Clean Creek Campus

Instructor's Manual

Updated January 2018

City of Austin WATERSHED PROTECTION

KEEP AUSTIN BEAUTIFUL

clean creek campus

Watershed Model

Background Information

What is a Watershed?

Everyone lives in a watershed, an area of land that drains water into a particular creek, river, or lake. These bodies of water interconnect to form a larger watershed that drains to the ocean. The watershed of the Colorado River begins in San Saba near the Texas/New Mexico border and includes all the land that drains into the Colorado River as it travels down to Matagorda Bay and the Gulf of Mexico. Austin has 66 creek watersheds which drain to Edwards Aquifer/Barton Springs, Lake Travis, Lake Austin, or Ladybird Lake. All these lakes are part of the Colorado River, Austin's source of drinking water. Water in Austin also drains into caves and sinkholes in the recharge zone and flows into the Edwards Aquifer. Groundwater resurfaces at hundreds of springs around Austin and contributes water to our creeks.

Topographic maps are used to define a watershed boundary, along with a walk of the area to observe terrain, changes in water flow due to erosion, man-made changes in the landscape, and unusual storm sewer flow routes. Watershed maps are available from the City of Austin.

Scientists divide the land into watersheds to understand how water flows on land and where it will eventually end up. Gravity pulls water downhill; therefore a watersheds boundary is defined by high points such as peaks and ridges. After it rains, water can either soak in to the ground where there is **pervious cover** (garden, forest and wetland) or run off **impervious cover** (parking lots, roads, buildings) into a storm drain or creek.

Rainwater travels over all the surfaces in a watershed, so water quality is greatly affected by the condition of the land and what is occurring on it. Pollutants on land can make their way to nearby water systems through the storm drain system, which drains directly to creeks to prevent flooding. This type of pollution is called non-point source because after a rainstorm we cannot tell which part of the watershed the pollution came from. An example of point source pollution would be effluents from a factory draining directly into a river.

It is useful for elementary students to define the boundary of the smaller watershed where they live and go to school. The condition of the body of water in their watershed will be an indicator of the environmental problems facing their neighborhood. Students can relate to the effect of their own behavior and choices and focus efforts on cleaning up pollution sources close to home.

Examples of neighborhood pollution can include:

- **Oil** leak from a car.
- Spraying **pesticides, fertilizers**, and **weed killers** in yard.
- Leaving **litter** on the ground after a party or overflowing trashcans.
- **Detergents** from washing the car or dumping out dirty mop water.
- **Pet waste** from not picking up after pets.
- **Sediment** from construction sites.
- **Paint** and other household chemicals.

Watershed Model

Background Information

VOCABULARY

Watershed	An area of land that drains water into a particular creek, river, or lake. Water flows downhill, so hills, ridges, and other high points define the boundary of a watershed.
Runoff	Rainwater that does not soak into the ground, but flows rapidly over the land surface into a body of water or into a storm drain which leads to a body of water (creek, river, or lake).
Surface Water	Water that is on the earth's surface, such as creeks, rivers and lakes.
Ground Water	Water storage found underground where water flows through soil or fractured rock supplying water to springs and water wells.
Impervious Cover	Land surface that does not allow water to permeate through.
Pervious Cover	Land surface that allows water to permeate through.
Storm drain	A pipe for carrying off rainfall drained from paved surfaces, roofs, etc.
Pollution	The introduction by man into the environment of contaminants that cause harm or discomfort to humans or other living organisms, or damage the environment.
Erosion	Wearing away and removal of rocks, sediment, minerals, and soils by agents such as ice, wind, water.
Tributary	A stream or creek that flows into a larger body of water such as a river.

Watershed Model

Core Activity

Activity Summary:
Investigate the connections between the ground under your feet and the water we drink through this hands-on watershed model exploration. Students will predict how water flows on a watershed, identify major pollution types, and observe how this pollution travels to our water systems.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Enviroscape Watershed Model
- Watering Can or Spray Bottle
- Tub of model figurines
- Tub of pollutions
- Set of Watershed Scenario cards
- Watershed maps

TIME REQUIRED: 45 minutes

OBJECTIVES:
Students will be able to:
- Define Watershed
- Predict and observe the flow of water on a watershed
- Define and identify common pollutants
- Identify ways to mitigate pollutions in our water systems.

TEKS CORE CONCEPTS:
- 3rd grade: 1B; 2A, D; 8C-D; 9A-B; 11A-B
- 4th grade: 1B; 2A, D; 5A-B; 10A
- 5th grade: 1B; 2A, D; 5A-B; 6B; 11A; 12A

Introduction (*10 minutes*)

1. Today we are going to talk about "sheds". What comes to mind when I say that word? *With that definition do you think water could shed off of land?*
2. When we talk about watersheds all we are talking about is land. EVERYTIME you are on land, you are in a watershed. So when I say "watershed" you say "land" (call and response).
3. Let's build our city of Austin to see how we as people impact our environment

Watershed model (*25 minutes*)

1. Set up the model without figurines. Fill watering cans with water and place container below model so water drains into container.
2. Have students gather in a circle around the model.
3. Pass out watershed maps and ask students to locate their school.
4. Build an Austin community on the watershed model using figurines.
   - Get students to help put figurines on model. Give clear instructions to keep this part manageable.
   - Landmarks to consider: Dog park, Zilker park, construction site, neighborhood, fast food restaurant, shopping center/mall, small farm, factory with point source pollution, school.
5. Pass out situation cards to students to read aloud to group. After each card, have a student recap the story and identify the watershed pollutions in each.
   - Another way to run the lesson is to make all of the situation cards into stories rather than having students read each card. For example, choose a student and 'speed up' their life so they turn 16 and have a car so that the car situation seems more realistic.
6. Before allowing a student to add the pollution to the model, discuss where the particular pollution would be found within the community. Then give the student clear directions of how to pour pollutants on the model.
7. Once all the stories have been read and pollutions placed, predict water flow after a rainstorm.
8. Have students create "thunder" by tapping on their legs while pouring water over the model to simulate a rain storm.
9. Discuss how storm drains and pervious/impervious cover affect water and pollution flow into our creeks, lakes, and river.
10. Display storm drain pictures to illustrate how water flows t hrough storm drains into our creeks. This water is NOT filtered or treated in any way in its journey to the creek.

Watershed Model

Closing (*5 minutes*)

1. Ask the students to share their findings; anything unusual, surprising, or interesting they learned or observed.
2. Change in Austin starts with individuals and families. Have students brainstorm on how they might change family habits to keep their house and yard pollution free. Below is a chart that highlights Austin's pollution problems and solutions:

Pollution Problem	Potential Solutions
Weed killers-harm amphibians and wildlife in creeks	Hand pull weeds, properly dispose of chemical containers.
Pesticides – Toxins to kill insects can also harm humans and wildlife.	Treat fire ant mounds with hot water. Use organic pest control methods such as predatory insects, diatomaceous earth, or a garlic pepper spray on plants.
Dog Waste/sewage-may carry harmful pathogens that cause diseases in humans and other mammals.	Pick up after your pet.
Fertilizer – nutrient pollution causing algae blooms and low dissolved oxygen	Plant native to reduce the amount of water and fertilizer needed. Use compost or compost tea as a natural fertilizer. Don't overfertilize.
Construction Debris – Dirt and sediment washes into creeks clogging fish gills, killing aquatic plants and insects	Place sediment barriers or tarps over sand and silt piles. Plant rain gardens near street to catch organic pollution and extra sediment.
Car chemicals – car soap, car oil, paint	Wash cars on lawn to filter soap. Use kitty litter to absorb oil then throw away. Recycle oil at a service station.
Toxic household cleaners	Pour dirty water down the sink to be treated at a wastewater facility. Choose non-toxic cleaners like vinegar or borax. Take paint and toxic chemical to the hazardous materials recycling center.
Litter	Keep a trash bag in your car, secure garbage bin with lid and bunji cord, clean up yard with guests after a party. Recycle, reuse, reduce.

3rd – Adult grades

- Find your Watershed – have students identify which Creek watershed the live in, go to school in, etc. http://www.austintexas.gov/GIS/FindYourWatershed/
- Complete a Service Activity
  - Storm Drain Marking Service, Litter Cleanup, Seed marbles
- Use the tile and sponge to demonstrate the difference between pervious and impervious cover.
- Watershed PowerPoint
  - Introduction is coupled with the PowerPoint, which is used as a tool to discuss concepts at a more advanced level if desired. Visual aids are included to highlight concepts.
  - Information and hints are in the notes at the bottom of each slide.

