



TWELVE HILLS  
NATURE CENTER

talk**STEM**  
Share. Engage. Inspire.™

walk**STEM**®

- at -



**TWELVE HILLS**

**NATURE CENTER**

Created by the North Texas Master Naturalist Class of 2019  
in partnership with the Twelve Hills Nature Center and the talkSTEM nonprofit organization  
Sponsored by the talkSTEM nonprofit organization

*Every child is a STEM child • Every space is a STEM space*



## Welcome to the Twelve Hills Nature Center

This walking tour consists of 10 stops. You may visit any number of stops that you like and you may visit the stops in any order you like. Each stop stands alone. Each stop has a key question as its focus. Some stops may require materials. **\*Two sets of tools are located in a plastic box inside the Nature Center, in the southeast corner along the gray fence.** If your group requires more than two sets of tools, please contact us a few days in advance of your visit at [twelvehillsnaturecenter@gmail.com](mailto:twelvehillsnaturecenter@gmail.com). Bring a notebook or print and bring the notes section included below.

### walkSTEM stops at Twelve Hills Nature Center:



#### 1. Welcome to Twelve Hills Nature Center - pg. 10

What ecosystem are you in right now, and what is unique about it?

STEM Concepts: comparison

Materials Needed: none



#### 2. What lives in these boxes? - pg. 12

Which bird do you think uses the box you see here? What is the box for? Why do we pick certain shapes and sizes for bird boxes?

STEM Concepts: comparison, estimation, design, engineering

Materials Needed: ruler or tape measure\*



#### 3. How far did I walk? - pg. 15

What is a quick and easy way to find out how far we walked?

STEM Concepts: measurement, calculation

Materials Needed: 10 feet of paracord, or rope, or string, calculator\*



#### 4. How strong is flowing water? - pg. 16

Why did they use concrete to surround the banks of the creek? And where does all the water go when it rains?

STEM Concepts: engineering, science

Materials Needed: paper and pencil



#### 5. Can you hear the Cottonwood tree leaves rustle in the breeze? - pg. 18

How loud can a tree be?

STEM Concepts: engineering, geometry, design

Materials Needed: paper and pencil



#### 6. Can a tree feel like a cave? - pg. 20

Why does this tree remind us of a cave? Why are trees important, especially for life in the city?

STEM Concepts: geometry, science

Materials Needed: air thermometer, angle-o-tron\*



#### 7. Yucca's Perfect Pom-Poms - pg. 21

How is the yucca's geometry unique?

STEM Concepts: geometry

Materials Needed: paper and pencil



#### 8. What is a snag? - pg. 23

What fraction of this particular tree is alive and what fraction is a snag?

STEM Concepts: measurement

Materials Needed: use the graphic provided



#### 9. The bedstraw is sticking to me! - pg. 25

How is this plant well-designed to go home with you?

STEM Concepts: biomimicry, botany

Materials Needed: none Season: Spring



#### 10. Picnic Table Contemplations - pg. 27

How does this area compare to the other spaces in the Nature Center?

STEM Concepts: comparison

Materials Needed: none





All the walking tour content is designed for you to make connections between what you see here and STEM questions and concepts. STEM is short for Science, Technology, Engineering, and Math and we have partnered with the talkSTEM nonprofit organization to produce this experience. Our goal is for every child and adult who goes on this walkSTEM@Twelve Hills Nature Center tour to see our space through the lens of STEM and to appreciate the fact that the questions are infinite. We hope you are inspired to ask and answer your own questions while you are here and that you enjoy this tour. You can enjoy the stops in any order you like.

## How To Be Present in a Nature Preserve

Welcome to Twelve Hills Nature Center! As you walk the trail, can you use all your senses to take in the rich experience offered by nature? Listen to birds singing and insects buzzing, smell the sweet or pungent odors emitted by plants, look at the vast variety of shapes, sizes and colors of flowers, plants, butterflies and other wildlife.

Volunteers have made this experience available to you by recreating the Blackland Prairie plant communities that were present on the site for eons until farms and buildings occupied it. Think of visiting Twelve Hills like you think of visiting a natural history museum or an arboretum. Conduct yourself accordingly, and consider with respect the flora and fauna, their origins, their support for pollinators, and the educational potential the Nature Center offers.

Please protect Twelve Hills and yourself by following these rules:

- Be careful as you walk on the rocky trails.
- Please stay on the trails and do not walk through the meadows.
- Do not pull, destroy or remove anything from the Nature Center.
- Please use care and caution as you view plants and pollinators.
- Do not write on the rock in the gathering area.
- Dogs must be leashed, kept on the trails, and picked up after.
- Please be courteous to other visitors.
- Smoking, alcohol and drug use are prohibited.

We want all our visitors to enjoy the beauty of the nature center with as little evidence of human disruption as possible – thank you!

*This material is based upon work supported by the National Science Foundation under Grant DRL 2115393. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation*





# Map of the Twelve Hills Nature Center







## About talkSTEM

talkSTEM is a nonprofit organization that wants to inspire today's youth to grow their unique STEM (science, technology, engineering and math) mindsets, to pursue STEM education, and to join the exceptionally large and varied STEM workforce. It has a focus on girls and other groups under-represented in STEM professions. talkSTEM's vast selection of resources emphasize equitable and inclusive experiences.

The walkSTEM initiative is an informal way to look at STEM connections of all sorts in all kinds of places, from playgrounds to palaces. The walkSTEM @ Twelve Hills Nature Center experience guides visitors of all ages to appreciate nature through the lens of STEM. There are many walkSTEM tours throughout Dallas.

You are invited to share your selfies, and your personalized STEM questions at #walkSTEM as you take this and other STEM walks. They'll inspire others exploring the world through the lens of STEM!

 talkSTEM  @talkingSTEM  @talkingSTEM  talkSTEM  @talkSTEM

talkSTEM and SMU are studying methods to inspire STEM engagement in youth through a recently awarded National Science Foundation grant: Mathfinders-Seeing the World through a Mathematical Lens. Find details at [sites.google.com/view/mathfinder](https://sites.google.com/view/mathfinder). Twelve Hills Nature Center is a partner site for Mathfinders.

## About Twelve Hills Nature Center

Established in 2005 on reclaimed land in the heart of North Oak Cliff, Twelve Hills Nature Center is a long narrow five-acre natural area being restored toward native Blackland Prairie by volunteers. The prairie provides habitat for wildlife, educational opportunities for local schools and a place of refuge for neighbors and nature lovers. A walk on the hilly .5 mile loop trail takes visitors through meadows with native grasses, wildflowers, butterflies and birds, and through forested edge areas.

