Bug Safari

Activity Leader Guidebook



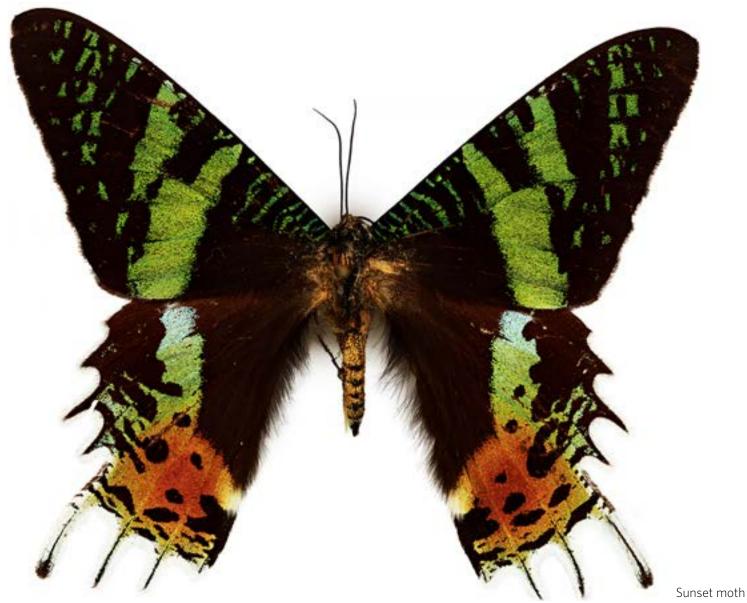




This guidebook belongs to: _____

iNaturalist username: _____

iNaturalist password: **Jellyfish123**





Chrysiridia rhipheus

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WHAT IS SCIENCE ACTION CLUB?

Designed for middle school youth in out-of-school time, <u>Science Action Club</u> (SAC) features hands-on science kits that spark curiosity and inspire wonder for the natural world. Through games, projects, and exciting investigations, youth in SAC explore nature, contribute to authentic science research, and design creative strategies to protect the planet.

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?

<u>iNaturalist</u> 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 <u>sacportal.calacademy.org</u> to access the *Bug Safari* training, flyers, forms, guides, and other helpful resources.



Giant African flower beetle Mecynorhina polyphemus

SUGGESTED PROGRAM TIMELINE

Responsibility	Description	Due Date
Complete the online training	This required online training is interactive, fun, and will help you succeed as an activity leader. Use the SAC guidebook and teaching kit to follow along as you learn.	Before the first club meeting session
Identify an outdoor location	You are responsible for finding an outdoor space where youth can look for bugs. Ideally, the space should be within a five-minute walk of your club. Ask your program supervisor for support, if needed.	Before the first club meeting session
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 digital technology during SAC time.	Before the first club meeting session
Recruit youth	SAC is more fun when the club is full. Use the <u>SAC Youth Flyer</u> to recruit 15 to 20 youth.	Before the first club meeting session
Connect with families	Once youth are enrolled, send home the <u>SAC Letter to Families</u> . Download and edit the template to fit your audience and include your own details.	Once youth are enrolled
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. 	Before you lead each SAC activity
Submit citizen science observations	Citizen science is an essential part of Science Action Club. Remember to submit your club's observations to iNaturalist regularly. If you need help navigating iNaturalist, check out the <u>Bug Safari video guide</u> .	During Activities 4-12
Record and share feedback	In your guidebook, jot down any highlights, challenges, or notes to remember for next time. Then, send your attendance and feedback to SAC so we can continue to improve and grow the program. You can do this using the hyperlinks or QR codes in the guidebook.	After completing each activity
Invite your supervisor and/or families to stop by your last SAC session and celebrate with your club Remember to sign SAC certificates of success.		

ACTIVITY SUMMARIES

Title	Activity Mission	Recommended For
Activity 1: Field Study	Discover the wild things that live in your environment.	<u> </u>
Activity 2: Observe Like a Scientist	Use scientific tools to observe your surroundings and create an expedition map.	<u> </u>
Activity 3: Engineer an Arthropod	Sort species scientifically and construct an anatomically correct arthropod.	<u> </u>
Activity 4: Tools of the Trade	Learn how to use research tools and become an expert at collecting arthropods.	<u> </u>
Activity 5: Arthropod Apartments	Investigate arthropod habitats and do citizen science.	<u> </u>
Activity 6: Color Your Camouflage	Explore camouflage and the relationship between predator and prey.	<u> </u>
Activity 7: Habitat Health	Explore how changes in the environment can affect arthropods.	<u> </u>
Activity 8: Pollination Station	Explore how arthropods and plants are connected through pollination.	<u> </u>
Activity 9: Indestructible Web	Weave an indestructible web inspired by spiders.	<u> </u>
Activity 10: Map the Habitat	Survey and map the conditions of an outdoor area near you.	<u> </u>
Activity 11: Critter Chronicles	Analyze the data you collected during your Bug Safaris.	<u> </u>
Activity 12: Food for Thought	Design a way to sustain arthropods in your surroundings.	<u> </u>