Litter Lifeline

Background Information

ADDITIONAL INFORMATION

Great Pacific Garbage Patch Info:

- http://www.projectkaisei.org
- www.greatgarbagepatch.org
- http://science.howstuffworks.com/environmental/earth/oceanography/great-pacific-garbage-patch.htm

Resources:

- www.wasteinplace.org

Litter Decomposition Rates in a Marine Environment:

- http://des.nh.gov/organization/divisions/water/wmb/coastal/trash/documents/marine_debris.pdf

What is Litter?

You've spotted it before - paper blowing in the wind, plastic bags tangled in tree branches, cans swirling out of truck beds these visible forms of pollution also known as litter find their way onto our streets and into our neighborhoods. Every person can think of an example of littering but may have a different definition of what it is. Generally speaking, **litter** is any waste or refuse that has unintentionally (blown out of a truck) or intentionally (illegal dumping) made its way into the environment such as streets, parks, or waterways. The difference between litter and **trash** is location.

Why Do People Litter?

With all those reasons not to litter, it's hard to imagine why people continue to do so. A great discussion can take place when debating whether people are **deliberately** hurting the environment or just **lazy, forgetful**, or simply **don't know** any different. More than likely it's the latter where someone leaves a drink can at a sports game or tosses a wrapper out of the car window thinking someone will pick it up. These examples illustrate why it's up to the community to educate others and take active steps with friends and family to solve Austin's litter problem.

A peek at the most common littered items tells us a little bit about our consumer lives. Check out some of the most commonly littered items:

Cups & Cans—24%
Food Wrappers—20%
Tobacco—19%
Printed Goods—6%
Household/ Personal Items—19%
Construction Materials—8%
Other—4%

Litter Lifeline

Background Information

Litter Impacts
People often don't realize that litter is not only aesthetically displeasing but it also poses a threat to wildlife, natural ecosystems, human health and safety, and communities. Below is a chart highlighting just a few of the ways that litters affects wildlife, water quality, and people:

Wildlife	Water Quality	Human and Financial
1. Plastic ring entanglement around beaks, necks, and flippers 2. Ingestion, choking, or starvation can occur due to waste mimicking food – sea birds will often feed plastic on shore to offspring. 3. Harmful chemicals leaching into soils and food sources	1. Liquid litter such as oil and paint entering aquifer recharge zones, creeks, and storm drains 2. As plastic degrades, chemicals such as BPA leach into water 3. Waste can affect microscopic organisms and bacteria levels 4. Damage to fishing and recreational boats 5. Litter blocks storm drains which can cause flooding	1. A piece of litter costs 10 cents every time a city worker picks it up 2. Physical harm to swimmers or hikers from broken glass or buried metal 3. Decrease in tourism and use of recreation areas 4. Even though we have our water cleaned, more research is needed on body harm from chemicals

City staff and volunteers clean up more than 6,200 tons of trash and debris from roadways and another 250 tons that wash to our waterways each year. That's the equivalent weight of more than 4,300 cars! At KABs annual Clean Sweep, thousands of volunteers collected over 45,000 cigarette butts from all over Travis County in just two hours.

There are two major examples of deliberate littering that can be discussed further with students. One of them is the **Great Pacific Garbage Patch** that exists where the ocean currents meet in the Pacific Ocean. Before we had regulated landfill systems for our waste, much of the trash including debris from fishing industries was dumped into the ocean. Litter also makes its way to the ocean from creeks and rivers. The garbage has collected to form a thick patch that floats just under the water due to the density of plastic which makes up the majority of the waste. Scientists estimate that throughout the Pacific Ocean there is up to six times more plastic than plankton biomass (dry weight). The other major source of litter is illegal dumping. To avoid landfill fees large items such as old couches, appliances, or industrial waste are often illegally dumped in lakes, rivers, and wooded areas. In Austin, call 311 to report illegal dumping.

What Happens to Litter?
When litter is not removed from our streets, waterways and neighborhoods it lingers! View Keep Austin Beautiful's Litter Lifeline to see just how long litter lingers before **breaking down**.

Litter Lifeline

Background Information

Vocabulary

Litter	Trash, wastepaper, or garbage lying scattered about in the environment or water.
Decomposition	Decomposition is the natural process by which large organic materials and molecules are broken down into simpler ones. The ultimate products of decomposition are simple molecules, such as carbon dioxide and water.
Break Down	Litter gradually breaks into smaller and smaller pieces; pieces are small enough that we cannot tell what they used to be part of
Trash	Something that is discarded as worthless or useless; rubbish; garbage.
Contaminant	A minor and unwanted constituent in another material, metal, chemical or mixture, often at the trace level.
Pollution	The introduction by man into the environment of contaminants that cause harm or discomfort to humans or other living organisms, or damage the environment.

Litter Lifeline

Core Activity

Activity Summary:
Investigate the connections between the ground under your feet and the water we drink through this hands-on watershed model exploration. Students will predict how water flows on a watershed, identify major pollution types, and observe how this pollution travels to our water systems.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Teaching prompts
  - What is litter?
  - Why do people litter?
  - Commonly littered items
- 6 bags of litter including:
  - Litter timeline banner
  - Styrofoam
  - Plastic bottle
  - Glass
  - Chip bag
  - Tin can
  - Aluminum can
  - Piece of plastic food
  - Paper cup
  - Newspaper
  - Cigarette filters

TIME REQUIRED: 45 minutes

OBJECTIVES:
Students will be able to:
- Comprehend the impact of litter on the environment
- Determine how long it takes for litter to break down
- Discuss commonly littered items, where they end up and how they get there
- Understand how people adapt and modify their environment
- Identify ways to mitigate litter in our water systems

TEKS CORE CONCEPTS:
- 3rd grade: 1B; 2A, D; 8C-D;

Introduction (*15 minutes*)

1. Review watersheds. *When I say watershed you say land!* (Call and response) *What else do you remember from our lesson last time?*
2. Do you remember all of the litter that we placed on the model? Today we're going to see how long litter takes to *break down* in Austin, TX.
3. Before we do that what is litter? How is it different than trash? *Show teaching prompt and discuss location of litter vs. trash.*
4. Why do people litter? *Show teaching prompt with photos and discuss accidental littering, cultural littering and other reasons*
5. What commonly littered items do we see? *Show teaching prompt with pie chart and discuss examples of each.*
6. Break students into table groups (about 4-6 students/group) and you are going to have a chance to decide how long you think each piece of litter takes to break down on the side of the road in Austin.
7. Discuss what you mean by "break down" (break into pieces so tiny you wouldn't be able to tell what it once was) compared to decompose (turn into soil).
   a. For younger students review the process of decomposition (the natural process of a dead animal or plant tissue rotting or being broken down by insects, bacteria and fungi) and decay (to decrease gradually in size, quantity, activity and force)
   b. For younger students discuss what a timeline is
8. Ask students if they think the timeline would change if they were to do it for conditions in Alaska. Discuss how weather affects the breakdown rate.
9. Drop a piece of litter to the ground: what happens to the item? Could it blow away? Get trapped under something? Will it still be there in 2 weeks, 2 months, 2 years?
10. Give very clear instructions before handing out bags:
    a. *There is glass in the bag; Be careful when emptying bags, take items out one by one to not break the glass jar.*
    b. *Ask students not to rip up the litter—it travels to many other schools to use!*
    c. *Pretend the plastic food is real food: how long would it take for real food to break down on a street in Austin?*
    d. *Plastic bags are common litter items; include the large plastic bag in your timeline*
    e. *There should be at least one piece of litter in each time interval, sometimes two pieces*
    f. *Do not take small items out of ziplock bags (i.e. cigarette butts)*
    g. *Please do not crush aluminum cans—it makes them have sharp edges that can cut students*
    h. *As soon as you receive your bag with your group you may begin*

Litter Lifeline

Core Activity

Litter Lifeline (*25 minutes*)

1. Have students lay out their litter timeline and hypothesize answers to the litter timeline
2. Note: the litter lifeline is designed to focus on commonly littered items and also on how long it takes those items to break down and on the impact the items have on the environment and the community during that time
3. Once complete, choose one student from each group to be the team captain.
   - The team captain will be the only student allowed to touch the litter from this point on
     - This strategy is not necessary but helps set expectations and keeps students focused
4. Go through each category starting from 2-6 months and put each in perspective
5. Have the team captain shuffle items to the correct order as you go through the timeline

Litter Lifeline

Timeline	Item	Notes	Historical Perspectives
2-6 months	Newspaper, notebook paper	• Newspaper may have been recycled several times before, speeding up decomposition	You were enjoying a hot Texas summer! Maybe you were back to school shopping or on vacation?
6 months – 1 year	Food scraps, paper cup, cardboard, paperboard	• Food can take longer due to preservatives • A paper cup can take longer due to a waxy coat	You were taking the TAKS test (or starting school).
10 – 12 years	Cigarette filter	• Filter is made of cellulose acetate, a type of plastic	You might have been born around this year! What's your earliest memory? The last original Peanuts comic strip was printed.
20 – 30 years	Chewing gum, plastic bag	• A plastic bag will thin and turn brittle, resembling tissue paper	
40 – 50 years	All plastics (except Styrofoam)	• Each of the seven kinds of plastic decomposes at a different speed and releases different chemical • Plastic bags decompose much faster in water	A gallon of gas costs $0.25! Neil Armstrong lands on the moon.
80-100 years	Tin can, battery	Batteries are especially dangerous as litter due to heavy metals such as cadmium inside	The longest film to date, 12 minutes, is produced. Plastic were invented and put into production in 1905.
200-500 years	Aluminum can, chip bag, juice box, diaper	• Aluminum is produced from Bauxite, an extremely durable mineral good for withstanding high pressure (carbonation from soda) • The juice box is lined with aluminum	America is referred to as the "New World" while being explored by Spain and Portugal. The *Mona Lisa* is painted in 1503.
Never	Styrofoam tray, glass	• The oils used to make Styrofoam never decompose	

* Items in blue can be recycled.