The mission, "cultivating conservation ethics through our Blackland Prairie restoration and nature education" comes alive through our workdays and educational offerings. Local schools visit Twelve Hills on their own and for organized programs.

Volunteers restore Blackland Prairie habitat and maintain the entrance and butterfly gardens. They lead nature walks and nature events, develop educational materials, and record plant and animal presence with iNaturalist and eBird. They conduct hands-on education and conservation activities for students from local schools.

Twelve Hills is an all-volunteer 501(c)3 nonprofit. There is a deed restriction on the land so it will not be developed. It is a North Texas Master Naturalists' volunteer project. Find more information at:

[twelvehills.org](https://twelvehills.org)

 TwelveHills

 twelvehillsnaturecenter



## A Note to Families and Teachers:

A walkSTEM® tour is a walking tour of any place where you look at the place through the lens of science, technology, engineering, and math. It's for all ages and all backgrounds – anyone with curiosity about what's around them. No – you don't need to be a brainiac to go on a walkSTEM tour, and you don't need any special academic training! And, yes, we also definitely include arts and design connections!!

### What is walkSTEM®?

A walkSTEM® tour is deliberately designed to include questions that strengthen critical thinking skills by encouraging learners to explore their real-world environment and think “outside the textbook.” We believe every person is a STEM person and every space is a STEM space, and the ultimate goal of walkSTEM® is to foster the development of each individual's unique STEM identity. We hope that as you explore the nature center (or any space!) you will have fun and develop your inner STEM explorer.

### How to use our walkSTEM® @Twelve Hills Guide

The walkSTEM® @Twelve Hills guide is meant to help learners of all ages slow down and discover how much one can learn about this gem in Oak Cliff as well as more about nature, conservation efforts, and everyday surroundings.

*Parents:* We hope you will enjoy exploring the Nature Center with your children.

*Teachers and after school educators:* The walkSTEM® methodology promotes collaboration between learners. Please consider using a variety of grouping strategies (e.g. whole group discussion, Socratic Method, partners, small groups, or by learning style) with your learners as they work through activities.

The goal of the suggested activities outlined in each guide is to promote critical thinking and inquiry amongst learners as they actively explore the robust activities designed by the Twelve Hills Nature Center team. As such, these guides are flexible – choose the activities you feel will best fit your child's learning styles or support concepts they are currently studying. You can choose one or multiple walkSTEM® stops to focus on during your visit.

Learn more at [talkSTEM.org](https://talkSTEM.org) (click on the walkSTEM tab)  
Questions? Email [koshi@talkSTEM.org](mailto:koshi@talkSTEM.org)





## Notes section for students

*Write your questions and notes, draw your sketches, and have fun!*

### Entrance to Twelve Hills Nature Center

*What ecosystem are you in right now, and what is unique about it?*

### Bird Boxes

*Which bird do you think uses the box you see here? What is the box for? Why do we pick certain shapes and sizes for bird boxes?*

### How far did I walk?

*What is a quick and easy way to find out how far we walked?*



### Creek

*Why did they use concrete to surround the banks of the creek? And where does all the water go when it rains?*

### Cottonwood Trees

*How loud can a tree be?*

### Cave Tree

*How do we determine tree age? Why are trees important, especially for life in the city?*

### Yucca

*How is the yucca's geometry unique?*



### Snag

*What fraction of this particular tree is alive and what fraction is a snag?*

### Bedstraw

*How is this plant well-designed to go home with you?*

### Picnic Table

*How does this area compare to the other spaces in the Nature Center?*





# Welcome to Twelve Hills Nature Center

(All Seasons | Grades 2-5) • Map Stop 1 • Inside the butterfly garden, looking out to the open meadow

Take a look at the list of ecosystems below.

What ecosystem are you in right now, and what is unique about it?



Forest



Coastal Area



Mountain



Desert



Prairie

## Background Information:

An **ecosystem** is an area where **biotic** (living) and **abiotic** (nonliving) factors interact with one another. Twelve Hills Nature Center is in the process of restoring the area into a **Blackland Prairie** ecosystem. The Blackland Prairie is characterized by several hundred distinct plant species. Grasses four-feet tall are the dominant plants, wildflowers grow among them, trees grow only along waterways. They support a wide variety of wildlife from insects to bison.

Blackland Prairie covered the land for many thousands of years prior to farming and development. Less than one percent of this endangered ecosystem remains in Texas today. Most recently, this area held an apartment complex from 1960 to 1990.

## Activity:

Take a look at the photos above and compare the different ecosystems and plants you see in each photo to those at Twelve Hills. As you continue to walk around the Twelve Hills Nature Center, list some abiotic things you observe in the Nature Center and compare them to biotic features. If you want, you can compare your list with ours in the **Answer Key** section on the next page!





## OUR ANSWERS:

### Which ecosystem is this and why?

This is the **Blackland Prairie** ecosystem. It's characterized by a wide diversity and number of plant species. Trees occur along rivers and streams. **Tall grasses** are dominant during the fall and winter, and abundant prairie **wildflowers** bloom during the spring, summer, and fall.

It is not:

A **forest** because it lacks enough trees to be a forest.

A **coastal area** because there is no ocean.

A **mountainous region** because it is relatively flat.

A **desert** because the land is covered with plants, indicating that it receives more rain than a desert and is not arid. The plants present are not desert plants with specialized adaptations to conserve water, ie cacti)

### Biotic factors at Twelve Hills:

Birds

Bugs

Grasses, trees, and other plants

Mushrooms, and other fungus and lichens.

Squirrels

Us humans!

### Abiotic factors at Twelve Hills:

Fences

Birdhouses

Bright sun

In the trail: debris from buildings (i.e. bricks, rebar, a sewer drain, occasionally a piece of glass, former road surface, a bench, a picnic table)

Cement on the creek bank

Entrance areas assembled of rock and metal (south entrance steps, the Mary Cliff entrance, etc.)







# What lives in the Boxes?

(All Seasons | Grades 2-8) • **Map Stop 2** • Find bird boxes along the long trail that is on the side of Twelve Hills away from the school and soccer field

Which bird do you think uses the box you see here? What is the box for?  
Why do we pick certain shapes and sizes for bird boxes?



## Background Information:

**Cavity-nesting birds** nest in tree cavities, and sometimes in bird houses or bird boxes. They choose places to nest that are the correct **size** for them and are in the correct **habitat**.

## Activity:

Measure the box height, width, and depth, and the width of the entrance hole. Then, check it against the chart below, and try to figure out which of the listed cavity-nesting birds can live there before viewing the answer on the next page.



### Whose bird box is this?

height 10.38 in.  
width 6 in.  
depth 5 in.  
hole diameter 1.5 in.

