Wildlife Explorers

an After School Curriculum

Exploring Conservation Careers & Community Roles

from

Audubon | Spring Creek Prairie Audubon Center

for

Beyond School Bells

nebraskachildren

Mission: *The National Audubon Society protects birds and the places they need, today and tomorrow. Spring Creek Prairie Audubon Center focuses on conservation of the tallgrass prairie ecosystem and the birds that rely on it.*

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WILDLIFE EXPLORERS:

Exploring Conservation Careers & Community Roles

The WILDLIFE EXPLORERS program considers the driving question, "What is a conservation scientist, what skills would I need to become one, and how can this knowledge help me and my community?" Each section is themed on a conservation career and begins with the question, "What's the Problem?"

Activities in the following conservation science disciplines will make up the WILDLIFE EXPLORER program. Themed around "A Day in the Life of an '-ologist,'" each activity comes with lesson plans and leader back-packs filled with supplies and survey tools. The program provides instructions for five careers / community roles. The full program has a framework created so that many more outdoor careers can fit within this list.** A program would not need to do all of the below, but focus on those that the students choose, or those for which the site has the right tools or expertise to help lead.

1. **Ornithologist / Birdnerd**

   Utilizing several bird survey techniques (point-count and transects) and Audubon Bird Migration Explorer technology, this activity provides skills and hands-on experience in ornithological field techniques.

2. **Entomologist / Bugnerd**

   Utilizing insect and invertebrate ID, sweep net surveys, the NE Bumblebee Atlas, and iNaturalist, this activity explores the importance of invertebrates and insects in Nebraska ecosystems, especially pollinators. It also enhances skills in field surveying techniques.

3. **Botanist / Plant Pro**

   Utilizing plant classification, identification and survey techniques, this activity provides exploration into the importance of Nebraska's trees, shrubs, forbs, grasses and the ecosystems they support.

4. **Soil Scientist / Dirt Detective**

   Utilizing soil sampling, color tubes, percolation tests, and erosion and weather displays, students will gain knowledge and skills to test and grade soil and to understand the importance of healthy soil that provides the foundation of all other life on and in the soil.

5. **Aquatic Scientist / Water Warrior**

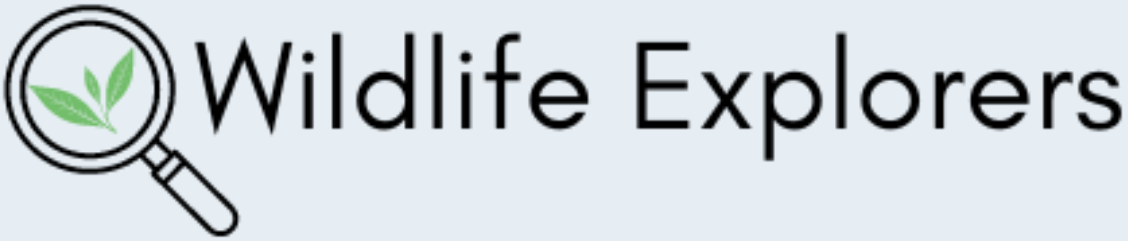
   Utilizing water sampling techniques, chemical water testing, and macroinvertebrate ID and comparison, this activity gives students an appreciation for the importance of the quality and quantity of fresh water wetlands on the landscape – and the techniques of how to manage the habitat.

*** Other "-ologists" or outdoor careers can be considered within the framework, like mammalogist, herpetologist microbiologist, etc.*

Each CAREER / COMMUNITY ROLE section is filled with activities in 5 main subsections**:**

1) What's the Problem?
2) **Delve into Details**
3) **Consider the Characters**
4) Ready to Research
5) React to Results

ACTIVITY & LESSON PLANS



ACTIVITIY OVERVIEW & LAYOUT

This column on each page will include material lists, time expectations, subject and skill connetions, key words, enrichment ideas, and more.

SUBJECTS: Science

STEM SKILLS

Investigation, Data recording and analysis, science tool/ technique usage, Career experience

TIMING

40 - 60 min.

KEY WORDS

Adaptation, Ornithology, Feather, Rachis, Barb, Barbule, Zygodactyl, Migration, Survey

NOTE: Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.

LAYOUT

In the following pages you will find all the specific Career & Community Role Activities and Lesson Plans that make up the WILDLIFE EXPLORERS curriculum. These lesson plans are laid out in a specific way to provide all the information you will need to facilitate the activities, including materials lists, enrichment ideas, connections to grade level and key words, and activity time lengths. This page(s) is a general example to help you prepare you for the fun of what is tome come.

Each CAREER or COMMUNITY ROLE section is filled with activities in 5 main sections**:**

1) **What's the Problem?**
2) **Delve into Details**
3) **Consider the Characters**
4) **Ready to Research**
5) **React to Results**

OBJECTIVES *[Each Activity will start with clear objectives]*

Students will

- Learn about what an Ornithologist is and an issue they face
- Learn about bird anatomy, identification, and conservation
- Explore birds by utilizing tools and techniques used by an Ornithologist
- Have opportunity for student-lead projects to help with the issue

BACKGROUND *[Each Activity will have background information]*

More than half of U.S. birds are in decline. A 2022 U.S. State of the Birds report shows plummeting bird populations across almost all habitats while highlighting the need for further conservation efforts. Grassland birds are in steepest decline.

Of the nearly 3 billion birds lost, 90% came from just 12 bird families, including sparrows, warblers, finches, and swallows. These common, widespread species play influential roles in ecosystems. If they're in trouble, the wider web of life, including us, is in trouble, too.

Birds are a part of every child's life, even if only as a part of the background. By teaching students how to identify some birds, you can help make them more aware of your local biological diversity and more attentive to your loca environment in

ACTIVITIY OVERVIEW & LAYOUT

This column on each page will include material lists, time expectations, subject and skill connections, key words, enrichment ideas, and more.

MATERIALS: mist net, scale, banding pliers, bands, data sheets, etc.

ENRICHMENT Opportunites

- Take a Field Trip to the Zoo, Banding Lap, etc
- Invite a local Ornithologist or Audubon Member to come talk

FURTHER RESEARCH

- Run surveys once more
- evaluate data (graph/chart)
- survey new locations to compare/contrast

SETUP

To get this first Ornithologist activity set-up, please print out the *PROBLEM PAGES* and plan a space for the students to meet to discuss the over-arching "What's the Problem" question. You may want to have computer access available for research, as well as some books out on bird conservation, identification, and more. Don't forget to check the supplies list for all you might need for the upcoming activities.

DOING THE ACTIVITIES *[Each Activity will have clear instructions]*

Once all your materials are ready and setup is complete, bring students together to start the activity with the question "What's up with Birds?" After about 5-10 minutes of some early discussion, have students check out the video or problem pages and profiles to learn about declining birds across the U.S. and those specific species declining in Nebraska. "Who Cares?" Provide the information on a local professional doing the work and more about what they do which can lead into individual or team time to research more and bring questions back. Connect this information to the activity up next or the next day.

*** SPECIAL NOTE** Many of the Career Sections will have more than one activity per day. Each activity will be separate and go within the CAREER (example: Ornithologist) five day scheduled sections. This timing is flexible, so if you need more days to complete activities, please feel free to stretch or condense the activities to fit your program's and the students' best availability.*

1. WHAT'S THE PROBLEM?

In this section, an over-arching problem will be introduced such as bird population declines, insect and pollinator extinctions, and/or soil health degradation. Each section will come with "Problem Pages" to provide facts, data, and the leading question for students to understand and begin to explore the problem that connects to the conservation career. For example: for Ornithologist, the "Problem Pages" may introduce findings that bird populations have decreased by nearly 3 BILLION since 1970. What could be causing this? [habitat loss, climate change, pollution, etc.] Who can help? [page on what an Ornithologist does and a special profile highlight on a local Ornithologist doing the work] These pages will be followed by activity instructions/options to use them with students inside or outside and follow-up connecting questions to connect with the next section, "Delve into Details." *(For example "Problem Pages," see pages 21-24)*

ACTIVITIY OVERVIEW & LAYOUT

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- evaluate data (graph/chart)
- survey new locations to compare/contrast

2. DELVE INTO DETAILS

This is the "lab" section of each career unit. Students will take a much closer look at the organisms being studied and learn more about them as a group. For example, activities for Ornithologist would involve looking closer at birds in general. Students would explore feathers, beaks, hollow bones, and other bird adaptations and anatomical feathers that make birds the unique organisms they are. This would be similar for all other careers, looking closely at plants, insects, soils., etc. This section will involve hands-on lab exercises and activity sheets to go with them. The section will also include tips for further enrichment and projects for students to explore even more if they are interested, individually or in groups. By the end of this section, students will understand the problem facing the organisms, a career or community role that can study the organisms and help with conservation projects, and a deeper knowledge of the organisms themselves.

3. CONSIDER THE CHARACTERS

In this section, students will take what they have learned in previous activities and look even closer at a Nebraska/local organism in great detail. For example, if studing birds as an Ornithologist, they may looks very close at the Western Meadowlark, the Nebraska state bird. If they are exploring as Entomologist, they may study Monarch butterflies and their life cycle even closer. Or if learning to be a Soil Scientist, they may examine the state soil, the Holdrege, and its properties.

This section will come with both inside and outside exploration of these important "characters" to help continued investigation into the over-arching problem introduced in section one. This section will also prepare the students for the next and most important outdoor section performing scientific surveys outside in the "Ready to Research" section.

For example "Consider the Characters" activities , check the index.

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FURTHER RESEARCH

- Run surveys once more
- evaluate data (graph/chart)
- survey new locations to compare/contrast

4. READY TO RESEARCH

In this section students will get to see what it is like to BE an Ornithologist, Botanist, or other outdoor scientist by participating in real field techniques and research to help solve the over-arching problem introduced in section one. This section will have several options for outdoor field research surveys of 20-30 minutes each. Leaders/students can decide to do one or try all of the survey techniques depending on time and outdoor space. Each activity/survey will come with instructions, a list of tools and how to use them, data sheet templates to use, and tips on locations to contrast and compare when surveying.

For example, if exploring as an Ornithologist, instructions will be provided on how to do both a sound map listening for birds as well as doing a point count survey looking for birds in the area.

Also, this section will have options and ideas for entering data taken in community science websites/apps or looking at data as a group to connect to the next and final section, "React to Results."

5. REACT TO RESULTS

This section may have the most flexibility for the leaders and students as it depends upon the data taken and whether or not the data is entered, shows results supporting the introductory problem, and if the students and program have time and resources to decide to do some next steps.

Tips will be provided on analyzing the data or utilizing community science databases and software to help with this step. In its simplest form, this final section asks the students what the observed and what the datum tells them. After these discussions or reports or posters/projects by students, we recommend asking the students a final question: "So now what? What can you/we do?" The structure is designed to offer the opportunity for individual, team, or groups projects such as education posters, community projects like pollinator gardens or bird feeder stations, or recommendations and/or resolutions by the students for the school, after school program, or community to change behavior. Perhaps the final suggestion will be that the students need to research more and take more data - bringing the whole program full-circle back to the introductory problem.

This is also the section that most logically aligns with more enrichment opportunities, though they can be scheduled throughout the program sections wherever they fit best. The program is designed with the idea that perhaps students can take a field trip to another location, meet a visiting expert on the subject, or work with a professional in the field to ask questions they may have or practice techniques.

Wildlife Explorers

Grades 6 - 10

ACTIVITIY DRAFT SCHEDULE(s)

ENRICHMENT Opportunites

- Take a Field Trip to the Zoo, Banding Lap, etc
- Invite a local Ornithologist or Audubon Member to come talk

FURTHER RESEARCH

- Run surveys once more
- evaluate data (graph/chart)
- survey new locations to compare/contrast

WRAP-UP & ASSESSMENT

Each full activity may not have an indivicual wrap-up and assessment, but each section / career will end with several wrap-up ideas and opportunities to assess both the students' participation with chances for further research (if needed or time allows), creation of communication materials about the topic like posters, brochures, social media content, and/or perhaps the creation and implementation of a community project to help solve them problem. An example would be creation of more bird habitat by building birdhouses or feeders, planting of a native plant pollinator and bird garden, or hosting a community bird count. These activities are built in to the final section of the program, "React to Results."

Many of the assessment and enrichment opportunities may take more time so plan ahead and remember to try and keep them student-led.

SCHEDULING THE ACTIVITIES

Scheduling activities throughout the program is very flexible and should work with all types of after school programs. The full program is designed for activities to be from 20 minutes to no more than one hour. A group of students could go through a career/community role in one quick week using 45 minutes to 1 hour each day, Monday through Friday. Or, a student group formatted more like a club could do a section or activity once a week on a certain day for a month, quarter, or semester depending on the amount of time available. Using the ORNITHOLOGIST career, please see a couple of example schedules below to help in planning.

1-week Schedule

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Problem Pages and Professional Profile	Delve into Details: look bird anatomy, feathers, beaks with games, activities, and labs.	Characters: activity pages and outdoor exploration about 1 or 2 specific local important birds like Western Meadowlark	Research! Perform 1-3 surveys - Sound Map, Point Count, Feeder Watch, Transect, etc.	React: look at results of surveys and discuss. Plan projects, enrichment time, or wrap- up on findings.
30 - 45 min	45 min - 1.5 hr	45 min - 1 hr	1 - 2 hrs	45 min - 1 hr

Quarter/Semester "club" schedule

Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
Introduce problem and career with Problem Pages and Prof. Profile.	Start details: look at bird feathers/ beaks with games / activity pages	More details: review and more games / activity pages about birds	Characters: look close at state bird W Meadowlark and school bird, Cardinal	Characters 2: outdoor search for cardinal, posters about Cardinals.	Research: Get outdoors and try 1 or 2 surveys, feeder watch & sound map	Research 2: more time to do more outdoor survey, point count	Research 3: bring in local expert or take field trip to compare survey	React: look at data, enter in database, discuss results, plan projects	React/Wrap: ask students observations, what else they could do and plan
30 - 45 min.	*45 min. - 1hr*	45 min. - 1 hr	45 min. - 1 hr	45 min. - 1 hr	1 -2 hr	1 - 2 hr	1 - 2 hr	45 min. - 1 hr	45 min. - 1 hr

ACTIVITY & LESSON PLANS

Ornithologist

Wildlife Explorers

ORNITHOLOGIST / BIRDNERD

SUBJECTS: Science

STEM SKILLS

Investigation, Data recording and analysis, Science tool/ technique usage, Career experience

TIMING

40 - 60 min. each activity,

2-6 hrs full section

KEY WORDS

Ornithologist, Adaptation, Feather, Rachis, Barb, Barbule, Migration, Survey, Transect, Species, Avian.

