizing what is not in the food chain. This evidence proves their line of thinking.

Phase 3: Communicating

Students use the model to write an essay explaining where the deer fits in a food chain and why - by addressing the following questions:

- What role does this animal play in the food chain?
- What interdependencies are evident in this food chain?
- What observations from the environment/habitat did you notice that helped you with your deductive and inductive reasoning?
- Complete a model with evidence to justify reasoning and eliminate other possibilities.
- Students present their findings and why it is conclusive citing evidence.

In the last activity, the students will recreate a food chain of their choice. My students used a sentence strip and divided it up into segments for the phases of the food chain. The students were required to name and label each animal, describe their function in a food chain, and include environmental/habitat details in the drawings. This was a good summative assessment as well as a well-deserved, fun activity for the students. They also display nicely on a bulletin board.

Lesson 2: Fantastic Photosynthesis! Gigantic and green vs withered and white

This lesson takes a closer look at producers and the process of photosynthesis. The three elements required for this photosynthesis are light, water, and air. All three components are key. The realization of the significance of each of these components drives home the understanding of our interdependency with plant life, water, and air. The process of photosynthesis is a crucial process for our living planet Earth to sustain life, and we too need to protect its balance and live responsibly.

Phase 1:

Phenomenon - Picture of two terrariums. As seen in the terrarium on the left, the grasses have grown very tall, and the right terrarium's grasses are short and dyeing. What happened? (See Figure 2)

Figure 2

Students ask and record questions of wonder that might help to explain what happened.

<u>Gathering (Obtaining Information)</u>

Students ask questions from clues in the picture or of actual terrariums that have grown in the classroom. They will try to make connections with the clues that would lead to determining what where the environmental growing conditions for both examples, infer what happened previously, and predict what will happen next. This questioning strategy (cause and effect) guides students to closely observe the plant photo or samples. (Teacher hint: The students should discuss in small groups and then share out in class discussion.)

<u>Plan a strategy</u> to explain and describe the process of photosynthesis.

Their investigations should draw evidence from content-specific articles, non-fiction books, picture cards, and websites. (Teacher hint: This investigative work should be done in pairs. Students take turns reading and taking notes. Resources can be set-up as centers. Differentiated materials can be made available at this time as well.)

Phase 2: Reasoning

<u>Model</u>: Create a model of the process of photosynthesis.

Students analyze and incorporate the information into a model, or diagram according to the process of photosynthesis. It should also include arrows, labels, details, and captions describing the process. (Teacher hint: Students can cut out items on the photosynthesis sheet and glue them onto a graphic illustration to demonstrate that they know where they belong and then describe the significance of each item).

<u>Ask Questions</u>: Students will answer the following questions as a result of their research:

- Why is an energy source important in a food chain?
- How does a producer transform energy from the sun?
- What other factors influence growth and why?
- Explain the role of the producers in a food chain?

<u>Construct Explanation:</u> use evidence to explain your reasoning. Students will turn and talk with a partner to describe the process of photosynthesis and why each phase of this

process is important. Students are required to cite specific evidence from their investigation and articles.

Develop Arguments from Evidence – Students defend their position by recognizing what is and is not part of the photosynthesis process. This is evidence that proves their line of thinking. Other information that affects photosynthesis and growth can be included at the end.

Phase 3: Communicating

Students use the model to write an explanation of the process of photosynthesis:

- How it plays a significant role in the growth of producers,
- Dependencies within the food chain,
- Include observations from the environment/habitat,
- Complete a model with evidence to justify reasoning and eliminate other possibilities.
- Students present their findings and why it is conclusive citing evidence.

Essay Prompt: If you could pick any place to live and be self-sustaining, where would it be and why? This question requires the student to use reasoning skills to identify the geographical location, the climate, the vegetation, the animal life, the food webs that would offer food sources, etc.

Lesson 3: What is a watershed?