**Carolina Chickadee**  
length 4.75 in.  
wingspan 7.5 in.  
weight 0.37 oz.



**Eastern Bluebird**  
length 7 in.  
wingspan 13 in.  
weight 1.1 oz.



**Red-bellied Woodpecker**  
length 9.25 in.  
wingspan 16 in.  
weight 2.2 oz.



### Wood Duck

length 18.5 in.  
wingspan 29.9 in.  
weight 1.3 lbs.



### Barred Owl

length 20.9 in.  
wingspan 42 in.  
weight 1.6 lbs







Do you have your **ANSWERS**? The boxes are used by **bluebirds** for nesting. Bluebird boxes must have holes **1.5 inches** in diameter so predators and pest birds (which are larger) cannot enter.

Wild birds use nests to raise their young. Each specific bird species nests in a specific structure; the size and location of nesting boxes are different for different birds. Bluebirds like to nest **alone** facing wide, open spaces (like the prairie these boxes are facing), while birds like purple martins like to nest in large **group** houses that are very high up. Others, like cardinals, build more “traditional” round twig nests.



Where do birds live in the wild? Many people might answer the question with “their nests”, but **birds only use nests while they raise their chicks**. Most of the time birds will **roost** (rest) just about anywhere - trees, bushes, reeds, electric lines, cacti, and even on the ground.

**Fun Fact:** At Twelve Hills Nature Center, **Carolina chickadees** nest in the nest boxes, even though they're meant for bluebirds! Bluebirds have not been sighted at Twelve Hills at least since 2008. Bluebirds prefer to nest in large open meadows. Perhaps they need more space than Twelve Hills provides.

### Design:

Allow yourself to be inspired by these birds that build unique nests using their own designs and materials. Then, use your knowledge about bird houses and bird nests to sketch a bird house for another type of bird that nests alone.

**Note to Educators:** Encourage students in grades 6 through 8 to think out of the box and create a complex design.



## Bald Eagles

Bald eagles build large nests of interwoven sticks, high in tall trees. Nests are 4 to 5 feet in diameter and at least 2-4 feet deep. They live in the United States, including Dallas, Texas.

<https://www.nationaleaglecenter.org/eagle-nesting-young/>

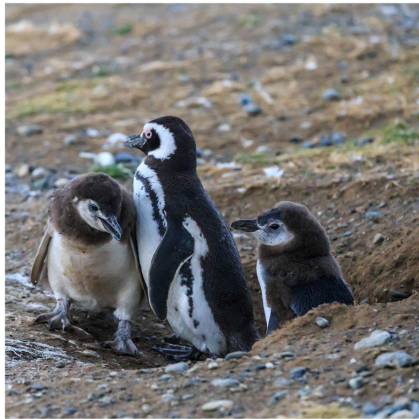




## Cliff Swallows

Cliff swallows build nests made of mud, and cements them to the walls of cliff ledges, under bridges, eaves, and culverts. They are 8 inches X 6 inches by 4.5 inches. They live in the United States, including Dallas, TX.

[https://www.allaboutbirds.org/guide/Cliff\\_Swallow/id](https://www.allaboutbirds.org/guide/Cliff_Swallow/id)



## Humboldt Penguins

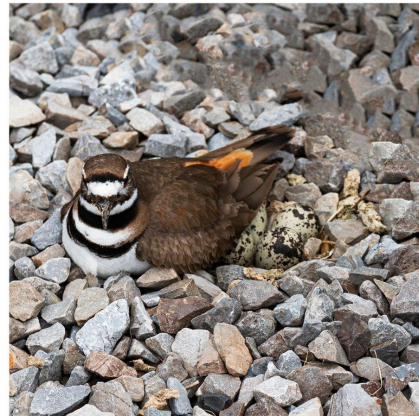
Humboldt penguins dig burrow-like nests in caves and along cliffs amid piles of guano from sea birds. They live on the coasts in Chile and Peru.

[https://www.biologicaldiversity.org/species/birds/penguins/Humboldt\\_penguin.html](https://www.biologicaldiversity.org/species/birds/penguins/Humboldt_penguin.html)

## Killdeer

Killdeer scratch a shallow depression 3.5 inches across into bare ground. This is called a scrape. Rocks, bits of shell, sticks, etc. are added. Killdeer live in the United States, including Dallas, TX.

<https://www.allaboutbirds.org/guide/Killdeer/lifehistory>



## Black-headed Weaver

Weaver birds like to create hanging nests stitched together from plants. To view another type of weaver, the African taveta golden weaver, at work building his nest, scan the QR code below!

<https://youtu.be/bUd3sfXpz7s> | [sharpphotography.com](http://sharpphotography.com)







# How far did I walk?

## (Beginning Orienteering)

(All Seasons | Grades 4-8) • **Map Stop 3** • The hilltop (or anywhere you want!)

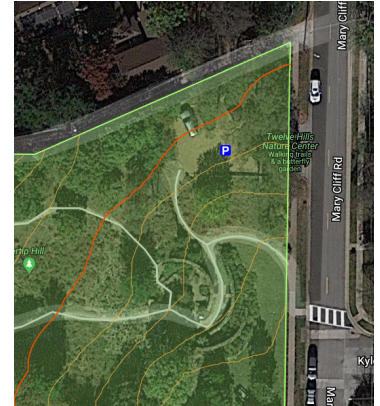
**What is a quick and easy way to find out how far we walked?**

**Additional Tools Needed:** Map (on p.4), 10ft of cord (pre-cut), calculator; available in the plastic box inside the Nature Center, in the southeast corner along the gray fence

### Background Information:

Take a good look at the map at the beginning of this packet. How can you use it to figure out **distance**? Do you have any ideas? You can use the **scale** on the map to help you **measure** along the trail. If you know how big an inch on the map is in the real world, you can measure anything you want!

Another way to figure out distance is to use math to **calculate the length of your stride** (how big your steps are). Follow the below activity to learn how.



### Activity:

Lay out the piece of **paracord (10ft long)**. The end closest to you will represent point “**A**” and the other end of the cord will represent point “**B**”. Walk from A to B and count how many steps it takes - make sure to take normal-sized steps, not giant strides.

Because the paracord is 10ft long, we can **divide** those 10ft by the number of steps you took to calculate the number of feet you travel with every step. Once you’ve figured out that number (your own personal **ft/step** measure) using a calculator, you can use this stride length to measure any unknown distance!

Choose another two points, anywhere you want - we’ll call them point “**C**” and point “**D**,” so we don’t get confused. C and D should be farther apart than the 10 feet covered by the paracord, but don’t worry about knowing exactly how big it is just yet - that’s what we’ll be measuring using our ft/steps number. If you can’t come up with a place to walk, try making a straight path across the top of the hill you are standing on, or walk between this stop (#3) and the previous stop (#2) for a larger distance.