Litter Lifeline

Closing (*5 minutes*)

1. Have students carefully pack all of the litter items into their bag, roll up their timeline and hand it to you
2. Discussion points after activity:
    - Litter that takes hundreds of years to "break down" is essentially unable to be broken down efficiently by natural processes. Even when placed in a landfill, these items can linger much longer than the litter lifeline numbers which is why it's so important to remember to **Reduce, Reuse, and Recycle.**
    - Extension: Go through each item on the timeline and discuss whether it can be recycled or reused.
    - The samples of litter are convenient and cheap for us to use in everyday life, but are costly when it comes to the environment.
        i. Note how some cities in California have banned Styrofoam use by food vendors despite its convenience and affordability, because of the health and environmental concerns of Styrofoam use.
        ii. Styrofoam is mostly made of air which means it takes a lot to produce a little bit of recycled plastic so there are just a handful of places to recycle it around the country.
        iii. If Styrofoam is used, however, it can be recycled (if cleaned and dry) at Cycled Plastics (183 and Burnet).
        iv. Litter takes a long time to breakdown which allows for it too move around the environment and cause damage
        v. Much of the litter seen on streets or neighborhoods will end up moving downhill to creeks and rivers after a heavy rain.
    - Cleaning up litter is important, but so is recycling the waste if possible. Austin recycled over 30% of its waste - a great start.
    - Discuss importance of individual action and review ways to prevent litter and improve the environment.
        i. What are the most commonly littered items around your school or home? Where are they concentrated?
        ii. If you walk past litter will you pick it up or think someone else will get it? Imagine if everyone picked up a piece of litter every day. Would that have an impact?
        iii. What are ways to encourage people from littering? Cleanup, fines, etc.
        iv. Report illegal dumping by calling 311.
        v. Report citizens throwing out cigarette butts from cars by writing down their license plate number and reporting it at http://dontmesswithtexas.org/.
    - Despite these large scale problems, keeping Austin litter free is easy and can start with just a few steps.
        i. Consider bringing reusable items, instead of disposable to waterway picnics
        ii. Dispose of waste properly in trash cans or recycling bins
        iii. Cover truck beds so that items don't fly out
        iv. Host a campus or neighborhood cleanup with friends or family
        v. Remember to spread the word about the real effects of litter in Austin.
3. By taking these simple actions you are performing a community service to clean up the environment and decrease solid waste.
4. Next time we will be going on a fieldtrip together to clean up litter, go on a scavenger hunt, plant native wildflowers and explore our water quality.

Next Steps: See Supplemental Activities

Litter Lifeline

Supplemental Activities

Elementary School

- Read The Wartzville Wizard (Elementary School). The story is true of our society - ask students why they think people litter. Brainstorm what the most common litter items are.
- *Waste in Place*
    - Check out KAB Litter Activity Kit through at www.keepaustinbeautiful.org/activitykits. The kits includes *Waste in Place* lesson plans:
        i. Litter Literature – an activity to complement The Wartzville Wizard
        ii. Good Habits – a fun activity to highlights various Litterbugs
- Debate: What is litter?
    - Ask students if they have ever thrown out an apple core or banana peel from their car window onto the side of a busy highway.
    - Discuss as a class or divide into teams to debate why some people might consider this to be litter or not.
    - Apple cores are organic and break down into soil over time, but this doesn't happen right away. Animals could be attracted to the food and we don't want them to see a busy road as a place to find food. Remember our definition of litter – trash in the wrong spot!
- Archeology Dig
    - Distribute a piece of litter/trash to each group.
    - Students tap into their creative writing skills to write a backstory for their piece of litter – where it came from, who used it, how it could have ended up as litter in a creek, road, or neighborhood.
- Start a litter awareness campaign
    - Students make posters to teach others about litter.
    - Students teach other students about what they have learned about litter.
    - After their service project, students study what litter their found on campus and what might be needed (reusable materials, reminders, new trash cans).

ADDITIONAL LESSONS

- Waste in Place
- The Wartzville Wizard
- Debate: What is Litter?
- Archeological Dig
- Clean and Upcycle Littered Items

SERVICE ACTIVITIES

- Litter Cleanup
- Litter Awareness Campaign
- Micro-trash Cleanup

Middle School Modification

Litter PowerPoint (www.keepaustinbeautiful.org/campusresources)

- Introduction is coupled with the PowerPoint, which is used as a tool to discuss concepts at a more advanced level if desired. Visual aids are included to highlight concepts.
- Information and hints are in the notes at the bottom of each slide.

Service Project Stations

1. Litter Cleanup
2. Native vs. Invasive Game
3. Scavenger Hunt
4. Seed Balls
5. Water Chemistry
6. Macroinvertebrates

Litter Cleanup Station

Core Activity

Activity Summary:
Students will have a chance to see firsthand how litter impacts the community and the environment. Students will work in teams and learn how to safely pick up litter in order to clean their watershed, improve local water quality and have a positive influence on their community.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Trash & Recycling Bags
- Disposable Gloves (1 per student)
- Litter Grabbers (~10-12)
- Hand Sanitizer
- First Aid Kit
- Poison Ivy Block
- Sharps Container
- Clipboards (10-12)
- Litter Tally Sheet
- Wax Pencils

TIME REQUIRED: 30-45 min

OBJECTIVES:
Students will be able to:
- Conduct a litter cleanup
- Practice field safety procedures while picking up litter
- Understand how litter ends up in creeks
- Work in teams to clean a local green space
- Understand how their service positively impacts the community

TEKS CORE CONCEPTS:
- 3rd grade: 3.1A&B, 3.2B&C
- 4th grade: 4.1A&B, 4.2B&C
- 5th grade: 5.1A&B, 5.2B&C
- 6th grade: 6.1A&B, 6.2B&C

Introduction *(5 minutes)*

1. Review flow paths in a watershed. *How does litter get to the creek? Why are we participating in a litter cleanup? What type of impact does litter have on our environment?*

Litter Cleanup *(20-30 minutes)*

Team Activity:

1. Divide students into groups of 3

2. Assign the following jobs in each group: recorder, trash bag holder, and litter grabber (collector). Explain that the recorder will mark the type of litter on the tally sheet. The collector will tell the team what type of litter they are collecting before discarding in trash bag.

3. Encourage students to take turns with each job

Cleanup Safety and How to Procedures:
Discuss expectations:

- Students must remain within view of the teacher/ boundaries that you set (use whistle, call response, or megaphone as system for making students stop, look and listen)

Discuss hazards-do NOT pick up any sharp items including needles and broken glass, do not step in the water, be aware of poison ivy (show photo or point out example) and snakes. If students see a snake remind them not to run and scream but to stand back at least 5 feet (demonstrate approximate distance- 5ft)
Demonstrate proper use of grabbers and explain grabbers should stay below the waist and should not be used like a weapon. Consequence is return grabber to leader.

3. Hand out gloves to each student. Each group of 3 students will receive a trash bag, a litter grabber, clip board, wax pencil and litter tally sheet

4. Leader will carry a bag for recyclables. Students should find the leader when they pick up an item that is able to be recycled

Closing (*5 minutes*)
Ask students to total up tally marks on the litter tally sheet.
1. What was the most common piece of litter?
2. What was the most interesting piece of litter found?
3. What materials could be recycled?
4. How do you think our cleanup efforts helped the creek?

Litter Cleanup Station

Core Activity

Native vs. Invasive Game

Background Information

Invasive species are a large problem in many ecosystems. Invasive species are defined as any organism that is brought into an ecosystem that is not their own. Once an invasive species arrives in an ecosystem, the organism attempts to fill niches that are already occupied by native species.

The problem is that there is a limited amount of resources in any given environment. These resources are necessary for survival and include water, space and food (nutrients). Once an invasive species is introduced into an area, the native species populations will have to compete for resources. If an invasive species adapts well in its new environment, usually because of lack of predation, the native species will decline because of the new competition.