NOTE: *Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.*

OVERVIEW

Bird populations are declining across the world. Here in Nebraska, grassland birds are declining the most steeply due to habitat loss, climate change, and other environmental stressors and dangers. Students gain an understanding about birds, their unique adaptations, and how Ornithologists study them in the field to help them survive a changing planet.

OBJECTIVES

Students will

- Learn what an Ornithologist is and the issues they and birds face
- Learn about bird anatomy, identification, and conservation
- Explore birds by utilizing tools and techniques used by an Ornithologist
- Participate in real-time avian surveys and techniques and enter data
- Have opportunity for student-led projects to help with issues identified

BACKGROUND

More than half of U.S. birds are in decline. A 2022 U.S. State of the Birds report shows plummeting bird populations across almost all habitats while highlighting the need for further conservation efforts. Grassland birds are in steepest decline.

Of the nearly 3 billion birds lost, 90% came from just 12 bird families, including sparrows, warblers, finches, and swallows. These common, widespread species play influential roles in ecosystems. If they're in trouble, the wider web of life, including us, is in trouble, too.

Birds are a part of every child's life, even if only as a part of the background. By teaching students how to identify some birds, you can help make them more aware of your local biological diversity and more attentive to your local environment in general—applying knowledge and providing sense of place.

Bird education is an exciting field of study that offers numerous benefits for the next generation. As children are exposed to nature and its wonders, they develop a greater appreciation for the world around them. Bird education provides invaluable opportunities for kids to learn about birds' unique characteristics, habitats, and behaviors while fostering a sense of curiosity and wonder.

MATERIALS:

⇒ Ornithologist Problem Pages

⇒ Binoculars

⇒ 3 to 5 Bird Beaks

⇒ Various Bird Feathers

⇒ Bird Bone(s)

⇒ Bird ID Field Guide(s)

⇒ Bird Anatomy Chart

⇒ Survey Data Sheets

⇒ Access to PC to use Audubon Migration Explorer

GETTING READY

- Gather materials and equipment and students in a comfortable outdoor or indoor location. Be near outdoor location for activities / surveys.
- Plan your Ornithology research schedule for 3 to 5 days or more of 30 min. to an hour each day.
- Gather all the problem pages, research papers, quizzes, and survey tools for all Ornithology activities. Make copies of problem pages, activity sheets, data sheets, etc.
- PRESENT THE PROBLEM: Bird populations are declining rapidly.

DOING THE ACTIVITIES

1. What's the Problem?

To start each career section, ask the student group/class/club:

Are there any issues facing birds in the U.S. and/or Nebraska today?

Provide some time for discussion to get students just thinking about birds in general and any risks they face.

Next, using the following Problem Pages about declining bird populations, introduce this issue to the students by having them read the problem pages individually, in groups, or read it aloud to the group and provide the photos in copied handouts or projected on screen from a computer.

After time to consider the problem but without too much more information or description, have the students do the BIRD BLITZ activity on top of the second Problem Page. Go outside and try and see some birds and take some observations. Following this, have the students answer the short questions on the activity sheet with the Problem Pages. Instruct them this is just to gauge what they saw and know so far, so don't worry.

After some time to answer the bird questions on the activity sheet, share the local Ornithologists profiles and give the students time to see themselves as an Ornithologist. This can also be done later at the end of the whole Ornithologist section.

Now that we know the problem and just a little about birds, let's get ready to look closer at these amazing organisms. In the section "Delve into Details," we want to learn as much about birds in general as we can to be on our way to becoming **ORNITHOLOGISTS!**

PROBLEM PAGES

What's the Problem?

What You Need to Know

More than half of U.S. birds are in decline. A 2022 U.S. State of the Birds report shows plummeting bird populations across almost all habitats while highlighting the need for further conservation efforts. Grassland birds like Nebraska's state bird, the Western Meadowlark, along with Boblinks and Grasshopper Sparrows are in steepest decline.

Another way to look at it is that since 1970 one in every four birds is gone. But why? What could be happening to our feathered friends? We don't want to give you all the answers, but some things to consider and research are the effects of climate change, habitat loss, pollution, and invasive species to name just a few.

But why does it matter? Does losing some birds and bird species make a difference? Of the nearly 3 billion birds lost, 90% came from just 12 bird families, including sparrows, warblers, finches, and swallows. These common, widespread species play influential roles in ecosystems. If they're in trouble, the wider web of life, including us, is in trouble, too.

Birds can provide pollination and pest control. They are keystone species and key indicators in healthy ecosystems. And watching birds, or birding, is one of the most popular hobbies in the world providing countless hours of physical and mental health & wellness benefits.

Take some time to read, research, and discuss this problem, the causes, and then use the activity page and questions on the back of this page. When finished, you'll be ready for the next section, **Delve into Details,** all about our feathered friends . . . BIRDS!

Activities and Questions

What Do You Know and What More Can You Learn?

Before you tackle the below questions, let's start with a simple and fun activity for everyone - BIRD BLITZ! It's easy. As a group, individually, or in teams, go outside (or you can watch from the windows if weather isn't great) and see if you can find 3-5 types of birds in 15 minutes or less. It is ok if you don't know what kind of bird it is, but take observations (in your mind, on paper, etc.) about what you saw: size, color, shape, sound, etc. Also notice where the birds were and what they were doing, or, just as important, where the birds were NOT. [*If you'd like to identify the birds or learn more, use a Field Guide or Audubon's online bird guide at audubon.org/bird-guide.]* You can do this activity more than once, and each time, see if you can find or identify more birds in more places, especially once you know more about bird habitats, behavior, and lives.

Now, from your experience with BIRD BLITZ and reading and learning about the problems facing birds today, see if you can answer the questions below. Not everyone may answer the same—so share & discuss your answers afterwards.

Can you name 3 to 5 birds that you can see from your home or school? _____

_____

Name 2 or 3 causes of bird populations declining _____

Are there other things you see that could be harming birds? _____

From what you have seen, heard, and read, do you think birds need our help? _____

Are you, your family, or your school already doing something to help birds in some way?_____

If yes, what? _____

If time allows, find some scratch paper and draw, paint, or write a description of one of the birds you saw during the BIRD BLITZ!

Now get ready to become real "bird nerds" as we move to the next section and learn more about birds!

Who and What IS an Ornithologist?

WHO you need to know

In the most basic of terminology, an **ornithologist** is someone who studies birds. Some might assume you need a Ph.D. to be considered an ornithologist; however, a Ph.D. is not 'required' to simply study birds. There are numerous ornithologists of fame and lore that did not have those three letters after their name, like Peter Pyle, David Sibley, and Nebraska's own Dr. Paul Johnsgard.

Ornithologists study birds in their natural habitats or in the laboratory. They also may write research reports and proposals for grants, teach classes, present research to the public, and have administrative duties related to these activities. Some ornithologists do all these tasks and others may do some of these and many other things related to birds and/or habitat.

We have many ornithologists, or "bird nerds," researching birds right here in Nebraska in many different ways.

Here are profiles of three amazing local ornithologists to inspire your bird exploration.

Dai-zaburo Shizuka

Daizaburo "Dai" Shizuka *is an Associate Professor of Biological Sciences at the University of Nebraska-Lincoln. Dai not only teaches classes about birds, but also focuses on special research on birds linking their social interactions and relationships to their evolutionary patterns. He has his Ph.D. from the University of California-Santa Cruz and is currently leading research on how small sparrows and other birds regulate their temperatures in cold Nebraska winters.*

Allison Johnson *is a postdoctoral researcher at the University of Nebraska-Lincoln working in Daizaburo Shizuka's lab. She completed her Ph.D. at the University of Chicago but got her start in ornithology in western Nebraska. Allison has spent most winters growing up watching Sandhill Cranes migrate through the Platte River Basin, and several summers at Cedar Point Biological Station studying Cliff Swallows and teaching other ornithology students. These experiences have instilled in her a love of ornithology, and of Great Plains birds in particular.*

Who and What IS an Ornithologist?

Who you need to know *(continued)*

Stephen Brenner

Stephen Brenner *is an avian biologist involved in all sorts of bird research projects in Nebraska for both Audubon and The Nebraska Game & Parks Commission. This includes counting birds and analyzing trends in the number of birds over time to monitor their population size. Other work involves tracking different species across their long migrations. This helps us (conservationists and everyone) understand where birds that live in Nebraska for only parts of the year travel when they are not in the state, connecting the Great Plains to the rest of the continent, be it Central America or northern Canada.*

Can you see YOURSELF as an ***ornithologist****? What more would you like to know about birds? Where would you go to study them? How could your work as an ornithologist help your family, community, state, or the world? Draw or put a picture of yourself studying birds in the box below and write some ideas of what you would be doing 5 or 10 years from now as an* ***ornithologist!***

YOU! Name: _____

Materials:

True/False Question Sheets

Feathers

Beaks/Bone Clones

Hollow Bone Examples

Feather Diagrams

Bird Cards

Bird Field Guides

2. Delve into the Details

Ok, Ornithologists and bird nerds, it is time to look a little closer at our feathered friends. In this section we will find out how much you may already know about birds - YOUR funds of knowledge - and explore several amazing adaptations birds have that make them unique.

We have several lab activities planned to explore birds in detail and you can do one or all of them depending on the time you have, but let's start with a check-in of what students may already know with our "What Makes a Bird a Bird?" True or False activity.

On the following page are 10 - 15 true or false questions about birds. There are many active and fun ways to do this. The simplest is to just have students draw a bird and write answers down next to them. But a more hands-on and visual way to introduce the topic is to have space indoors or outdoors for the students to stand in a group. Then, proceed with the T/F questions and have students answer in one of the following ways:

1) This version of the activity takes more preparation. Each student would make (or the leader could have premade) TWO large bird shapes. One bird shape or picture will have a large word TRUE printed on it, the other will have FALSE printed on it. When the question is asked, the student holds up the corresponding bird so all can see. It is okay to be wrong, but ask students to please, give it an educated guess. You can do this activity again at the end of the full Ornithology section as a form of assessment.
2) The other version is to use spatial separation. Designate an area of the room or outdoor space with a spot for TRUE and a spot for FALSE and have students stand in between them. When asked the question, they "migrate" to either the TRUE or FALSE location and visually see how their fellow students answered. Again, it is okay to be wrong, we just want to see how much the students may or may not know about birds and build on that throughout the section.

Once finished with the T/F activity to get to know what you know or don't know, give the students 5 minutes to discuss a few things that surprised them or may have been easy. Then, read the following statement:

IF IT HAS FEATHERS, IT IS A BIRD! Birds are unique organisms with many adaptations, but there are three main ones that make them like no other animal on the planet: FEATHERS, BEAKS, and HOLLOW BONES.

Let's look at one or all of these along with other amazing avian adaptations (time-permitting) our feathered friends possess as we continue to "Delve into Details!"

2. Delve into the Details *(cont.)*

What Makes a Bird a Bird? True or False

Remember, use either bird shapes with TRUE and FALSE printed on them or the spatial option to have students move to one space or other to answer TRUE or FALSE. Encourage discussion by asking students to share why they chose "True" or "False." Allow students to change their chosen side based on the discussion. At the end of questions and discussion, be sure to reveal the correct answer and, if possible, give an example. Again, it is ok to be wrong. *[If you'd like to use this activity as part of the assessment at the end of the section, make sure to keep scores of answers or ask a student to do so. Then you have data to compare to later.]*

BIRD STATEMENTS - TRUE or FALSE?

1. Birds are the only living animals that have feathers. *[note - we now know many dinosaurs had them]*
2. All birds fly.
3. All birds have two wings.
4. Birds lose and replace their worn or damaged feathers.
5. All birds have thick, heavy bones that provide the structure needed to fly.
6. Birds have poor eyesight.
7. Bird hearts beat more slowly than human hearts.
8. All birds lay eggs.
9. Most birds eat worms.
10. All birds sing.
11. Birds are Vertebrate organisms.
12. All birds are warm-blooded.
13. All baby birds hatch covered in downy feathers.
14. All birds migrate.
15. Male and female birds always look different.

Answers

1) T 2) F 3) T 4) T 5) F 6) F 7) F 8) T 9) F 10) F 11)T 12)T 13)F 14)F 15) F

Did You Know? IF IT HAS FEATHERS, IT'S A BIRD!

Birds are the only living creatures with feathers. Feathers are made of keratin, the same protein that makes up a bird's beak, lizard scales, mammal hair, human fingernails, animal hooves, and horns! Feathers help birds fly and keep them warm and dry. The color pattern of feathers, called **plumage**, can help birds stay camouflaged or find mates.

2. Delve into the Details *(cont.)*

If time permits and/or the students liked this first version of learning about their funds of knowledge about birds, you can continue with more T/F questions about nesting behavior in birds. Or, this is a great way to continue the Ornithologist section if weather does not allow exploration or surveying outdoors later in the section. The activity is done exactly as the general "What Maks a Bird a Bird?" true or false activity.

Nesting True or False

1. All birds build nests.
2. Some birds give birth to live chicks rather than lay eggs.
3. Eggs and chicks are not always safe in their nest.
4. Most birds live in their nests year round.
5. Only the female incubates the eggs.
6. Most baby birds are fed seeds and berries by their parents.
7. Birds can breathe inside their eggs before they hatch.
8. Eggshells are made out of the same materials as chalk.
9. The egg yolk (yellow) grows into a baby bird.
10. If you find a baby bird you should feed it bread and milk.