This lesson focuses on watersheds and all the activity that occurs within it, both above ground as well as below. It is the portion of the unit where the students can now start to understand all of the potential ramifications and/or consequences of the interactions of air, water, soil, nutrients, and pollution. Endangered animals and adaptations are also part of the conversation since disruption of the food web and habitat loss plays such a key role in many of the situations for these animals. Students also begin to realize the importance of the need to find solutions to the problems that we face today and prevention measure to take to minimize problems of tomorrow.

Phase 1:

Phenomenon: Present two eco-columns. The aquarium of the eco-column on the left is healthy with clean water, minnows, snails, elodea, and algae. The other one on the right is polluted with discolored, cloudy water, rot on the bottom, and bacteria growing on the sides (See Figure 3).

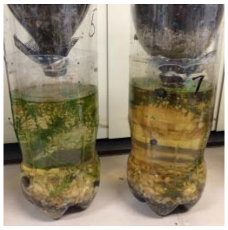

Figure 3

Ask students to observe the two environments. Students ask and record questions of wonder to explain what happened.

<u>Gathering (Obtaining information)</u>

First, students *ask questions* from clues in the pictures or of actual terrariums that have grown, and have been intentionally polluted, in the classroom. They will make connections with these clues to determine what the natural and unnatural environmental growing conditions were for both examples, infer what happened previously, and predict what will happen in the future. This questioning strategy (cause and effect) guides students to closely observe the photos or samples. (*Teacher hint: The students should discuss in small groups and then share out in class discussion).*

Second, students *plan a strategy* to explain and describe the flow of water in a watershed. Their investigations should draw evidence from content articles, non-fiction books, picture cards, and websites. (Teacher hint: This investigative work should work in pairs. Students take turns reading and taking notes. Resources can be set-up as centers. Differentiated materials should be made available at this time as well.)

Phase 2: Reasoning

Model: Create a model of a watershed.

Students analyze and incorporate the information into a model**,** or diagram according to the flow of the watershed and the natural and unnatural environmental factors that influence the water flow as well as the water quality. It should also include arrows, labels, details, and a caption describing the process. (Teacher hint: Students can cut out items on the labels from a modeling illustration and glue them onto a graphic illustration to demonstrate that they know where they belong and then describe the significance of each item).

<u>Ask Questions</u>: Students will answer the following questions as a result of their research:

- What affects the flow of water?
- How do landforms affect water flow in a watershed?
- What other factors influence how the water is absorbed?
- How does the water flow affect the ecosystems in the basin?

- How does the climate affect watersheds?
- How do rural communities affect their watershed differently than densely populated areas?
- What are the major pollutants that effect water quality?
- What are the adverse effects of poor water quality on the surrounding ecosystems?
- How do plant and animal life adapt to their living environments?
- How can we protect Earth's natural resources?

Construct Explanation: use evidence to explain your reasoning. Students will turn and talk with a partner to describe what a watershed is; using a topography map –describe ecosystems within them, population effects, pollution problems, and ramifications on the water quality. Students are required to give specific evidence gathered from their investigations, and cite the sources, i.e. websites, articles, books, etc.

Develop Arguments from Evidence: Students defend their position by recognizing what is and is not part of a specific watershed. They will also include any other information that pertains to the topic. This evidence proves their line of thinking**.**

Phase 3: Communicating

Students complete a model or poster as part of their description of what a watershed is comprised of, the possible pollutants that affect the quality of the water, how the quality of the water affects plant and animal life, and how people can help to protect Earth's natural resource and gift of life – water.

Projects:

Biome Report: Students form biome interest groups. In these groups, students research, write a brief report, and create a diorama to explain how its geosphere, biosphere, hydrosphere, and/or atmosphere interact in this location. Water quality in that specific area is highlighted; i.e. how it is affecting the environment, as well as what is being done if action is required.

Brochure: Students research, compile, and design a brochure or presentation with a model that will address how the community can help to protect the health and welfare of our local watershed.

Adapt-a-Fish Project: For this project students consider a specific type of fish and the changes that are occurring in its environment. Students will predict how the fish might adapt to these changes. Will it eat different foods? If so, will its body adapt in a physical, biological, or metamorphic way?