Invasive species are introduced to new environments both intentionally and unintentionally. Some are accidently released or transported, while others are introduced for a specific purpose and have unintended consequences.

Invasive species affects the whole environmental system because they outcompete native plants for environmental resources and can reduce the amount of nutritious food available to our native wildlife.

Vocabulary

Native Species	An organism that is "from" a particular area and is therefore adapted to that specific environment. (ex. Blue Bonnet, Mesquite, Pecan, Texas Lantana)
Invasive Species	An organism that is not from the particular area where it is found and becomes a pest in that area. (ex. Kudzu, Chinese Tallow, Japanese Privet)
Resource	A source of supply or support; Examples include water, space, food (nutrients), shelter
Biodiversity	Variety of life in a certain area
Wildlife	Animals living in nature

Native vs. Invasive Game

Core Activity

Activity Summary:
Investigate the connections between invasive and native plants by exploring what resources plants need to survive and how they compete for those resources. Understand how the loss of native plant species relates to a loss of biodiversity and less food choices for native wildlife.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Rope for Outer Circle Boundary
- Blue Circular Patches (~25)
- Plastic Food (10-12 pieces)
- Rulers (10-12)
- Optional-Large Paper Pad and Marker to Create Graph

TIME REQUIRED: 20-35 minutes

OBJECTIVES:
Students will be able to:
- Define Native & Invasive
- Define biodiversity and understand how it is diminished when invasive spp. are present
- Understand why invasive spp. can be harmful to an ecosystem
- Understand how/why invasive spp. compete with native spp.
- Make a connection between the loss of native species and lack of food choices for wildlife
- Name environmental resources plants need to survive

TEKS CORE CONCEPTS:
3rd grade: 1A-B; 2A, D; 3A; 9A-C; 10A-C
4th grade: 1A; 2A, D; 9A-B; 10A-C
5th grade: 1A; 2A, D; 9A-C; 10A
6th grade: 1A; 2A; 12E
7th grade: 1A; 2A, B; 10B
8th grade: 1A; 2A, B; 11B, C

Activity *(15-30 minutes)*

1. Let students stretch out large circular rope and lay it on flat ground outside. Have students spread out and sit on the outer edge of the rope circle.
2. Group students in pairs and have them stand with their partner on the edge of the rope circle. Together each pair will create one NATIVE plant (choose a plant that they are planting that day or that they already know).
   - One student will act as the roots of the native plant and one student will act as the "shoots" of the native plant. (Allow the pair to switch roles in different rounds)
3. Ask what kinds of resources plants need to survive and have props ready.
   - Water= blue patches
   - Food (nutrients)= plastic food
   - Space = rulers
4. As soon as the students have hypothesized what kinds of resources plants need to survive, toss the blue water patches, rulers, and plastic food into the middle of the rope circle.
   - Count the number of pairs in the group to determine how many resources to include (ie. 10 pairs of students= 10 rulers, 10 pieces of food, 20 blue patches in the first round)
5. Have the student that is acting as the "shoots" take three big steps back from the edge of the circle and "plant" their feet. They should still be standing, but will not be moving for the remainder of the round.
6. Explain that the partner who is acting as the "roots" will have to gather resources from the center of the circle.
   - ****Emphasize that the "native plant roots" may ONLY GATHER ONE RESOURCE EACH TIME THEY COME IN THE CIRCLE. That means the roots need to run in and out of the circle at least 4 different times****
   - They will then run the resource to their partner, the "shoots", who is standing outside of the circle.
   - Once they have **handed** their resource to their partner they may return to get another resource, on and on until they have gathered all the resources they need to survive.
7. Explain that the "roots" will have to compete with all of the other plant's roots in order to obtain all of the resources they and their partner need to survive. Clarify expectations: no pushing, no grabbing, no diving.
8. IN ORDER TO SURVIVE the roots need to get four things in total:
   a. One ruler (space)
   b. Two blue patches (water)
   c. One plastic food piece (nutrients)

9. Explain that the "roots" are not allowed to throw any resources to their "shoots". They must instead run out of the rope circle and hand it to their partner before returning for another resource.
10. Time the first round so that about ½ to ¾ of the pairs survive as native plants.
11. After the first round, the pairs that were not able to gather the four resources they needed to survive will turn into invasive plants (i.e. Bermuda grass/ bamboo/ kudzu)
12. The roots of the invasive plants are allowed to gather TWO RESOURCES EACH TIME THEY COME IN THE CIRCLE, which will give them advantage over the native plant roots who are still only allowed to gather one resource at a time.
    - Any native plants that survive will remain a native plant
    - Native plants that die turn into invasive plants
    - Invasive plants that survive stay invasive
    - Invasive plants that die remain invasive
13. After the invasive plants have been introduced, and depending on time, you can put the students in different scenarios:
    - DROUGHT: Take away about ¼ of the blue water patches (increase competition)
    - BUILD A WALMART: Take away a few rulers (space)
14. Play for a few rounds and ask if the game became more difficult for the native plants
    - Discuss why the natives could only gather one resource while the invasives could gather two and what advantage the invasives had.
        i. For example, invasive species usually do not have limitations like natives do. They may not have any predators in the new environment or may spread very quickly and can therefore outcompete native plants.
15. In the end most pairs of students should represent the invasive species. Discuss what happened to the native plants (they died because they were outcompeted by the invasives)

Closing (*5 minutes*)

1. Review what happened in the game (all the student pairs started as native species and most became invasive species)
2. Ask if this scenario is something that happens in Texas (discuss examples like Bermuda grass, nandina, kudzu, bamboo)
3. Explain that when an invasive takes over there is less biodiversity in the environment. That means that wildlife will not have many food choices (or perhaps no food choices at all)
    a. Help the students visualize lack of food choices by relating it to a grocery store with only one type of apple in the entire store. That apple is their only food option for every meal, day in and day out.
    b. Ask if they would be happy or healthy eating one kind of apple for the rest of their lives and explain that wildlife are faced with this reality when invasive plant species take over in their habitat.

Extensions

1. Graph the Game Rounds – using a simple plot graph, plot the number of native plants to number of invasives per round. This works best with large groups and at least 5 rounds.
2. Native vs. Invasive plant walk around school campus - show examples of native and invasive plant species right on their school campus
3. Invasive Species Removal Game - show the students just show difficult it is to remove invasive species from an area without harming the native species. http://greenteacher.com/around-the-world-the-invasive-species-challenge/

Scavenger Hunt Station

Core Activity

Activity Summary:
Students will explore a local green space in their community and become more aware of flora and fauna in the local environment.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Scavenger hunt bags
- Scavenger Hunt Sheet (10-12)
- Plant/animal field guide
- Wax Pencils
- Trash & Recycling Bags
- First Aid Kit

TIME REQUIRED: 30-45 min

OBJECTIVES:
Students will be able to:
- Conduct a scavenger hunt to explore a local green space
- Practice field safety procedures while exploring
- Find local flora and fauna
- Work in teams to observe and become more aware of surroundings
- Understand how everything impacts our watershed

Introduction *(5 minutes)*

1. Introduce students to the space where they will be conducting the scavenger hunt.
2. Let students know that they will be looking for smaller details in their environment that they may not usually see

Scavenger Hunt *(20-30 minutes)*

Team Activity:
1. Divide students into groups of 2-3
2. Give each group one scavenger hunt bag (includes scavenger hunt sheet, wax pencil, field guide & cloth for erasing).
3. Review and/or explain terms ie. watershed, limestone, erosion
4. Discuss rules: stay with group, both students must see item to check it off, do not collect anything, walk, observe using senses.
5. Take students on guided hike so you can point out specific items on the list.
6. When you reach an open space, encourage students to explore within boundaries and find items on their sheet
- Refer to lesson at http://austintexas.gov/sites/default/files/files/Watershed/field guides/All-Parks-Scavenger-Hunt-lesson-rev2015.pdf

Cleanup Safety and How to Procedures:
1. Students must remain within view of the teacher/ boundaries that you set
2. **Students are NOT to pick up any litter during this station because they do not have appropriate safety equipment
3. Show students where the bathroom is located (if there is one available) and give instructions on when/ during which station they will be able use it
4. Remind students to be aware of poison ivy (show photo or point out example) and snakes. *If students see a snake remind them not to run and scream but to stand back at least 5 feet (demonstrate approximate distance- 5ft)*
5. Give students a time limit and allow them to explore. *Make the hunt into a competition if the group needs more encouragement*
6. Remind students to find you with any questions on their scavenger hunt sheet

Closing *(5 minutes)*
1. Take this time to point out interesting plants/ animals/ features in the environment.
2. What was the most interesting thing you saw during the scavenger hunt? How can we protect our watershed so that all of the amazing things we found can live on?