Answers 1) F 2) F 3) T 4) F 5) F 6) F 7) T 8) T 9) F 10) F

Did You Know? A NEST IS A NURSERY

Birds do not live in their nests year round. Nests are only used for incubating eggs and raising chicks. Some nests aren't made of leaves and twigs—some are burrows in the ground, holes in trees, or just round depressions in sand or rocks. Some birds may go back and use a nest for shelter in storms, but do not live in them all year.

Materials:

True/False Question Sheets

Feathers

Beaks/Bone Clones

Hollow Bone Examples

Feather Diagrams

Bird Cards

Bird Field Guides

2. Delve into the Details *(cont.)*

As we delve further into the amazing avian world, let's look much closer at some important adaptations that make birds unique: feathers, beaks, and hollow bones. *(note: doing all is optional, time-permitting, but exploring at least one or two is important for students to understand birds in general.)*

Let's begin with the one structure that no other living organism on the planet has: **FEATHERS!**

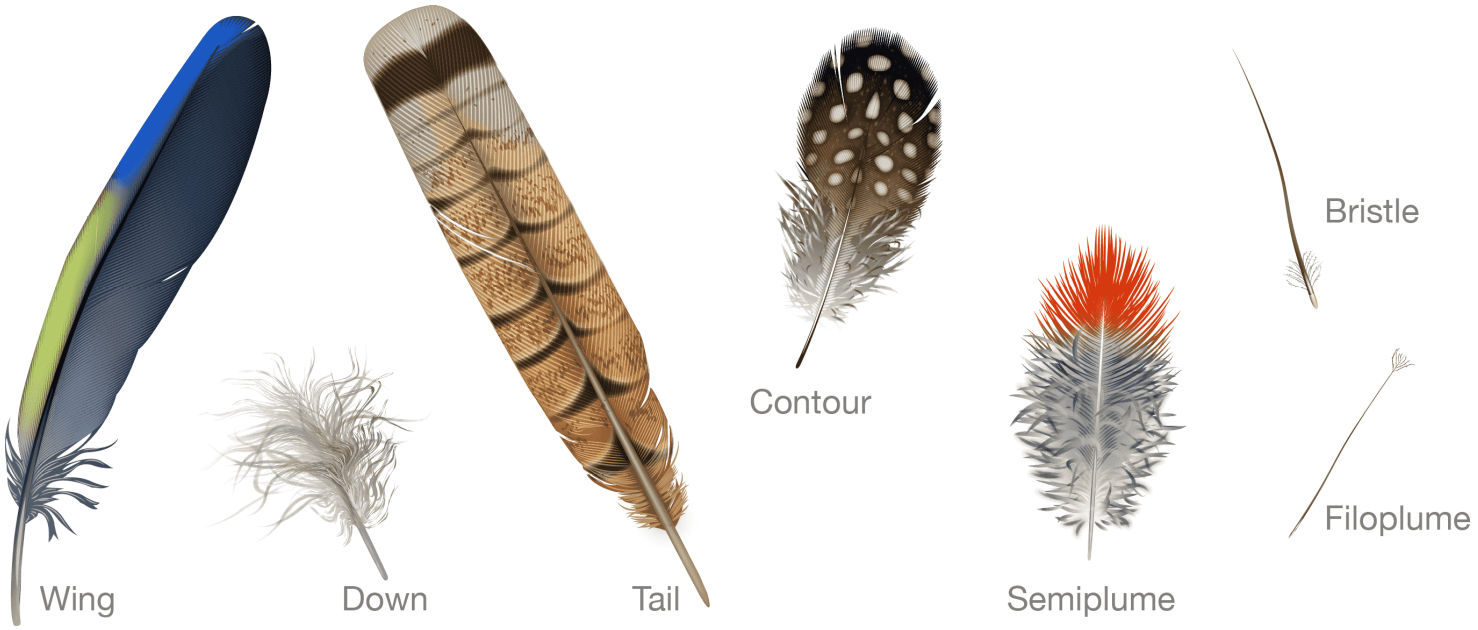
Feathers are amazing adaptations with many parts and functions we could list and list. But before we get into those details, let's just observe and discuss some feathers and then come back to some questions to help you look even closer.

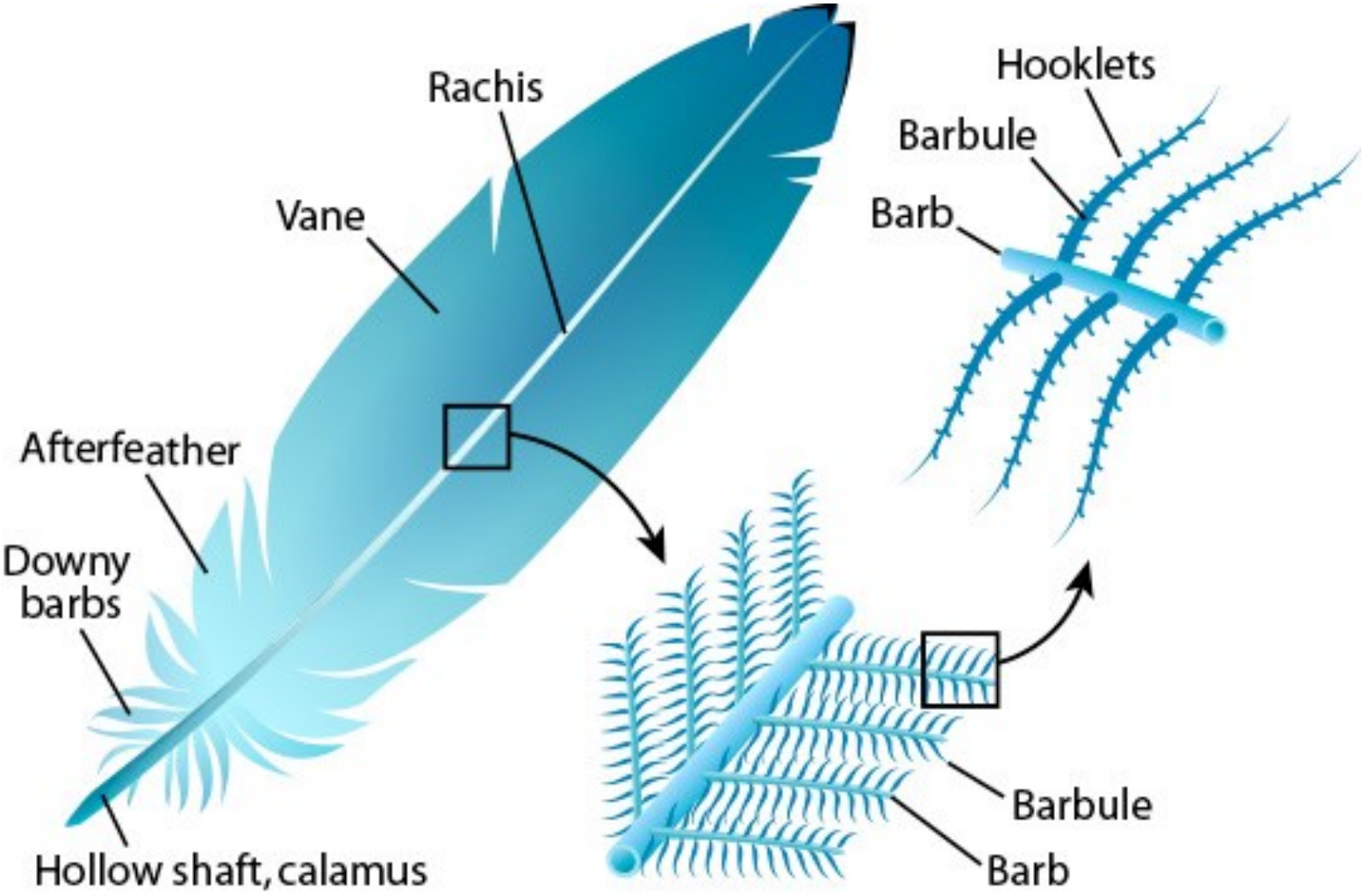
1) Pass out at least one flight/contour feather to each student or in pairs along with magnifying glasses and/or a jeweler's loupe. Ensure all students or teams have paper and pencils or computer to be able to write down and/or sketch observations and follow-up questions. *(feathers provided with Ornithology section kit or borrowed from Spring Creek Prairie Audubon Center or NE Game & Parks Commission.)*
2) Ask students to observe their feather up close. Draw what structure(s) they see. Write down questions they may have. Have the students "test" the feather carefully for wind/lift, strength and durability, waterproofing, etc.
3) Have students/teams report back and discuss findings on their feathers.
4) Now present the students/teams with several different kinds of feathers from downy to semi-plume and repeat steps 2 and 3.
5) After time for reporting on observations, provide printed or projected versions of feather types with labeled structures on the following page. Have students look for these parts on their feathers.
6) Bring out strips of Velcro and demonstrate or provide to students to demonstrate. How is this like a feather?
7) What structures do humans have that are similar to feathers? Are they made out of the same material? Why?

Similar to human hair**, feathers** are extensions of epidermis, or skin, and are made from **keratin** like human hair and fingernails. Once emerged from the skin, feathers are "dead" and need to be kept in good shape or molted (shed) and regrown.

Now that we've looked closer at the structure of feathers, let's explore their many important functions. To start, ask the students how many functions of feathers they can list. *[flight, warmth, shape, color, attract mate, water-proofing, egg incubation, UV protection, etc.]*

FEATHERS!


Wing
Down
Tail
Contour
Semiplume
Bristle
Filoplume


Rachis
Vane
Afterfeather
Downy barbs
Hollow shaft, calamus
Hooklets
Barbule
Barb
Barbule
Barb

Materials:

True/False Question Sheets

Feathers

Beaks/Bone Clones

Hollow Bone Examples

Feather Diagrams

Bird Cards

Bird Field Guides

2. Delve into the Details *(cont.)*

FEATHER Functions

Feathers are amazing adaptations with specialized structures we have looked at up close. But what are some of the main functions of these super light superstructures?

1) Have the students look back at their original observation notes or sketches from the BIRD BLITZ outside at the start of the section. Think about the birds you saw. If none were seen, bring up some video clips or have the students find their own to watch.
2) Ask students to discuss some of the main functions of feathers:
   - ⇒ FLIGHT
   - ⇒ INSULATION
   - ⇒ WEATHERPROOFING
   - ⇒ DISPLAY
3) Split students into 4 or more teams, each assigned or allowed to choose one of the feather functions above.
4) Ask the team to discuss and possibly research (if books/internet available) more on how feathers are used for this function.
5) Provide each team with large or poster-sized paper or access to whiteboard, etc., and ask each team to create their own bird with specialized feathers that demonstrate this function. Be creative. It doesn't have to be real. The more creative the better.
6) Have teams report to the full group on their feather functions and specially created birds.

** For further feather study, check out Cornell Lab of Ornithology's amazing Feather web learning: academy.allaboutbirds.org/feathers-article

Now that we've looked closer at the function of feathers, and explored their many important functions, it is time to look at another important avian adaptation, **BEAKS!**

MATERIALS (Fill the Bill)

All in Fill the Bill bin, or:

- ⇒ Bird Skulls (3-5 var.)
- ⇒ Chopsticks
- ⇒ Clothespins
- ⇒ Slotted Spoons/Strainers
- ⇒ Tweezers
- ⇒ Tongs
- ⇒ Dry Uncooked Rice
- ⇒ 2-3 Large Bowls/Dishpans
- ⇒ Pipe Cleaners
- ⇒ Dry Oatmeal
- ⇒ Tall Cup or Mug
- ⇒ Sunflower Seeds
- ⇒ Pliers
- ⇒ Pipettes
- ⇒ Small Styrofoam Pieces
- ⇒ Large Pieces of Bark
- ⇒ Small Rocks

2. Delve into the Details *(cont.)*

BEAKS!

Bird beaks (or bills) are made mostly of bone — they're just a specialized modification of the upper and lower jaw bones growing outside the skin, minus teeth, shared by almost all vertebrates. The outside of a bird's beak is not covered in skin, but in a thin sheath of keratin, the same protein that makes up your hair and fingernails AND all those feathers we just looked at! Let's look closer at these diverse and amazing anatomical adaptations, their structures, and functions.

Let's start with an activity called **FILL THE BILL.**

(See materials list left or used the provided Fill the Bill bin in the Ornithology Kit.)

1) Before the students get to the Fill the Bill activity, set out several of the demonstration Bone Clone beaks from the Ornithology kit to get the students thinking of the many shapes, sizes, and functions of bird beaks. Give them perhaps 5-10 minutes just to look, silently, and take observations or sketch. For a leading question, ask the students to draw or write about a bird beak they don't see demonstrated by the Bone Clone beaks. How would your created bird's beak help it survive? What could it eat that the others couldn't? (Come back to these questions after you do the next FILL THE BILL activity.)
2) **See full INSTRUCTIONS for FILL THE BILL Activity in APPENDIX.**

** For further feather study, check out the American Bird Conservancy's amazing beak web learning: abcbirds.org/blog/bird-breaks

Now that we've looked closer at the function of beaks, and if there is more time to look closer at birds, use the following pages to learn about many other unique and amazing bird adaptations.

A great activity to use to learn more about bird physical adaptations is **BUILD A BIRD.** The instructions and materials needed can be found in the Appendix under BUILD A BIRD.

EXTRA FUN: If students have time and the interest, have them research more on adaptations like birds' specialized feet. Or, dig into bird behavior adaptations—from migration and dancing to egg laying and camouflage.

Now let's move on and look closer at a few specific birds that the students may see around them at home, in their school, or across the state.

Materials:

Consider the Character Sheets for Birds *(from Appendix)*

Journals

3. Consider the Characters

An important part of being an ornithologist is knowing more than general information about birds, but also specializing and learning about local birds and their habitat needs.

