Activity Leader Guidebook

Bug Safari

CALIFORNIA ACADEMY OF SCIENCES

SCIENCE ACTION CLUB

This guidebook belongs to: _____

iNaturalist username: _____

iNaturalist password: **Jellyfish123**

Sunset moth
Chrysiridia rhipheus

Fall 2017

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WHAT IS SCIENCE ACTION CLUB?

Science Action Club (SAC) is a nationwide STEM program for middle school youth in out-of-school time. We provide afterschool staff with in-depth training, teaching kits, and best practices for informal STEM education. Our goal is to get middle school youth outside, connected to nature, and contributing to citizen science research.

What is Citizen Science?

Citizen science is a global movement in which scientists and the general public collaborate to answer some of the most pressing questions about our planet. Many big scientific questions require more data than one single scientist, or even a team of scientists, could collect. In SAC, youth will contribute to the iNaturalist database of observations. Through citizen science, anyone can learn the process of science and make valuable contributions.

What is iNaturalist?

iNaturalist is an online social network of people sharing observations of nature. This citizen scientist database is used by researchers to better understand and monitor global biodiversity.

School-day Standards

The activities in this guidebook support the Next Generation Science Standards (NGSS).

No Experience Necessary!

Just like citizen science, this guidebook is designed to be accessible to everyone, even those with little-to-no science background. Each activity plan includes step-by-step instructions and techniques for engaging youth in fun science exploration. The focus is on curiosity, investigation, and community. Through these experiences, youth and activity leaders learn and discover together.

Educator Portal

Visit sacportal.calacademy.org to access the *Bugs* online training and other helpful resources.

Giant African flower beetle
Mecynorhina polyphemus

SAC TERMS AND DEFINITIONS

Term	Definition	Notes and Examples
activity leader (AL)	Person responsible for leading SAC activities with youth	SAC activity leaders have many titles. Some are afterschool instructors, camp counselors, school teachers, and librarians. Throughout SAC materials, the term activity leader refers to anyone who leads Science Action Club with youth.
trainer	Person responsible for training and supporting SAC activity leaders	Your trainer is your main contact for support. Keep your trainer informed of any changes that come up or questions you may have about Science Action Club.
agency	Name of the organization that oversees your program	The agency might be an afterschool provider, a library system, a school district, parks and recreation, or any other organization through which Science Action Club is offered.
location	Name of the specific program or location that offers SAC	Many agencies have multiple locations. The Oakland Public Library system may offer SAC at several branches and the local YMCA may support several schools. The club location is the specific school, library, or site where SAC meets.
club	Group of youth participating in SAC	Sometimes there is more than one Science Action Club offered at a single location. For example, the Berkeley YMCA at Roosevelt Middle School may run one club with grades 5-6 and another with grades 7-8. In this case, the agency is Berkeley YMCA, the location is Roosevelt Middle School, and there are two clubs at that location.
online training	Required training accessible through the SAC Educator Portal	This interactive training covers all 12 SAC activities, important science concepts, and teaching strategies for the informal STEM learning environment.
activity leader training (ALT)	Required in-person training led by a SAC trainer	This workshop provides hands-on practice for leading the *Bug Safari* curriculum with youth.

TIMELINE OF EXPECTATIONS

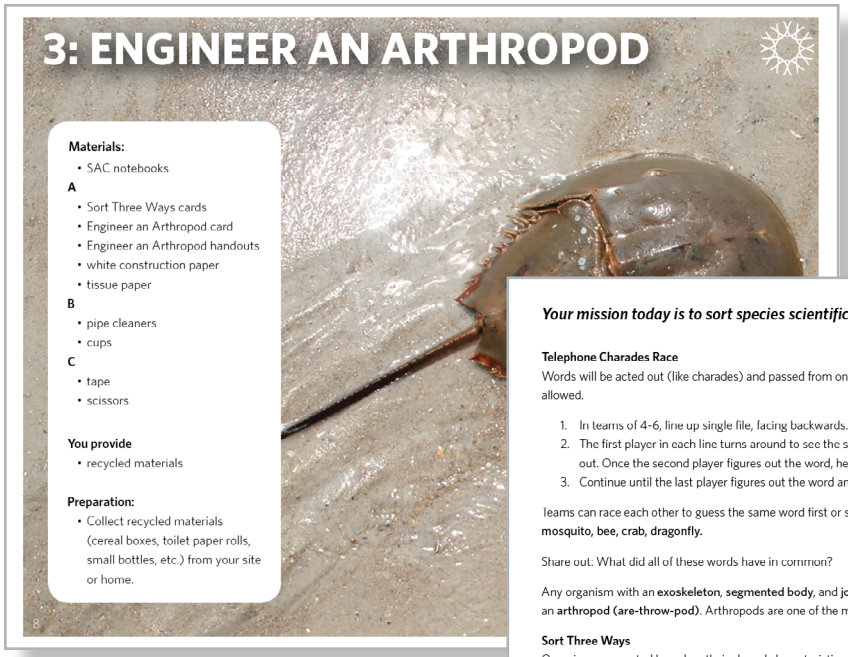
Expectation	Description	Due Date
Complete the online training	This required online training will help you succeed as an activity leader. Use the SAC guidebook to follow along. You must complete this training in order to be eligible to receive the SAC activity guidebook and kit. To learn how to navigate the SAC Educator Portal, see the Guide to the SAC Educator Portal (written guide or video).	Before the ALT
Attend the ALT	Practice leading activities, test out the kit materials, and trade teaching tips with other SAC activity leaders at this required in-person workshop.	Dates vary
Identify an outdoor location	You are responsible for finding an outdoor space where youth can look for arthropods. Ideally, the space should not be more than a five-minute walk from where your club meets. Ask your program supervisor for support, if needed.	Two weeks after the ALT
Secure technology equipment	In order to participate in citizen science, your club will need at least one mobile device and a working internet connection. A projector and speakers are also highly recommended. Check with your supervisor to make sure you have access to technology during Science Action Club.	Two weeks after the ALT
Recruit youth	SAC is more fun when the club is full. You are responsible for recruiting 15-20 youth and maintaining strong attendance. Use the *Youth Program Flyer* template to help with publicity.	Two weeks after the ALT
Connect with families	Once youth are enrolled, send home a letter introducing Science Action Club. Use the *SAC Letter to Families* template. Download and edit the template to fit your audience and include your own details.	Two weeks after the ALT
Lead Science Action Club activities	There are 12 *Bug Safari* activities. To prepare for each activity in advance: • Read activity instructions in the guidebook. • Gather the materials needed. • Revisit the online training, if necessary.	After your kit arrives Complete all activities by __/__/____

Expectation	Description	Due Date
Submit citizen science observations	Citizen science is an essential part of Science Action Club. Please submit club lists to iNaturalist regularly. Your trainer and the SAC Team will periodically check for your club's observations on iNaturalist. If you need access to your iNaturalist account, contact your trainer for the username and password. Never change the username or password of your iNaturalist account, as both your trainer and the SAC team need access to your account. If you need help navigating iNaturalist, check out How to Make an Observation on iNaturalist.	During Activities 4-12
Provide feedback	You are responsible for submitting Attendance and Feedback after each *Bug Safari* activity. You can do this using the hyperlinks or QR codes in the guidebook, or by accessing Activity Leader Resources on the SAC Educator Portal.	After completing each activity
Administer the SAC Youth Survey	You are responsible for administering the *SAC Youth Survey* during Activities 9, 10, or 11. Let your trainer know when this is complete. All clubs that complete the survey will be entered into a raffle for special prizes.	During Activities 9 - 11 Completed surveys are due by __/__/____
Host a site visit or complete a phone interview	You may be asked to participate in a SAC site visit or phone interview. If you are selected to participate in a site visit, please help arrange the visit with your trainer. Contact your supervisor for help. If you are selected to participate in a phone interview, please help arrange the call with your trainer. Contact your supervisor for support. Ensure you have a quiet space to make the call.	As needed
Celebrate!	Invite your trainer to stop by your last SAC session and celebrate with your club. Remember to print and sign SAC certificates of success.	

ACTIVITY SUMMARIES

Title	Activity Mission	Materials You Provide
Activity 1: Field Study	Discover the wild things that live in your environment.	-
Activity 2: Observe Like a Scientist	Use scientific tools to observe your surroundings and create an expedition map.	-
Activity 3: Engineer an Arthropod	Sort species scientifically and construct an anatomically correct arthropod.	Recycled materials
Activity 4: Tools of the Trade	Learn how to use research tools and become an expert at collecting arthropods.	Penny, scratch paper
Activity 5: Arthropod Apartments	Investigate arthropod habitats and do citizen science.	One small potted plant, sticks, rocks
Activity 6: Color Your Camouflage	Explore camouflage and the relationship between predator and prey.	-
Activity 7: Habitat Health	Explore how changes in the environment can affect arthropods.	-
Activity 8: Pollination Station	Explore how arthropods and plants are connected through pollination.	-
Activity 9: Indestructible Web	Weave an indestructible web inspired by spiders.	Small items such as erasers, paper clips, etc.
Activity 10: Map the Habitat	Survey and map the conditions of an outdoor area near you.	-
Activity 11: Critter Chronicles	Analyze the data you collected during your *Bug Safaris*.	-
Activity 12: Food for Thought	Design a way to sustain arthropods in your surroundings.	Photocopies, snack foods, recycled materials

HOW TO USE THIS GUIDEBOOK



3: ENGINEER AN ARTHROPOD

Materials:

- SAC notebooks

A

- Sort Three Ways cards
- Engineer an Arthropod card
- Engineer an Arthropod handouts
- white construction paper
- tissue paper

B

- pipe cleaners
- cups

C

- tape
- scissors

You provide

- recycled materials

Preparation:

- Collect recycled materials (cereal boxes, toilet paper rolls, small bottles, etc.) from your site or home.

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Check the activity title page before your club meets for a list of all materials and preparation.

"A" indicates materials found in Bag A of the kit.

Some activities require additional materials that you need to provide.

Share each activity's mission statement with youth.

Your mission today is to sort species scientifically and engineer your own arthropod.

Telephone Charades Race 10 min. | inside

Words will be acted out (like charades) and passed from one person to the next (like telephone). No sounds or lip-syncing allowed.

1. In teams of 4-6, line up single file, facing backwards.
2. The first player in each line turns around to see the secret word (written on a card), then taps the next player and acts it out. Once the second player figures out the word, he or she turns to tap the next player.
3. Continue until the last player figures out the word and calls it out. Play up to three rounds.

Teams can race each other to guess the same word first or start with different words. Secret words: **butterfly, spider, lobster, mosquito, bee, crab, dragonfly.**

Share out: What did all of these words have in common?

Any organism with an **exoskeleton**, **segmented body**, and **jointed arms and legs**—such as spiders, butterflies, and lobsters—is an **arthropod (are-throw-pod)**. Arthropods are one of the most abundant types of creatures on the planet.

Sort Three Ways 20 min. | inside

Organisms are sorted based on their shared characteristics into scientific groups, like the large group of arthropods. Similar characteristics tell us that animals might share a common ancestor, like humans and apes.

1. Divide into two teams, each with one set of Sort Three Ways cards. Examine your cards.
2. Sort the cards into **three** groups based on the type of animal.
3. These creatures can also form smaller groups with shared characteristics. As a team, try to sort your cards more specifically. Keep track of your groupings in your notebook.

Share out: How did you sort your cards? What characteristics did you use? What other ways could you group these creatures?

Engineer an Arthropod

Imagine you could engineer a brand-new arthropod. What would it look like? How would it surv

Time estimates and location suggestions are provided for each part of the activity.

Additional tips for activity leaders are included to the right of the dotted line.

1. Working independently or in pairs, select an Engineer an Arthropod card for your arthropod to live in.
2. Brainstorm ideas using the Engineer an Arthropod handout. Your arthropod must:
   - Have all 3 essential arthropod characteristics: exoskeleton, segmented body, and jointed arms and legs.
   - Have the right body parts to eat one (or more) of the food sources listed on your card.
   - Be able to hunt or hide in that environment.
3. Use color construction paper, tissue paper, pipe cleaners, and the recycled materials available to design an arthropod suited for your location.
4. Present your arthropod and describe its environment, body shape, food source, and special abilities.

- **To help get started, practice with one Engineer an Arthropod card together as a club.**
- **Remember, arthropods are more than just insects. Check out the horseshoe crab photo on page 8.**

Explore More: *Arthropod Music Video*

Explore More: Get down with arthropods with the *Arthropod Music Video*.