Seed Balls Station

Background Information

Biodiversity

A diversity of plants helps our ecosystem and wildlife by: 1) providing nectar, seeds, and fruit; 2) increasing insect numbers to provide the greatest variety of food sources for wildlife; and 3) providing year-round color. For example, an oak tree can provide food, shelter, and places to raise baby birds. Planting and promoting native plants and wildflowers adds beauty to our city, conserves water, reduces erosion, attracts wildlife, and protects our water quality since there is less need for chemical sprays.

Native plants are species that were present in the local landscape at the time of European settlement. Over thousands of years, these plants have adapted to the climate, soil and water conditions of the area. Since they are well adapted to their region, native plants tend to need less water and fertilizers, and therefore less maintenance, than do other plants. Local wildlife have similarly adapted to their surroundings, so native plants best meet their food and cover needs, and provide good places for them to raise their young. In general, native plants will not out-compete other plants in a natural area or more broadly in an ecosystem but instead generally enhance biological diversity.

ADDITIONAL INFORMATION

- Armadillo Clay: Red Clay Seller 3307 E 4th St., Austin 78702
- Invasive Plant Field Guides: www.texasinvasives.org
  www.austintexas.gov/sites/default/files/files/Watershed/plants/invasiveplants.pdf
- LBJ Wildflower Center www.wildflower.org
- Grow Green Native & Adapted Landscape Plants Guide: www.growgreen.org

Although native plants bring lots of value to our natural landscapes they are being taken over by invasive plants. Invasive species of plants are those that have been transplanted into a new environment, either intentionally or unintentionally. Invasive species are one of the top threats to biodiversity (variety of life).

Common Invasive Plants in Austin: Waxleaf Ligustrum, Water Hyacinth, Chinaberry, *Hydrilla*, Privet, Giant Cane, Nandina, Johnson Grass, Mediterranean Mustard, and Japanese honeysuckle.

Non-Native, Exotic, Invasive Plants
Germinate quicker and grow faster - dominate space
No natural predators - seeds not eaten so continue to grow.
Monopolize nutrients or water
Harm animal habitats
Increase erosion because do not stabilize soil with roots
Produce more seeds - create monocultures

Transport of Invasive Plants

What are some ways that humans spread weed seeds?

- Vehicles: Cars, trucks, trains, motorcycles
- Recreation: Hiking, Camping, Bicycling, Clothing/Gear
- Animals: Horses, Dogs, Livestock
- Collecting: Picking weed flowers or buying and planting weedy plants, like French Broom, in our yards

Seed Balls Station

Background Information

What can we do to promote native plants and/or minimize non-natives?

- to stop the spread of invasive weeds
  - Prevent
  - Pull
  - Plant Natives
  - Educate Others
- to remove and control the spread of invasive weeds
  - Manual – pulling, digging and cutting
  - Mechanical – mowing and plowing
  - Biological – grazing, insects, and plant diseases
  - Cultural – prevention and education
  - Chemical – herbicide as a last resort

Seed Balls

Seed balls are a method for distributing seeds by encasing them in a mixture of clay and soil humus. Some native North American tribes used forms of seed balls. More recently natural farmer Masanobu Fukuoka has applied them, as have others inspired by his work. He has worked for over fifty years, throughout the world, implementing this beautifully simple method of rehabilitating damaged lands. This cheap, low maintenance method of re-vegetation and agriculture requires no water, other than natural rainfall.

Seed balls are simply scattered directly onto ground, and not planted. They could be useful for seeding dry, thin and compacted soils and for reclaiming derelict ground. This method takes a fraction of the time or cost of other methods to cover large areas and is also very applicable in small areas.

The clay and humus ball prevents the seeds from the drying out in the sun, getting eaten by predators like mice and birds, or from blowing away. When sufficient rain has permeated the clay and the seeds inside sprout they are protected within the ball that contains nutrients and beneficial soil microbes. Seed balls are particularly useful in dry and arid areas where rainfall is highly unpredictable.




Watch:
https://www.youtube.com/watch?v=MTVAjHffMDE&index=7&list=PLDKZTUlNzz3oErOxiufs8duewSNmQFQ_j

Vocabulary

Habitat	The place where an organism lives.
Native Plant	A plant endemic (indigenous) or naturalized to a given area.
Biodiversity	The number and variety of organisms found within a specified geographic region.
Invasive Plant	A plant that displaces natives and cause economic or environmental harm to human health.
Compost	Mixture of decomposing living materials, which include plants, animals, fungi, and microorganism, that is used as fertilizer.
Clay	Very small particles of soil that stick together holding in water and nutrients but has poor soil drainage.

Seed Balls Station

Core Activity

Activity Summary:
Investigate the importance of planting native plants especially in grow zones and areas along creeks. Students will learn what resources a seed needs to germinate and be able to identify human roles in preventing invasive species and promoting native plants. Finally students will understand how native plants reduce erosion and runoff.
****Replace "Seed Balls" with "Seed Marbles" if students are distracted by the name****

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Root model
- Laminated photos
- 1 gallon bag terracotta clay
- 1 quart bag of native wildflower seeds
- 1 gallon bag of organic soil/compost
- A water bottle full of water
- 6 lunch trays

TIME REQUIRED: 15-25 minutes

OBJECTIVES:
Students will be able to:
- Define the importance of native plants
- Describe environmental problems associated with invasive species
- Identify human roles in preventing invasive species and promoting natives
- Identify common native plants in central TX
- Create a seed marble to promote native species planting
- Understand what a seed needs to germinate

TEKS CORE CONCEPTS:
Kindergarten: 1A, 2A, 2E, 4B, 5A
1st Grade: 1.1A, 1.2A, 1.2E, 1.7A
2nd Grade: 2.5D, 2.7A, 2.9A, 2.9B
3rd Grade: 3.5D, 3.7A, 3.10
4th Grade: 4.7A, C
5th Grade: 5.5C, 5.59

Activity *(15-30 minutes)*

BENEFITS OF NATIVE PLANTS TO WATER QUALITY:
"Can plants help keep the water clean? (yes, they act as a filter)
EXPLORE: Let's look at different kinds of plants to determine which would grow and filter the water best in the watershed or over the aquifer." Discuss native vs. non-native and function of roots.
What is your hypothesis? Which plant has the longest roots?
(Demo plant root model) Pick different students to pull out the roots of the 1) non-native grass; 2) native grass; 3) wildflower.
EXPLAIN: "Austin's climate is mostly drought/flood/freeze/hot, however, the weather, is what is happening today. The long periods of heat and drought can make it hard for a plant to survive since it needs water. Which part of the native plant has adapted in a way that enables the plant to get water even during long dry periods? (the roots) Why are the roots longer? (because there is groundwater deep underground)"
(Photo: Native Grass root) "Native plants have changed and adapted over thousands of years to survive in the harsh climate of Austin. Physical adaptations take many lifetimes to change, so you cannot buy a non-native plant with short roots, plant it in your Austin garden and expect it to adapt and survive."
Non-native plants and chemical use: "What kinds of chemicals do people sometimes use to try and get non-native plants to survive in Austin? (fertilizers, extra water, pesticides)"
Look at plants in park or on campus. "Native plants do not need any chemicals or extra water to survive. They're surviving because they have roots going deep to the water table. Think of the roots like a long highway where water can travel underground."
EVALUATE: "What kind of plants will grow in this rocky area of the recharge area? (native plants). Is planting a native plant in your yard or garden an action you can take to help the watershed, creeks and springs stay healthy? (yes)

Seed Balls Station

Core Activity

Make Seed Balls

- Divide students into 6 groups (ideally 4-6 students/ group)
- Distribute 1 tray to each group and have the students sit in groups around a central tray facing you. Talk about the advantage of making seed marbles to provide the native plant seeds with all of the resources they need to survive. Compare this method to simply tossing seeds on the ground
- Give each group a handful (~3/4 cup) of organic compost/ soil. Have student touch and explore with the soil but remind them to keep it on their trays. Discuss the importance of adding soil (adding nutrients!)
- Give each group a pinch of native wildflower seeds (~1/4 cup). Have students look at the diversity in the seeds and have them mix the seeds with the soil on their trays.

- Give each group about ¼ cup of clay and have them mix the clay with their other ingredients. By adding powdered clay you are adding lots of minerals to your soil. Make sure to set clear expectations: This is powdered clay which is a lot like flour you would find in the kitchen. If you clap your hands together what will happen? Remind students to avoid clapping their hands together when they have powdered clay on them and instead focus on mixing the ingredients.

[Middle school extension focused on particle size. See extension sheet.]

- The last ingredient is water. Add enough water to make the ingredients into a cake-like batter. Have students hold their hands in an "A-ok" sign to show how large they should make their seed marble

Remind students to mix *gently*
Have students mix all of the ingredients together on the tray and have each student make one quarter-sized seed marble.