Performance Expectations (Standard) from State Standards or NGSS

Lesson 1: Mysterious Animal Remains
5-LS2-1 Ecosystems: Interactions, Energy, and Dynamic
Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. Emphasis is on the idea that matter that is not food (air, water, decomposed material in soil) is changed by plants into matter that is food, such as ecosystems.

Lesson 2: Fantastic Photosynthesis
5-LS1-1 From Molecules to Organisms: Structures and Processes
Support an argument that plants get the materials they need for growth chiefly from air and water.

5-PS3-1 Energy
Use models to describe that energy in animals' food was once energy from the sun.

Lesson 3: What is a Watershed?
5-ESS2.1 - Earth Systems
Develop a model using an example to describe ways in which the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS2.2 – Earth Systems
Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

5-ESS3.1 - Earth and Human Activity
Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Lesson Performance Expectations:
- Construct a model explaining how water moves through a watershed.
- Construct an explanation, supported by evidence, to communicate the elements that affect water as it flows throughout the watershed to its ultimate destination.
- Construct a model to describe ways in which the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- Construct an explanation, supported by evidence, to explain how the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
- Research and develop a communication tool to educate communities on how to protect the Earth's resources.
- Use representations to explain phenomena.
- Share science concepts and understandings with others using representations.
- Share science findings in writing and graphic presentations to others.
- Make careful observations that generate evidence.
- Discuss and compare observations with others observing the same samples.

- Explain science observations using evidence.
- Share explanations with others.

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Web Link Resources

General

https://www.childrenandnature.org/learn/research-resources/summaries/
https://www.youtube.com/watch?v=QnMoGP576PA
http://www.cbf.org/ncli/landing
https://www.childrenandnature.org/learn/research-resources/http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0059519
http://water.usgs.gov/edu/characteristics.html#pH
http://www.outdoorfoundation.org/research.youth.html
http://treeday.planetark.org/about/health-benefits.cfm
http://www.cnaturenet.org/02_rsrch_studies/PDFs/Burdette_LookingBeyond.pdf
http://fishwatch.dnr.sc.gov/FishFusion/FishFusionWindow.html

For the Classroom Lessons

What is a Watershed?

http://www.ctic.purdue.edu/Know%20Your%20Watershed/What%20is%20a%20Watershed?/
http://www.ctic.purdue.edu/media/files/Getting%20To%20Know%20Your%20Local%20Watershed.pdf
http://delawarewatersheds.org/
http://www.deldot.gov/stormwater/watershed.shtml
https://www.youtube.com/results?search_query=watershed collection of watershed videos
https://www.youtube.com/watch?v=1cEPz5qNLyg model of pollution into the watershed
https://www.youtube.com/watch?v=j50E_TyDdio

New Castle County

DelDOT
Delaware's Tributary Action Teams
EPA Clean Water Act
EPA NPDES
EPA Water
Delaware's Sediment and Storm Water Program
Delaware Greenways
Delaware Nature Society
Delaware Solid Waste Authority
Partnership for the Delaware Estuary
The Center for Inland Bays
Delaware Sediment and Storm-water Regulations

Why is important?

http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/indiana/journeywithnature/watersheds-101.xml
http://www.watershedcheckup.ca/benefits-of-healthy-watersheds

Where are they in our immediate area?

http://delawarewatersheds.org/
http://www.deldot.gov/stormwater/watershed.shtml
http://www.dnrec.state.de.us/DNREC2000/Admin/WholeBasin/wbm/intro.pdf

What is presently being done to address their current condition?

http://www.nature.org/photos-and-video/video/urban-strategieshcst
http://www.nature.org/ourinitiatives/habitats/riverslakes/multimedia/how-we-protect-watersheds-interactive.xml
http://www.dnrec.delaware.gov/swc/wa/Pages/WatershedAssessment.aspx

What action can we take to help solve the problem of their current condition?