Call to Action: As you explore your neighborhood, notice how the organisms you see compare to each other. For example, what characteristics make a pigeon the same as or different from a dog?

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This icon indicates a media link. Scan the QR code to access videos and other digital content. In the digital guidebook, you can also click the hyperlink.

KIT MATERIALS

A

1 set	*Arthropod Puzzle* cards
10 sheets	*Biodiversity Bingo* grids
1	*Bug Safari* and iNaturalist guide
1 set	*Camouflage Standoff* cards
2 packs	color construction paper
5 sets	*Color Your Camouflage* cards
2 sets	*Creature Catch Phrase* cards
1 set	*Engineer an Arthropod* cards
20	*Engineer an Arthropod* handouts
2 sets	*Indestructible Web* cards
2 sets	*Map the Habitat* cards
1 set	*Pollination Station* cards
6 sheets	*Pollination Station* data
1 set	*Race for Resources* food tokens
20	SAC certificates
30	SAC stickers
4 sets	*Taxonomy* cards
60 sheets	tissue paper
1 set	*Tools of the Trade* station cards
20 sheets	white construction paper

B

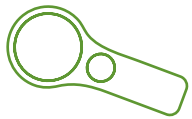
3	brushes
20	cups
80	paper straws
20	pipe cleaners (long)
120	pipe cleaners (short)
40	rubber bands
1 roll	string

C

2 packs	crayons
5	scissors
1 stick	sidewalk chalk
5 rolls	tape

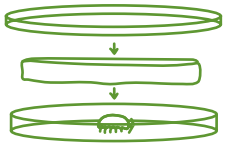
D

10	magnifying lenses
1	magnifying loupe



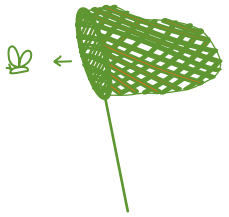
E

10	filter papers
10	paper plates
14	pH strips
2	thermometers



F

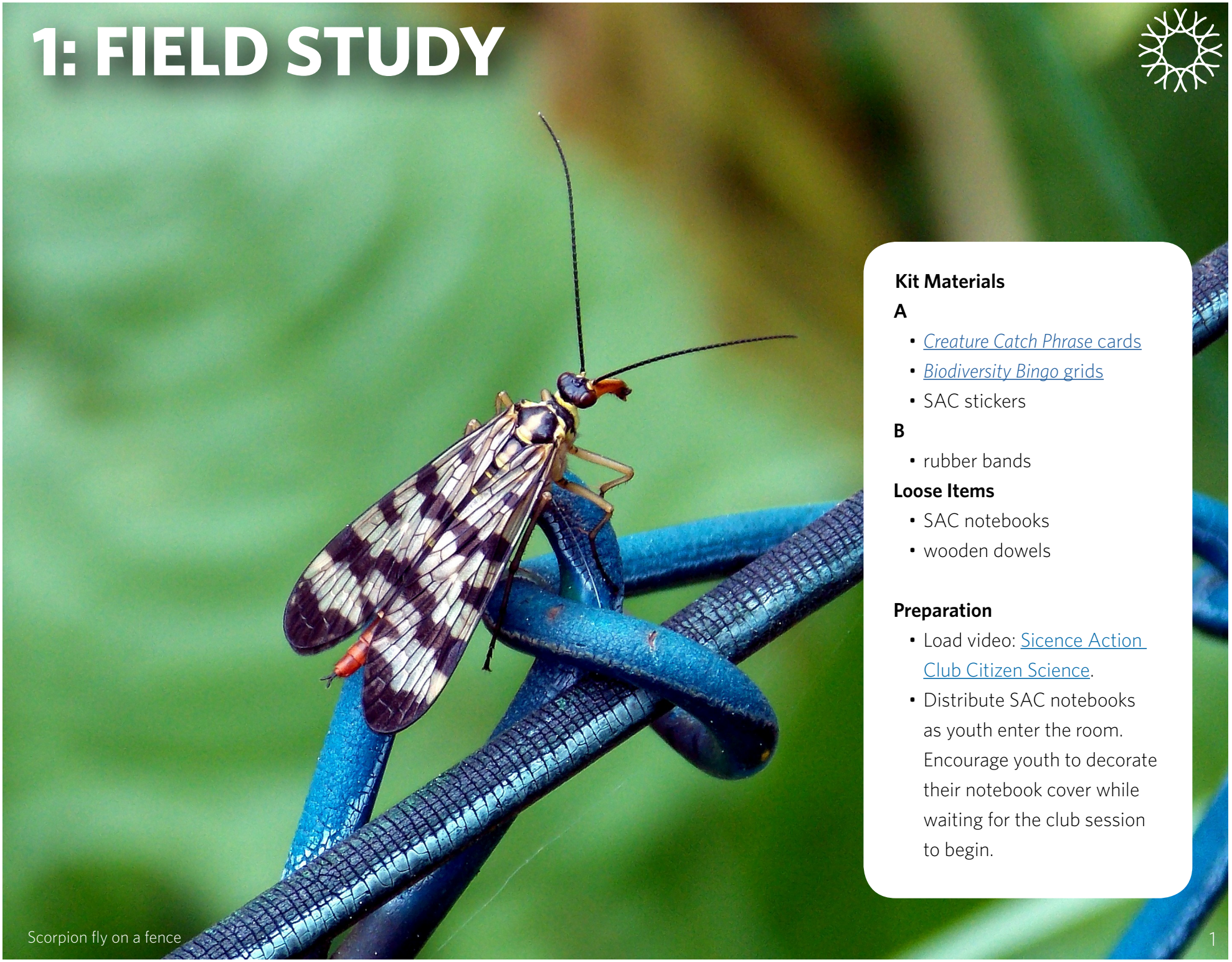
8	foam circles
8	petri dishes



Loose Items

1	aerial net
2	beating sheets
1	*Bugs* guidebook
20	*Bugs* buttons
20	pine cones
5	pooters
20	SAC notebooks
40	wooden dowels

1: FIELD STUDY



Scorpion fly on a fence

Kit Materials

A

- *Creature Catch Phrase* cards
- *Biodiversity Bingo* grids
- SAC stickers

B

- rubber bands

Loose Items

- SAC notebooks
- wooden dowels

Preparation

- Load video: Sicence Action Club Citizen Science.
- Distribute SAC notebooks as youth enter the room. Encourage youth to decorate their notebook cover while waiting for the club session to begin.

Your mission is to discover the wild things that live in your environment.

10 min. | inside

Creature Catch Phrase

Describe the word on your card until your team can guess what it is.

1. Divide the club into two teams and give one set of *Creature Catch Phrase* cards to each. Form a circle with your team.
2. The first player will describe the word on the first card.
3. Once it is guessed, quickly pass the deck to the next person.
4. After two minutes, the team with the most words guessed wins. Play at least two rounds.

Our surroundings are crawling with life. Creatures large and small make their home in buildings, yards, and gardens, but we need to look closely to find them. Your goal is to discover, identify, and share out about these creatures.

5 min. | inside

Science Action Club Citizen Science

Why Take on This Mission?

Scientists don't know exactly which non-human life forms exist near you or how they might affect the environment. You can help answer that question! In Science Action Club, you will learn how to be a citizen scientist and conduct important research to share with the scientific community. You will collect specimens, identify them, and compare your results with other Science Action Clubs around the country to better understand and protect our planet.

Watch the Science Action Club Citizen Science video (2 min.) to learn more about your mission.

20 min. | outside

Biodiversity Bingo

Your goal is to discover organisms to match each description on your *Biodiversity Bingo* grid. An **organism** is a living thing, such as an animal or a plant.

1. Work in pairs to scan an area, such as a field or yard, and identify locations with living things.
2. Look for organisms that match the descriptions in the *Biodiversity Bingo* grid. When you find one, sketch or describe the organism on the grid.

When you introduce an unfamiliar word to the group, ask them to repeat it after you. This can help remember the word better.

Share out: Take turns to present your discoveries. What was easy or hard to find? Why?

Focus Your Findings 25 min. | outside

Now that you have strengthened your observation and recording skills, use a quadrat to explore a single location in extreme detail. A **quadrat** is a square frame that marks off a study area.

1. Divide into 10 teams. Each team will build a quadrat by connecting four wooden dowels with rubber bands.
2. Place or toss your quadrat on your field site.
3. Observe everything inside the quadrat. Make a list or draw and label quick sketches of what you find. Notice size, color, shape, and any special features.
4. If you have time, study several locations.

Remind youth that this is not a race or competition; it is a chance to slow down and look closely.

Share out: Which places had the most life? What did the teams find most often? What were the most interesting things you found?

Count up the total number of different living things you discovered. This is known as the **biodiversity** of the field or yard you chose. Biodiversity comes from the Greek words **bios**, which means *life*, and the English word **diversity** means *many different forms*.

Explore more: See how all life is connected in Habitat Earth.

Call to action: As you walk around your neighborhood, keep an eye out for living things in your environment. Check the nooks and crannies of buildings and sidewalks, or survey your local park to see what you can find. Whenever possible, stop to sketch, photograph, or write down what you see.

Explore more: Habitat Earth

How did it go? Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

2: OBSERVE LIKE A SCIENTIST

Kit Materials

A

- white construction paper

B

- string

C

- crayons
- scissors

D

- magnifying lenses

Loose Items

- SAC notebooks
- pine cones

Preparation

- Cut string into 1 foot sections—1 per pair.

A tray of specimens at the California Academy of Sciences

Your mission today is to use scientific tools to observe your surroundings and create an expedition map.

I Spy Science 5 min. | inside

Choose one object around you and describe it in detail, but don't name it.

1. Work in pairs and see how quickly your partner can identify and point to your object.
2. Take turns describing and guessing until time runs out. Play for three minutes.

Share out: What do you think is the difference between seeing and observing? What does it mean to observe something scientifically?

Observe Like a Scientist 20 min. | inside

A **magnifying lens** is a tool that scientists use to look closely at objects. Where have you seen or used one before? What does it do? In this challenge, you will use a magnifying lens to examine a pine cone in detail, then try to pick yours out of a crowd.

1. Give everyone a pine cone. Share the magnifying lenses.
2. Hold the lens directly in front of your eye. Move the pine cone closer or further until its details come into focus.
3. Observe your pine cone closely with and without the magnifying lens. In your notebook, record detailed information that would help you find your pine cone in a crowd.
4. Put all of the pine cones on a table, mix them up, and try to find yours using your notes. For an added challenge, try to find someone else's pine cone using their notes.

Share out: If you were to do this again, what would you do differently? What new information would you record?

Shrunken Expedition 35 min. | outside

Imagine the California Academy of Sciences has invented a machine that shrinks humans to the size of ants. They plan to send a group of tiny ant-sized scientists to investigate what the world is like from an ant's point of view.

They need your help to identify a good research location and create a map for the scientists to follow. Remember, at that scale, things that seem small to us could look huge. A tiny puddle could seem like a vast ocean, a rock might look like a mountain, and a flower would appear as a tree.

1. With a partner, choose an area outdoors and use your string to lay a path for the scientists to follow. Use a magnifying lens to help you look closely.
2. Draw a map that describes the path in detail on white construction paper. For example, scientists may need to climb up a cliff, swim across a lake, or traverse a great valley.
3. Label any areas that could endanger the scientists. Assume they have equipment to help them safely through the journey (for example: climbing gear, boats, ropes).
4. Present your map and describe your path.

- **Possible expedition locations for youth: a tree, a pile of leaves, a large rock, a gutter, underneath a bush, a patch of grass, etc.**
- **Show youth the example map for inspiration.**
- **Your elbow to wrist is about a foot; it doesn't have to be exact.**

Explore more:
Macro Color

Big Pictures, Tiny Creatures

Share out: What were the most challenging obstacles or interesting adventures for your tiny scientists?