Once each student has at least one completed seed marble in their hand (**ideally students will make as many seed marbles as possible**), have the students stand up and walk to an area that would be a good place to plant wildflower seeds. *Look for an area that is sunny, out of the way and not regularly mowed. Distribute wildflower guides and ask students to identify a few flowers as you walk to site.*

- The last thing our wildflowers will need is space. Ask students how they can make sure that the seeds in their seed balls have enough space. *Have students line up shoulder to shoulder and count down so students throw their seed balls all together!*
- Talk to students about their muddy hands and remind them to be respectful by not touching other students clothing.

Closing (*5 minutes*)

1. Review the importance of native plants
2. Ask how native plants help our local creeks (connect to watershed model)

Water Chemistry Station

Background Information

ADDITIONAL INFORMATION

- Watershed Locator: www.austintexas.gov/GIS/FindYourWatershed/
- LCRA interactive Watershed Map and Flooding Data: http://hydromet.lcra.org/full.aspx
- TX Rivers Curriculum: http://www.meadowscenter.txstate.edu/Service/TexasStreamTeam/educators/curriculum.html
- Chemical Water Quality Testing Supplies: http://www.lamotte.com
- Collecting Water Quality Data in Austin: http://www.austintexas.gov/department/hydrofiles

When referring to water quality, scientists are concerned with the overall health of a water ecosystem – whether it's a pond, creek, river, or wetland. Indicators of a healthy creek include insect, plant, and animal diversity, amount of oxygen in the water, suspended sediment, available sunlight, and nutrients. Clean creek water is not the same as clean drinking water. The city adds chemicals such as chlorine to kill bacteria that might otherwise benefit a fresh water system. The chemicals that keep us safe can be harmful to aquatic wildlife, disturbing the food web. Therefore, the parameters for measuring clean water for people and animals are very different.

Pollution and Watersheds (provided by City of Austin, Watershed Protection Department)
Most everyone has washed family cars, seen litter on the sidewalk, or walked a dog. In urban settings, car wash detergent, litter, animal waste, paint, and oil are present on the street but also end up in our creeks. All land is in a watershed. When water runs over the land during a rainstorm, it picks up whatever can be dissolved or carried by water and flows into the local creek, river, or lake. This water is referred to as "runoff" and can increase pollution in local creeks if land in the watershed is polluted. The land and what is done to it and on it, greatly affects the quality of water in a water body.

Water Quality Testing
Many city scientists, volunteers, and organizations monitor water quality by visiting the creek and collecting data. Much can be learned just by observing the body of water. Turbid, or cloudy, water is a sign of sediment runoff from erosion and construction sites. Too much algae covering the top of a creek is a sign of nutrient pollution. Strong, foul odors can be caused by sewage leaks or bacteria problems. Once scientists have recorded these observations they further investigate their suspicions to determine the source and type of pollution.

Test Kit Safety-see MSDS and page 8 of LaMotte booklet
Wear gloves and eye protection during experiments. Wash hands after performing tests.

Collecting a water sample
Collect the water sample in a clean, wide mouthed jar or container (approximately 1 liter) that has a cap. The container should be filled completely with your water sample and capped to prevent the loss of dissolved gases. Test each sample as soon as possible or within 1 hour of collection. See page 10 of LaMotte booklet on collecting procedure. When walking in the water, try not to agitate sediment on the bottom (avoid getting sediment in sample).

Test Descriptions and Instructions:
Just like a doctor, a scientist looks for clues to determine the health of a waterway. What signs does a doctor use to determine a person's health? (checks temperature, checks pulse, takes blood samples) What are clues a scientist would look for to determine the health of a waterway? Being an aquatic scientist means conducting tests, gathering information/data, and knowing what the data means. The students are going to be aquatic scientists by testing water and recording data.

Water Chemistry Station

Background Information

Water Temperature
Temperature affects the amount of dissolved oxygen in the water (cold water holds more oxygen), the rate of photosynthesis by aquatic plants and the sensitivity of organisms to toxic wastes, parasites and disease. Aquatic organisms are dependent on certain temperature ranges to stay healthy. **Expected level:** 22 to 35°C.

Dissolved Oxygen (D.O.)
Fish and other animals in the water need oxygen to survive. Plants, bubbles, and wind add oxygen to the water. High levels of bacteria from sewage pollution or large amounts of rotting plants (algae) lowers the oxygen in water and causes fish and other organisms to die. **Expected levels:** 4-12 mg/L.

pH
pH is a measurement of the acidic or basic quality of water. The pH scale ranges from 0 (very acidic) to 14 (very basic) with 7 being neutral. Most organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly. Low pH may slow development rates, decrease hatching success, cause embryo toxicity, and reduce growth of some aquatic organisms. pH can be affected by industrial waste (spills), agricultural runoff (pesticides, fertilizers and animal wastes), and sewer overflows. Limestone neutralizes acids and often results in a more basic pH. **Expected levels:** 6.5-9.0.

Nitrate
Nitrate is a nutrient needed by all aquatic plants and animals to build proteins. Nitrate gets in the water from human and animal waste and runoff from heavily fertilized lawns. Excess nitrate in the water increases plant growth and decay, promotes bacterial decomposition and therefore lowers oxygen levels. **Expected levels:** less than 4 ppm.

Phosphate
Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity and decreased oxygen levels. Phosphate comes from human and animal waste, industrial pollution, and agricultural runoff. **Expected levels:** less than 1 ppm.

Turbidity
Turbidity is the measure of the relative clarity of water. Turbid water is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter, and microscopic organisms. Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances. **Expected levels**: less than 40.

Solutions
Solutions to these urban storm water pollution problems require participation by everyone. Homeowners can help by carefully following directions when applying pesticides and fertilizers, using biodegradable products whenever possible, cleaning up pet waste, not disposing of household wastes in the street and fixing oil leaks in vehicles. The City of Austin receives its drinking water from the Colorado River, where almost all of the 66 creeks drain into. Monitoring water quality and problem in the creeks not only benefits the habitats but people as well.

Water Chemistry Station

Background Information

Vocabulary

Aquatic	Relating to water.
Water Quality	The physical, chemical and biological characteristics of water that determine if the water is considered a healthy ecosystem or polluted.
Chemistry	The branch of science that deals with the identification of the substances of which matter is composed.
pH	A measurement that tells us if the solution/water is acidic, neutral or basic.
Dissolved Oxygen	The amount of oxygen dissolved in a body of water as an indication of the health of the water and its ability to support a balanced aquatic ecosystem.
Phosphate	A nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions.
Turbidity	The cloudiness or haziness of a fluid created by suspended particles.
Riparian Zone	The interface between land and a stream or river.
Ppm-parts per million	A way of expressing very dilute concentrations of substances (Ex. 1 gallon in 1 million gallons of water); mg/L
Nitrate	A nutrient needed by all aquatic plants and animals to build protein.

Water Chemistry Station

Core Activity

Activity Summary:
Using chemical tests and physical observations, students will develop an understanding of how scientists monitor the health of freshwater bodies and why it's important.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- thermometers
- 5-6 cups
- 6 Safety Goggles
- test kits: DO, pH, Nitrate, Phosphate, Turbidity
- Test Worksheets
- Pencils
- Waste Container (100 mL bottle)
- Buckets or Tubs—hold water

TIME REQUIRED: 30-45 minutes

OBJECTIVES:
Students will be able to:
- Understand that urban waterways require certain things to be healthy
- Identify physical and chemical characteristics used to gauge the health of a waterway
- Analyze data using chemical tests to determine the health of a local creek

TEKS CORE CONCEPTS:

Introduction
Water Quality (Adapted from *Wet in the City* Curriculum)
1. Show class the water sample collected from a local creek. Ask the following:
2. Does the water look clean or dirty?
3. Does it look clean enough to drink? Tell students where the sample was collected and explain that there might be pollutants in the water that make it unhealthy.
4. We can't always see pollutants in water so how do we know they are there? (we test it)
5. Have you seen people testing water before? (lifeguards at swimming pools, fish tanks)
6. Just like a doctor a scientist looks for clues to determine the health of a waterway. What signs does a doctor use to determine a person's health? What are clues a scientist would look for to determine the health of a waterway?