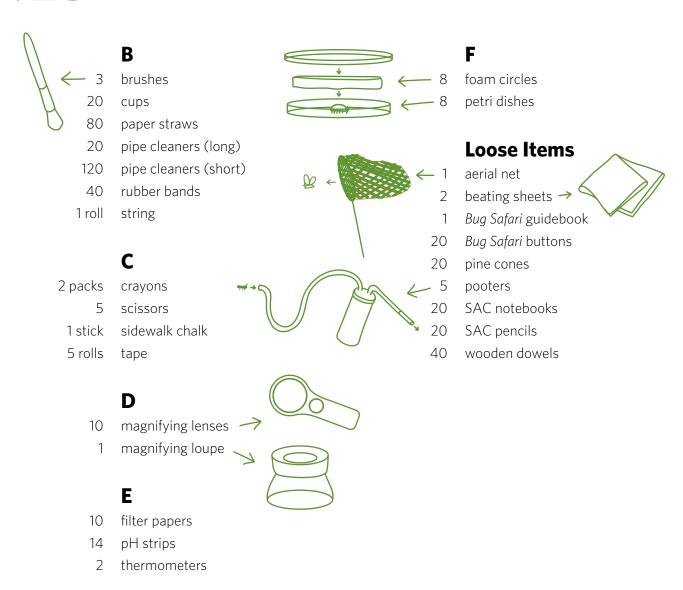
hysical Distancing

KIT MATERIALS

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

white construction paper

20 sheets



HOW TO USE THIS GUIDEBOOK

Share each activity's mission statement with youth.

Before your club meets, check

of things to prepare.

each part of the activity.

Time estimates and location

suggestions are provided for

the preparation section for a list

The introduction gives an overview of the activity's goals and purpose.

Scientists categorize organisms to make them easier to study. In this activity, youth learn how

 $Your\ mission\ to day\ is\ to\ sort\ species\ scientifically\ and\ construct\ an\ anatomically\ correct\ arthropod.$

scientists organize living things, and learn to recognize the essential features of all arthropods.

Preparation

- Write the secret words for Telephone Charades Race on index cards.
- · Collect recycled materials (cereal boxes, toilet paper rolls, bottles, etc.) in advance

elephone Charades Race 10 min. Linside

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.
- 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

ecret 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.
- 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

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.

vw.calacademy.org/sac | Activity 3: Engineer an Arthropod 9

Kit Materi

- color construction
- Engineer an Arthropod cards

3: ENGINEER AN ARTHROPOD

- Engineer an Arthropo
- Taxonomy cards
- cups
 nine cleaners (short)
- only)

 scissors
- tape
 Loose Items
 SAC notebook

Materials Not Included

• recycled materials

ttendance & Feedback: How many youth attended? How did it go? Record notes here then click or scan the link to let us kny

Explore More: Watch What is an Arthropod? (3 min.) to learn more about arthropods, then sing and dance along to Baby, You're a

Call to Action: Notice features that make the organisms in your neighborhood similar to or different from each other. How many different

1. Working independently or in pairs, select an Engineer an Arthropod card to detern

2. Use the Engineer an Arthropod handout to brainstorm ideas for how your arthropod

The right body parts to eat the food sources listed.
The right features to hunt or hide in the environment.

Use the materials available to construct your new arthropod.

vays could you sort these organisms?

· All three essential arthropod characteristics: an exoskeleton, a segmented box

4. Present your arthropod to the group. Describe the body parts and features that would help it su



Scan the QR code to access videos and other digital content. In the digital guidebook, you can also click the hyperlink.