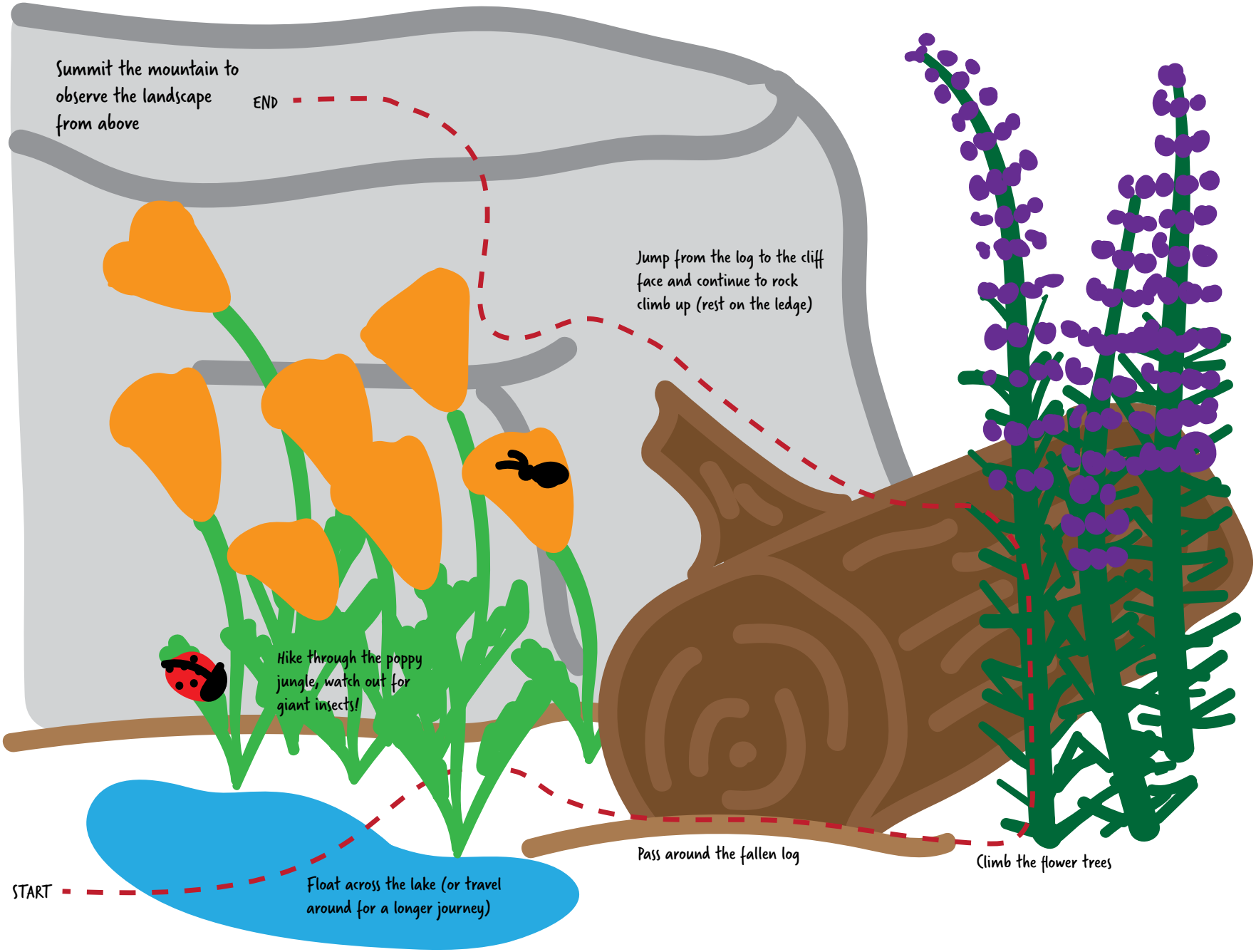
Explore more: Take a closer look with Macro Color and explore the Academy's collections through Big Pictures, Tiny Creatures.

Call to action: Now that you're a seasoned science observer, be on the lookout for small details in your home and around your school. Try to create a map for tiny scientists to explore your kitchen or locker.

How did it go?
Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

Shrunken Expedition map example



3: ENGINEER AN ARTHROPOD

Kit Materials

A

- *Engineer an Arthropod* cards
- *Engineer an Arthropod* handouts
- *Taxonomy* cards
- color construction paper
- tissue paper

B

- pipe cleaners (short only)
- cups

C

- tape
- scissors

Loose Items

- SAC notebooks

You provide

- recycled materials

Preparation

- Write the secret words on index cards.
- Collect recycled materials (cereal boxes, toilet paper rolls, bottles, etc.) beforehand.

Horseshoe crabs are an example of an arthropod

Your mission today is to sort species scientifically and construct an anatomically correct arthropod.

Telephone Charades Race 10 min. | inside

Words will be acted out (like Charades) and passed from one person to the next (like Telephone). No sounds or lip-syncing allowed.

1. In teams of four to six, line up single file, facing backwards.
2. The first player in each line turns around to see the secret word, then taps the next player and acts it out. Once the second player figures out the word, he or she turns to tap the next player.
3. Continue until the last player figures out the word and calls it out. Play up to three rounds.

Secret words: butterfly, spider, mosquito, crab, grasshopper, dragonfly (or choose your own)

Sort it Out 20 min. | inside

Scientists organize living things based on similarities and differences. Practice this using the *Taxonomy* cards provided.

1. Divide into four teams, each with one set of cards.
2. Sort the animals on the cards according to any characteristics you like, except color or size.
3. When you finish, choose a new characteristic and sort again.
4. See how many different ways you can sort the animals in 15 minutes.

- **Allow five minutes for first sort (into birds, mammals, and arthropods), and 10 minutes for second sort.**
- **Encourage youth to notice size, color, shape, and types of body parts.**

Share out: What characteristics did you use to sort the animals? How did you handle any disagreements that came up within your team?

Shared characteristics present clues about how species are related. For example, any organism with an exoskeleton, segmented body, and jointed arms and legs is an **arthropod** (are-throw-pod). Arthropods, such as spiders, butterflies, scorpions, and crabs, make up 80% of all animals and 75% of all living things on our planet.

Engineer an Arthropod 30 min. | inside

Imagine you could engineer a brand-new arthropod. What would it look like? How would it survive in the wild?

1. Working independently or in pairs, select an *Engineer an Arthropod* card to determine your arthropod's environment and sources of food.
2. Use the *Engineer an Arthropod* handout to brainstorm ideas for how your arthropod might look. Each arthropod must have:
   - All three essential arthropod characteristics: an exoskeleton, a segmented body, and jointed arms and legs.
   - The right body parts to eat the food sources listed.
   - The right features to hunt or hide in the environment.
3. Use the materials available to construct your new arthropod.
4. Present your arthropod to the group. Describe the body parts and features that would help it survive in its environment.

- **To help get started, practice with one *Engineer an Arthropod* card together as a club.**
- **Remember, arthropods are more than just insects. Check out the horseshoe crab photo on page 8.**

Explore more: Sing and dance to this Arthropod Music Video.

Call to action: Notice features that make the organisms in your neighborhood similar to or different from each other. How many different ways could you sort these organisms?

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

4: TOOLS OF THE TRADE

Magnified view of a house fly

Kit Materials

A

- *Tools of the Trade* station cards
- *Bug Safari* and iNaturalist guide

B

- brushes
- paper straws

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- pooters
- beating sheets

You provide

- digital device (with camera)

Preparation

- Load video: How to Do a *Bug Safari*.
- Set up the six tool stations.

Your mission today is to learn how to use research tools and become an expert at collecting arthropods.

5 min. | inside

Dream Job

Think about your ideal job.

1. In your notebook, list the tools you would need for that job.
2. Compare your list with a partner.

Share out: What types of tools do different jobs require? Why are these tools necessary?

15 min. | inside

Tools of the Trade

At the California Academy of Sciences, citizen scientists like you collect organisms from nature to learn about the diversity of life on Earth. They use scientific tools to gather and examine organisms carefully.

Follow the *Tools of the Trade* station cards to practice using the collection tools. The tools will be organized into stations. Visit the tool stations in small groups. Each group spends a few minutes at each station.

- Aerial Net: Move your net back and forth in the air where you see flying arthropods. Twist the net a little so that whatever you catch doesn't fly out.
- Beating Sheet: Place or hold the beating sheet under a bush or tree branch, then gently shake or tap the plant so arthropods fall out.
- Pooter: Put the metal end of the tube next to an arthropod. Inhale through the straw attached to the rubber tube until the arthropod is in the jar. A small net blocks arthropods from entering your mouth. Do not share straws.
- Brush, petri dish, and foam: Place a petri dish close to an arthropod and use a brush to gently coax it into the dish. Place the foam gently on top to secure the arthropod in place. Avoid touching arthropods with your hands.
  Note: Do not use a petri dish with live moths and butterflies because it can damage their wings. Never destroy a web to collect a spider. Instead, just take a photo.
- Loupe and camera: Place the loupe directly onto the petri dish so that you can look through it and see the arthropod in the center. Focus the loupe first, then hold the camera lens directly against it. Make sure the lens focuses on the arthropod before you take a photo. Shine a light sideways on your arthropod to get a better quality image.
- Magnifying lens: Hold the lens between your eye and the object you want to observe. Move the lens closer to or further from your eye until the object's details come into focus.

Share Out: Which tool was most difficult to use? What questions do you still have about the tools? Are there any strategies that you discovered while using the tools?

Bug Safari

30 min. | outside

Watch How to Do a *Bug Safari* (2 min.). Now you are ready for your first *Bug Safari*. Each time you record observations, be sure to note where you are looking.

How to Do a *Bug Safari*

In teams, use your tools to gently collect arthropods. Use a digital device to take photos. Then, release the animals.

Look under logs and bricks, behind sheds, under or near benches. Be sure to trade collection tools and record what you find in your notebooks. Collecting will get easier with practice.

Bug Safari keys to success:

- Be careful not to injure the animals. As scientists, it is important to treat every specimen with respect and protect life wherever possible.
- Always use tools—not your hands—to collect arthropods. Always use an empty petri dish for each arthropod.
- Return everything—dead or alive—when you are done. If your arthropod is alive, get as close as possible to the spot where it was collected. Coax it out of the petri dish onto the ground. Do not drop it from above.

Critter Chronicles

10 min. | outside or inside

It is important for scientists to document their research experience. As a club, you will create a *Critter Chronicles* video to summarize your findings for each *Bug Safari*. Have fun with your video! Try different presentation styles and formats like a news report, talk show, or nature documentary. In Activity 11, you'll watch all of your *Critter Chronicles* videos to review what you've discovered, so be specific.

Record a 1-2 minute *Critter Chronicles* video. Make sure to:

1. Describe your procedure. Where did you go? What did you do?
2. Report on your findings. What types of arthropods did you collect? How many? Where?
3. What challenges came up when trying to collect? What strategies would you recommend for next time?

Make sure to save each video on your digital device so that you can watch them again in Activity 11.

From now on, remember to record a *Critter Chronicles* video after each *Bug Safari*.

Explore more: Observe Nature with iNaturalist

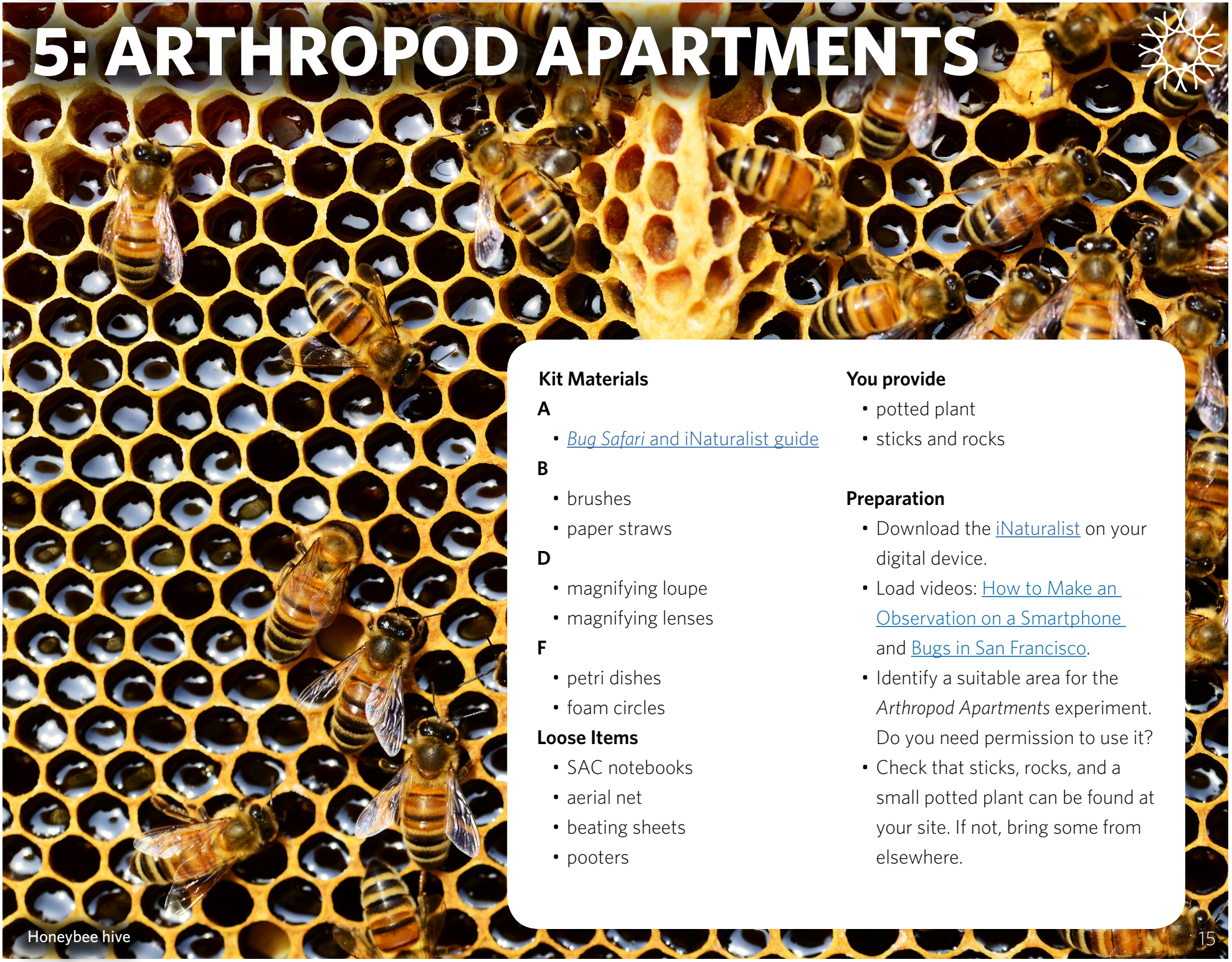
Explore more: Next time, you'll upload your photos so that other scientists can help identify them. Watch Observe Nature with iNaturalist to see what to expect.