Signs a doctor looks for to determine the health of a patient	Clues a scientist looks for to determine the health of a waterway (water quality parameters)
Temperature	Temperature
Pulse	Dissolved Oxygen
Blood Pressure	Turbidity
Reflexes	pH
X-Ray/MRI	Pollutants/Litter
Urine Sample	Conductivity
	Nitrates/Phosphates

Water Chemistry Station

Core Activity

Water Quality - Chemistry

1. Being a scientist means conducting test, gathering information/data, and knowing what the data means. Today you are going to be scientist by comparing different kinds of data.
2. Visit a local creek to collect water samples. If a local creek is not accessible bring in water samples to be tested. (When collecting samples rinse the container with the creek water to ensure accurate results and no contaminants.) Using samples students will determine the health of a waterway:
3. Explain to students that they will be given a test bag with materials and instructions for the test in the bag. Tell students "After we collect our water samples, you will follow the directions in the bag to test the water sample." Divide students into groups of 3-4 and pass out tests.
    a. See *Chemical Test Instruction Cards* for specifics on conducting each test.
    b. Show students how to fill test tubes (submerge and cap under the water).
4. In groups, students complete *Observation and Data* sheets testing for: pH, nitrate, phosphate, temperature, and dissolved oxygen.
5. Groups record their results to discuss as a class.

Classroom Modification

Compare creek sample to tap water-have half of class test each. Compare results and ask why tap water might harm aquatic organisms (chlorine is added).

Cleanup: All reacted test samples can be disposed of by flushing down the drain with excess water. While in the field, reacted samples can be poured together into a **waste container** for later disposal.

Conclusion and Solutions

1. Create a chart similar to data sheet on chalkboard and ask students to record results.
2. Discuss results and decide on water quality rating.
    a. Ask students if enough data was collected to make a final judgment about the water quality.
    b. What else could we have looked at? (Organisms in the water, other tests like: oil residues, pesticides, herbicides, metals, etc.).
3. Brainstorm solutions for keeping our water clean:
    a. Changing home practices.
    b. Creek cleanups
    c. Proper hazardous waste disposal – Austin's drop off facility location http://www.austintexas.gov/department/household-hazardous-waste
4. Cleanup: All reacted test samples can be disposed of by flushing down the drain with excess water. While in the field, reacted samples can be poured together into a waste container for later disposal.

Macroinvertebrate Station

Background Information

When referring to water quality, scientists are concerned with the overall health of a water ecosystem – whether it's a pond, creek, river, or wetland. Indicators of a healthy creek include insect, plant, and animal diversity, amount of oxygen in the water, suspended sediment, available sunlight, and nutrients. Clean creek water is not the same as clean drinking water. The city adds chemicals such as chlorine to kill bacteria that might otherwise benefit a fresh water system. The chemicals that keep us safe can be harmful to aquatic wildlife, disturbing the food web. Therefore, the parameters for measuring clean water for people and animals are very different.

Pollution and Watersheds

Most everyone has washed family cars, seen litter on the sidewalk, or walked a dog. In urban settings, car wash detergent, litter, animal waste, paint, and oil are present on the street but also end up in our creeks. All land is in a watershed. When water runs over the land during a rainstorm, it picks up whatever can be dissolved or carried by water and flows into the local creek, river, or lake.
This water is referred to as "runoff" and can increase pollution in local creeks if land in the watershed is polluted. The land and what is done to it and on it, greatly affects the quality of water in a water body.

Benthic Macroinvertebrates

"Benthic" means animals that live on the bottom of a stream. "Macro" means that they can be seen without a microscope and "invertebrate" means they do not have a backbone. The macroinvertebrates (macros) live on or under stones, sticks, and leaves in the stream or burrow into sand and silt on the stream bottom. Macros are useful for determining water quality because they are abundant, there are many varieties, and they stay in one place in the stream for much of their lives.

Purpose of the Macroinvertebrate Test

Scientists can determine the health of a creek by testing for different chemicals such as nitrate and pH but that gives them just a snapshot of what the creek looks like at that moment. Another way to check the health of a creek is to identify and count the variety of aquatic insects. Low oxygen, high turbidity (cloudy water) and acidic or basic pH can severely impact or kill certain macros. A chemical test will not identify pollution in the water after it has washed downstream but the macroinvertebrate community will respond fairly quickly and change. If sensitive macros are not living in an area where they should be, then it is a sign something in the environment is not healthy.

ADDITIONAL INFORMATION

- Watershed Locator: http://www.austintexas.gov/GIS/FindYourWatershed/
- LCRA interactive Watershed Map and Flooding Data: http://hydromet.lcra.org/full.aspx
- Chemical Water Quality Testing Supplies: http://www.lamotte.com
- Collecting Water Quality Data in Austin: http://www.austintexas.gov/hydrofiles

TRAINING VIDEO: https://www.youtube.com/watch?v=88YUqR0NNHg

Macroinvertebrate Station

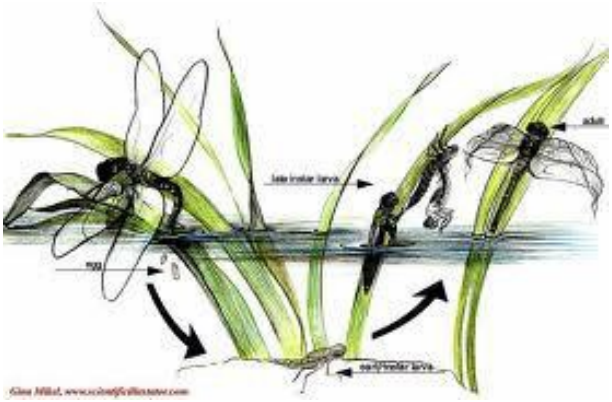
Background Information

Bio Indicators
The macros that are used to indicate water quality are separated into three Pollution Sensitivity groups called Group 1, Group 2, Group 3:

Group 1	Group 2	Group 3
Macros that are very sensitive to pollution. They can only survive in water of excellent quality.	Macros that are somewhat sensitive to pollution. They are not quite as sensitive as the macros in Group 1. They can survive in water of high quality and water that is not quite as healthy.	Macros that are tolerant of poor water quality. They can survive in water of high quality, water that is not quite as healthy, and polluted water. **Finding a macroinvertebrate in the poor water quality group does not necessarily mean the creek is polluted.**

We can collect macros from a stream and determine the quality of water. This is done by counting the number of different species from each Group that are found in a sample from the stream. The healthiest water has macros from each Group with most from Group 1. A larger variety of macros means better water quality!

Life Cycles
Some macros are insects that only live in the water in their nymph or larval stage (for example dragonfly nymphs). A dragonfly goes through **incomplete metamorphosis** (no pupal stage). When they grow into adults, they fly from the stream and live on land. Other macros are not insects (like snails, crayfish, and aquatic worms) and live in the water their entire life.



Macroinvertebrate Station

Background Information

Vocabulary

Aquatic	Relating to water.
Benthic	The bottom of the creek.
Complete Metamorphosis	The complete form of metamorphosis (change) in which an insect passes through four separate stages of growth, as egg, larva, pupa, and adult.
Dissolved oxygen	The amount of oxygen dissolved in a body of water as an indication of the health of the water and its ability to support a balanced aquatic ecosystem.
Food Web	A community of organisms where there are several inter-related food chains.
Habitat	The type of environment in which an organism or group normally lives or occurs.
Incomplete Metamorphosis	A life cycle of certain insects, such as dragonflies, characterized by the absence of a pupal stage between the immature and adult stages.
Macroinvertebrate	An organism with no backbone and visible with the naked eye.
Riffle	A shallow creek habitat for macroinvertebrates where water flows over rocks and creates bubbles.

Macros Station

Core Activity

Activity Summary:
Ever wonder what lives in your water? Students will get up close and personal with all the wonderful critters that call the local creeks, ponds, and lakes home. With a set of observational tools, ID guide and a natural water source, students will practice catching and identifying macroinvertebrates while decoding what they can tell us about the water quality.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Macroinvertebrate/ Water sample
- 8 "Is the Creek Clean or Polluted?" bug identification sheets
- 12 Magnifying viewers
- 12 forceps
- 6 containers (hand size)
- 3 large white, flat pans
- 8-10 nets for students
- Large dip net
- 8 wax pencils/ dry erase

TIME REQUIRED: 30-45 minutes

OBJECTIVES:
Students will be able to:
- Understand that urban waterways require certain things to be healthy
- Identify aquatic macroinvertebrates
- Analyze data to determine the health of a local creek
- Understand diversity and food web interactions

Introduction
1. Define macroinvertebrate
2. Discuss using macros as "bio indicators" (like the canary in the coal mine) and the purpose of macro tests to field test water quality
3. Discuss macroinvertebrate habitat and explain how macros are collected in a creek. *Encourage students to look for riffles, under rocks, around aquatic plants and along the shoreline*
4. Discuss safety and care of organisms
5. Give clear boundaries and set behavior expectations.

Macroinvertebrates & Habitat
1. Ask students why ***oxygen*** is important in the creek? (organisms breath it) Where does the oxygen come from? (plants, algae, bubbles in a **riffle**)
2. Ask students why the macroinvertebrates are important to the creek? (food for fish and other organisms). Without oxygen and macroinvertebrates, what would happen to the creek? (the ***food web*** would break down)
3. Macroinvertebrates can be found at the shallow, bubbly, rocky area (riffle) because it is their habitat. Riffles provide protection from predators and are full of oxygen (bubbles).