Walk the chosen unknown distance, and **count** your steps as you do. Once you know how many steps are between C and D, **multiply** that number by your ft/step rate. This new number is a good estimate of the actual distance, measured in feet.

#### **Example:**

*An adult walks a known distance of 10 feet in 6 steps. This reduces to approximately 1.67 feet per step. The adult then walks an unknown distance and it takes 110 steps. Multiplying the foot per step value times the number of steps results in the distance 330 feet.*

$$\begin{aligned} 10 \text{ ft} \div 6 \text{ steps} &= 1.67 \text{ ft / step} \\ 110 \text{ steps} \times 1.67 \text{ ft / step} &= 183.7 \text{ ft} \end{aligned}$$

Both math and maps can be used to help humans figure out where they are, and how far they are traveling. These methods have been used by humans for hundreds of years, long before we developed the digital mapping technology we have today.

What else can you measure with this method? Come up with a few different ideas and try them out, recording your results!

Our **ANSWER** would be that you can measure **any** distance once you determine your own foot/step measure. A few places you might measure are a room in your house, the length of a city block, and anywhere else you’re curious about.



# How strong is flowing water?

(All Seasons | Grades 3-8) • **Map Stop 4** • Look for a small paved area with a wooden fence on one side. The creek is in a ravine on the other side of the fence.

Why did they use concrete to surround the banks of the creek? And where does all the water go when it rains?

## Background Information:

What is **concrete**? It's a mixture of a **cement** (any substance that binds materials together), water, and an **aggregate** (sand, crushed rock, or other small bits). You can have concrete of different strengths depending mostly on how much water and which minerals are in the mixture. The minimum concrete strength starts at 2,500 pounds per square inch. It makes a good barrier because it is able to withstand a good amount of force.



## Erosion:

Why do we have a concrete **barrier** here around the creek? When water travels down to and along rivers, it pulls things like dirt and rocks away from the path it travels along. Over time, water can pull a lot of material, which makes rivers and creeks wide and deep over time - this is how the Grand Canyon was formed! Any process by which material is gradually taken away like this is called **erosion**.

So what's the **ANSWER**? The concrete wall was built to hold the steep banks of the creek in place, to stop the water from eroding the bank. The wall will prevent the creek from removing soil from the surrounding yard, which would widen the creek and move its banks.

Erosion is alright when there are no buildings close by, but humans often build next to rivers. By using concrete, humans can help **slow down** creek bank erosion. The bank is stabilized so that the water can't pull so much dirt from the bank that it widens the creek. This prevents houses from falling into creeks - you can see the house across the creek as an example.

What else can slow down erosion? In many cases, planting the proper **plants** along creek banks and other places can stop erosion in its tracks, thanks to the way plants' extensive **root systems** hold together all of the dirt and rocks - acting like the cement holding together aggregate in a sort of living concrete! However, some plants can worsen erosion when put where they don't belong, which makes maintaining plant life and healthy **ecosystems** important for making sure waterways, soil, and shores stay safe.

## The Water Cycle:

When it rains, some water goes into the soil and is taken up by plants, or is soaked deep underground. But when the ground is compacted, full, or covered with roads or rocks, most of the water (whether rain, snow, or other **precipitation** falling from the sky) washes away as **runoff**. This means it travels across the ground, running downhill until it reaches a storm drain, or a creek or river, before eventually flowing into a larger body of water like an ocean or a lake.

This creek is part of a larger system of flowing water all flowing to one place, known as a **watershed** - specifically, the **Trinity Basin Watershed**. Rain water drains from high areas of the watershed to low areas, and finds its way to creeks like this one, which flows into Coombs Creek, then into the Trinity River, then to the Gulf of Mexico.