Call to action: Scientists are always looking to improve their techniques. Try to invent a new tool or method to help you collect arthropods.

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

How did it go? Let us know!

5: ARTHROPOD APARTMENTS



Honeybee hive

Kit Materials

A

- *Bug Safari* and iNaturalist guide

B

- brushes
- paper straws

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

You provide

- potted plant
- sticks and rocks

Preparation

- Download the iNaturalist on your digital device.
- Load videos: How to Make an Observation on a Smartphone and Bugs in San Francisco.
- Identify a suitable area for the *Arthropod Apartments* experiment. Do you need permission to use it?
- Check that sticks, rocks, and a small potted plant can be found at your site. If not, bring some from elsewhere.

Your mission today is to study arthropods and do citizen science.

25 min. | outside

Bug Safari

Review the arthropod collection tools and techniques, then get started.

1. Collect arthropods in your search area.
2. Take photos.
3. Release arthropods.
4. Record your *Critter Chronicles* video.

Share out: Where did you find arthropods? What features of those locations seem to make a good home?

20 min. | outside or inside

Citizen Science and iNaturalist Introduction

iNaturalist is an online community where citizen scientists—like you!—can share their observations of any kind of organism. When you upload your sightings to iNaturalist, scientists around the world can use your observations and identify the organisms for you.

How to Make an Observation on a Smartphone

1. Set up your digital device:
   - Download iNaturalist app.
   - Log into your club's account.
   - Search for Bug Safari in the **Projects** tab at the top. Select **Join**.
2. Watch How to Make an Observation on a Smartphone for an overview of uploading to iNaturalist. You can also refer to the Safari and iNat Guide for step by step instructions of how to submit observations.
3. Upload your observations from today's *Bug Safari*. Explore the observations made by other Science Action Club members.

15 min. | outside

Arthropod Apartments

Bugs in San Francisco

Watch the Bugs in San Francisco video (4 min.) for inspiration from scientists who are searching for arthropods just like you.

The environment in which an organism lives is called its **habitat**. Arthropods live in different habitats depending on the type of food, shelter, and climate they need to survive.

As scientists, you have observed that arthropods live all around us. Today's research question is: Do certain habitats attract a greater number or variety of arthropods than others?

1. Divide into four teams and each choose a habitat to build:
   - **Plant patch:** Position a small pot upright or on its side.
   - **Bare soil:** Clear a patch of bare soil. Turn and mix it until it's light and loose.
   - **Wood pile:** Stack several pieces of wood in a pile on a cleared patch of ground. It helps to have holes in the wood and spaces between sticks.
   - **Stone stack:** Create a solid base of stones directly on a patch of cleared ground.
2. Find a location away from people and unlikely to be disturbed. You may want to add small signs that say, "Experiment in progress. Please do not touch".
3. Predict what you think will happen at each station.

Your research stations need time to attract arthropods. You will come back during Activity 7: Habitat Health to gather evidence and make conclusions.

- Use the examples on the next page for ideas of what your habitats could look like.
- Encourage youth to think about what information they will need to collect to be able to see differences in the:
  - total number of arthropods present
  - number of different types (diversity) of arthropods

Share out: What data do you plan to collect from your habitats next time?

Explore more: Watch Meet the Dust Mites (3 min.) to learn about your tiny roommates.

Call to action: Introduce your friends and family to iNaturalist.org. Explore the site to learn more about biodiversity and see what other organisms are found around the world.

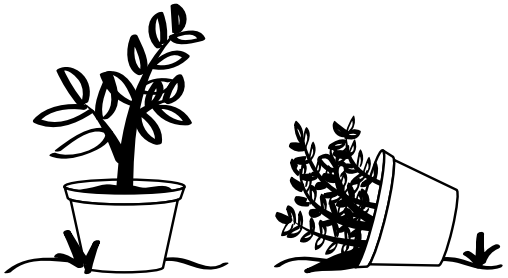
Explore more: Meet the Dust Mites

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

How did it go? Let us know!

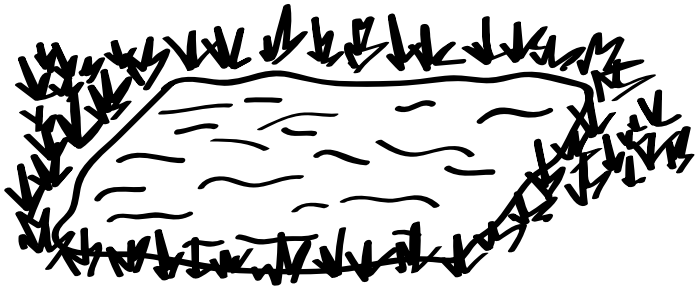
Arthropod Apartments habitat set up

Plant Patch



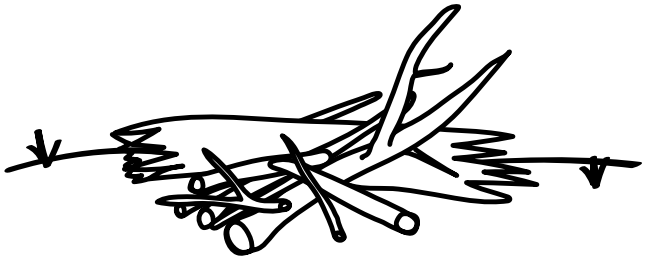
Position a small pot upright or on its side.

Bare Soil



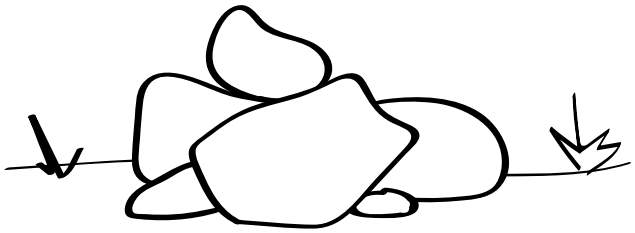
Clear a patch of bare soil. Turn and mix it until it's light and loose.

Wood Pile



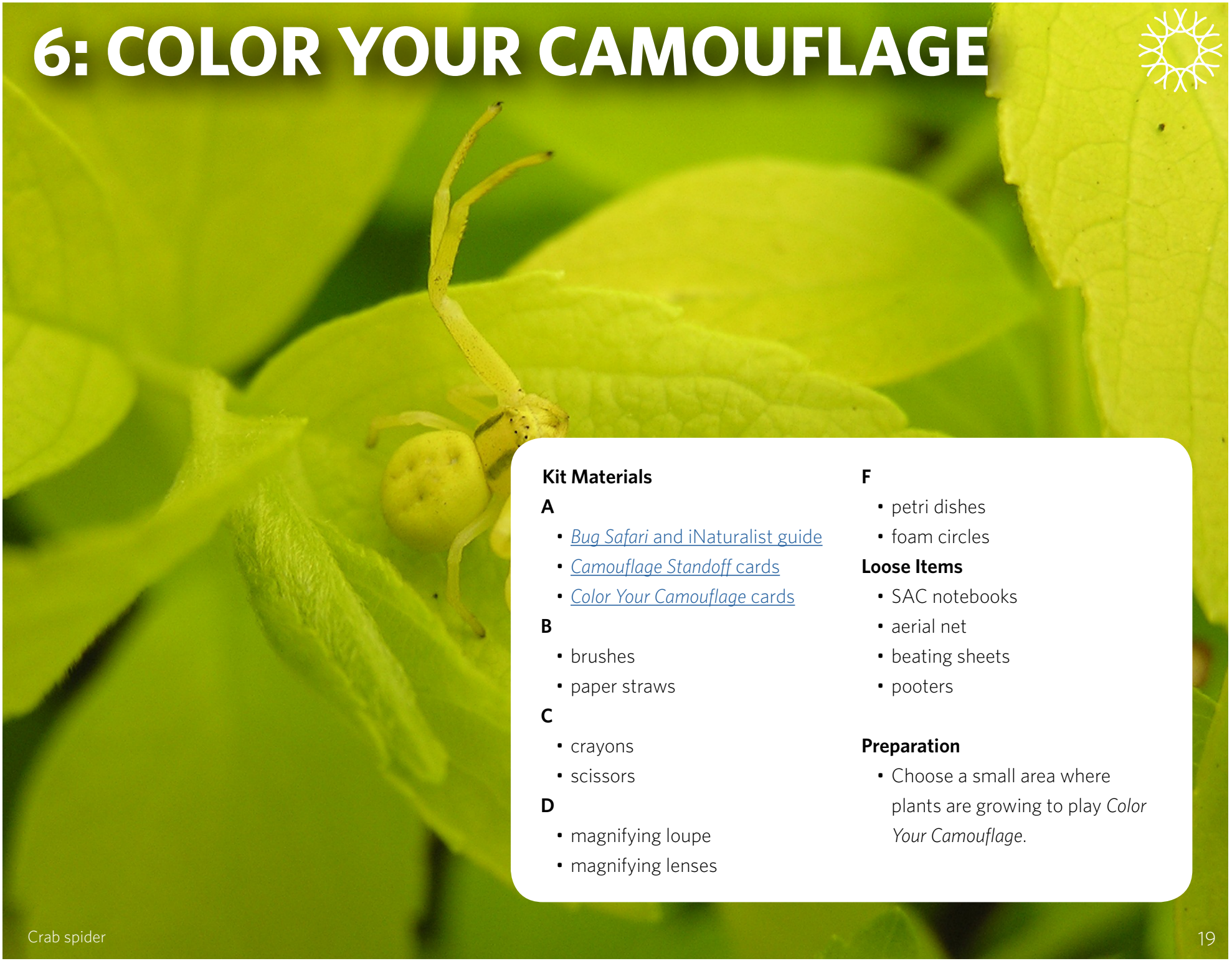
Stack several pieces of wood in a pile on a cleared patch of ground. It helps to have holes in the wood and spaces between sticks.

Stone Stack



Create a solid base of stones directly on a patch of cleared ground.

6: COLOR YOUR CAMOUFLAGE



Kit Materials

A

- *Bug Safari* and iNaturalist guide
- *Camouflage Standoff* cards
- *Color Your Camouflage* cards

B

- brushes
- paper straws

C

- crayons
- scissors

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

Preparation

- Choose a small area where plants are growing to play *Color Your Camouflage*.

Crab spider

Your mission today is to explore camouflage and the relationship between predator and prey.

30 min. | outside

Bug Safari

With each *Bug Safari*, you are collecting data to help answer the question "What arthropods live around you?" Remember to record where you are searching and use collection tools properly.

1. Collect arthropods in your search area.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your Critter Chronicles video.

- **Break into smaller groups with different tools.**
- **Remind youth to notice size, color, shape, and behavior of arthropods.**

Share out: Did you find any arthropods that use camouflage?