Macroinvertebrate Identification & Documentation
1. Organize students into groups of 2-3 and explain that they will determine the water quality by 1) finding and 2) identifying macros.
2. Give each group a "Is the Creek Clean or Polluted" bug ID sheet, one wax pencil, one small net and a holding dish
3. Show groups where the larger white flat pans are located and remind them to place their macros in the pans so the entire group can observe at the end
4. Demonstrate how to check off the type of macroinvertebrate found on the worksheet.
5. Emphasize the importance of correct identification. Discuss how to tell macros apart by looking at their structures:
   a. Legs or no legs
   b. Body type
   c. Number of tails
   d. Color patterns
   e. Other appendages

6. Use the Bug ID sheet to help the student identify the macroinvertebrate collected.
7. Once identified, check off the macro found on the worksheet.
8. Put the macros in the collection bin. Look for more in the water.
9. Allow time for everyone to collect, identify and document (**15 minutes**).

Conclusion and Solutions

1. Allow all students to observe the macros collected and identify species with students
2. Emphasize positive individual and family actions; the health of our water is everyone's responsibility.
3. Remember that testing your water is not enough-once you've identified a problem in your creek, then you can determine what caused the problems and begin to address those issues.
4. Discuss results and decide on water quality rating.
    a. Ask students if enough data was collected to make a final judgment about the water quality. *You would have to sample multiple times in various sections of the river to make a better judgement about water quality.*
    b. What else could we have looked at? (Other water quality tests like: oil residues, pesticides, herbicides, metals, pH, nitrate, water temp, etc.).
5. Brainstorm solutions for keeping our water clean:
    a. Changing home practices—reduce pesticide, herbicide and fertilizer use; pick up dog waste, do not litter, etc.
    b. Creek cleanups
    c. Proper hazardous waste disposal – Austin's drop off facility location http://www.austintexas.gov/department/household-hazardous-waste
6. Cleanup: Dump macros back into creek or bucket for use in later classes and rinse supplies. Have students count their supplies and look for missing pieces.

Native vs. Invasive Game

Background Information

ADDITIONAL INFORMATION

- Central TX Invasive Plant Guide: http://www.austintexas.gov/sites/default/files/files/Watershed/invasive/2013_Invasives_guide_small.pdf
- Central TX Native Plant Guide: https://www.austintexas.gov/sites/default/files/files/Watershed/growgreen/plantguide.pdf

Invasive species are a large problem in many ecosystems. Invasive species are defined as any organism that is brought into an ecosystem that is not their own. Once an invasive species arrives in an ecosystem, the organism attempts to fill niches that are already occupied by native species.

The problem is that there is a limited amount of resources in any given environment. These resources are necessary for survival and include water, space and food (nutrients). Once an invasive species is introduced into an area, the native species populations will have to compete for resources. If an invasive species adapts well in its new environment, usually because of lack of predation, the native species will decline because of the new competition.

Invasive species are introduced to new environments both intentionally and unintentionally. Some are accidently released or transported, while others are introduced for a specific purpose and have unintended consequences.

Invasive species affects the whole environmental system because they outcompete native plants for environmental resources and can reduce the amount of nutritious food available to our native wildlife.

Vocabulary

Native Species	An organism that is "from" a particular area and is therefore adapted to that specific environment. (ex. Blue Bonnet, Mesquite, Pecan, Texas Lantana)
Invasive Species	An organism that is not from the particular area where it is found and becomes a pest in that area. (ex. Kudzu, Chinese Tallow, Japanese Privet)
Resource	A source of supply or support; Examples include water, space, food (nutrients), shelter
Biodiversity	Variety of life in a certain area
Wildlife	Animals living in nature

Native vs. Invasive Game

Core Activity

Activity Summary:
Investigate the connections between invasive and native plants by exploring what resources plants need to survive and how they compete for those resources. Understand how the loss of native plant species relates to a loss of biodiversity and less food choices for native wildlife.

UNIT: Clean Creek Campus

GRADES: 3rd grade and up

MATERIALS:
- Rope for Outer Circle Boundary
- Blue Circular Patches (~25)
- Plastic Food (10-12 pieces)
- Rulers (10-12)
- Optional-Large Paper Pad and Marker to Create Graph

TIME REQUIRED: 20-35 minutes

OBJECTIVES:
Students will be able to:
- Define Native & Invasive
- Define biodiversity and

Activity *(15-30 minutes)*

1. Let students stretch out large circular rope and lay it on flat ground outside. Have students spread out and sit on the outer edge of the rope circle.
2. Group students in pairs and have them stand with their partner on the edge of the rope circle. Together each pair will create one NATIVE plant (choose a plant that they are planting that day or that they already know).
   - One student will act as the roots of the native plant and one student will act as the "shoots" of the native plant. (Allow the pair to switch roles in different rounds)
3. Ask what kinds of resources plants need to survive and have props ready.
   - Water= blue patches
   - Food (nutrients)= plastic food
   - Space = rulers
4. As soon as the students have hypothesized what kinds of resources plants need to survive, toss the blue water patches, rulers, and plastic food into the middle of the rope circle.
   - Count the number of pairs in the group to determine how many resources to include (ie. 10 pairs of students= 10 rulers, 10 pieces of food, 20 blue patches in the first round)
5. Have the student that is acting as the "shoots" take three big steps back from the edge of the circle and "plant" their feet. They should still be standing, but will not be moving for the remainder of the round.
6. Explain that the partner who is acting as the "roots" will have to gather resources from the center of the circle.
   - ****Emphasize that the "native plant roots" may ONLY GATHER ONE RESOURCE EACH TIME THEY COME IN THE CIRCLE. That means the roots need to run in and out of the circle at least 4 different times****
   - They will then run the resource to their partner, the "shoots", who is standing outside of the circle.
   - Once they have **handed** their resource to their partner they may return to get another resource, on and on until they have gathered all the resources they need to survive.
7. Explain that the "roots" will have to compete with all of the other plant's roots in order to obtain all of the resources they and their partner need to survive. Clarify expectations: no pushing, no grabbing, no diving.
8. IN ORDER TO SURVIVE the roots need to get four things in total:
   a. One ruler (space)
   b. Two blue patches (water)
   c. One plastic food piece (nutrients)

Native vs. Invasive Game

Core Activity

Explain that the "roots" are not allowed to throw any resources to their "shoots". They must instead run out of the rope circle and hand it to their partner before returning for another resource.

9. Time the first round so that about ½ to ¾ of the pairs survive as native plants.
10. After the first round, the pairs that were not able to gather the four resources they needed to survive will turn into invasive plants (i.e. Bermuda grass/ bamboo/ kudzu)
11. The roots of the invasive plants are allowed to gather TWO RESOURCES EACH TIME THEY COME IN THE CIRCLE, which will give them advantage over the native plant roots who are still only allowed to gather one resource at a time.
    - Any native plants that survive will remain a native plant
    - Native plants that die turn into invasive plants
    - Invasive plants that survive stay invasive
    - Invasive plants that die remain invasive
12. After the invasive plants have been introduced, and depending on time, you can put the students in different scenarios:
    - DROUGHT: Take away about ¼ of the blue water patches (increase competition)
    - BUILD A WALMART: Take away a few rulers (space)
13. Play for a few rounds and ask if the game became more difficult for the native plants
    - Discuss why the natives could only gather one resource while the invasives could gather two and what advantage the invasives had.
        i. For example, invasive species usually do not have limitations like natives do. They may not have any predators in the new environment or may spread very quickly and can therefore outcompete native plants.
14. In the end most pairs of students should represent the invasive species. Discuss what happened to the native plants (they died because they were outcompeted by the invasives)

Closing (*5 minutes*)

1. Review what happened in the game (all the student pairs started as native species and most became invasive species)
2. Ask if this scenario is something that happens in Texas (discuss examples like Bermuda grass, nandina, kudzu, bamboo)
3. Explain that when an invasive takes over there is less biodiversity in the environment. That means that wildlife will not have many food choices (or perhaps no food choices at all)
    a. Help the students visualize lack of food choices by relating it to a grocery store with only one type of apple in the entire store. That apple is their only food option for every meal, day in and day out.
    b. Ask if they would be happy or healthy eating one kind of apple for the rest of their lives and explain that wildlife are faced with this reality when invasive plant species take over in their habitat.

Extensions

1. Graph the Game Rounds – using a simple plot graph, plot the number of native plants to number of invasives per round. This works best with large groups and at least 5 rounds.
2. Native vs. Invasive plant walk around school campus - show examples of native and invasive plant species right on their school campus
3. Invasive Species Removal Game - show the students just show difficult it is to remove invasive species from an area without harming the native species. http://greenteacher.com/around-the-world-the-invasive-species-challenge/