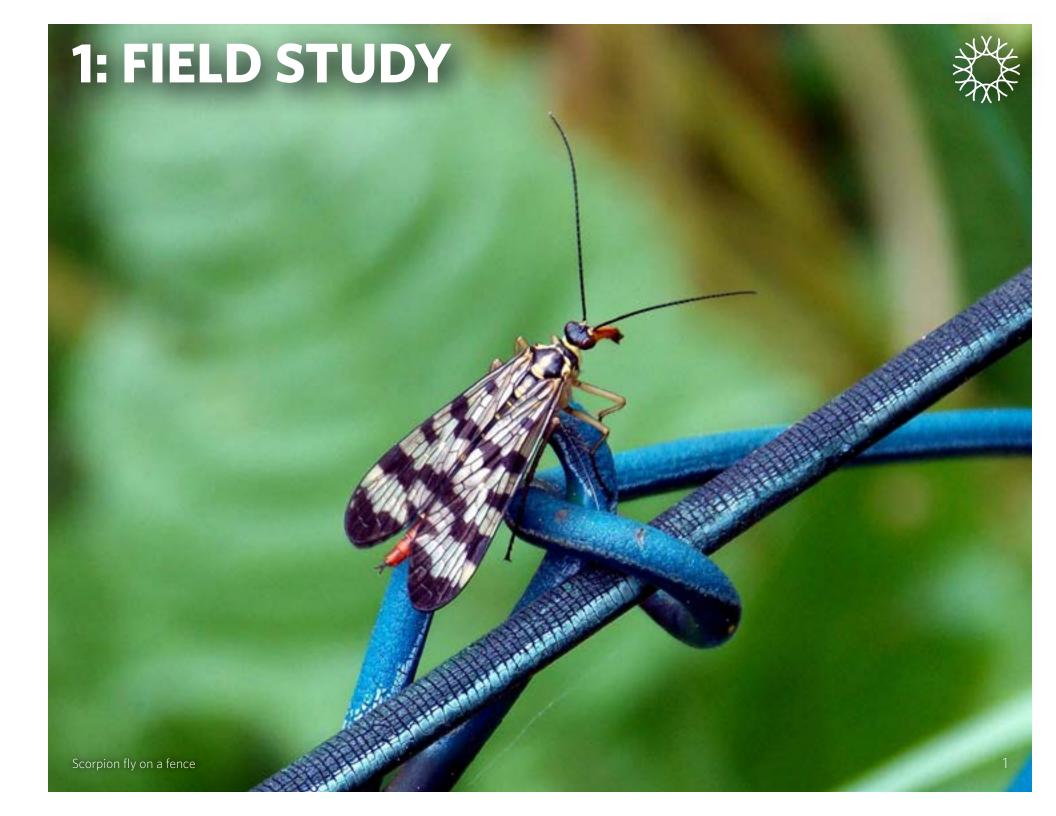
Encourage youth to continue learning with family and friends in their community.

Before your club meets, check the yellow box for the supplies you need.

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

Some activities require additional materials that are not included in the kit.

Activity 3: Engineer an Arthropod | www.calacademy.org/s



Life is found all around us, in a diverse array of sizes, shapes and forms. In this activity, youth learn about Science Action Club, and develop their observation skills.

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

Preparation

- Load video: Science 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.

Creature Catch Phrase 10 min. | inside

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 homes 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.

Why Take on This Mission? 5 min. | inside

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

Biodiversity Bingo 20 min. | outside

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.

Kit Materials

Α

- Biodiversity Bingo grids
- <u>Creature Catch Phrase</u> cards
- SAC stickers

B

rubber bands

Loose Items

- SAC notebooks
- wooden dowels

Science Action
Club Citizen
Science







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 pairs. 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. This is not a race or competition; it is a chance to slow down and look closely.
- 4. If you have time, study several locations.

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 your area. 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 (2 min.). Then, create a field guide to the biodiversity in your community.

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.

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









Scientists use tools to make observations and carefully document their findings so that others can replicate their work. In this activity, youth continue to develop scientific observation skills and practice communicating their findings clearly and accurately to others.



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

Preparation

Cut string into 1 foot sections—1 per pair of youth.

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,

Kit Materials

 white construction paper

В

string

- crayons
- scissors

D

magnifying lenses

Loose Items

- pine cones
- SAC notebooks

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.

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 (3 min.).

Call to Action:





Now that you are 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.

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!

Explore More:

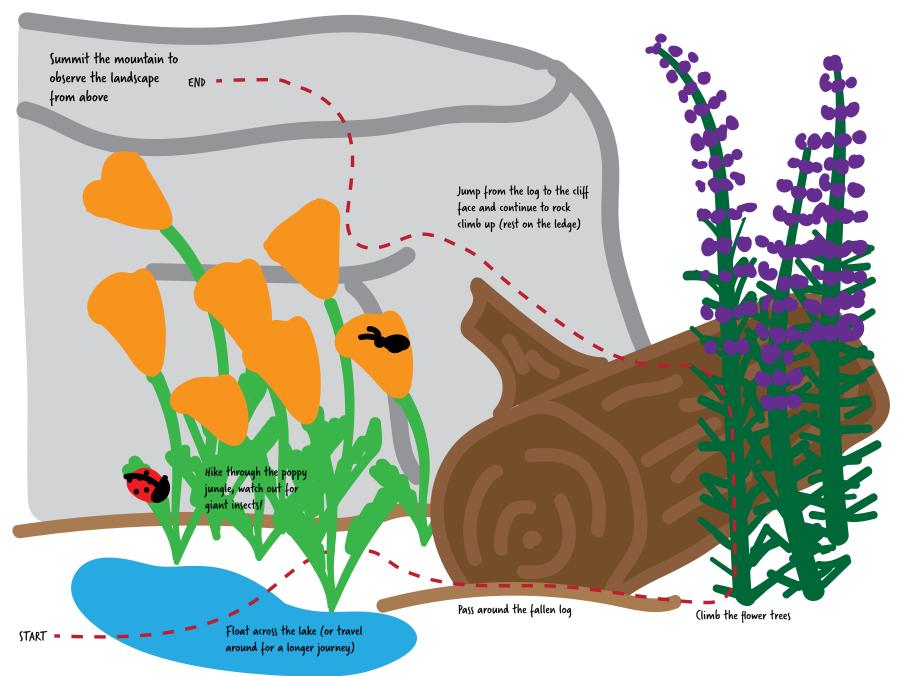






Shrunken Expedition map example





3: ENGINEER AN ARTHROPOD

Scientists categorize organisms to make them easier to study. In this activity, youth learn how scientists organize living things, and learn to recognize the essential features of all arthropods.



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

Preparation

- Write the secret words for *Telephone Charades Race* on index cards.
- Collect recycled materials (cereal boxes, toilet paper rolls, bottles, etc.) in advance.

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.

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.

Kit Materials

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

В

- cups
- pipe cleaners (short only)

C

- scissors
- tape

Loose Items

SAC notebooks

Materials Not Included

recycled materials

Explore More:

What is an





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.

Explore More:

A





Watch What is an Arthropod? (3 min.) to learn more about arthropods, then sing and dance along to Baby, You're an Arthropod! (4 min.) 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.

How did it go?







4: TOOLS OF THE TRADE





Scientists use a variety of tools to carefully gather and examine organisms. In this activity, youth practice using scientific collection tools and conduct their first Bug Safari observation.

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

Preparation

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

Dream Job 5 min. | inside



Think about your ideal job.

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

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

Tools of the Trade 15 min. | inside

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: Set up your pooter by connecting the shorter tube to the mesh hole and the longer tube to the clear hole. Hold the longer tube near an arthropod and gently inhale until it is in the jar. The mesh hole 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

Kit Materials

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

В

- brushes
- paper straws

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

Materials Not Included

• digital device (with camera)





- 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 to your eye and move yourself closer to the object you are looking at 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 <u>How to Do a Bug Safari</u> (2 min.). Now you are ready for your first *Bug Safari*. Each time you record observations, be sure to note where you are looking.

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 have discovered, so be specific.

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



Explore More:

Observe Nature with iNaturalist



- 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?
- 4. 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:





Next time, you'll upload your photos so that other citizen scientists can help identify them. Watch <u>Observe Nature with iNaturalist</u> (1 min.) 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!









Organisms live in natural environments, called habitats, that provide the food, shelter, and climate needed for survival. In this activity, youth conduct a Bug Safari observation, submit their findings to iNaturalist, and set up research stations to conduct an arthropod investigation.

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

Preparation

- Create an iNaturalist account.
- Download the iNaturalist app on your digital device.
- Load videos: How to Make an Observation on iNaturalist 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.

Bug Safari 25 min. | outside |



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

- Collect arthropods in your search area.
- Take photos.
- Release arthropods.
- Record your Critter Chronicles video.

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

Citizen Science and iNaturalist Introduction 20 min. | outside or inside



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.

- 1. Watch How to Make an Observation on iNaturalist (2 min.) for an overview of uploading to iNaturalist. You can also refer to the Bug Safari and iNaturalist guide for step by step instructions of how to submit observations.
- 2. Upload your observations from today's Bug Safari. Explore the observations made by other Science Action Club members.

Arthropod Apartments 15 min. | outside



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

How to Make an Observation



Bugs in San



Kit Materials

• Bug Safari and iNaturalist guide

В

- brushes
- paper straws

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

Materials Not Included

- potted plant
- sticks and rocks





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 using the examples on the next page:
 - 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 is 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.

Share out: What data do you plan to collect from your habitats next time? What information do you need to collect to be able to see differences in the total number of arthropods present and number of different types of arthropods?