10 min. | outside or inside

Camouflage Standoff

An organism's natural coloring or form that enables it to blend in with its surroundings is called **camouflage**. Can you spot an animal that is camouflaged?

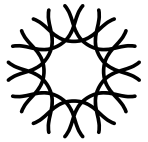
1. Break into groups of three to four. Pass out several *Camouflage Standoff* cards to one person in each group.
2. The rest of the group should stand about six feet from the card. They will have three minutes to guess what is shown in as many photos as possible. In order to get a new card, you have to identify three things (the answers are on the back of each card):
   - What is the animal?
   - How is it camouflaged?
   - Is it a predator or prey?
3. Pass the cards that have been used to another group. Take turns holding the cards.

Share out: What were the different ways an animal could camouflage? Which were hardest to spot?

20 min. | outside or inside

Color Your Camouflage

Predators eat other animals. **Prey** are eaten. Both can use camouflage to blend into their surroundings. Prey hide to avoid being seen by predators, and predators hide to sneak up on their prey. How well can you camouflage an arthropod and hide it in plain sight?



1. Everyone needs a *Color Your Camouflage* card. Share the pastels.
2. Select an area in the yard where your arthropod might wish to hide; choose a relatively small area, about 10 steps by 10 steps, ideally with many colors and textures.
3. Color your arthropod and its background to match the color and texture of the environment.
4. Use your knowledge of camouflage to hide your arthropod in the area you picked.
5. To win, your partner must spot your arthropod within one minute.

Share out: Consider your arthropod, was it a predator or prey?

Explore more: See how a seahorse gets its color with Pygmy Seahorse Camouflage.

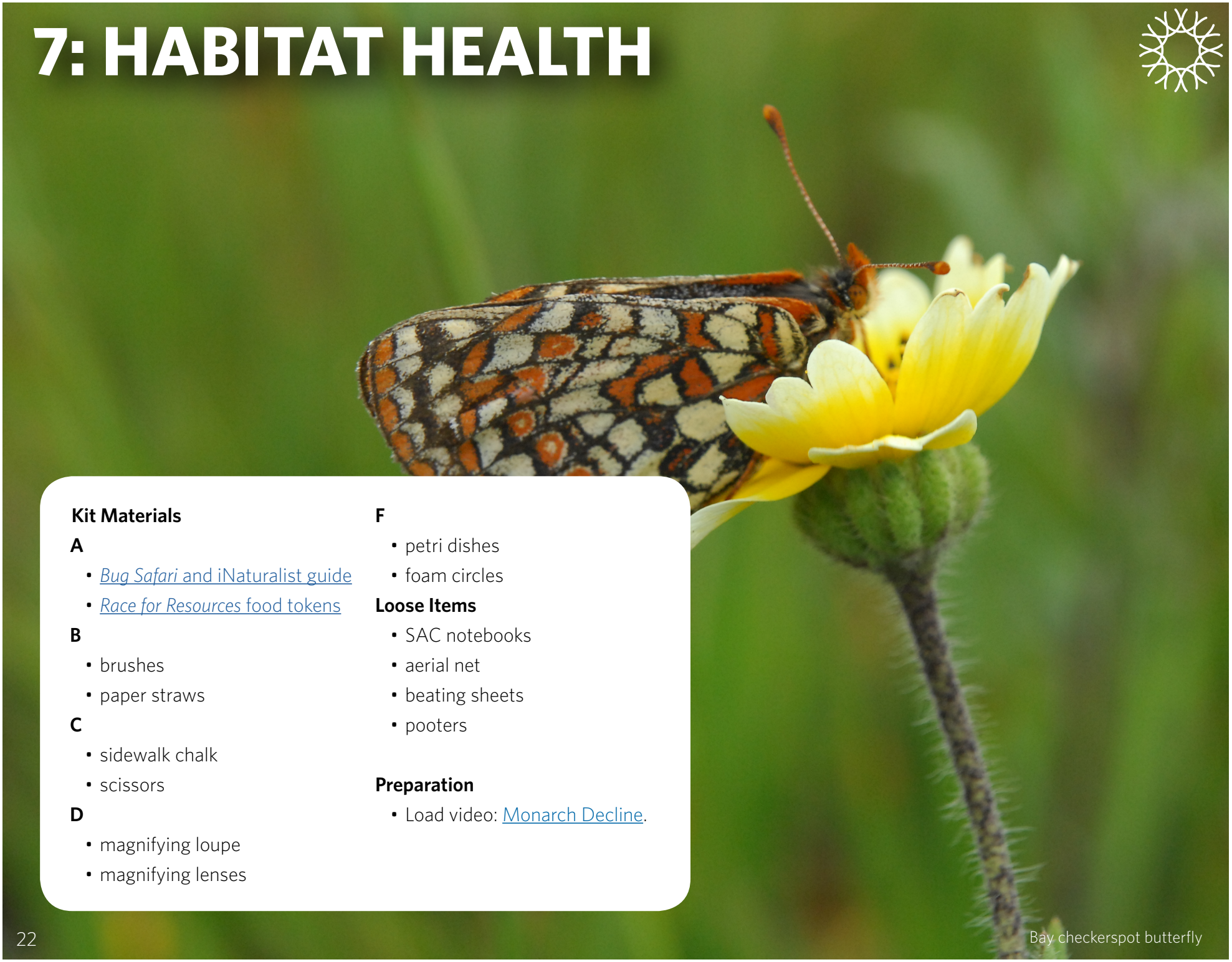
Call to action: Some animals do the opposite of camouflage. They have bright colors to attract a mate or to signal that they are dangerous. Explore your backyard or park and identify animals that are using camouflage or trying to stand out.

Explore More: Pygmy Seahorse Camouflage

How did it go? Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

7: HABITAT HEALTH



Kit Materials

A

- *Bug Safari* and iNaturalist guide
- *Race for Resources* food tokens

B

- brushes
- paper straws

C

- sidewalk chalk
- scissors

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

Preparation

- Load video: Monarch Decline.

Bay checkerspot butterfly

Your mission today is to explore how changes in the environment can affect arthropods.

Bug Safari

30 min. | outside

For today's *Bug Safari*, your mission is to search your arthropod apartments to see which habitats attract which arthropods. Think about the data you want to collect before you disturb the habitats.

1. Collect arthropods in your four habitats. Keep track of what was found in each.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your *Critter Chronicles* video.

Share out: Did you find certain kinds of arthropods in one habitat, but not others? Are there any arthropods that you found in all of the habitats? What can you conclude about the arthropods you found?

- **Remember to move logs and stones carefully and to put them back in the same way in order to protect the arthropods living there.**
- **Include your results and share out discussion highlights in your *Critter Chronicles* video.**

Healthy Habitats

10 min. | inside

As scientists, it's important to understand how changes in the environment can affect arthropod populations.

Watch the Monarch Decline video (2 min.).

Monarch Decline

Share out: What is happening to the monarch butterfly? What is causing this effect? Explain your answers using evidence from the video.

Race for Resources

20 min. | outside

In this game, you will play the role of an endangered species, the Bay checkerspot butterfly, which faces several challenges within its habitat. Each player is a butterfly that needs to gather six *Race for Resources* tokens as food for each round. To prepare for the game:

1. In an open space, mark off a large rectangle about 20 steps wide and 50 steps long. This represents the San Francisco Bay Area, where Bay checkerspot butterflies are found.
2. Count the number of players. Place that number of food tokens in each of six piles (e.g. if you have 20 players, make six piles of 20 tokens). Each pile represents a habitat. Make sure the tokens in each pile are spread out, not on top of each other.

Share the photo of the Bay checkerspot butterfly on the previous page.

The game will have four rounds. Each round involves all the players. In each round, a player needs to gather **six food tokens in 30 seconds** to avoid going hungry. Collect and redistribute tokens at the beginning of every round.

- Round 1: The butterflies are collecting food from their natural habitat. Players have to gather **six food tokens** from **six habitats**. If you don't gather six tokens, you go hungry.
- Round 2: An highway is built nearby and part of butterflies' habitat is destroyed. Remove all tokens from two habitats. Place the remaining tokens into **four habitats**. Players have to gather **six food tokens** from **four habitats**. If you don't gather six tokens, you go hungry.
- Round 3: You are going forward in time. The effects of climate change—higher temperatures and less rainfall—have reduced the number of plants that the butterflies need to survive. Place the food tokens in **four habitats**, but **halve the number of tokens** in each pile (if a pile had 20 tokens in Round 1, it should now have 10). Players have to gather **six food tokens** from **four habitats**. If you don't gather six tokens, you go hungry.
- Round 4: With the help of scientists and the community, some of the habitats are restored. Place tokens in **five habitats**, and **increase the number of tokens** in each pile back to the level in Round 1. Players have to gather **six food tokens** from **five habitats**. If you don't gather six tokens, you go hungry.

- **Make sure youth are walking to simulate a butterfly slowly finding its food (and for safety).**
- **If the amount of time per round is too short or too long, feel free to adjust.**
- **Use the drawing on the next page to help set up for each round.**

Explore more: Witnessing Butterflies Emerge

Share out: How many butterflies went hungry in each round? How did habitat health affect the number of butterflies left hungry?

Explore more: Watch Witnessing Butterflies Emerge (2 min.).

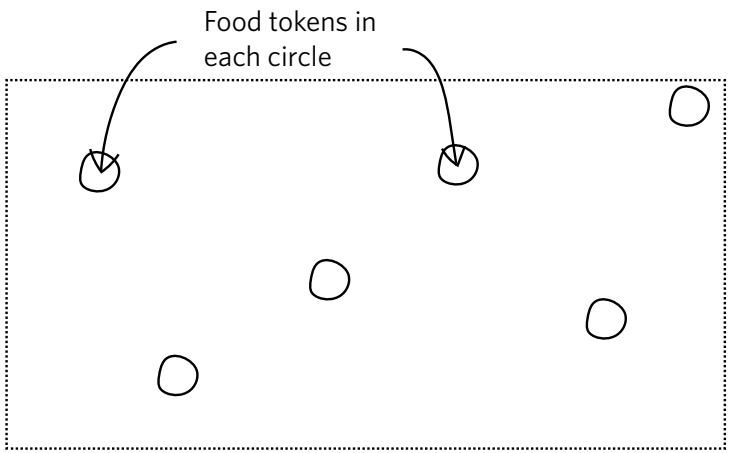
Call to action: Observe habitat spaces in and around your neighborhood. What conditions help organisms thrive where they live? How might people help improve those habitats? Brainstorm a plan with your family and friends.

How did it go? Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

Race for Resources playing field set up

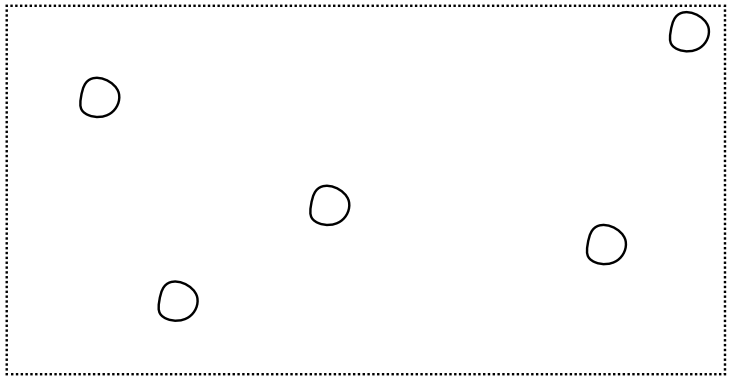
Round 1 · 6 habitats · 30 seconds



Round 2 · 4 habitats · 30 seconds

Round 3 · 4 habitats · 30 seconds

Round 4 · 5 habitats · 30 seconds



8: POLLINATION STATION

Kit Materials

A

- *Bug Safari* and iNaturalist guide
- *Pollination Station* cards
- *Pollination Station* data
- tissue paper
- color construction paper

B

- brushes
- paper straws
- pipe cleaners (short only)

C

- tape
- scissors

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

Preparation

- Check if anyone has identified or commented on your club's iNaturalist observations.

A bee pollinating a flower

Your mission today is to explore how arthropods and plants are connected through pollination.

Bug Safari 25 min. | outside

Remember, with each *Bug Safari*, you are collecting data to help answer the question "What arthropods live around you?" It is just as important to record familiar species as it is to record new sightings.

1. Collect arthropods in your search area.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your Critter Chronicles video.

Instead of netting pollinators, wait for them to land, and then try to snap a photo.

Share out: Did you find any arthropods on or around flowers?