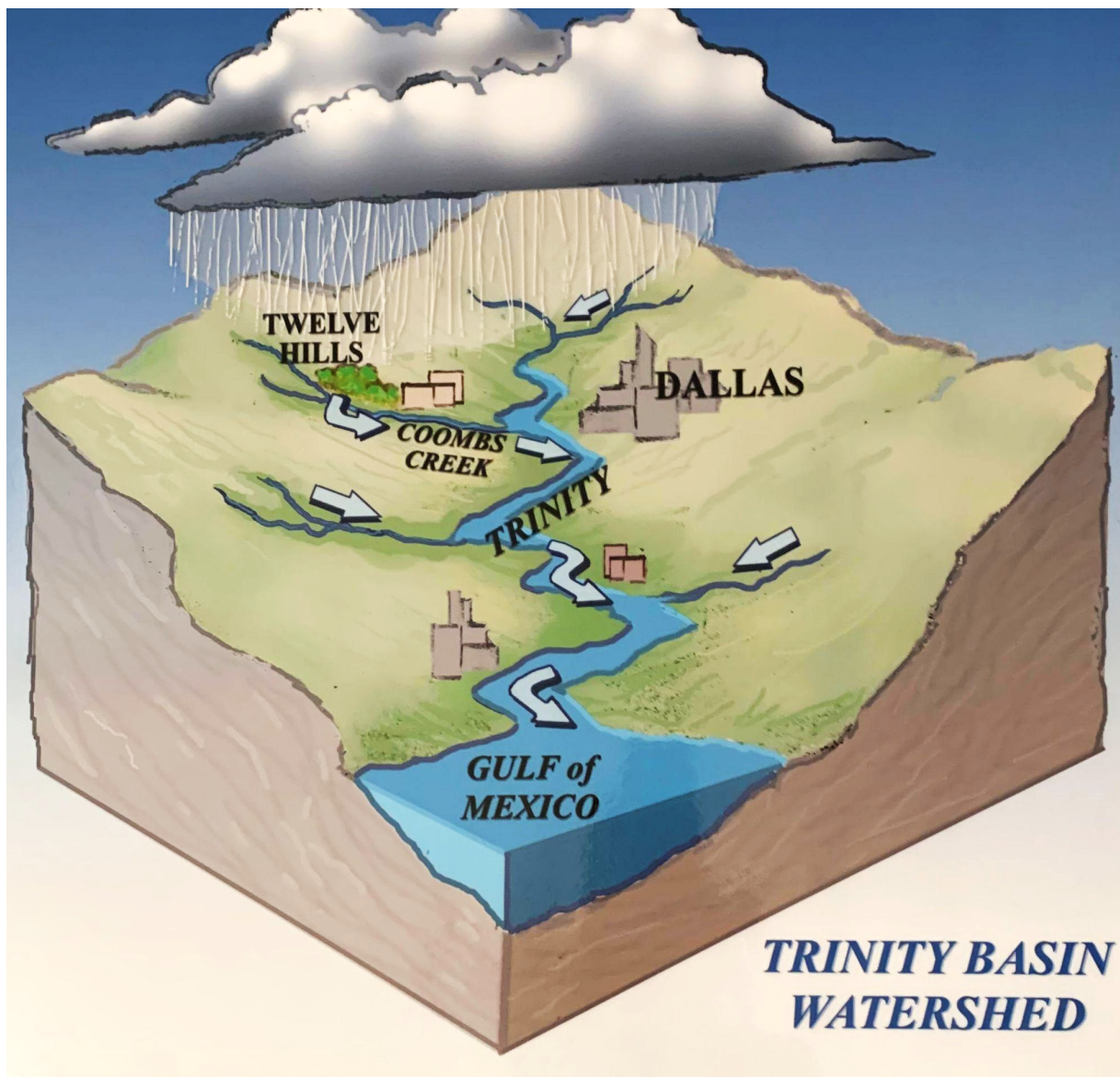




When the sun heats up creeks, rivers, lakes, and oceans, in any part of the watershed, some of the **liquid** water becomes water **vapor** (a **gas**, present in all the air we breathe), eventually rising up into the clouds and starting the cycle all over. The water vapor eventually comes down as precipitation like rain once again. The water you see in the creek is part of our **Water Cycle**, and has been a part of it for **millions of years**. That means we drink the same water that the dinosaurs drank, recycled over and over again!

### For the Activity:

Draw a picture that tells the story of this creek's water as it flows through the water cycle. Then, draw a picture of an area being affected by erosion, and what stories that process may tell. Use our illustration below as a helpful starting point! You may draw on the illustration provided, draw in your notepad or draw on the note sheets included at the top of this document if you printed them.







# Can you hear the cottonwood trees' leaves rustle in the breeze?

(Spring and Summer | Grades 2-8) • **Map Stop 4** • Opposite the creek, surrounded by the trail



## How loud can a tree be?

**Stop at one of the cottonwood trees** around the creek area during the spring and summer. Cottonwood leaves are almost heart-shaped, and the trees have white and fluffy catkins in spring and early summer (as seen in the pictures below).

*If you're visiting Twelve Hills at a time on a day without wind or leaves, scan the **QR code** or go to [youtu.be/HAV23m4mgeM](https://youtu.be/HAV23m4mgeM) to see a video of our cottonwood trees' leaves in action!*

## Background Information:

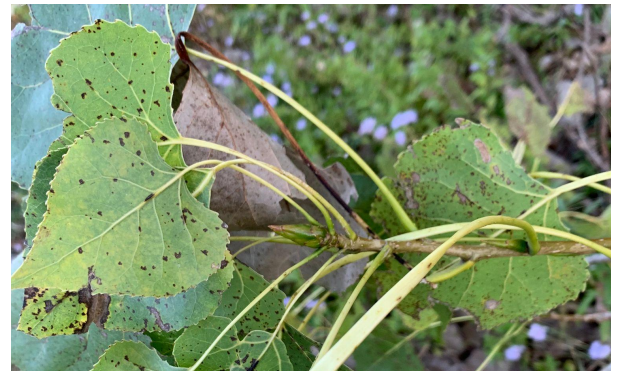
**Listen:** do you hear a rustling sound? How do you think the leaves are making this distinct noise?

They are channeling the **wind** in some way. Why don't all the trees around you make this sound? What is special about the cottonwood tree leaf shape or geometry that allows this tree to be this loud? Come up with a **hypothesis** of your own, and then read ahead for an answer!

Have an idea of an **ANSWER** yet? Look carefully around - you may find leaves that have fallen to the ground. Notice the long **stalk** that joins the flat leaf area to the stem - this is called the **petiole**. The cottonwood's long petiole is **flattened near the base of the leaf**. The wide flat edge of the petiole acts with the leaf to capture wind, like a little **sail**, so that even the slightest breeze can cause the leaves to move in a major way, causing that unique sound!

Why might it be helpful to be shaped like this? Look around you some more - do you see any fluffy white cottonwood **seeds** around? All that fluff helps cottonwood seeds spread out by sailing on the wind. Having petioles shaped to capture even *more* of the wind likely allows their seeds to be scattered further.

Leaf shape is one of the ways plants can **adapt** and change over time to fit the environment they live in. It probably wouldn't be useful for cottonwoods to have such big petioles and fluffy seeds if they grew somewhere without any wind, for example. Since the plants able to grow and spread best are the ones that are able to then keep growing, over time plants end up extremely well-suited to the place that they live!







### Activity:

Now that we know what a windy leaf might look like, design a leaf that can survive **cold, snowy weather**. Keep in mind the sorts of problems it might face - if snow piles up on this leaf, it might break; if it can't stay warm, the water inside might turn to sharp ice and hurt the plant. Make a few notes about how your design features allow the leaf to survive. If you want to go farther, you can also add adaptations to **other parts** of the plant to help it survive in a cold climate.

After you have your icy plant, try to design a leaf that can survive in the **dry, hot climate of a desert**. This leaf needs to be able to keep as much water in as possible, and protect the rest of the plant from getting sunburnt. Once again, you can add adaptations to other parts too to help the plant survive in a desert. Make a few notes about how your design features allow the leaf to survive. For one possible design that really exists in nature (and here at Twelve Hills), check out the **Yucca** stop!

If you're curious, try looking up real-life plants that grow in those areas. Do they have leaves that look like yours? How do you think their adaptations work?





# Can a tree feel like a cave?

(Spring, Summer, and Fall | Grades 2-5) •

**Map Stop 5** • Across from a bordering house, you'll see a large live oak

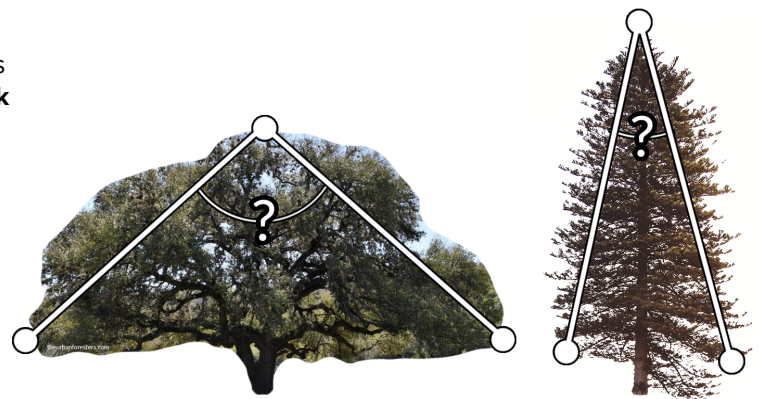
Why are trees important, especially for life in the city?