Explore More:



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

Call to Action:



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

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

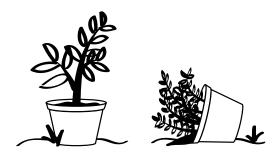






Arthropod Apartments habitat set up

Plant Patch



Position a small pot upright or on its side.

Bare Soil



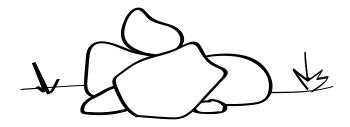
Clear a patch of bare soil. Turn and mix it until it's light and loose.

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.





All organisms have physical features that help them survive and thrive. In this activity, youth conduct their Bug Safari observations and learn about camouflage—one of the most important adaptations for survival.

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

Preparation

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

Bug Safari 30 min. | outside

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.

- Collect arthropods in your search area. Remember to notice size, color, shape, and behavior of arthropods.
- Take photos and upload to iNaturalist.
- Release arthropods.
- 4. Record your Critter Chronicles video.

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

Camouflage Standoff 10 min. | outside or inside

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?

- 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?

Kit Materials

Α

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

В

- brushes
- paper straws

- crayons
- scissors

D

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks





Color Your Camouflage 20 min. | outside or inside

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 arthropods have evolved their camouflage to survive in Nature's Masters of Disguise (4 min.).

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.

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



Explore More: Nature's Masters of







7: HABITAT HEALTH

Bay checkerspot butterfly

22

Understanding how human actions impact life around us is key to finding solutions to environmental challenges. In this activity, youth conduct their Bug Safari observation and explore how changes to the environment impact arthropods.

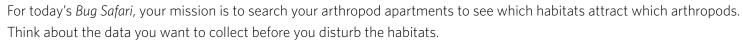


Your mission today is to explore how changes in the environment can affect arthropods.

Preparation

Load video: Monarch Decline.

Bug Safari 30 min. | outside



- 1. Collect arthropods in your four habitats. Keep track of what was found in each. Remember to move logs and stones carefully and to put them back in the same way in order to protect the arthropods living there.
- 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?

Healthy Habitats 10 min. | inside



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

Watch the Monarch Decline video (2 min.).

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

Kit Materials

Α

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

В

- brushes
- paper straws

C

- scissors
- sidewalk chalk

D

- magnifying lenses
- magnifying loupe

Monarch

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

- 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. Use the drawing on the next page to help set up for each round.
- 3. 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. Players must walk to simulate a butterfly slowly finding its food. 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.

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.