Many flowers have **pollen**, a sticky powder that plants use to make seeds. Animals called **pollinators** help spread pollen from flower to flower. This transfer of pollen, called **pollination**, is important for plant reproduction. Bees, butterflies, moths, bats, and hummingbirds are some examples of pollinators.

How does a pollinator transfer pollen? Pollinators, such as bees and butterflies, visit flowers to get food. When a pollinator visits a flower, the pollen can stick to body parts such as legs and hair. As its goes from flower to flower, it spreads the pollen.

Pollen Freeze Tag 10 min. | outside

Why do bees spend time near flowers? Think about it and share with a friend.

In this game, one or two people will be birds and everyone else will start as bees.

1. Bees will fly around by flapping their wings and making a buzzing sound. If a bee is tagged by a bird, it freezes and becomes a flower.
2. Flowers kneel on one knee and make beautiful petals with their arms. To unfreeze, flowers must attract a bee and say "bumble bee, bumble bee, please take some pollen from me". If a nearby bee stops and chooses to high five the flower, the flower can continue as a bee again.
3. If the birds tag all of the bees, start a new round.

Share out: Why can't the game continue without bees? Think about the relationship between bees and flowers.

25 min. | inside

Pollination Station

Not all pollinators are the same. Certain flowers have evolved over time to attract certain pollinators.

1. Divide into 6 teams, each with a *Pollination Station* card. Study your card to learn about your pollinator.
2. Look at the *Pollination Station* data. Circle the flower(s) your pollinator visited the most. If your pollinator visited more than one flower, pay special attention to the things those flowers have in common.
3. Based on the information you gather and using the materials provided, design and build a flower that would attract your pollinator. Be sure to think about shape and color. Add a label about its fragrance, when it blooms, and where it will grow.
4. When you're done, present your flower to another club member.

Each youth can construct their own flower or work together.

Explore more: This Vibrating Bumblebee Unlocks a Flower's Hidden Treasure

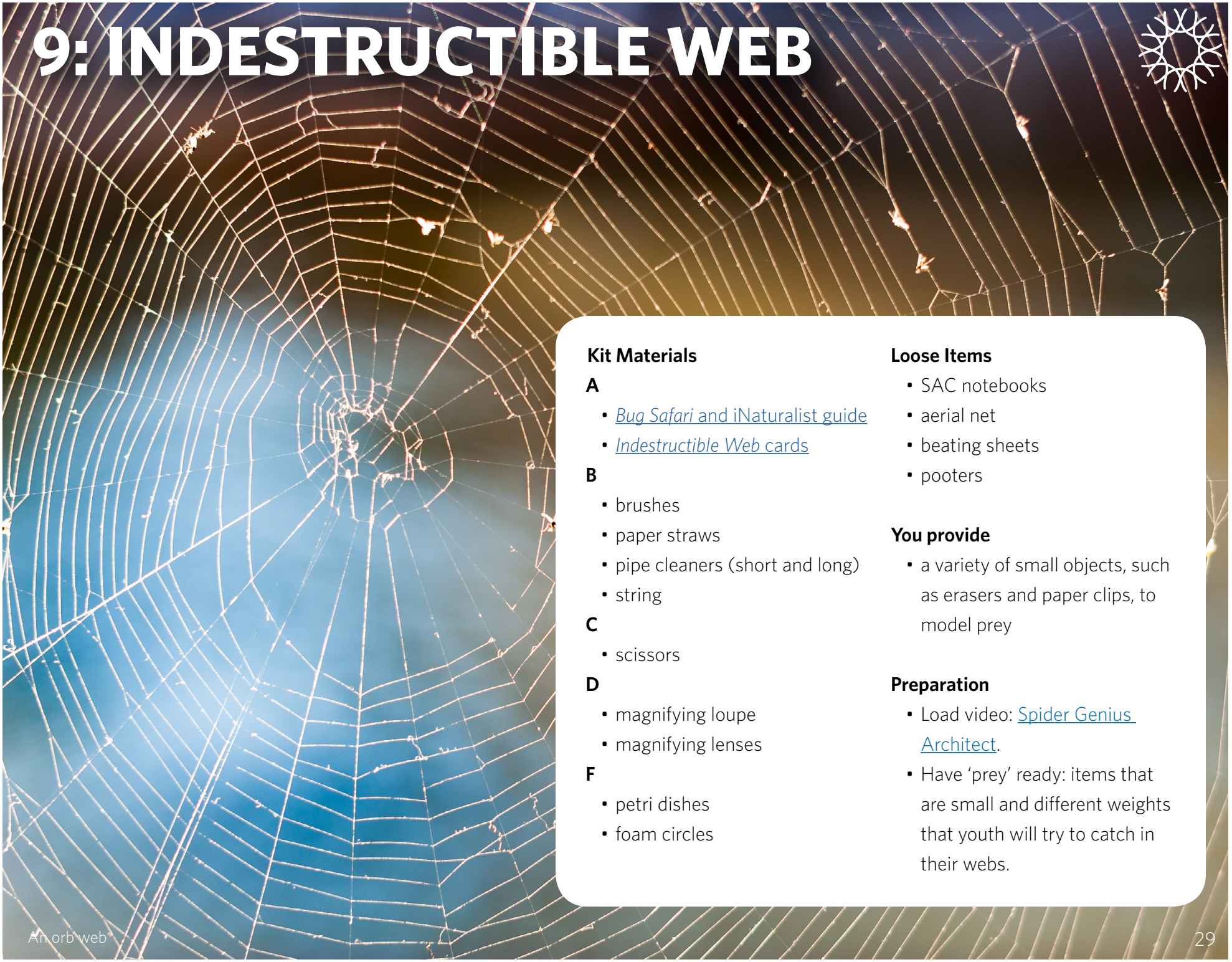
Explore more: Learn more about the unique relationships that can from between bees and flowers: This Vibrating Bumblebee Unlocks a Flower's Hidden Treasure.

Call to action: How can you attract pollinators to your neighborhood? Check out the Great Pollinator Habitat Challenge to learn how.

How did it go? Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

9: INDESTRUCTIBLE WEB



Kit Materials

A

- *Bug Safari* and iNaturalist guide
- *Indestructible Web* cards

B

- brushes
- paper straws
- pipe cleaners (short and long)
- string

C

- scissors

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

You provide

- a variety of small objects, such as erasers and paper clips, to model prey

Preparation

- Load video: Spider Genius Architect.
- Have 'prey' ready: items that are small and different weights that youth will try to catch in their webs.

An orb web

Your mission today is to weave an indestructible web inspired by spiders.

25 min. | outside

Bug Safari

As you continue to explore the arthropods around you, remember to leave things how you found them; release arthropods safely and leave their habitats unharmed.

1. Collect arthropods in your search area.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your *Critter Chronicles* video.

Share out: Did you find any spiders or spider webs? Did all of the webs look the same? What kind of prey were caught in the webs?

- **Look along fences, in corners, under benches, behind doors, around trees and bushes.**
- **Never destroy a web to collect a spider. Just take a photo. The photo can help scientists identify the spider.**
- **If fear of spiders comes up, remind students that most spiders are harmless. Mention the benefits of spiders, like that they eat mosquitoes.**

10 min. | inside

Web Weavers

What do you think of spiders? Do you find them interesting or scary or both?

Spider Genius Architect

Spiders are nature's engineers. Watch the Spider Genius Architect video (5 min.) and record 3 new or interesting things you learned about spider web designs.

Share out: Did the video change your opinions about spiders? If so, how?

25 min. | inside

Indestructible Web

There are many different types of web designs to meet the spider's food, mating, and habitat needs. Webs are mostly used to catch prey; they need to be transparent enough that prey will accidentally fly into them but also strong enough to hold prey.

Your goal for this challenge is to create a web that can catch an eraser that is dropped from shoulder height. Think of the eraser as a prey item for a spider.

1. Review the *Indestructible Web* cards for inspiration from real webs. How will you construct your web? What sort of pattern will make it most effective for catching prey?
2. Individually or in pairs, plan your web and sketch a picture in your notebook.

3. Use the pipe cleaners and no more than 10 feet of string to construct a web.
4. Test your web to see if it catches the prey. Then, redesign your web to improve its strength.
5. Present your web and explain your design choices. Once everyone has shared, hang your webs together and compare and contrast the different styles.

Note that 10 feet is about three arm lengths.

Explore more: Watch this video about humans can learn from the engineering skills of spiders: Spider Silk Tech.

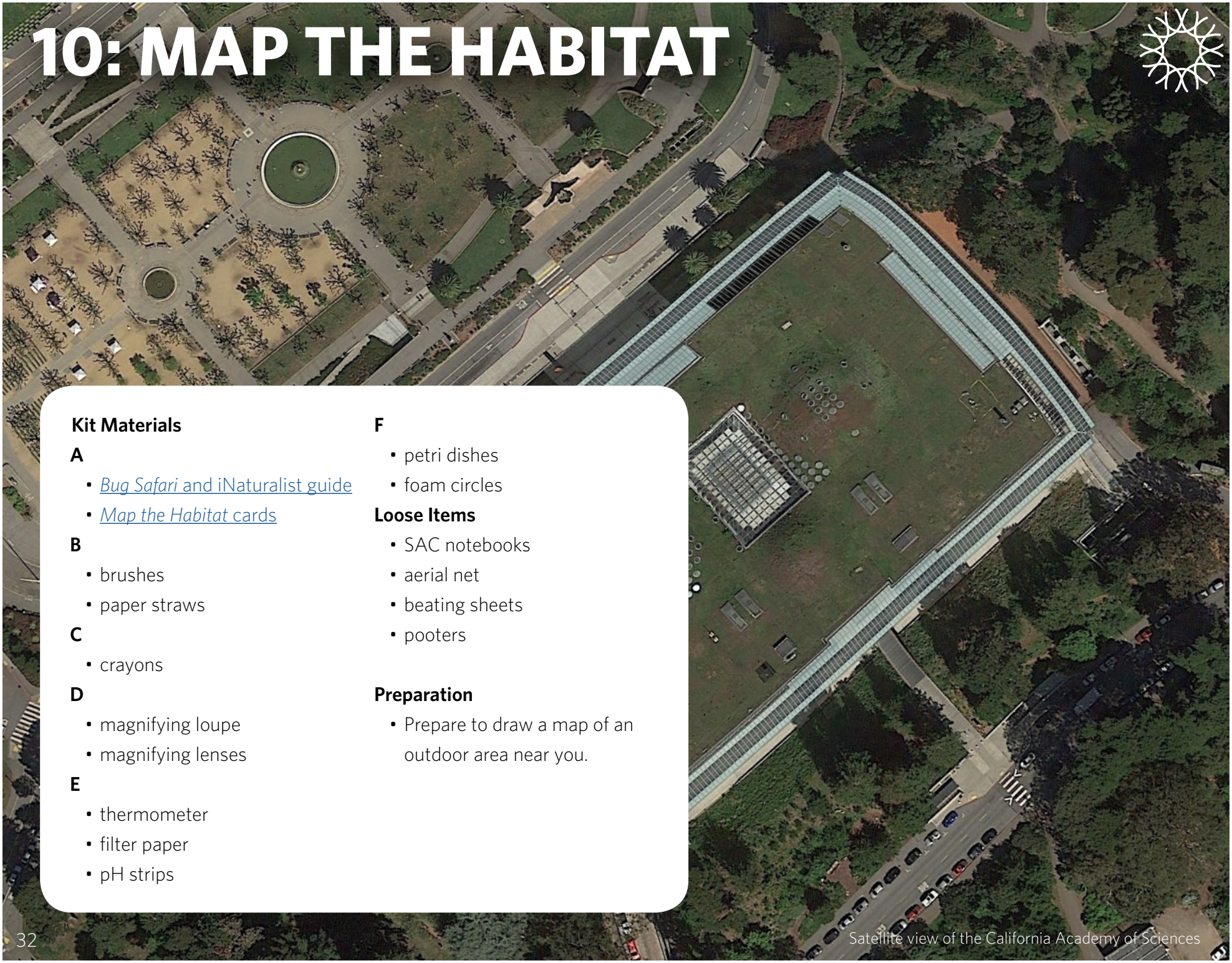
Explore More: Spider Silk Tech

Call to action: Now that you're an expert on web building, pay attention to the kinds of webs in your house or neighborhood and look out for any prey caught in them. You can record what you find in your notebook or on iNaturalist.

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

How did it go? Let us know!