In this section we will focus on two Nebraska birds. First, our state bird, the Western Meadowlark. We will also look close at a common bird of suburban areas that is popular as school mascots, the Northern Cardinal. These in-depth studies can be ways to learn more about all birds by focusing close on a local bird that is easy to observe and study. *** Note. If you have a bird for your mascot, please consider using that species and look closer at it—like Blue Jays, Eagles, etc. It will add to the students' sense of place & pride.***

But before we even consider these characters, it is time for another outdoor activity (weather permitting) or observation period from the window.

BIRD BLITZ 2! This is just like the BIRD BLITZ we used to open this section. Gather the students in an outdoor location near the school, local park, or if weather does not allow, at a window that might allow bird observations. Ask the students to watch for birds over the next 10 minutes. This time, ask them to focus on looking for Cardinals and Meadowlarks.

***NOTE: please feel free to substitute another species here if you know in your area you do not have any of these three birds. Other suggestions for Nebraska that are common and important are: American Crow, American Robin, American Goldfinch, Eastern Bluebird, or Bald Eagle.*

Once students have done their observations, either written or sketched, have them discuss what they saw and specifically, did they find any Cardinals or Meadowlarks. If YES, why? Where? What were they doing? If NO, why not? What DID you see? If no birds, why not?

After this discussion and activity, it is time to look much closer at 2 Nebraska birds: Western Meadowlark and Northern Cardinal.

Please reference the **CHARACTER CONSIDERATION pages** in the appendix for each of these birds. You may want to make copies or show these on a large screen. You can choose one species or several depending on time and student interest, or let them choose which bird. Read/discuss with students.

This next and final step is the lead up to doing outside research and surveys as an ornithologist would, but connects to the lab research and studies done first before deciding what and how to explore birds outdoors.

Finally, ask students—individually or in teams—to do a report on one of these specific birds in one of three forms:

- *Educational Poster to help the bird's habitat*
- *Oral presentation about the bird's behavior/adaptations*
- *Comic Strip / Art project showing why the bird is important to Nebraska and vice versa*

(Some great online resources for further research on these birds are Audubon's Bird Guide, All About Birds from Cornell Lab of Ornithology, and Birds of Nebraska—Online.)

Now it is time for everyone to get **READY TO RESEARCH!**

MATERIALS:

- ⇒ DATA SHEETS
- ⇒ Pencils/Pens
- ⇒ Binoculars
- ⇒ Bird Field Guides/App
- ⇒ Survey Location Map(s)

4. Ready to Research

One of the major tasks of an **Ornithologist** is to look at ways to understand bird populations and the habitat they need and to help these birds if the research shows it is necessary. What are some of those ways and techniques of studying the birds and their habitats?

So now it is time for the students to truly become Ornithologists, using tools and techniques ornithologists use in the field, and perform some outdoor research in the form of avian (bird) surveys!

AVIAN SURVEYS!

Biological surveys are field techniques and tools to study populations and answer questions about living organisms, especially birds. There are several techniques to use to survey bird populations depending on the question(s) you want answered. This curriculum will cover three techniques.

- ⇒ **Point Count**
- ⇒ **Transect**
- ⇒ **Sound Map**

Depending on time, students can participate in one or all of these bird survey techniques. Data sheets for each are included at the end of this lesson plan including instructions for each type of survey and a list of the tools you will need. These tools may be in the Ornithology kit or can be purchased or borrowed. This is also a great time/activity to consider bringing in a guest expert/speaker to help lead surveys with students, perhaps a local ornithologist, bird expert, or college/grad student.

Below, find short descriptions of each type of survey to help students decide which you might do. REMEMBER: Instructions for each survey technique will be on or with the survey data sheets for that survey type.

POINT COUNT: A point count is a survey for birds by sight and sound from pre-designated locations for a short bit of time. Point count surveys usually consist of a route containing 10 to 12 points to survey from. Each point is surveyed usually for 5 or 10 minute time periods during the breeding season depending on the type of birds and habitat. For example, some birds (secretive marsh bird) take a bit longer to detect so points may last longer. As a demonstration, use the Point Count protocol instructions on the top of the included Point Count data sheet and perform 1 or 2 surveys at your location. You may need to pre-plan the locations or "points" to survey from. Share with students an example of a full Point Count route map.

TRANSECT: A transect survey is done by walking along a pre-determined line through a habitat to detect the birds seen and heard along it. Records are also taken sometimes about bird behavior as well. Surveys are usually done during breeding season and completed at least twice. Use the included TRANSECT protocol instructions with the data sheet to complete a transect bird survey. Afterwards, discuss how the survey went and early findings.

ENRICHMENT Opportunities:

- ⇒ Consider a field trip to practice bird identification or surveying techniques with the group. Compare habitat to local habitat at school/community with a local park, nature center. Try this with a guide and without—or have students guide.
- ⇒ Contact a local bird expert / Ornithologist to come and speak to students or perhaps provide a bird banding demonstration
- ⇒ Contact a local bird / wildlife rehabilitation center or zoo to see if students could get the opportunity to observe a live bird up close and learn more about techniques of bird banding, captive breeding, etc.
- ⇒ Consider having students participate in local bird community science projects like the Christmas Bird Count, Great Backyard Bird Count, or eBird.

4. Ready to Research!

SOUND MAP: A SOUND MAP is a survey technique utilizing only birds heard and not seen. It is similar to a point count but uses bird song and noises as markers on a map. Locations may be the exact same as those for the POINT COUNT and, many times, Sound Maps and Point Count surveys are done together. The surveyor/student sees themselves at the center of the circle on the sound map data sheet and marks all bird sounds on the map in the direction and estimated distance away they were heard. Use the included SOUND MAP data sheet and protocol instructions to perform one or two examples with the students. NOTE: if a sound is unknown, it can still be mapped by drawing what the sound looks like or writing a description.

ONE MORE SPECIAL SURVEY TECHNIQUE: BANDING!

BANDING: Bird banding is one of the most valuable survey techniques. It involves catching birds safely in nets, putting small, unique numbered bands on their legs, and releasing them with the hopes to recapture them again in the future to learn about where they go, their health, etc. Technology has made it even more valuable and immediate with the use of GPS locators providing real-time data to computers without having to catch the bird again. Banding can also be intrusive and difficult (and needs a Federal permit) as you must capture (and sometimes recapture) the birds to do this.

Banding is not something students can do on their own, as it takes a licensed bander with tools, permits, and know how. But, working with a local banding expert for a demonstration can be valuable enrichment for students to understand migration, bird populations and more.

As a form of enrichment or extra study, consider having the students work with a local expert for a bird banding demo. Students can also use Audubon's Migratory Bird Explorer online to see real-time data for bird species banded and tagged as they migrate across the Earth.

Migratory Bird Explorer: **explorer.audubon.org**

Wrap-Up & Data Entry

After surveys techniques have been completed, make sure to leave time for students to discuss these experiences. What worked and what didn't? What can the data we took tell us or help us to do in the future? What questions could you answer with one or all of these survey techniques?

DATA ENTRY. Entering the data you have taken in a spreadsheet or database is a very important step, if applicable. For bird data, entering sightings and survey data in eBird or the USGS database is a place to start. We understand this step may need to be done by the teacher/leader or be skipped for student safety & security. If data cannot be entered by the students, please do not skip the chance for students to discuss their observations.

ENRICHMENT Opportunities:

⇒ Consider a field trip to practice bird identification or surveying techniques with the group. Compare habitat to local habitat at school/community with a local park, nature center. Try this with a guide and without—or have students guide.

⇒ Contact a local bird expert / Ornithologist to come and speak to students or perhaps provide a bird banding demonstration

⇒ Contact a local bird / wildlife rehabilitation center or zoo to see if students good get the opportunity to observe a live bird up close and learn more about techniques of bird banding, captive breeding, etc.

⇒ Consider having students participate in local bird community science projects like the Christmas Bird Count, Great Backyard Bird Count, or eBird.

5. React to Results

Well, we hope that was fun! But now what?

There are several next steps to consider once surveys and research are completed and data has been entered. It is time to react to the results the data are showing us.

Let's start this with an activity that can be done indoors or outdoors (though we prefer outdoors, weather permitting). Gather the students into small groups for a "World Café" session. They will discuss in small groups and then rotate to new groups and provide their observations and answers to the following:

- What is your favorite or most interesting thing you have learned about birds in your time researching?
- What is something that concerns you about birds and bird populations in Nebraska or the U.S. currently?
- Is there anything that sticks out from the data or surveys that you notice?

After time to discuss in smaller groups, bring the full group of students back together and look at some data results. Perhaps ask the students to make a chart or graph of bird survey findings and compare to Nebraska or national historic data from eBird. Finally, to use both as a final project (if time allows) and as a form of assessment, ask the students to work together to identify projects they could plan and create to help bird populations in their community. Some options are:

⇒ *Students could work individually and create an informational poster about a bird species with information on how to help it and its habitat*

⇒ *Students could work all together to create habitat at the school or in their community by planting native plants, building and erecting bird boxes, etc.*

⇒ *Students decide as a group that there is not enough data yet to provide any answers, so more research is needed*

ASSESSMENT

Ask students to answer the following questions or complete final tasks.

- What 3 things make a bird a BIRD?
- Name at least 3 reasons bird populations are declining and provide a possible solution.
- Discuss how surveying birds (local and migratory) and collecting this data helps conserve birds and bird habitat.
- Create their own bird species with unique adaptations to survive 50 to 100 years from now in a changing climate.
- Provide students time and venue for feedback on fellow student projects and posters.

DATA SHEETS & SURVEY INSTRUCTIONS

Ornithologist

STUDENT PAGES / DATA SHEETS / RESOURCES

POINT COUNT Survey Instructions

Point counts are the most commonly used method currently available for determining the relative abundance of most land birds. A traditional point count involves standing at a predetermined location, often along the road-side, and counting all birds seen or heard during a set period of time. Standard point counts are 5 minutes long at each point and can have upt to 12 points in one survey route. These routes can be in any habitat or along roads, depending on access.

For our student-led point count surveys, we will need to have 3-5 POINTS and a route pre-determined. We suggest 3 different locations on the school campus or in a local park within walking distance. Get GPS coordinates of these locations or sketch them on a map of the area so that students can return to the exact location for each survey of the point. Writing point descriptions in the notes for the map is also helpful.

Binoculars are preferred for this survey along with the data sheet and pencils. Birds will be detected and recorded by sight and sound. Also, you may not want to do the survey if it is raining or extremely windy, as inclement weather causes birds to not be heard or be active and seen as they usually would.

Most point counts are done during the breeding season of late spring and summer here in the U.S. They are also almost always performed starting at sunrise or 30 minutes before sunrise as that is when most birds are active. For this curriculum counts can be done when it is most conducive for the students and program, but note that may change your results.

Using the data sheet that follows, ask the group or the individual student to imagine themselves walking the path on the map and stopping at each location to look and listen for birds. Looking at the habitat, do they expect to find birds at all? Do they expect to find different birds at different locations? Are the habitats the same at each? Also, an important question is: Should we do this survey just once? (*No!)* Why not?

(*Most biological surveys are done 2 or 3 times in a season to gather the most data and ensure that a certain day's weather doesn't cause a bias in the data.)*

See the below example of a point count route map and a filled-in data sheet to help you plan your survey!

AVIAN POINT COUNT SURVEY DATA SHEET

Route Name: Crete SchoolGrounds Route
Date: 2/29/2024
Observers: Jason the Birdnerd, Dakota Staggs
Weather: low wind, sunny, 68 deg F

POINT #	START TIME	BIRD SPECIES	0 - 1 Min	1-2 Min	2 - 3 Min	3-4 Min	4-5 Min
1	0732	Amr. Robin		X	X	X	
		Blue Jay					X
		Amr. Robin					X
2	0751	Cardinal	X	X			
2		Cardinal		X	X		
3	0804	E Bluebird	X				
		Amr. Robin			X	X	

NOTE: Individual birds get their own line. If you see more than one Robin at a point, each one gets their own line and mark when they were detected by sight or sound.

AVIAN POINT COUNT SURVEY DATA SHEET

Route Name:

Date:

Observers:

Weather:

POINT #	START TIME	BIRD SPECIES	0 - 1 Min	1-2 Min	2 - 3 Min	3-4 Min	4-5 Min

NOTES:

TRANSECT Survey Instructions

Driving or walking transects are common survey methods for birds and other organisms. A traditional transect count involves walking or driving a pre-determined and mapped line through or along a habitat several times a year. Transect surveys allow data to collected all through the habitat and provide great connections between bird abundance and habitat health.

For our student-led point transect surveys, we will need to have a pre-determined straight line transect through a habitat we want to survey that is at least .25 miles long or more. You will need a starting and ending point on the map or to be able to follow GPS coordinates as you walk. Imagine walking from one end of a soccer field to the other and recording any of the birds seen or heard along this walk. That is a transect survey! You can also add data to transect surveys about what the birds were doing and what vegetation/ habitat they were in or on. This helps in answering questions and making decisions about habitat management later.

Binoculars are preferred for this survey along with the data sheet and pencils. Birds will be detected and recorded by sight and sound. Also, you may not want to do the survey if it is raining or extremely windy, as inclement weather causes birds to not be heard or be active and seen as they usually would.

Most transect counts are done during the breeding season of late spring and summer here in the U.S. They are also almost always performed starting at sunrise or 30 minutes before sunrise as that is when most birds are active. For this curriculum, counts can be done when it is most conducive for the students and program, but note that may change your results.

<u>See the below example of a transect count map and a filled-in data sheet to help you plan your survey!</u>

AVIAN TRANSECT COUNT SURVEY DATA SHEET

Route Name: Spring Creek Prairie transect North
Date: 2/29/2024
Observers: Jason the Birdnerd, Dakota Staggs
Weather: Breezy, Partly Cloudy, 52 Deg F

Transect	TIME	BIRD SPECIES	Distance	Behavior	Habitat Notes
SCP N	0630	Red-winged blackbird	25 m E	flying	
	0637	E Meadowlark	10m W	singing	on plub shrub
	0639	Cardinal	50 m NE	singing	in oak tree
	0642	3 Blue Jays	30m SW	calling	eating acorns

AVIAN TRANSECT COUNT SURVEY DATA SHEET

Route Name:

Date:

Observers:

Weather:

Transect	START TIME	BIRD SPECIES	Distance	Behavior	Habitat Notes

NOTES:

SOUND MAP Survey Instructions

Assemble students at a predetermined site suitable for bird surveys. Some considerations are areas with bird habitat near trees, shrubs, prairie, etc. Area should also be free of noise distractions noise if possible. Using a Sound Map survey helps determine if an area is healthy habitat for local birds to sing for territory, mate, and nest. Binoculars are NOT needed for this survey, only ears. Closing one's eyes may actually help focus on sounds and directions.