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



Explore More: Witnessing

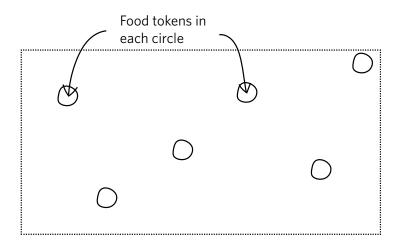
Butterflies



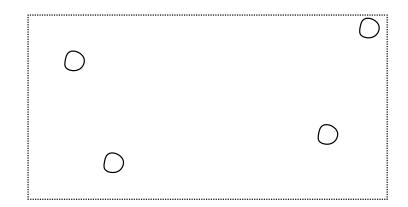
Race for Resources playing field set up



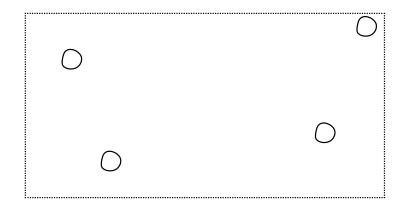
Round 1 · 6 habitats · 30 seconds



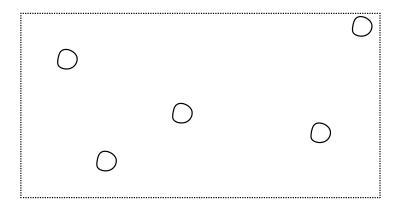
Round 2 · 4 habitats · 30 seconds

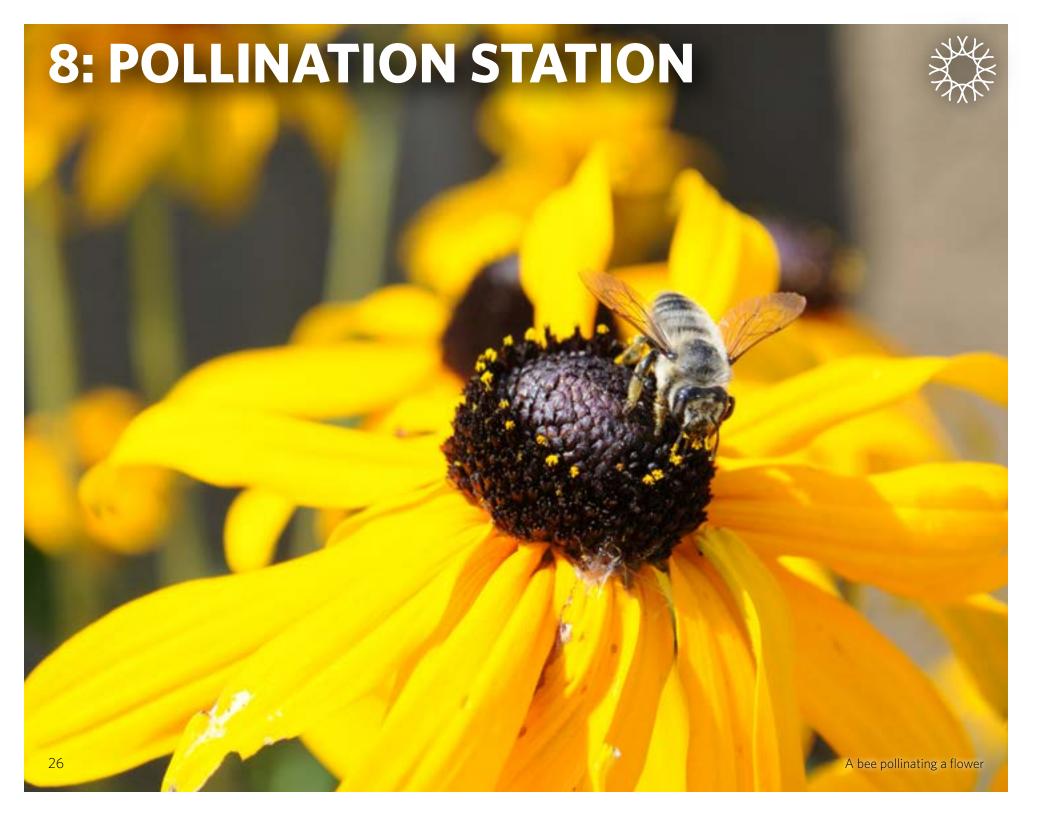


Round 3 · 4 habitats · 30 seconds



Round 4 · 5 habitats · 30 seconds





Most flowering plants need help to reproduce. In this activity, youth analyze data to determine the relationships between flowers and pollinators, and use the data to design scientific models.



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

Preparation

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

Bug Safari 25 min. | outside L

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. Instead of netting pollinators, wait for them to land, and then try to snap a photo.
- 2. Take photos and upload to iNaturalist.
- 3. Release arthropods.
- 4. Record your Critter Chronicles video.

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,

Kit Materials

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

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

C

- scissors
- tape

D

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

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.

Pollination Station 25 min. | inside

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, work indivudally or in pairs to 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 are done, present your flower to another club member.

Explore More:





Watch This Vibrating Bumblebee Unlocks a Flower's Hidden Treasure (4 min.) to learn more about the unique relationships that can from between bees and flowers.

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?

Explore More:

This Vibrating Bumblebee

Flower's Hidden

Unlocks a

Treasure



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





Spider webs are an impressive and beautiful adaptation that humans have learned from and emulated. In this activity, youth learn about spider web designs and create their own webs.

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

Preparation

- Load video: Spider Genius Architect.
- Collect erasers and other small items of different weights that youth will try to catch in their webs.

Bug Safari 25 min. | outside

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?

Web Weavers 10 min. | inside



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

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?

Indestructible Web 25 min. | inside |



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.

Spider Genius Architect



Kit Materials

- Bug Safari and iNaturalist guide
- Indestructible Web cards

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

scissors

D

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

Materials Not Included

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





- 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, about three arm lengths, 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.

Explore More: 🔲 🛞





Watch Spider Silk Tech (4 min.) to learn how humans learn from the engineering skills of spiders.