10: MAP THE HABITAT



Kit Materials

A

- *Bug Safari* and iNaturalist guide
- *Map the Habitat* cards

B

- brushes
- paper straws

C

- crayons

D

- magnifying loupe
- magnifying lenses

E

- thermometer
- filter paper
- pH strips

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

Preparation

- Prepare to draw a map of an outdoor area near you.

Satellite view of the California Academy of Sciences

Your mission today is to survey and map the conditions of an outdoor area near you.

Bug Safari 25 min. | outside

As you look for arthropods, pay attention to the environmental conditions around them.

1. Collect arthropods in your search area.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your *Critter Chronicles* video.

Share out: What was the area like where you found arthropods?

Extreme Tag 10 min. | outside

Your surroundings can be an extreme environment for arthropods. From hot blacktops to stampedes of students, animals that thrive here have to be tough.

In this game of tag, everybody is 'it'.

1. Everybody spreads out on the playing field before the game starts.
2. If you are tagged, you have to put a hand where you were tagged, as if holding an injury.
3. Because you only have two hands, the third time you are tagged, you are out and sit down.
4. The last person standing wins.

Map the Habitat 25 min. | outside

Within any ecosystem there are smaller habitats. The arthropods you find in moist, cool areas under bushes in a yard may be different from those you can find on the dry, hot basketball court. This is because environmental factors, such as temperature, moisture, and pH, influence where arthropods can live.

1. As a club, draw one large bird's-eye view map of an outdoor area near you.
2. Select three spots to perform your measurements.
3. Divide into groups of three to four, and give each group a *Map the Habitat* card and the tools for measuring the factor on that card.
    - **Temperature**: Use the thermometer to compare the temperature in different regions of the area you

Sketch your map on a large piece of chart paper or the classroom board.

chose. Allow the thermometer to sit for 1 minute in the location you are testing. Then take a reading.

- **Moisture**: Press the filter paper to any surface for five seconds and then estimate how wet the paper is using a 1-5 scale (1 is *very dry* and 5 is *flooded*).
- **pH**: This is a measure of how acidic or basic something is on a scale of 0-14. Collect samples of soil, sand, or crushed leaves in a petri dish and add water. Let it sit for one minute before using the pH strip to test the liquid solution. Follow the pH strip instructions to dip and compare to the table.

4. Record each measurement in the table on your Map the Habitat card. After each group is done collecting data, come together as a club and mark your measurements on the map.

Other factors that can affect arthropods include foot traffic, sound, and wind. For an added challenge, create ways to test these other factors and add them to your map.

Share out: What types of habitats does the outdoor area you chose contain? Which arthropods have you seen living in each area?

Explore more: How Insects Survive Winter

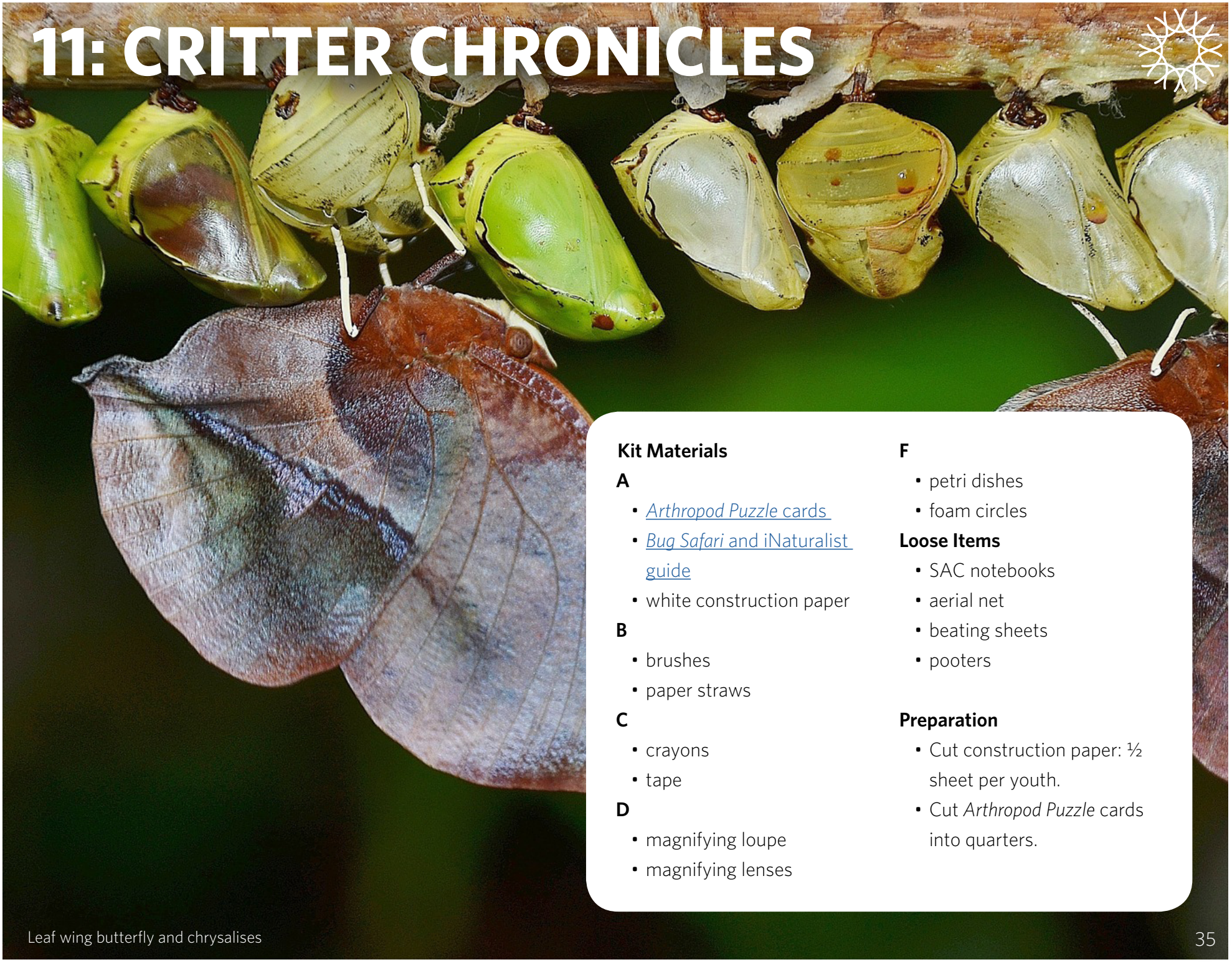
Explore more: Watch how insects survive winter.

Call to action: Many of these tests can easily be done with household materials. Test your neighborhood's environmental factors with friends and family.

How did it go? Let us know!

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

11: CRITTER CHRONICLES



Kit Materials

A

- *Arthropod Puzzle* cards
- *Bug Safari* and iNaturalist guide
- white construction paper

B

- brushes
- paper straws

C

- crayons
- tape

D

- magnifying loupe
- magnifying lenses

F

- petri dishes
- foam circles

Loose Items

- SAC notebooks
- aerial net
- beating sheets
- pooters

Preparation

- Cut construction paper: ½ sheet per youth.
- Cut *Arthropod Puzzle* cards into quarters.

Leaf wing butterfly and chrysalises

Your mission is to analyze the data you have collected during your Bug Safaris.

20 min. | outside

Bug Safari

As you look for arthropods, consider which species you have seen regularly and those which are rarer.

1. Collect arthropods in your search area.
2. Take photos and upload to iNaturalist.
3. Release arthropods.
4. Record your *Critter Chronicles* video.

Share out: What is your favorite arthropod you have found?

15 min. | inside

Arthropod Puzzle

Scientists bring together different pieces of evidence to make discoveries. Our goal in this activity is to draw one section of an arthropod image and match it with the rest of your team's pieces to solve the puzzle.

1. Divide into teams of four, with one *Arthropod Puzzle* card each.
2. Examine your part of the arthropod photo. Draw your section on a half sheet of white construction paper.
3. As a team, match the edges of your drawings and tape them together to create a complete image of the arthropod.
4. Tape the original *Arthropod Puzzle* cards back together to compare with your drawings.

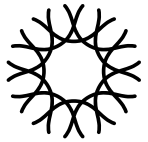
Share out: How does your group's completed puzzle compare to the original? What did you notice about the arthropod after looking at its photo in detail? What would you do next time to help make the drawing more accurate?

25 min. | inside

Critter Chronicles

You've explored every corner of your surroundings and discovered an exciting diversity of arthropods. Now analyze the data you've collected. Your iNaturalist observations will help youth in Science Action Clubs on future missions, and will help scientists around the world learn more about the arthropods that live around you.

1. Review the *Critter Chronicles* videos from each of your *Bug Safaris*.
2. As you watch, create a table to tally all of your sightings on the board or a large piece of paper. Include the types of arthropods found, the total number of each arthropod, and the habitats of those arthropods.



Example Table:

Arthropod	Observations	Total	Habitat
Ladybug	𝍸 𝍸 IIII	14	On plants and in grass
Woodlouse Spider	𝍸 IIII	9	Under wood, mulch on ground
Pillbug	𝍸 𝍸 𝍸 𝍸 III	23	Potted plants, edges of grass

If your *Critter Chronicles* videos are not available, you can also use your iNaturalist observations to help tally.

3. Once you complete your table, you can create other charts to visualize your data. For example:
   - Pie chart showing the percentage of each species
   - Timeline showing how many organisms were found
   - Bar graph showing the number of species on each day

Explore more: [Bioluminescent Scorpions]

Share out: Does the data match what you expected? What do you find most surprising?

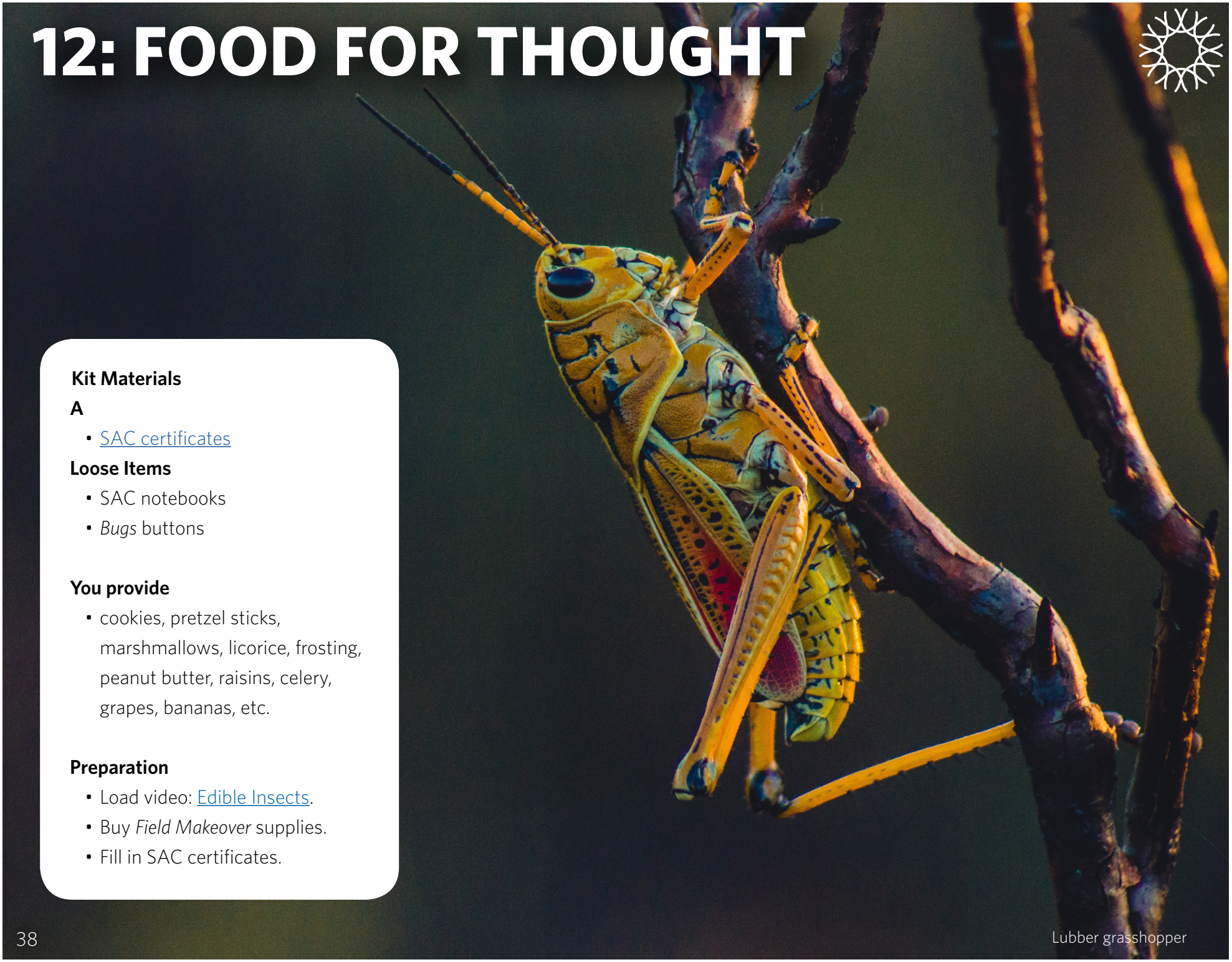
Explore more: Check out why a black light is part of some scientists' toolkit in [Biofluorescent Scorpions].