**Additional Tools Needed:** Air thermometers, and angle-o-trons, available in the plastic box inside the Nature Center, in the southeast corner along the gray fence. **Note:** for field trips, check with our team on organizing the amount of materials needed!

## Background Information:

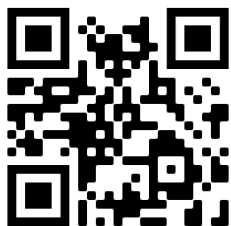
In hot cities like Dallas, old, established **trees** can help cool us by shading air and keeping it cold until wind can come and spread it around as a nice comfortable breeze. So what's the **ANSWER**? More so than smaller plants, trees keep us cool, and trees with leaves that block the most sun will be cooler underneath than trees that let in dappled light and do not fully block the sun. Trees also supply **food** for living things, keep the surrounding **soil** in place, absorb **carbon dioxide** and produce **oxygen**, provide **shelter** for animals, and create **shade** to sit under.

So now we know why this tree feels cool like a cave, but why is it shaped like one? The **angle** of the leaves and branches help low-growing trees like this **live oak** grow large and sprawling. They are arranged to maximize the amount of leaves exposed to the sun while still covering a wide area. You might notice that no leaves grow underneath the outer layer of the "cave," only appearing on the surface. This low, spread-out shape also helps keep these trees from blowing over in **high winds**. In fact, live oaks are particularly well-adapted to staying upright in strong storms - even hurricanes!



## For the Activity:

Using the provided **air thermometer**, you can see this effect for yourself by measuring the temperature both in the tree cave and out on the trail. Where is it cooler? Are some trees better at cooling than others? Note that this air temperature difference will be most dramatic in the **summer**!



Using the **angle-o-tron** tool, try to estimate the angle that the tree's canopy forms, measuring from its lowest, outermost leaves to its highest point (as in the illustration above). Are most angles acute or obtuse? Are there any right angles? For a video on using the tool, scan the QR code on the left.  
(Alternate link: [youtu.be/Dqm\\_4i0XxSM](https://youtu.be/Dqm_4i0XxSM))

What angle do you get? How does that angle compare to the other taller, more upright trees around you? What might be the benefit of growing in a taller, more narrow shape? Which type of tree shape do you think likely **grows faster**, and why?





# Yucca's Perfect Pom-Poms

(All Seasons | Grades 2-8) • **Map Stop 6** • Look around the cross path at the top of the hill. Please stay on the path! Fragile, tiny plants adapted to growing on limestone grow around this stop

## How is the yucca's geometry unique?

### Background Information:

This plant is a type of **yucca**. Yuccas have adaptations that allow them to grow in warmer, **drier climates**, like the desert. These adaptations help the plant conserve water.

The **spiky leaves** help collect rain, and the leaf tissues hold a lot more water than the leaves of other types of plants. The thick **waxy outer layer** of the leaves slows down evaporation. They are very different from the flat thin leaves on most other plants at Twelve Hills.

### For the Activity:

Compare the shapes you see in the yucca with the shapes you see in most of the other plants here at Twelve Hills. Do you notice anything else unique about their leaves?

**Do you have your ANSWER ?** Yucca leaves grow from the **center** of the plant in a **sphere-like shape**, to maximize sunlight reaching each leaf and increase the amount of energy it can produce through photosynthesis. This is different from many of the other large plants and trees at Twelve Hills, which have leaves growing from branches!

When older leaves die off, they gather around the lower parts of the growing trunk, creating a shaggy "**skirt**". The shade this skirt creates helps keep the plant cool, preventing it from drying out in the sun and letting it better conserve water.

As you walk through Twelve Hills, can you find any other plants or flowers that grow in sphere-like or other unusual shapes? What adaptations do you think might have resulted in those structures? Use the **chart** on the next page for our suggestions of what to watch out for, and to keep track of some of your observations!







Complete the chart below comparing the yucca with some of the other plants you see growing all around it. Write your answers and observations in the appropriate columns!

CHARACTERISTICS	YUCCA	OTHER PLANTS
ARE THE LEAVES STIFF OR FLOPPY?		
DO THE LEAVES HAVE SHARP POINTS THAT CAN POKE YOU OR ARE THEY SMOOTH?		
ARE THE LEAVES THICK OR THIN?		
DO THE LEAVES GROW FROM ONE CENTRAL PLACE OR FROM MULTIPLE PLACES ON BRANCHES AND STEMS?		
DO YOU HAVE ANY OTHER OBSERVATIONS?		



# What is a snag?

(All Seasons | Grades 2-8) • **Map Stop 7** • From the picnic table, look towards the back of the Twelve Hills, for a nearby, big, almost dead tree with a bat house on

What fraction of this particular tree is alive and what fraction is a snag?

**WARNING:** Please do not leave the trail to see the snag up close, the area surrounding the snag has poison ivy

## Background Information:

A tree that is still standing, but is dead or dying is called a **snag**. In urban environments, these trees are usually removed by humans, so that they don't hurt anyone when they do eventually fall.

However, it is often best for the environment to leave snags where they are if they don't pose a safety risk. A snag can benefit the environment in many different ways, including:

1. **A place to live** for animals like birds, bats, squirrels, mice, and insects that love to nest in its cracks and crevices
2. **A source of food** for bugs, lichen, mosses, and fungi living in snags (and any other wildlife who eat *them* in turn!)
3. **A temporary shelter** from weather
4. **A lookout perch**, where birds can look for prey, rest, or sleep for a bit
5. **A soil refresher**; as it decays, the snag will eventually return nutrients to the ground for new plants to use

Parts of this tree were broken off by strong winds in a storm several years ago. There are two limbs up high that are dead, but much of the rest of the tree is alive. Walk around the tree and look closely at them. There is at least one **hole** and cavity in each dead limb that has been made by a **red-bellied woodpecker**. Those woodpeckers (at right) can often be seen on the tree's limbs.



## For the Activity:

Take a close look at the snag near the Picnic Table tree. What **organisms** can you see on it, whether **animals**, **plants**, or **fungi** like mushrooms and lichen? What do you think they're doing there?