Call to Action:





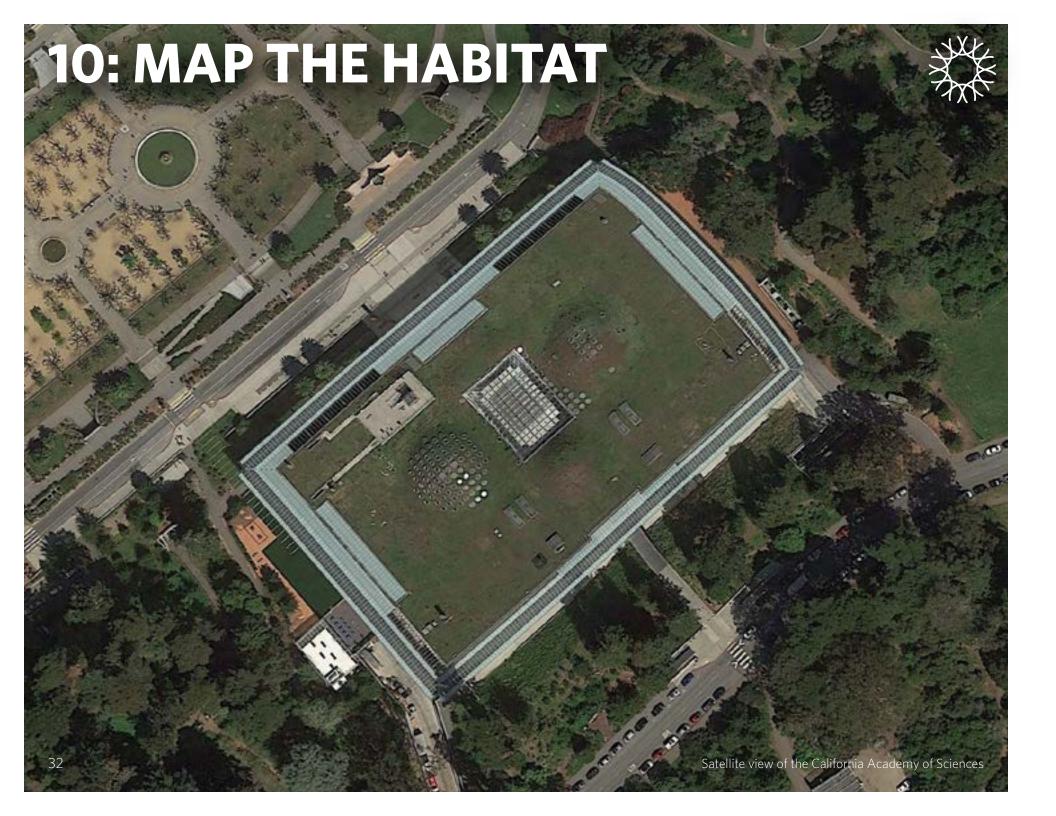
Now that you are an expert on web building, pay attention to the kinds of webs in your house or neighborhood and look out for any prey caught in them. You can record what you find in your notebook or on iNaturalist.

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



Explore More:





Environmental conditions affect where arthropods can survive. In this activity, youth use scientific methods and tools to analyze different habitats and consider the features that make some places more hospitable than others.



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

Preparation

Practice using the Map the Habitat tools.

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. When you run out of hands, 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 on a large piece of chart paper or the board.
- 2. Select three spots to perform your measurements.

Kit Materials

- Bug Safari and iNaturalist guide
- Map the Habitat cards

- brushes
- paper straws

crayons

D

- magnifying lenses
- magnifying loupe

E

- filter paper
- pH strips
- thermometer

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks

- 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 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:





Watch How Do Insects Survive the Winter? (3 min.) to learn how insects keep from freezing in cold climates.

Call to Action:

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

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?

Explore More:

Survive the

How Do Insects









Scientists review their data and notes to look for patterns and make discoveries that enhance our understanding of the natural world. In this activity, youth review all their arthropod observations, analyze them, and create visuals to communicate their findings.

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

Preparation

- Cut construction paper: one-half sheet per youth.
- Cut Arthropod Puzzle cards into quarters.

Bug Safari 20 min. | outside L

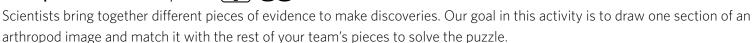


As you look for arthropods, consider which species you have seen regularly and those which were rare.

- 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: How have your Bug Safari skills changed over time?

Arthropod Puzzle 15 min. | inside , Arthropod Puzzle 15 min. | Ins



- 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?

Critter Chronicles 25 min. | inside



You have explored every corner of your surroundings and discovered an exciting diversity of arthropods. Now analyze the data you have 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.

Kit Materials

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

- brushes
- paper straws

- crayons
- tape

D

- magnifying lenses
- magnifying loupe

- foam circles
- petri dishes

Loose Items

- aerial net
- beating sheets
- pooters
- SAC notebooks





- Review the Critter Chronicles videos from each of your Bug Safaris. If your Critter Chronicles videos are not available, you can also use your iNaturalist observations to help tally.
- 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	 	14	On plants and in grass
Woodlouse Spider	 	9	Under wood, mulch on ground
Pillbug	 	23	Potted plants, edges of grass

- 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

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 <u>Biofluorescent Scorpions</u> (1 min.).