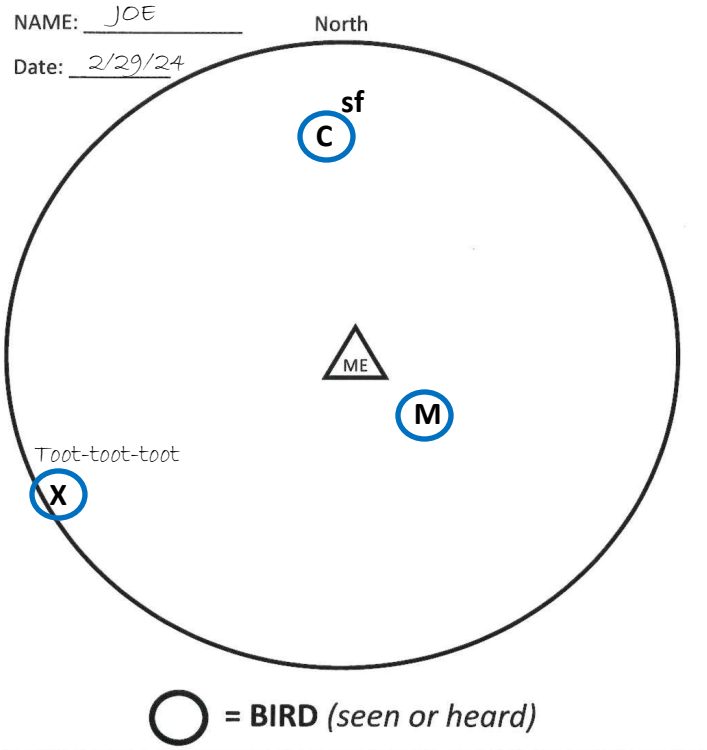
Sound Map surveys can be done in a group or individually. We recommend doing one with everyone to demonstrate how it is done, and then having students split up and perform one survey individually. The goal of a SOUND MAP survey is to record in writing on the data sheet all the birds HEARD within the area as well as the direction the sound comes from, the estimated distance the sound is away from the surveyor/student, and identification of the bird type if possible. If ID is not possible, sketching what the bird sound might look like can be used, or writing words that describe what it sounds like.

Using the data sheet that follows, ask the group or the individual student to imagine themselves in the center of a large circle. Assign boundaries about 50 to 100 m out if possible. Each survey should last 5 minutes, but can be done for 10 minutes if time allows.

When a bird sound is heard, a circle is made on the map to estimate the location and direction from the surveyor. If the bird species is known, the code for that species is written inside the circle. If the species is not known, leave the circle blank or put an X. If the bird can be seen, you can put a behavior code letter outside the circle on the right to mark what the bird was doing. Please see the example below.

If you look at the example to the right, you will see that 3 birds were detected. One bird directly north of the student was a Cardinal and it was singing and flying. Another bird was very close and just to the SE and was a Meadowlark, but wasn't seen, only heard, so no behavior was marked. The third bird, very distant at the edge of our 100 m circle, was heard but what kind of bird was unknown, so what it sounded like was written down. Later, this data can be used to see if birds prefer to sing in forested areas or in the open. Does one location have more or less singing birds using it?

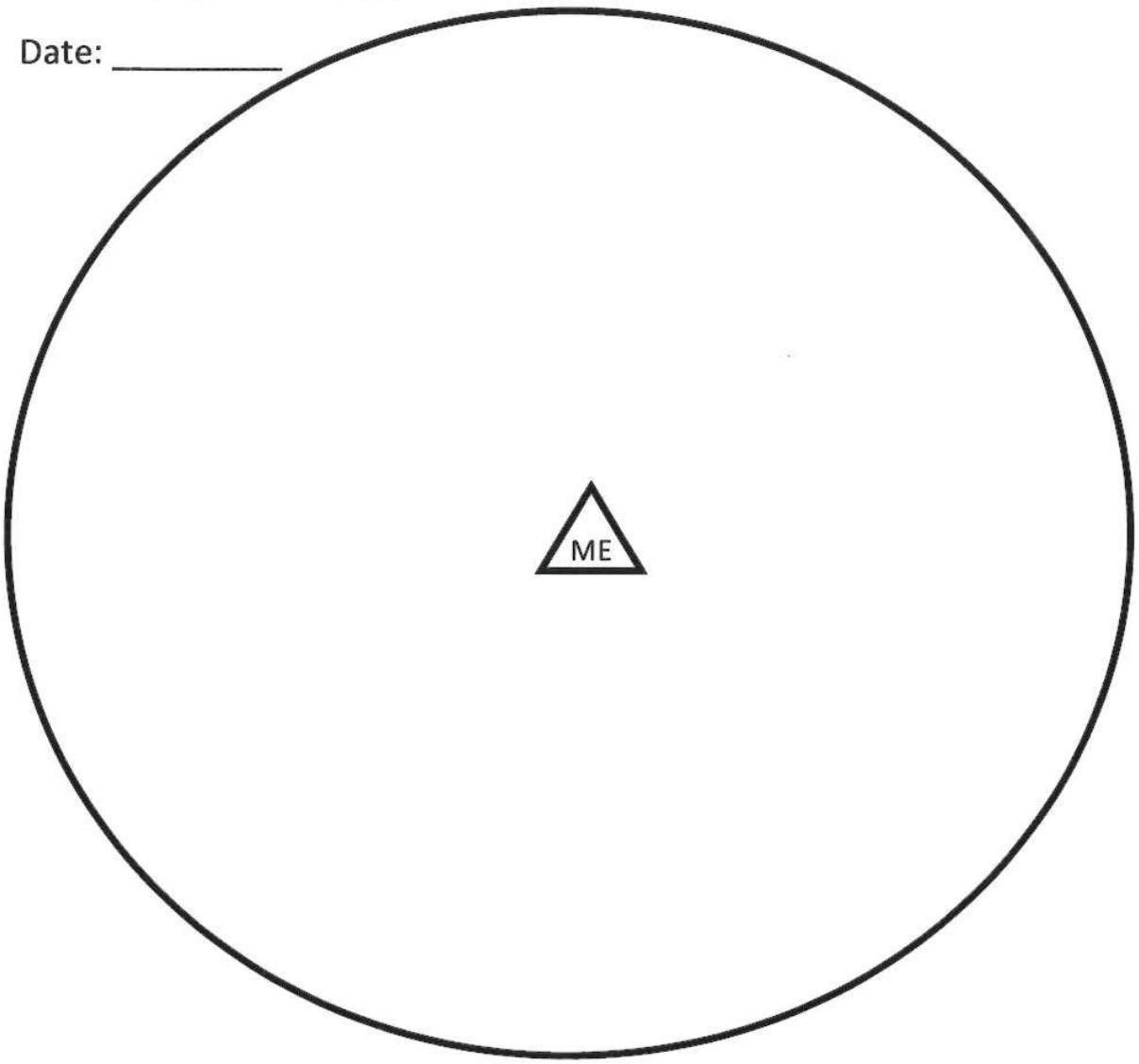
If time permits, try this sound map survey technique in several different locations, both as a group and individually, and ask students to put their findings together on a larger map and discuss their observations. Comparing the schoolyard to a local park or a nature center is a good way to compare habitat with a sound map survey.



Behavior Codes	Bird Codes	
s = singing	M = Meadowlark	DO = Dove
f = flying	R = Red-winged Blackbird	CB = Catbird
p = perching	A = Amr. Goldfinch	K = Kingbird
e = eating	C = Cardinal	J = Blue Jay
h = hopping	D = Dickcissel	O = Oriole
o = other	V = Vulture	AC = Crow
	H = Red-tailed Hawk	S = Sparrow
	W = Woodpecker	X = Unknown

NAME: _____ North

Date: _____



○ = **BIRD** *(seen or heard)*

Behavior Codes	**Bird Codes**	
s = singing	M = Meadowlark	DO = Dove
f = flying	R = Red-winged Blackbird	CB = Catbird
p = perching	A = Amr. Goldfinch	K = Kingbird
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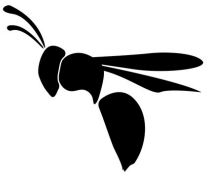
	W = Woodpecker	X = Unknown

ACTIVITY & LESSON PLANS

Entomologist



Wildlife Explorers

ENTOMOLOGIST / BUGNERD

SUBJECTS: Science

STEM SKILLS

Investigation, Data recording and analysis, Science tool/ technique usage, Career experience

TIMING

40 - 60 min. activities,

2-6 hrs. full section

KEY WORDS

Entomologist, Insect, Arachnid, Invertebrate, Exoskeleton, Conservation, Pollinator, Pesticide, Antennae, Biodiversity

NOTE: Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.

OBJECTIVES

Students will

- Learn about what an **Entomologist** is and issues they face
- Learn about bug anatomy, identification, and conservation
- Explore bugs by utilizing tools and techniques used by an Entomologist
- Have opportunities for student-lead projects to help with issues bugs face

BACKGROUND

Insects and Invertebrates, or "bugs", are some of the most numerous and varied creatures on the planet. Recent figures indicate that there are more than 200 million insects for each human on the planet!

Insects are found in water, on land, and in the air, and other invertebrates like spiders and mites (arachnids) and millipedes and centipedes are extremely important to decomposition and the food web. Insects are both predators and prey and fill almost every ecological niche in the world. Pollination of wild and agricultural plants is one of the most important benefits to the human population that insects and other invertebrates provide.

But, insects and invertebrates are in dire trouble. Populations have decreased drastically over the past 30 to 50 years and this can cause great disruptions and harm to all of the life cycles and food links across the world.

Insect education is an exciting field of study that offers numerous benefits for the next generation. As children are exposed to nature and its wonders, they develop a greater appreciation for the world around them. Outdoor exploration of insects provides invaluable opportunities for students to learn about unique characteristics, habitats, and behaviors of invertebrates while fostering a sense of curiosity and wonder and building an important sense of place.

MATERIALS:

Insect PROBLEM PAGES

Insect ACTIVITY SHEET

Insect/Arachnid Field Guides

Insect/Arachnid Anatomy Charts

GETTING READY

- Gather materials and equipment and students in a comfortable outdoor or indoor location. Be near outdoor location to perform surveys.
- Start with basic "What makes a Bird a BIRD?" question and discuss details *[feathers, beaks, hollow bones]*
- Have tools for bird surveys ready to go.
- PLAN THE SCHEDULE with the 5 Main Sections and Activities in mind

DOING THE ACTIVITIES

1. What's the Problem?

To start each career section, ask the student group/class/club:

Are there are any issues facing bugs in the U.S. and/or Nebraska today?

Provide some time for discussion to get students just thinking about bugs (insects/arachnids/etc.) in general and any risks they face.

Using the following Problem Pages about declining bug populations, introduce this issue to the students by having them read the problem pages individually, in groups, or read it aloud to the group and provide the photos in copied handouts or projected on screen from computer.

After time to consider the problem but without too much more information or description, have the students do the BUG BLITZ activity on top of the second Problem Page. Go outside and try and see some insects and take some observations. Following this, have the students answer the short questions on the activity sheet with the Problem Pages. Instruct them this is just to gauge what they saw and know so far, so don't worry.

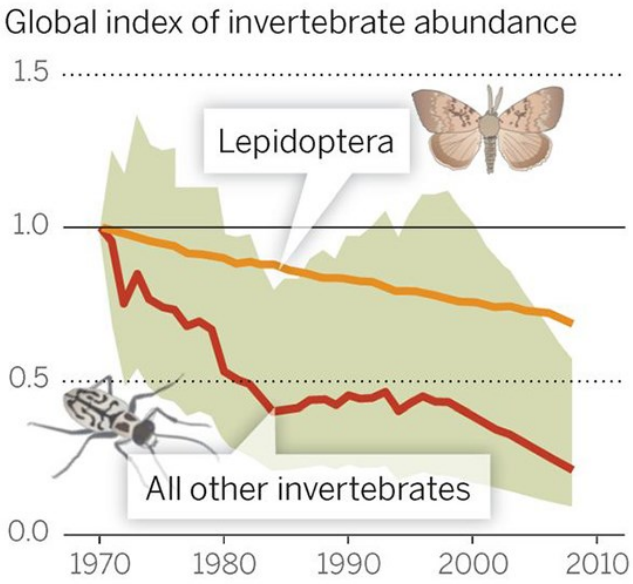
After some time to answer the early bug questions on the activity sheet, share the local Entomologist profiles and give the students time to see themselves as an Entomologist. This can also be done later at the end of the whole Entomologist section.

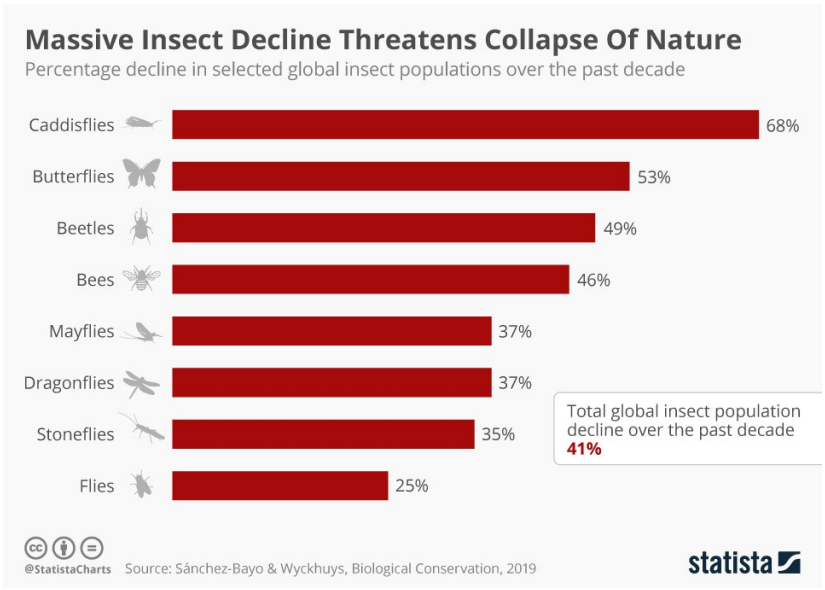
Now that we know the problem and just a little about bugs, let's get ready to look closer at these amazing organisms.