http://www.audubon.org/conservation/project/central-flyway-migration-corridor
http://www.delawarenaturesociety.org/DNS/Get_Involved/We_need_your_help/Stream_Watch/DNS/Conservation/Water_Conservation/Stream_Watch.aspx?hkey=0aaed8f5-4cfb-4c2b-b276-279c8ea08197

http://www.delawarenaturesociety.org/DNS/Conservation/Water_Conservation/Stream_Watch.aspx?New_ContentCollectionOrganizerCommon=2&WebsiteKey=87358163-decf-466e-b151-851764b92bce#New_ContentCollectionOrganizerCommon

What can you do in your community to help?

http://delnature.org/watersheds/tm_sites.html

Why would this be helpful?

http://voices.nationalgeographic.com/2015/06/07/5-things-you-can-do-to-save-the-ocean-world-ocean-day/
http://www.delawareestuary.org/
https://s3.amazonaws.com/delawareestuary/pdf/OysterBrochure.pdf
http://www.nationalgeographic.com/lovetheocean/

Endnotes

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[1] (Foundation 2010)

[2] (Ark 2011)

[3] (Burdette 2005)

[4] (Townsend 2010)

[5] (Kellert 2005)

[6] (Research 2005)

[7] (Dyment 2005)

[8] (Louv 2015)

[9] (Palmer 2013)

[10] (Chin 2015)

[11] (Coalition 2015)

[12] (Sarbanes 2012)

[13] (Louv 2015) (Coalition 2015)

[14] (Stevensonn 2013)

[15] (USGS 2015)

[16] (Center 2015) (Delaware 2014)

[17] (Partnership 2014)

[18] (Delaware 2014)

[19] (160 n.d.)

[20] (C. B. Partnership 2011)

Curriculum Unit Title: Project A.W.A.R.E.: Stewards for Clean Water

Author: Sonia D. Saunders

KEY LEARNING, ENDURING UNDERSTANDING, ETC.

All living organisms are interdependent to sustain life within its food web.
Matter that is not food is changed by plants into matter that is food.
Clean healthy water is essential to all life on our planet. Each person is capable of creating solutions to keep our planet Earth healthy.

ESSENTIAL QUESTION(S) for the UNIT

Why are plants, animals, and microbes interdependent?
How do Ecosystems work? Why is the balance of ecosystems dependent upon the quality of its water, air, and light?
Why does it matter what happens to the water? What can individuals do to help keep the earth's water healthy? How are the atmosphere, hydrosphere, geosphere, and biosphere interconnected?

CONCEPT A	CONCEPT B	CONCEPT C
Food to any animal can be traced back to plants. Organisms are related and interdependent in food webs.	In plants, photosynthesis occurs when light energy combines with water and air to create energy. This energy is transferred to its primary consumers.	Watersheds are large areas of land within which its water drains to one central area. Healthy watersheds are influenced by its atmosphere, hydrosphere, biosphere, and geosphere.
ESSENTIAL QUESTIONS A	**ESSENTIAL QUESTIONS B**	**ESSENTIAL QUESTIONS C**
How do food chains and webs work? Why is it important to understand food chains/webs?	How does Photosynthesis work and why is it so important?	Why does the health of the water play such a significant role in the health of an ecosystem? What can people do to help keep the earth's water healthy?
VOCABULARY A	**VOCABULARY A**	**VOCABULARY A**
Food chain/web, ecosystem, decomposer, composer, secondary composer, predator, scavenger, balance, endangered, extinct	Photosynthesis, chlorophyll, chloroplasts, oxygen, carbon dioxide, sugar, glucose, energy, matter, soil, nutrients, stem, leaf, stomata, energy, transfer, transform	Landforms, gravity, head/mouth of a river, streams, tributaries, current, watershed, groundwater, fertilizer, silt, acid rain, PH, nitrates, erosion, shore, bay, coast, plan, survey, data, evidence, atmosphere, hydrosphere, geosphere, biosphere.

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES

See resource list at the end of the unit