Call to Action:



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

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









As humans, we have the ability to make positive changes to our environment. In this final activity, youth weave together what they have learned to design strategies for supporting arthropod diversity and environmental health. This is also the time to celebrate their accomplishments as citizen scientists.



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

Preparation

- Load video: Bugs for Breakfast.
- Buy Field Makeover supplies.
- Fill in SAC certificates.

Game 10 min. | outside ↓

Vote to play your favorite arthropod game again; choose from Activity 1: Creature Catch Phrase, Activity 3: Telephone Charades Race, Activity 8: Pollen Freeze Tag, or 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 Bugs for Breakfast (4 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.

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 Buq 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?
 - o Which arthropod do you think would be helpful?
 - o What will it need to survive?
 - o 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

Kit Materials

• SAC certificates

Loose Items

- Bug Safari buttons
- SAC notebooks

Materials Not Included

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

Bugs for



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.

Explore More: Should We Eat



SAC Ceremony 10 min. | inside





Pass out SAC certificates one at a time. Give each person a Bug Safari 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 Should We Eat Bugs? (5 min.) to find out why bugs mights be the perfect food.

Call to Action:





Congratulations! You have 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.

How did it go?



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





CONNECT TO THE ACADEMY



California Academy of Sciences offers several ways to stay connected:



bioGraphic for Educators

This multimedia magazine powered by the Academy includes immersive infographics, data visualizations, and videos.



Citizen Science Toolkit

This toolkit is designed to help educators integrate citizen science projects into classroom curricula or afterschool programming.



Educator Tab

This is the entry point to all of the educator resources offered by the California Academy of Sciences.



Science Films for the Classroom

These award-winning planetarium dome shows have been reformatted for educational use as stand-alone films or as a series of short, modular clips.



Citizen Science Projects

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



Distance Learning

Distance Learning brings Academy experts, animals, collections, and exhibits to youth the world over, via the internet.



Flipside Science

These video-based units, designed for middle school educators and students, address food, water, and energy systems, environmental solutions, and design-thinking skills.



Science Video Vault

A collection of high-quality short-length videos to help your students visualize data and scientific and natural phenomena.



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.



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.

Unless otherwise stated, all vector graphics were created by the California Academy of Sciences.



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WEB LINKS

	Attendance and Feedback	http://sciclub.link/bugs-feedback	
1: Field Study	Science Action Club Citizen Science	http://sciclub.link/sacmission	
	Habitat Earth	http://sciclub.link/bugsa1em	
	Biodiversity Field Guide	http://sciclub.link/bugsa1em2	
2: Observe Like a Scientist	Macro Color	http://sciclub.link/bugsa2em1	
	Big Pictures, Tiny Creatures	http://sciclub.link/bugsa2em2	
3: Engineer an Arthropod	What is an Arthropod?	http://sciclub.link/bugsa3em1	
	Baby, You're an Arthropod!	http://sciclub.link/bugsa3em2	
4: Tools of the Trade	How to Do a Bug Safari	http://sciclub.link/bugsafari	
	Observe Nature with iNaturalist	http://sciclub.link/bugsa4em	
5: Arthropod Apartments	How to Make an Observation on a Smartphone	http://sciclub.link/iNat-video	
	Bugs in San Francisco	http://sciclub.link/bugsinsf	
	Meet the Dust Mites	http://sciclub.link/bugsa5em	
6: Color Your Camouflage	Nature's Masters of Disguise	http://sciclub.link/bugsa6em	
7: Habitat Health	Monarch Decline	http://sciclub.link/monarchdecline	
	Witnessing Butterflies Emerge	http://sciclub.link/bugsa7em	
8: Pollination Station	This Vibrating Bumblebee Unlocks a Flower's Hidden Treasure	http://sciclub.link/bugsa8em	
	Great Pollinator Habitat Challenge	http://sciclub.link/pollinatorchallenge	
9: Indestructible Web	Spider Genius Architect	http://sciclub.link/spidergenius	
	Spider Silk Tech	http://sciclub.link/bugsa9em	
10: Map the Habitat	How Do Insects Survive the Winter?	http://sciclub.link/bugsa10em	
11: Critter Chronicles	Biofluorescent scorpions	http://sciclub.link/bugsa11em	
12: Food for Thought	Bugs for Breakfast	http://sciclub.link/bugsforbreakfast	
	Should We Eat Bugs?	http://sciclub.link/bugsa12em	





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

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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

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The Science Action Club program is generously supported by



