In the section, "Delve into Details," we want to learn as much about bugs in general as we can to be on our way to becoming **ENTOMOLOGISTS!**

PROBLEM PAGES

What's the Problem?





What You Need to Know

Insect and Invertebrate populations are declining rapidly. This is happening not only in the U.S. and North America, but all over the word.

Habitat loss, pesticides, and climate change are threatening insect populations worldwide. In 2019, Biological Conservation reported that 40% of all insects species are declining globally and that a third of them are endangered. But does it matter? And Why?

While it may sound nice to live in a world with fewer roaches or garden pests, human beings would be in big trouble without insects and other important arachnids and invertebrates That's because insects play critical roles in pollinating plants we eat, breaking down waste in forest soil and forming the base of a food chain that other, larger animals — including humans — rely upon.

In Europe and the United States, researchers have documented declines in wild and managed bee populations of 30 to 40 percent and more due to so-called colony collapse disorder. Other insect species, such as the monarch butterfly, also have experienced sharp declines. These insects not only pollinate human food, but provide food for so many other creatures like birds, frogs, snakes, and fish. They pollinate wild native plants needed in healthy ecosystems and are themselves predators of invasive species and pest insects.

Take some time to read, research, and discuss this problem, the causes, and then use the activity page and questions on the back of this page. When finished, you'll be ready for the next section, Delve into Details, all about the amazing, important, and varied world of insects, arachnids, and other invertebrates we lovingly know as BUGS!

Activities and Questions

What Do You Know and What More Can You Learn?

Before you tackle the below questions, let's start with a simple and fun activity for everyone - BUG BLITZ! It's easy. As a group, individually, or in teams, go outside (weather permitting) and see if you can find 3-5 types of bugs in 15 minutes or less. It is ok if you don't know what kind of insect or invertebrate it is, but take observations (in your mind, on paper, etc.) about what you saw: size, color, shape, number of legs, etc. Also notice where the bugs were and what they were doing, or, as important, where the bugs were NOT. [*If you'd like to identify the bugs or learn more, use a Field Guide or Audubon's online bird guide or bugguide.net.]* You can do this activity more than once, and each time, see if you can find or identify more bugs in more places, especially once you know more about insect and invertebrate habitats, behavior, and life cycles.

Now, from your experience with BUG BLITZ and reading and learning about the problems facing bugs today, see if you can answer the questions below. Not everyone may answer the same—so share & discuss your answers afterwards.

Can you name 3 to 5 insects that you can see from your home or school? _____

_____

Name 2 factors causing invertebrate populations to decline. _____

Are there other things you see that could be harming pollinators? _____

From what you have seen, heard, and read, do you think bugs need our help? _____

Are you, your family, or your school already doing something(s) to help bugs in some way?_____

If yes, what? _____

If time allows, find some scratch paper and draw, paint, or write a description of one of the bugs you saw during the BUG BLITZ!

Now, get ready to become real "bug nerds" as we move to the next section and learn more about insects!

Who and What IS an Entomologist?

WHO you need to know!

In the most basic of terminology, an **entomologist** is someone who studies insects, arachnids, and other invertebrates. Some might assume you need a Ph.D. to be considered an entomologist; however, a Ph.D. is not 'required' to simply study bugs. There are numerous entomologists of fame and lore that did not have those three letters after their name.

Entomologists study bugs in their natural habitats or in the laboratory. They also may write research reports and proposals for grants, teach classes, present research to the public, and have administrative duties related to these activities. Some entomologists do all these tasks and others may do some of these and many other things related to insects, arachnids, and invertebrates and/or their habitat.

We have many entomologists, or "bug nerds," researching insects and other invertebrates right here in Nebraska in many different ways. Here are profiles of three amazing local ornithologists to inspire your bug exploration.

Judy Wu-Smart

Dr. Judy Wu-Smart *leads the Bee Lab at the University of Nebraska-Lincoln, organizing beekeeping workshops and field days, and answering questions about pollinator health and management as well as conducting research on bees. Dr. Wu-Smart has her doctorate in entomology from the University of Minnesota. Current research projects examine the non-target effects of pesticide exposure on bees in agroecosystems, the impact of landscape enhancements on bee communities, pest control strategies (including management of Varroa mites in honey bee colonies), and resistance management.*

Katie Lamke

Katie Lamke *is an endangered species conservation biologist for the Xerces Society. Based in Nebraska, her main role is to coordinate and engage people in the Midwest's numerous Bumble Bee Atlas efforts. Working with community scientists, researchers, and youth, she helps develop tools that drive bumble bee conservation. Katie earned her master's degree in entomology from UNL where she compared wild bee diversity and their floral associations between remnant and restored tallgrass prairies. She is enthusiastic about pollinator ecology and is committed to raising awareness about the conservation of wild bees. Outside of work, Katie enjoys birding, gardening, skating, and, well, looking for bees.*

Who and What IS an Entomologist?

Who you need to know *(continued)*!

Kait Champan *is an Extension Educator of Urban Entomology serving Lancaster, York, Seward, Cass and Otoe Counties. Kait received her Bachelor's degree in Insect Science and Master's in Entomology at the University of Nebraska-Lincoln. Through her programs, Kait serves Nebraskans by providing educational and research-based information on landscape and household pests. Kait works with homeowners and renters, pest management, healthcare and housing professionals, child care providers, schools and more to address relevant and local insect-related issues. Her primary focus is delivering programs related to plant- and food- insect issues and other insects that affect humans like head lice and bed bugs.*

Kait Chapman

Can you see YOURSELF as an ***entomologist*** *What more would you like to know about insects? Where would you go to study them? How could your work as a bug nerd help your family, community, state, or the world? Draw or put a picture of yourself studying insects in the box below and write some ideas of what you would be doing 5 or 10 years from now as an* ***entomologist!***

YOU! Name: _____

Materials:

Insect T/F Quiz Sheets

Insect / Arachnid Cards

Insect / Arachnid Specimens

2. Delve into the Details

Ok, Entomologists and bug nerds, it is time to look a little closer at our critters that crawl on many legs. In this section we will find out how much you may already know about invertebrates - YOUR funds of knowledge - and explore several amazing adaptations insects and other invertebrates have that make them unique.

We have several lab activities planned to explore bugs in detail and you can do one or all of them depending on the time you have, but let's start with a check-in of what students may already know with our "What Makes a Bug a Bug?" True or False activity.

On the following page are 10 - 15 true or false questions about bugs. There are many active and fun ways to do this. The simplest is to just have students draw an insect and write answers down next to them. But a more hands-on and visual way to introduce the topic is to have space indoors or outdoors for the students to stand in a group. Then, proceed with the T/F questions and have students answer in one of the following ways:

1) This version of the activity takes more preparation. Each student would make (or the leader could have premade) TWO large bug shapes. One bug shape or picture will have a large word TRUE printed on it, the other will have FALSE printed on it. When the question is asked, the student holds up the corresponding bug card so all can see. It is okay to be wrong, but ask students to give an educated guess. You can do this activity again at the end of the full Entomology section as a form of assessment.
2) The other version is to use spatial separation. Designate an area of the room or outdoor space with a spot for TRUE and a spot for FALSE and have students stand in between them. When asked the question, they "migrate" to either the TRUE or FALSE location and visually see how their fellow students answered. Again, it is okay to be wrong, we just want to see how much the students may or may not know about bugs and build on that throughout the section.

Once finished with the T/F activity to get to know what you know or don't know, give the students 5 minutes to discuss a few things that surprised them or may have been easy. Then, read the following statement:

IF IT HAS SIX LEGS and an EXOSKELETON, it is most likely an INSECT! All insects have six legs, three body segments, antennae, and an exoskeleton. If it has more legs, it may still be an invertebrate relative like an arachnid (spider) or other many-legged arthropods like centipedes and millipedes.

Let's look at one or all of these along with other amazing adaptations (time-permitting) our invertebrate friends possess as we continue to "Delve into Details!"

2. Delve into the Details *(cont.)*

What Makes a Bug a Bug? True or False

Remember, use bug cards with TRUE and FALSE printed on them or the spatial option to have students move to one space or other to answer TRUE or FALSE. Encourage discussion by asking students to share why they chose "True" or "False." Allow students to change their chosen side based on the discussion. At the end of question and discussion, be sure to reveal the correct answer and, if possible, give an example. Again, it is ok to be wrong. *[If you'd like to use this activity as part of the assessment at the end of the section, make sure to keep scores of answers or ask a student to do so. Then you have data to compare to later.]*

INSECT STATEMENTS - TRUE or FALSE?

1) Insects have bones.
2) All insects have 6 legs (3 pairs).
3) All insects are brightly colored.
4) Insects make up more than half of all living things on this planet.
5) Insects have a hard outer shell called an exoskeleton.
6) Insects give birth to live young.
7) Insects have different stages of development.
8) Spiders are arachnids.
9) Insects die in the winter.
10) Most insects have wings.
11) Spider silk is stronger than steel.
12) Most adult insects live for years.
13) Insects were here before dinosaurs.
14) Butterflies taste with their proboscis.
15) Most insects are pollinators.

Answers: 1)F 2)T 3)F 4)T 5)T 6)F 7)T 8)T 9)F 10)T 11)T 12)F 13)T 14)F 15)T

Explanations & More Information

1) Insects are invertebrates. While they have an exoskeleton (hard exterior) they do not have bones.
2) All insects have 3 pairs of legs. Most arachnids have 4 pairs of legs. Centipedes and millipedes are many-legged.
3) Some insects are brightly colored to warn of their toxicity, but many insects are cryptic with their coloration.
4) Insects are one of the most numerous living organisms on the planet. They inhabit almost every habitat.
5) The exoskeleton is a hard outer covering that protects the insect.
6) Insects lay eggs.
7) Insects go through many different stages depending on the species. These stages can include egg, larva, pupa, instar, adult. This development process is called metamorphosis.
8) Arachnids include spiders, scorpions, ticks, and mites.
9) While some insects die, many will go dormant in the ground, or seek warmth in decomposing material in forests.
10) Beetles, moths, butterflies, grasshoppers, katydids, mantises, dragonflies, flies, etc. all have wings!
11) Pound for pound, spider silk is 5x stronger than steel!
12) Most insects only live for a week or 2 as adults. Some, like mayfly adults, don't even have mouths!
13) Insects have been around for over 400 million years.
14) Butterflies taste with their feet, while they drink/eat with their proboscis.
15) Butterflies, flies, beetles, moths, and many other insects pollinate in addition to bees.

Materials:

Invertebrate Specimens

Wildlife Journals

Insect Activity Sheet

Student Phones/Cameras

Insect/Arachnid Field Guides

** Ants are amazing insects that are some of the strongest animals on the planet! Check out these videos for more:

⇒ **The Incredible Strength of Ants from Twig Secondary**

www.youtube.com/watch?v=I3qAJoEUhYg

⇒ **The World's Strongest Ants from Animalium**

www.youtube.com/watch?v=goTwDfSLBVw

2. Delve into the Details *(cont.)*

As we delve further into the amazing insect, arachnid, & arthropod world, we will look much closer at one to three important adaptations that make bugs unique. *(note: doing all is optional, time-permitting, but exploring at least one or two is important for students to understand bugs in general.)*

But, before we do, it is time for a bit of fun with a **BUG BLITZ!** There are two ways to do this simple activity, depending on weather. If weather and time permit a search outside, give the students 10 minutes outdoors to search and observe as many bugs as they can. Draw or write about them in their journals and/or take photos of them with their phones if allowed. Count how many different kinds the students can find. After the 10 minutes, bring the students back together to discuss and share what was found. Don't worry if you don't know what kind of bugs they were—just look, observe, count, and share.

Now it is time to look even closer as we Delve into Details.

Let's begin with the one group of bugs that is very important and unlike any others . . . **INSECTS!**

Insects are amazing creatures that have incredible adaptations and provide so many important benefits to humans and other wildlife. Let's look closer at some of the cool things that make them exciting to learn about.

⇒ *All insects have three body parts - a head, a thorax, an abdomen - they have six legs, a pair of antennae, and zero or two pairs of wings.*

But don't tell the students this yet! Let's have them observe some insect, arachnid, and other invertebrate specimens with a quick activity and see if they can get to the above answers.

Pass out or have students come up and look close, with their journals to take notes and/or draw, 6-12 specimens of invertebrates. Students can work in teams or as one team in a small group, and ask them to find similarities and differences in the specimens. If they know the kind of bug, great, but not necessary. The goal: group the specimens by similarities, ending with a group of insects, a group of arachnids, and a group of arthropods or other invertebrates.