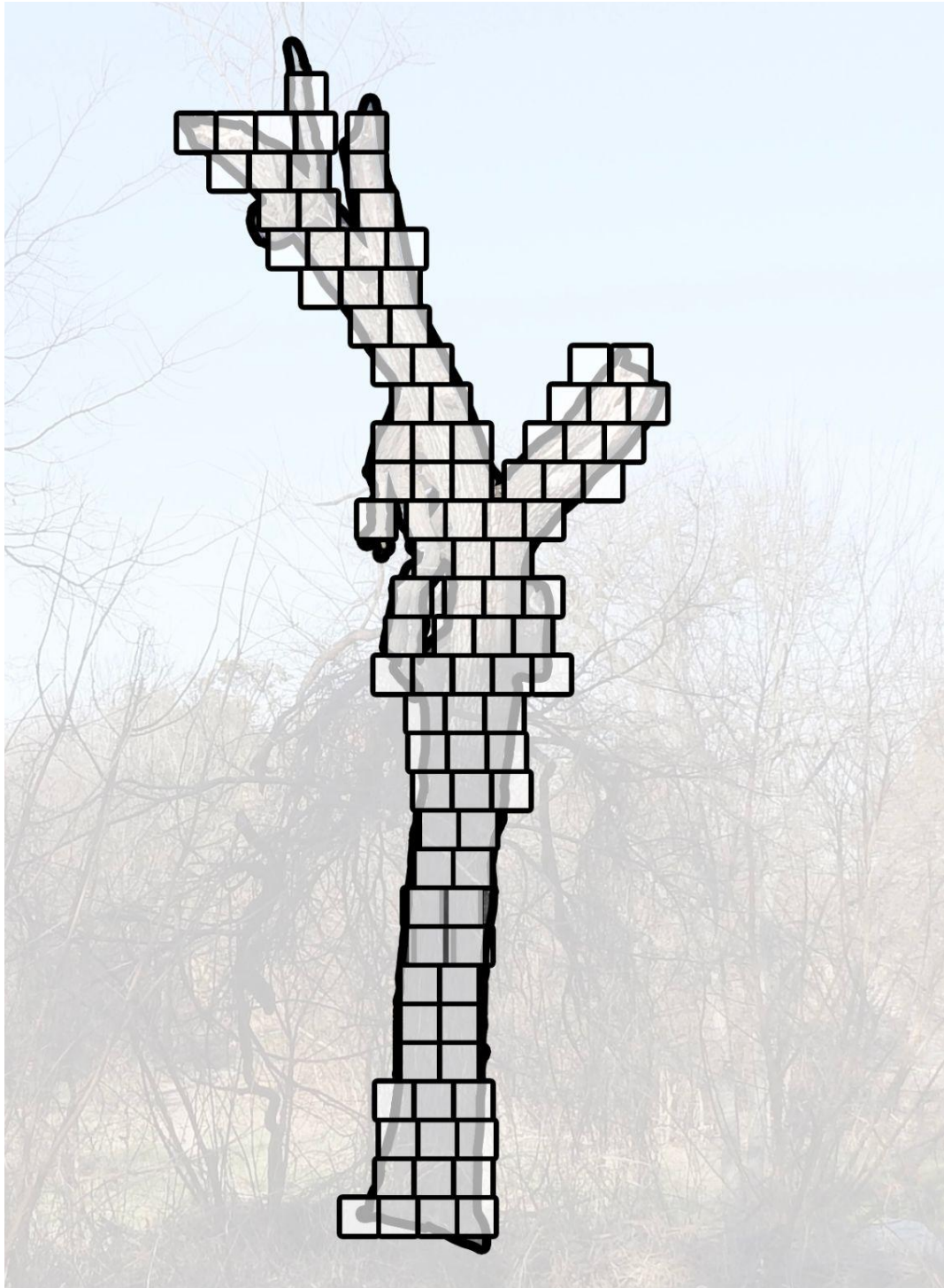
**Do you have an ANSWER?** We tend to spot woodpeckers, squirrels, lizards, and insects, often searching for food, like lichens and tiny organisms, and hide food (or themselves!) in crevices.





What **percentage** of the snag near the picnic table is dead wood? To make an estimate, use the grid below - walk around the tree until you're looking at the same side as the picture, and then shade in any squares that you think contain dead material on the tree. **Green leaves** indicate that that section is still living.

Since there's 100 squares, and percentages are just **a fraction out of 100**, the total number of shaded squares when you're done will be your estimated percentage!







# Bedstraw is sticking to me!

(March / April | Grades 2-8) • **Map Stop 7 & Fun Fact** • Bedstraw grows everywhere during spring, especially near the snag and parking lot

How is this plant well-designed to go home with you?

## Background Information:

Commonly called **bedstraw**, **cleavers** or **catchweed**, *Galium aparine* is an early spring plant closely related to coffee, visible approximately from late February through April. During colder springs, bedstraw may not emerge until a week into March. Bedstraw grows along the ground, with straggling square stems. Its leaves occur in a **whorled** arrangement around the stem. Stems with **tiny white flowers** grow from the whorls of leaves.



## For the Activity:

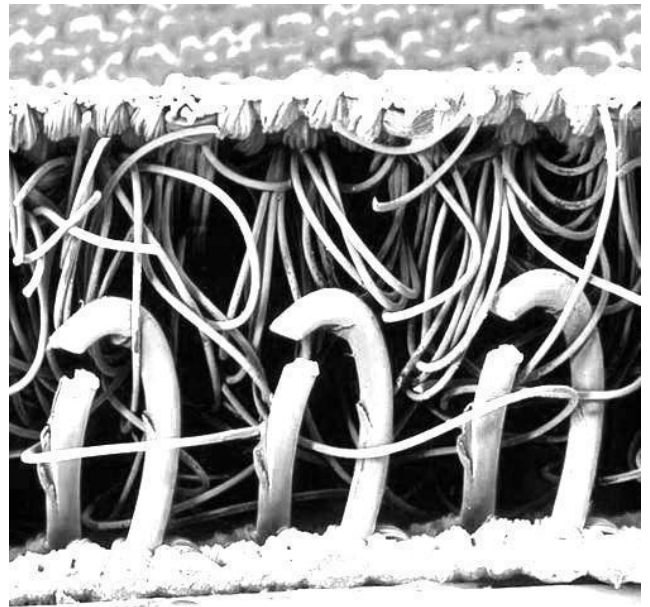
Use the map in the beginning of this packet to locate some bedstraw in the area between the yucca and the picnic table. This plant also grows in the parking area, along the wall close to the alley. It grows in many other places at Twelve Hills too - if you spot any during your walk, mark it down on your map!

Once you've found some, pull off a piece of the plant (just **two inches** or so will do the trick) and put it on your clothes. What happens? Why?