Call to action: How does your school compare to your neighborhood? You can keep track of sightings with friends and family for comparison.

How did it go? [Let us know!]

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

12: FOOD FOR THOUGHT



Kit Materials

A

- SAC certificates

Loose Items

- SAC notebooks
- *Bugs* buttons

You provide

- cookies, pretzel sticks, marshmallows, licorice, frosting, peanut butter, raisins, celery, grapes, bananas, etc.

Preparation

- Load video: Edible Insects.
- Buy *Field Makeover* supplies.
- Fill in SAC certificates.

Lubber grasshopper

Your mission today is to design a way to sustain arthropods in your surroundings.

Game

10 min. | outside

Vote to play your favorite arthropod game again; choose from among Activity 1: Creature Catch Phrase, Activity 3: Telephone Charades Race, Activity 8: Pollen Freeze Tag, and Activity 10: Extreme Tag.

Edible Arthropods

15 min. | inside

Arthropods are a sustainable, high quality source of protein, but in the United States you won't often find them on the menu. Watch Edible Insects (5 min.) to learn about the environmental benefits of eating arthropods. In your notebook, record two environmental benefits of eating arthropods.

Share out: Would you eat arthropods? Defend your opinion with evidence.

Edible Insects

Only watch video for as long as youth are engaged; after five minutes, stop and discuss.

Field Makeover

25 min. | outside or inside

As scientists, it is our responsibility to summarize our findings. We can use our evidence to propose actions to improve our local environment. Your final mission is to use what you have observed during *Bug Safaris* to create a plan to make your surroundings more arthropod friendly.

1. Consider:
   - Which arthropods were most common in your surroundings?
   - In which habitats did you find arthropods most often?
   - How can you improve your surroundings to benefit arthropods?
     - Which arthropod do you think would be helpful?
     - What will it need to survive?
     - How will it benefit the environment and people?
2. To share your plan, create a visual of your field makeover. Use the available edible or compostable materials to create a model of an outdoor area in your surroundings. The model should include key habitats for your chosen arthropods.
3. Present each plan to the rest of the club.

- **Possible materials for model: cookies, pretzel sticks, marshmallows, licorice, frosting, peanut butter, raisins, celery, grapes, bananas, etc.**
- **Youth can either compost their models or snack on them.**

10 min. | inside

SAC Ceremony

Pass out SAC certificates one at a time. Give each person a *Bugs* button. Feel free to add speeches and choose someone to emcee.

Explore more: Would you eat a bug? Insects have been a part of our diet for most of human history. Even today, billions of people around the world still consume them. Watch this video to find out why bugs mights be the perfect food: Should We Eat Bugs?

Explore more: Should We Eat Bugs?

Call to action: Congratulations! You've proven yourselves as scientists and members of the iNaturalist community. Take your notebooks and continue your safaris at home. You can also create your own iNaturalist account to get help identifying your local discoveries.

Attendance & feedback: How many youth attended? How did it go? Record notes here, then click or scan the link to let us know.

How did it go? Let us know!

California Academy of Sciences

presents this

Certificate of Success

to

_____

Presented on _____ , 20_____

_____

Science Action Club Leader

CALIFORNIA ACADEMY OF SCIENCES

CALIFORNIA ACADEMY OF SCIENCES

SCIENCE ACTION CLUB

CONNECT TO THE ACADEMY

California Academy of Sciences offers several ways to stay connected:

Field Trips to the Academy

The Academy is proud to offer special, discounted rates for Science Action Club youth.

Distance Learning

Visit the Academy virtually from your classroom. *Distance Learning* brings Academy experts, animals, collections, and exhibits to youth the world over, via the internet.

Citizen Science Projects

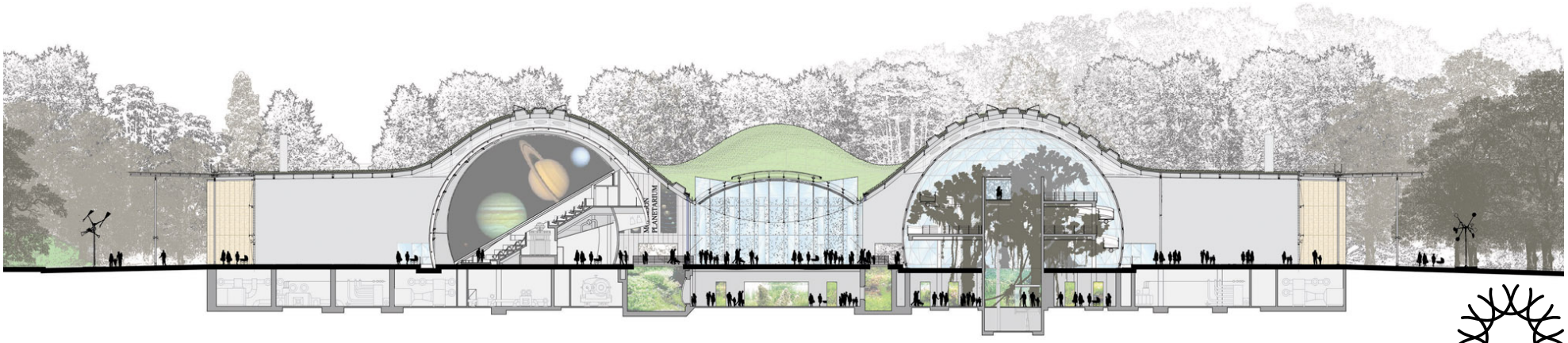
Learn how the Academy connects with community volunteers to explore and protect biodiversity in California.

Quick Links

Apply for a Field Trip

Distance Learning

Citizen Science Projects



NGSS CONNECTIONS

The Next Generation Science Standards (NGSS) offer a new vision for K-12 science education. Released for states' adoption in 2013, and designed with decades of research on best practices for teaching and learning science, the NGSS offer an opportunity to move science education into the 21st century.

The activities in *Bug Safari* support youth engagement in some aspects of the three dimensions of the NGSS. Specifically the Science and Engineering Practices (SEPs) are used as strategies for making sense of content that connects to the Crosscutting Concepts (CCCs) and the Disciplinary Core Ideas (DCIs).

Science and Engineering Practices (SEPs)

Analyzing and Interpreting Data
Activities 8, 10, 11
- Represent data in tables and/or various graphical displays (bar graphs, pictographs, and/or pie charts) to reveal patterns that indicate relationships.
- Analyze and interpret data to provide evidence for phenomena.

Designing Solutions
Activity 12
- Apply scientific ideas to solve design problems.

Engaging in Argument from Evidence
Activities 3, 7
- Construct and/or support an argument with evidence, data, and/or a model.

Obtaining, Evaluating, and Communicating Information
Activities 4, 5, 6, 7, 8, 9, 10, 11
- Communicate scientific and/or technical information orally and/or in written formats, including various forms of media as well as tables, diagrams, and charts.

Disciplinary Core Ideas (DCIs)

LS1.A: Structure and Function
- Organisms have both internal and external macroscopic structures that allow for growth, survival, behavior, and reproduction.

LS2.A: Interdependent Relationships in Ecosystems
- Organisms and populations are dependent on their environmental interactions both with other living things and with nonliving factors, any of which can limit their growth. Competitive, predatory, and mutually beneficial interactions vary across ecosystems but the patterns are shared.

LS4.D: Biodiversity and Humans
- Populations of organisms live in a variety of habitats. Change in those habitats affects the organisms living there.

ESS3.C: Human Impacts on Earth Systems
- Human activities have altered the biosphere, sometimes damaging it, although changes to environments can have different impacts for different living things. Activities and technologies can be engineered to reduce people's impacts on Earth.

Crosscutting Concepts (CCCs)

Patterns
Activity 11
- Patterns can be used as evidence to support an explanation.
- Graphs, charts, and images can be used to identify patterns in data.

Cause and Effect
Activity 7
- Cause and effect relationships may be used to predict phenomena in natural or designed systems.

Scale, Proportion, and Quantity
Activity 2
- The observed function of natural and designed systems may change with scale.
- Phenomena that can be observed at one scale may not be observable at another scale.

Connections are from 3-5 and MS grade bands. See www.nextgenscience.org for more information.

REFERENCES

Photos and images

The Science Action Club emblem is based on the California dogface butterfly, *Zerene eurydice*.

Unless noted on the photo, all photos were created by Science Action Club staff or were released to the public domain without copyright.

All vector graphics were created by the California Academy of Sciences.

WEB LINKS

	Attendance and Feeback	http://sciclub.link/bugs-feedback
1: Field Study	Science Action Club Citizen Science	https://goo.gl/7ZGz3t
	Habitat Earth	https://goo.gl/kj2eWR
2: Observe Like a Scientist	Macro Color	https://goo.gl/Q48vuV
	Big Pictures, Tiny Creatures	https://goo.gl/bzBCLv
3: Engineer an Arthropod	Arthropod Music Video	https://goo.gl/uzLl19
4: Tools of the Trade	How to Do a *Bug Safari*	https://goo.gl/YE4aMx
	Observe Nature with iNaturalist	https://goo.gl/Q48vuV
5: Arthropod Apartments	How to Make an Observation on a Smartphone	https://goo.gl/pSJvB5
	Bugs in San Francisco	https://goo.gl/hBmdFT
	Meet the Dust Mites	https://goo.gl/SzcKxy
6: Color Your Camouflage	Pygmy Seahorse Camouflage	https://goo.gl/vrI39U
7: Habitat Health	Witnessing Butterfies Emerge	https://goo.gl/SzcKxy
8: Pollination Station	This Vibrating Bumblebee Unlocks a Flower's Hidden Treasure	https://goo.gl/DV9fMN
	Great Pollinator Habitat Challenge	https://goo.gl/XahuuK
9: Indestructible Web	Spider Genius Architect	https://goo.gl/Chmcvb
	Spider Silk Tech	https://goo.gl/qKVnLN
10: Map the Habitat	How Insects Survive Winter	https://goo.gl/GRMwsL
11: Critter Chronicles	Biofluorescent scorpions	https://goo.gl/l3WKmQ
12: Food for Thought	Edible Insects	https://goo.gl/N7bNMX
	Should We Eat Bugs?	https://goo.gl/YimkqK

GLOSSARY

abdomen	the end (posterior) section of an arthropod's body, farthest from the head
arthropod	an animal with an exoskeleton, segmented body, and jointed legs
bio-	life, or related to life
biodiversity	the diversity or variety of life in a habitat or ecosystem
camouflage	an animal's natural coloring or form that enables it to blend in with its surroundings
characteristics	the features or qualities of an organism, often related to appearance or behavior
citizen science	a global movement in which scientists and the general public collaborate to answer scientific questions
data	information gathered for analysis
diversity	a variety or range of different things
exoskeleton	the hard outer covering of the bodies of some animals, especially arthropods, that provides support and protection
habitat	an organism's home
hypothesis	an explanation based on evidence that is a starting point for more investigation, also described as an educated guess
iNaturalist	an online community of citizen scientists recording and sharing information about biodiversity and learning about nature
insect	one kind of arthropod; insects have six legs and often have wings

jointed appendages	body parts that have joints, such as legs or antennae
organism	anything that is alive or used to be alive
pollinator	an animal that carries pollen from the male part of a flower to the female part of the same or a different flower
pooter	a scientific tool used to collect arthropods by sucking them through a straw into a chamber
predator	an animal that hunts and eats other animals
prey	an animal that is hunted and eaten by other animals
quadrat	a portable frame used to study a specific area
segmented body	a body that has sections or segments
species	a group of similar organisms that can exchange genes or interbreed
taxonomy	a system for classifying or organizing organisms
thorax	the middle section of an insect's body, where the legs and wings connect to the body

NOTES


iNaturalist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ACTION CLUB


Genentech
A Member of the Roche Group