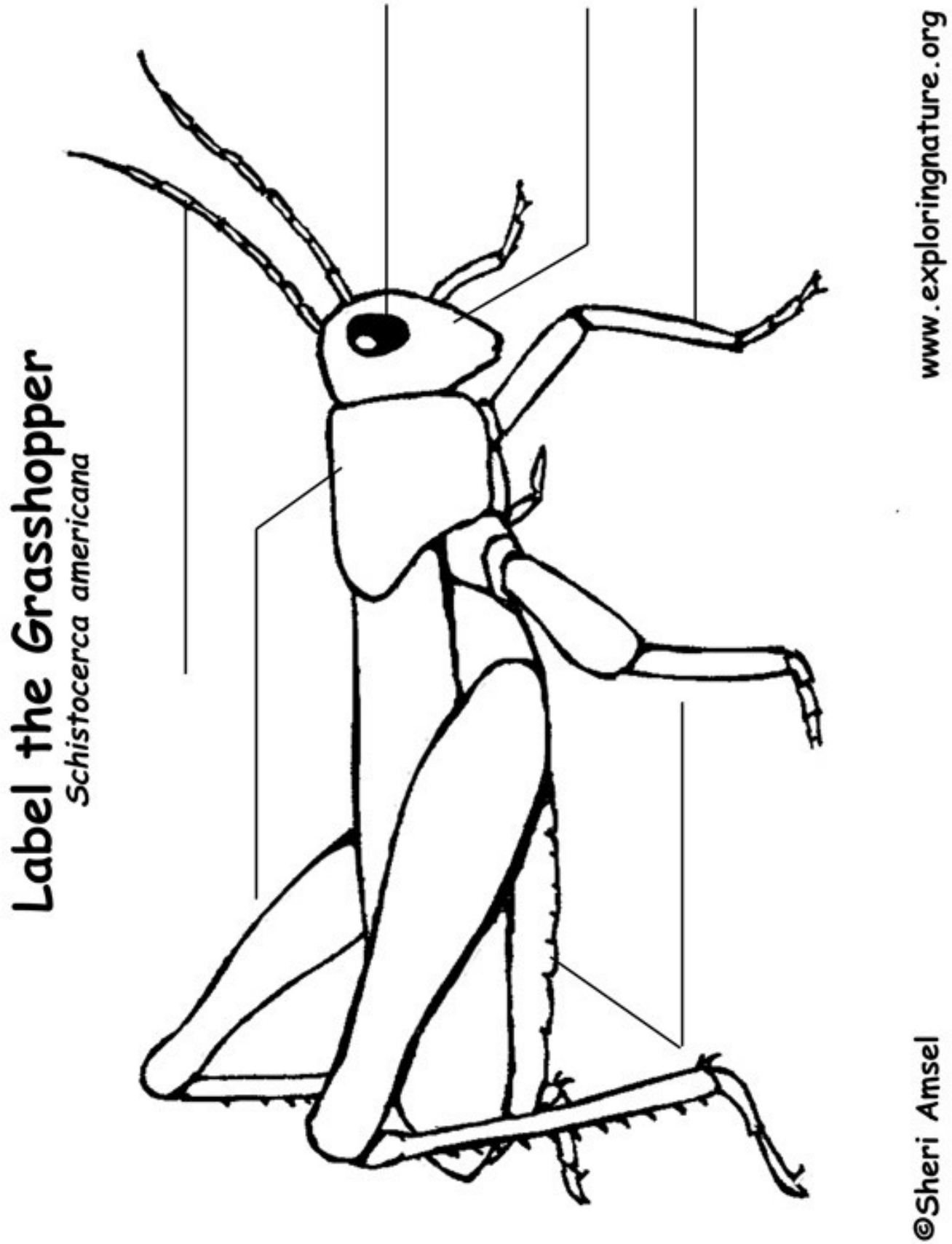
Once students have grouped the specimens, have them discuss and share why they grouped them this way. Which group are the insects? How many kinds or families of insects can they name?

Then hand out the activity sheet following and have the students individually or in teams answer these further questions about what they discovered in the Bug Blitz and specimen grouping activities. Get Buggy!

2. Delve into the Details *(cont.)*

Use the diagram below for students to try and fill in the important parts of an INSECT. Then, hand out the arachnid page and have them fill it out and compare and discuss.

Special discussion questions: How do these structures help the organism? Are some structures "better" than others for survival? Why or Why not?



Materials:

** Insects have amazing ways to sense and smell—their antennae! Check out these videos for more:

⇒ **Why Do Insects have Antennae from Insect Diaries**

www.youtube.com/watch?v=632iTOoVnV4

⇒ **Insect Anatomy 101: Antennae from Insectopia**

www.youtube.com/watch?v=f2Hjph7PrMA

2. Delve into the Details *(cont.)*

As we dig even deeper into the **INSECT** world, let's focus and look closer at one of their important adaptations… **ANTENNAE.**

Imagine being able to smell your dinner from the other side of a sports field. Insects do this with the pair of antennae on their heads. Insects have paired antennae so they can smell in stereo. They can detect the smallest of concentrations of scent.

But insects don't only use their antennae to smell. They can also use them to feel the surface of an object, sense hot and cold, listen to sounds, or detect the movement of air or wind.

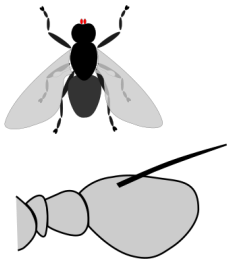
ACTIVITY: Ask the students to look at the diagram of antennae types below and/or watch the antennae videos included to the left.

What type of antennae do the insects you observed in the specimens have? _____

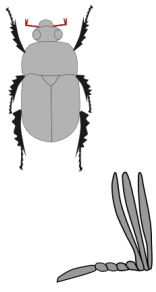
How do these antennae compare to the insects observed outside during the Bug Blitz?

_____

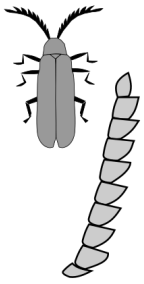
What are the tiny filaments on the antenna that do the sensing called?



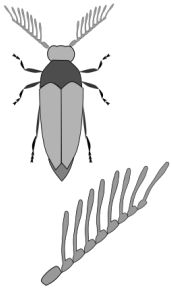
ARISTATE



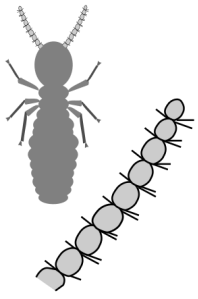
LAMELLATE



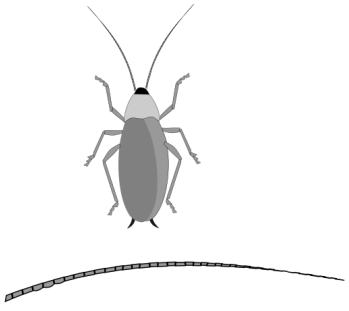
SERRATE



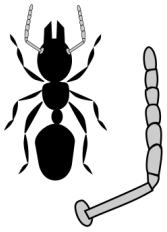
FLABELLATE



MONILIFORM

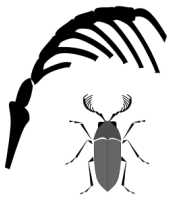


SETACEOUS

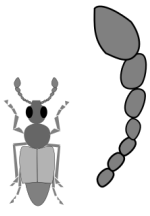


GENICULATE

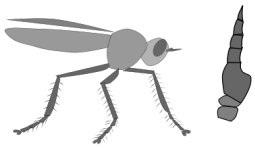
PLUMOSE



PECTINATE



CLAVATE



STYLATE

Materials:

** Spiders are amazing arachnids that produce and use a strong and versatile material called SILK. For more on its incredible uses and strength, check out these videos:

⇒ **Spinder Silk is Stronger than Steel from Interesting Engineering**

www.youtube.com/watch?v=UGcOKR-Aojs

⇒ **Is Spider Silk Stronger than Steel? from MythBusters, Jr.**

www.youtube.com/watch?v=dMN_wQGZyyO

2. Delve into the Details *(cont.)*

Now it is time to dig even deeper into another invertebrate group, the **ARACHNIDS,** and compare and contrast with **INSECTS.**

⇒ *Arachnids are spiders , harvestmen (daddy longlegs), mites and ticks , and their relatives like scorpions. All arachnids have eight legs, and unlike insects, they don't have antennae. The bodies of arachnids are divided into two sections, the cephalothorax in front and the abdomen behind.*

Unlike insects, arachnids do not have antennae. But an amazing adaptation they can produce is one of the strongest materials pound-for-pound on the planet . . . SILK!

Check out one or both of the video links to the left to learn more about the strength and uses of spider silk.

Another great adaptation of arachnids in place of antennae is the sensory hairs on their 8 legs that help them feel! Have the students do some more research on arachnids with field guides and/or online. Once done, have them fill out the spider diagram on the following page and the compare and contrast it to the grasshopper earlier.

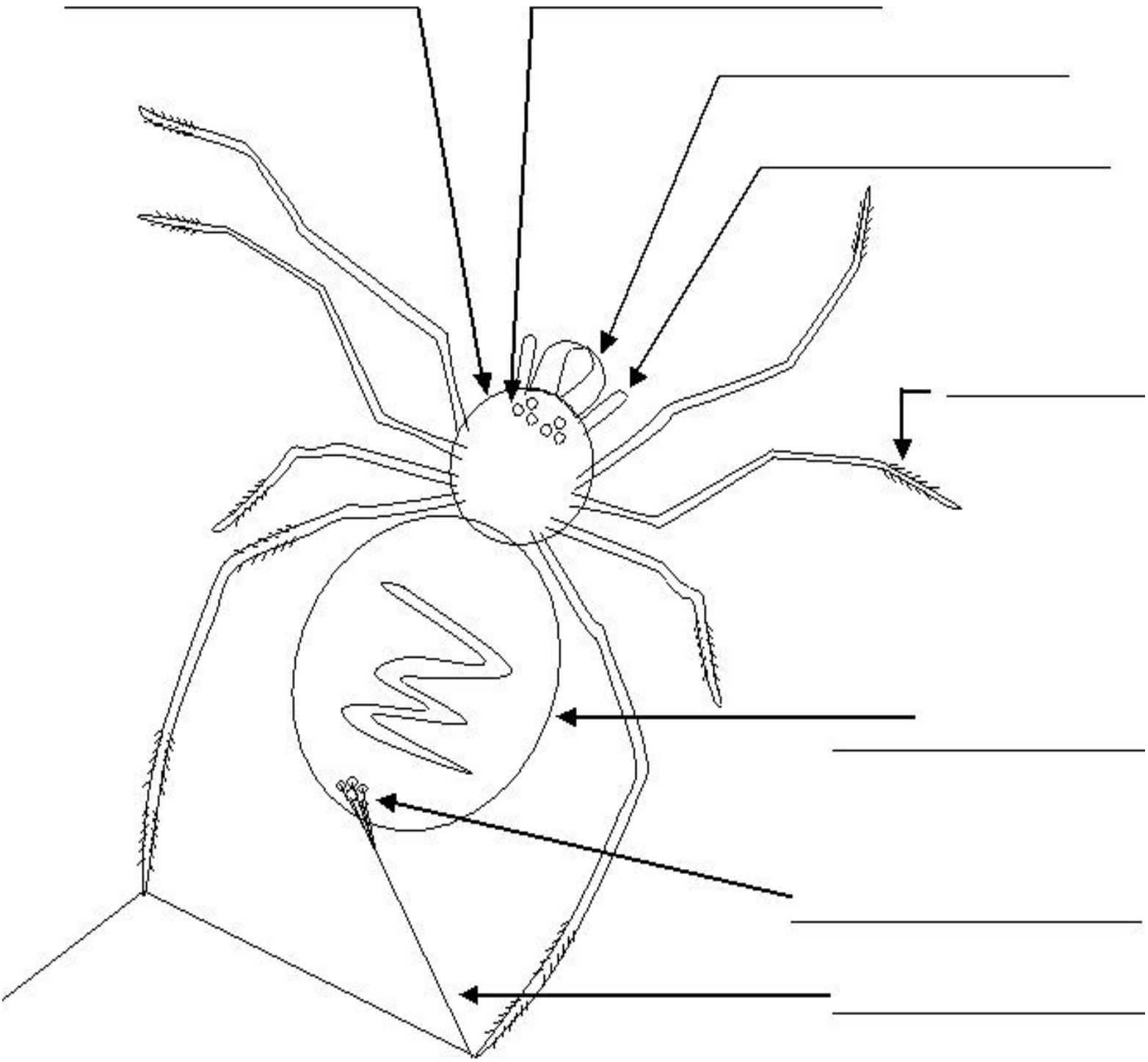
What are the similarities? _____

What are some main differences? _____

Finally, in the space below or on a separate piece of paper, have teams or individual students create their own insect and arachnid with new and unique adaptations. Perhaps this invertebrate needs to be able to adapt to our changing climate. What will it need? What habitat will it need to adapt to?

2. Delve into the Details *(cont.)*

Use this arachnid label page to compare to the insect label page. Some of these terms may be new, so some research online or in an insect/arachnid field guide may be necessary.



Materials:

CONSIDER the CHARACTERS Pages & Worksheets

3. Consider the Characters

An important part of being an entomologist is knowing more than general information about insects and other invertebrates, but also specializing and learning about local important bugs and their habitat needs.

In this section, we will focus on two Nebraska insects. First, a rare and endangered predator, the Salt Creek tiger beetle. We will also look close at a butterfly that is a Nebraska prairie specialist, the Regal Fritillary. These in-depth studies can be ways to learn more about all insects by focusing close on a local species that may be uncommon and hard to find outside.

But before we even consider these characters, it is time for another outdoor activity (weather permitting) or observation period from the window.

BUG BLITZ 2! This is just like the BUG BLITZ we used to open this section. Gather the students in an outdoor location near the school or local park. Ask the students to search for bugs over the next 10 minutes. With what they know now, see if they can keep a tally of how many were insects (and what kinds, like ants, butterflies, bees, etc.) and how many were arachnids or other invertebrates (like roly-polies).

Once students have done their observations, either written or sketched, have them discuss what they observed and specifically, if you found bugs—where were most of them? In which habitat? What areas did NOT have bugs?

After this discussion and activity, it is time to look much closer at the Salt Creek tiger beetle and Regal Fritillary.

Please reference the **CHARACTER CONSIDERATION pages** in the appendix for each of these bugs. You may want to make copies or show these on a large screen. You can choose one species or several depending on time and student interest, or let them choose which bug. Read/discuss with students or watch a video clip provided.

This next and final step is the lead up to doing outside research and surveys as an entomologist would, but connects to the lab research and studies done first before deciding what and how to explore bug biodiversity.