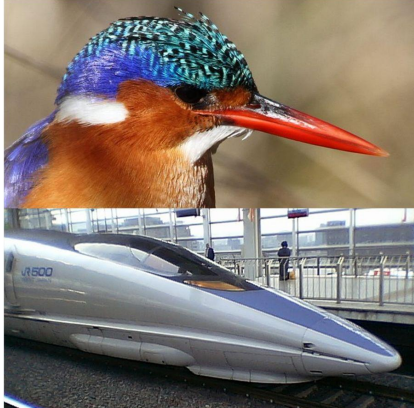
Have you found an **ANSWER**? The bedstraw **sticks** to your clothes! Look closely to see if you can spot what makes it stick. You should be able to spot a bunch of **tiny hooks** across its surface. How do you think these hooks help the plant to grow and spread?

These hooks help bedstraw seeds spread by sticking to animals passing by, and help bedstraw grip and climb above other plants while growing. Can you think of a man-made material similar to this plant? **Velcro** uses a similar set of tiny hooks paired with a fluffy second fabric to stick together! The inventor of Velcro, the Swiss engineer George de Mestral, was inspired by the hooks on **burdock** seeds, a plant with burrs and hooks similar to bedstraw, that stuck to him and his dog when they went out for hikes in the mountains. This burdock-inspired design is an example of **biomimicry** - the imitation of things in nature to develop human technology.

Can you think of other examples of biomimicry? We've included a few examples on the next page, but see how many others you can think of!







## High-Speed Trains

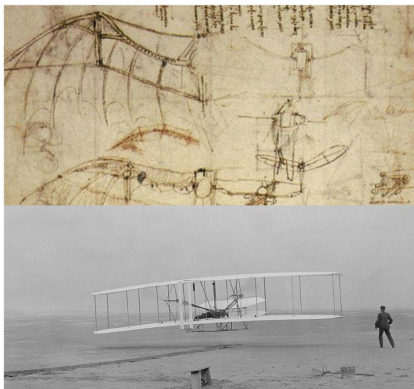
High-speed trains face a lot of difficulty overcoming drag from all the air they have to quickly pass through, and can create problematic sonic booms when exiting tunnels. To minimize this, Shinkansen 500 trains were modeled after the streamlined beak of a kingfisher.

Derek Keats, CC Attribution 2.0 Generic | Ercument Gorgu, CC Attribution 2.5 Generic

## Fabrics and Colors

Some organisms, like morpho butterflies and *Cyphochilus* beetles, appear iridescent or intensely-colored due to microscopic reflective structures like tiny, finely-tuned prisms. Thanks to designers and engineers, these structures have now been replicated in fabrics, paints, and makeup.

Didier Descouens, CC Attribution-Share Alike 4.0 International | Olimpia Illi, CC Attribution-Share Alike 4.0 International | Teijin Fibers Limited, Osaka, Japan



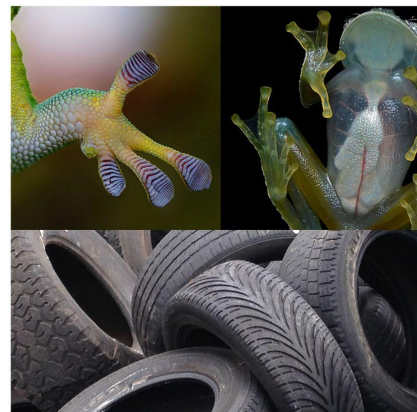
## Airships

Leonardo Da Vinci based his early glider shapes after bat wings, while the Wright brothers modeled their planes after pigeon wings. Modern planes also use bird-like designs to help shape their wing curvature.

## Extra Traction

Gecko feet are able to grip sheer glass without trouble, and frogs can climb slippery rocks even when wet. Both have been used as models to help develop more effective tires and climbing equipment in use today.

Geoff Gallice, CC Attribution 2.0 Generic







# Picnic Table Contemplations: Nature fuels innovations

(All Seasons | Grades 2-8) • **Map Stop 8** • Table on the Rosemont Primary School side of the meadow, by the entrance from Mary Cliff Road

How does this area compare to the other spaces in the Nature Center?

## Background Information:

Due to human interaction, this is not a wild ecosystem. If you look around, you can see things that are part of the **natural environment** (such as wild grasses, trees, rocks, snag, soil, etc.) and also **manufactured things** made by humans (such as houses, lawn grass, playgrounds, fences, patio furniture, schools, manufactured dirt, mulch etc.).

Twelve Hills used to hold an **apartment complex** (some of the bricks in the ground are there due to the apartment buildings), and has been converted back to a prairie - as most open areas once were in Dallas. However, since it is manmade and still surrounded by urban environments, the prairie never can quite be returned to its original state.

Many people are working hard to return the land as close to that original state as possible. When carefully tended to, we can help small pockets of “wild” land **survive and thrive** in midst of a city where it wouldn't ordinarily be able to on its own. Many **native prairie plants** continue to be planted by humans, and native wildlife is beginning to settle back in. The **trail** through the Nature Center, built and maintained by humans, makes the area easy to access with minimal disturbance to the environment, which means more people can **visit and learn**, and become interested in ways to help after spending time here. Although we can't build something exactly as nature does, we can build and protect spaces where nature can flourish, and work hard to fix what environments we have broken in the past. Just by coming to the Twelve Hills Nature Center and getting excited about what you discover here, you're already a part of something great! And with your **help and curiosity**, we'll be able to continue to cultivate and learn in the future.



## For the Activity:

Look around you; what differences do you see near the picnic table as compared to the prairie areas towards the entrance and across the trail, where you see land covered by grasses and flowers? What **observations** can you make about things that don't belong here? What observations did you make about **abiotic factors** throughout Twelve Hills?

What can humans do to create neighborhoods that protect nature? Is it necessary to get rid of natural environments to build neighborhoods? What would happen if everything was paved over, and there was little or no nature? How can we make a balance of nature and neighborhood in our own backyards?

You can see some of our thoughts and answers to these questions on the next page!





## OUR ANSWERS:

Notice that nothing is growing in the area surrounding the picnic table. The prairie areas surrounding the picnic table area are covered in a seasonally changing assortment of native grasses and wildflowers. These plants provide food and shelter for insects, butterflies and moths, native bees, spiders, etc., which provide food for birds, lizards, snakes, etc. They are essential to the food chain.

There are man-made items throughout Twelve Hills. Some include bricks, tile, rebar, etc. left from when buildings occupied the site. Some others are the picnic table, fences, and the rock entrance wall. At Twelve Hills, we've created a rich, diverse prairie among these manmade components.

It is not necessary to get rid of natural environments to build neighborhoods. Native plants can be included in backyards, medians, and any open space. Anyone is able to include many of these essential plants in their own outdoor space. Even a small strip, three feet by one foot, or a flower pot full of some native plants will provide sustenance for our native wildlife.

An excellent book with information on creating native habitat in your backyard or balcony is *Nature's Best Hope, A New Approach to Conservation that Starts in Your Yard*, by Douglas W. Tallamy.