Finally, ask students—individually or in teams—to do a report on one of these specific bugs (or one they observed outside) in one of three forms.

- *Educational Poster to help the bug's habitat*
- *Oral presentation about the bug's behavior/adaptations*
- *Comic Strip / Art project showing why the insect is important to Nebraska and vice versa*

A *great online resource for further research is BugGuide.net.*

Now it is time for everyone to get **READY TO RESEARCH!**

Materials:

Insect Sweep Nets

Bug Collection / Viewing Jars

Gallon Ziploc Plastic Bags

Survey Data Sheets

Insect / Arachnid Field Guides

Magnifiers

4. Ready to Research!

As an entomologist, one of the major tasks is to look at ways to understand bug populations and the habitat they need and to help these insects, arachnids, and other invertebrates if the research shows it is necessary. What might be some of those ways and techniques of studying the bugs and their habitats?

So now it is time for the students to truly become Entomologists, using tools and techniques to perform some outdoor research in the form of invertebrate biodiversity surveys!

INVETEBRATE BIODIVERSITY SURVEYS!

Biological surveys are field techniques to study populations and answer questions about living organisms, especially bugs. There are several techniques to use to survey insect populations depending on the questions you want answered. We will be doing one of these techniques and providing information about others. Utilizing sweep nets and other supplies listed at the left, students will be performing:

⇒ **Invertebrate Biodiversity Survey**

To see what it is really like to be an entomologist studying insects, arachnids, and other invertebrates, completing a biodiversity survey or two is both fun and important. This survey technique can tell you many things:

⇒ Is the habitat healthy for a large amount of invertebrates?

⇒ What type of habitat is the healthiest for the most insects?

⇒ Are invertebrates that should be present not found? Why?

Full instructions for this type of survey, which involves catching as many bugs as you can in 10 minutes and recording what types or groups of insects are caught, can be found with the data sheet following.

Another consideration is location. Surveying more than once in different habitat types is also important so students can compare habitat health, types of insects in each habitat, etc.

There are many other types of invertebrate surveys, from using light traps for nocturnal insects to walking a transect (much like the bird transect count) to look for and count a specific bug, like a Monarch or Regal Fritillary. For information on the NE Surveys for these two butterflies:

outdoornebraska.gov/about/give-back/help-wildlife/community-science/monarch-and-regal-fritillary-survey/

Another insect survey is an Atlas. Nebraska currently has a Bumble Bee Atlas to count and identify all kinds of bumble bees that can be found all across the state, county by county. For more info:

www.nebraskabumblebeeatlas.org/

ENRICHMENT Opportunities:

⇒ Consider a field trip to practice insect ID or surveying techniques with the group. Compare habitat at school/ community with a local park, nature center. Try this with a guide and without—or have students guide.

⇒ Contact a local bug expert / Entomologist to come and speak to students.

⇒ Contact a local nature center or zoo to see if students could get the opportunity to observe live insects up close and learn more about techniques used in invertebrate conservation.

⇒ Consider having students participate in local community science projects like the City Nature Challenge or Monarch Watch.

5. React to Results

Well, we hope that was fun! But now what?

There are several next steps to consider once surveys and research are completed and data has been entered. It is time to react to the results the data are showing us.

Let's start with an activity that can be done indoors or outdoors (though we prefer outdoors, weather permitting). Gather the students into small groups for a "World Café" session. They will discuss in small groups and then rotate to new groups and provide their observations and answers to the following:

- What is your favorite or most interesting thing learned about insects/arachnids while researching?
- What is something that concerns you about bugs and pollinator populations in Nebraska or the U.S.?
- Is there anything that sticks out from the data or surveys that you notice?

After time to discuss in smaller groups, bring the full group of students back together and look at some data results. Perhaps ask the students to make a chart or graph of bug biodiversity based on survey findings and compare to Nebraska or national historic data online at BugGuide.net. Finally, to use both as a final project (if time allows) and as a form of assessment, ask the students to work together to identify projects they could plan and create to help insect populations in their community. Some options are listed below:

⇒ *Students could work individually and create an informational poster about an insect species with information on how to help it and its habitat*

⇒ *Students could work all together to create habitat at the school or in their community by planting native plants, building and erecting bee nests, etc.*

⇒ *Students decide as a group that there is not enough data yet to provide any answers, so more research is needed*

ASSESSMENT

Ask students to answer following questions or complete final tasks.

- What 3 things make an insect an INSECT?
- Name at least 3 reasons bug populations are declining and provide a possible solution.
- Discuss how surveying invertebrate biodiversity and populations and collecting this data helps conserve bugs and their habitats.
- Create their own bug species with unique adaptations to survive 50 to 100 years from now in a changing climate.
- Provide students time and venue for feedback on fellow student projects and posters.

DATA SHEETS & SURVEY INSTRUCTIONS

Entomologist

STUDENT PAGES / DATA SHEETS / RESOURCES

INVERTEBRATE BIODIVERSITY Survey Instructions

Preparation: Gather supplies, data sheets, and tools and head into the field for surveys. More than one location is ideal so students can compare. Use separate data sheets for each location.

Procedure:

1. Assemble students at a site suitable for invertebrate collection. Areas with tall grass, small shrubs, and/or flowering plants is ideal, but any habitat should have insects and invertebrates.

2. Next, ask students to define **biodiversity** and discuss. Why is it important? Biodiversity in the environment is very important for a balanced successful natural community and ecosystem with producers and consumers (invertebrates are both) an important link on the food web/chain.

3. Demonstrate the correct use of the sweep net and Ziploc bag. Sweep low and quick through the grass/ environment 6 to 10 times, walking as you go, and then close the net off with your hand, keeping any invertebrates inside the net (they can fly or jump or both). Having students work in teams, one with net one with bag and then switching, works best. After sweeping, tip net over and empty insects into the plastic bag or collection jar and continue collection, students switching who is sweeping. Continue this to collect as many insects as possible in 10 minutes.

4. After 10 minutes, have students sit with their partners and their bags and data sheets. You may want clipboards or another hard surface to use with data sheets outside. The object is to try and count all the insect TYPES in their bags/jars. Students can use field guides or iNaturalist to try to identify inverts to species, but not necessary. Tally up the types of insects/inverts found in the categories on the data sheet.

5. Don't forget to also write notes about the bugs AND what type of microhabitat (ground, gravel, pond edge, tall grass, mowed grass, shrubs, etc.) the bugs were found in.

6. When the tallying is completed, have the students flip their data sheet over and write two things: *1) how many TYPES of bugs were found? 2) draw one of the bugs you caught and label at least 2 parts and/or adaptations.*

7. Finally, once all data has been taken, ensure students let ALL the invertebrates go back in their habitat, safely and quickly, and return nets and other tools if surveying is done. Keep these things if moving to another location for another survey to compare.

Invertebrate Biodiversity Survey Data Sheet Name: _____ Location: _____

SHAPE	FAMILY	COUNT	MICROHABITAT	NOTES
	Grasshoppers Katydids Crickets			
	Beetles			
	Cicadas Leafhoppers Planthoppers			
	True Bugs			
	Flies, Gnats, Mosquitos			
	Bees, Wasps, Ants			
	Butterflies, Moths			
	Caterpillars			
	Dragonflies Damselflies			
	Walkingsticks			
	Mantids			
	Lacewings			
	Weevils			
	Daddy-long-legs			
	Ticks			
	Spiders			
	Centipedes Millipedes			

ACTIVITY & LESSON PLANS

Botanist

Wildlife Explorers

BOTANIST / PLANT PRO

SUBJECTS: Science

STEM SKILLS

Investigation, Data Recording and Analysis, Science Tool/ Technique Usage, Career Experience

TIMING

20 - 40 min. activities,

2-6 hrs full section

KEY WORDS

Botanist, Forb, Spores, Seeds, Dispersal, Photosynthesis, Cover, Vegetation Density

NOTE: Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.

OVERVIEW

Plant populations and biodiversity here in Nebraska and across the planet are under threat. With rapid development, large areas of monoculture agriculture, and a proliferation of invasive plant species - all made worse by extreme weather due to our rapidly changing climate - healthy plant ecosystems need our help. From forests to tallgrass prairies and dry western sandhills, the producers in the food chain are struggling.

OBJECTIVES

Students will

- Learn what a Botanist is and the issues they and plants face.
- Learn about plant adaptations, identification, and conservation.
- Explore plants by utilizing tools and techniques used by a Botanist.
- Participate in real-time vegetation surveys and techniques.
- Opportunities for student-led projects to help with issues identified.

BACKGROUND

Biodiversity is being lost at an unprecedented rate! Over the course of our lifetimes, it is possible that another 130,000 plant species could be wiped out if we do not learn more and do something about it.

Biodiversity is being lost – locally, regionally and globally. It is now estimated that approximately one third of global plant species are at risk of extinction. Scientists say that plant extinction is occurring up to 500 times faster than what would be expected naturally. Over the last 250 years, almost 600 plant species have disappeared.

Plants are very important to our planet; they form the critical base of food chains in nearly all ecosystems. Without plants there would be no oxygen to breathe and no food to eat. In addition, plants help filter water and air, contain many medicinal properties, and provide humans with the ability to make fire and build houses. And, plants like trees and prairie grasses are also very important in the capture of carbon to help alleviate the effects of climate change.

Let's become Botanists and learn more and see how we can help!

MATERIALS:

Plant PROBLEM PAGES

Plant Activity Sheet

Journals

GETTING READY

- Gather materials and equipment and students in a comfortable outdoor or indoor location. Be near outdoor location to perform surveys.
- Start with basic "What Do You Know About PLANTS?" true/false activity.
- Have tools for later plant surveys available.
- PLAN THE SCHEDULE with the 5 Main Sections and Activities in mind.

DOING THE ACTIVITIES

1. What's the Problem?

To start each career section, ask the student group/class/club:

Are there are any issues facing plants in the U.S. and/or Nebraska today?

Provide some time for discussion to get students just thinking about plants, habitat, and ecosystems in general and any risks they face.

Next, using the following Problem Pages about the loss of plant biodiversity, introduce this issue to the students by having them read the problem pages individually, in groups, or read it aloud to the group and provide the photos in copied handouts or projected on screen from a computer.

After time to consider the problem but without too much more information or description, invite the students to the PLANT PARTY activity on top of the second Problem Page. Go outside and try and explore some plants on the school yard or local park and take some observations. Following this, have the students answer the short questions on the activity sheet with the Problem Pages. Instruct them this is just to gauge what they saw and know so far, so don't worry.

After some time to answer these plant questions on the activity sheet, share the local Botanist profiles and give the students time to see themselves as an Botanist or Plant Pro. This can also be done later at the end of the whole Botanist section if you prefer.

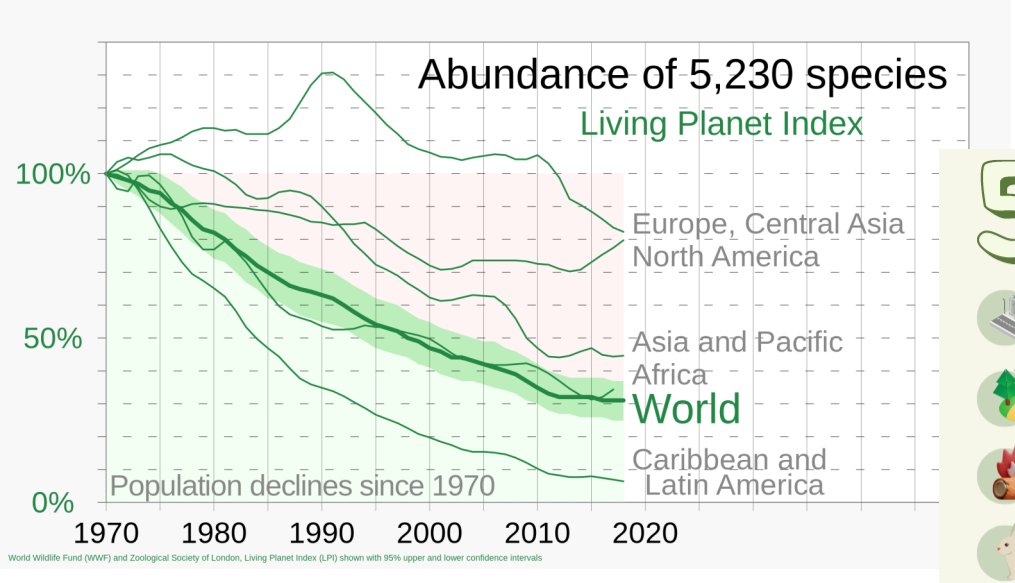
Now that we know the problem and some basics about plants, let's get ready to look closer at these amazing organisms.

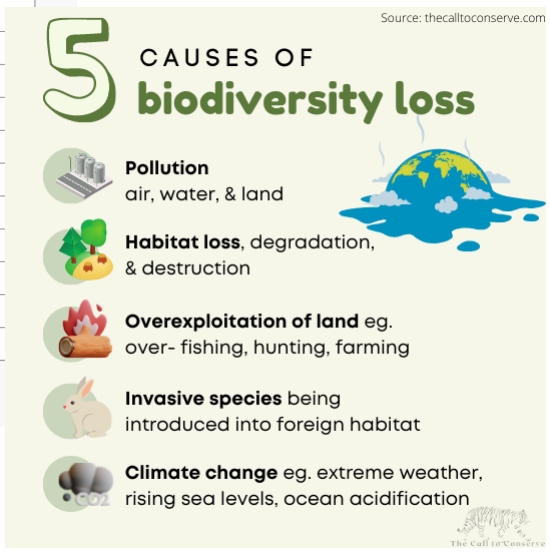
In the section, "Delve into Details," we want to learn as much about plants in general as we can to be on our way to becoming **BOTANISTS!**

Wildlife Explorers

PROBLEM PAGES

What's the Problem?





What You Need to Know

Biodiversity is being lost at an unprecedented rate! Over the course of our lifetimes, it is possible that another 130,000 plant species could be wiped out if we do not learn more and do something about it.

Biodiversity is being lost – locally, regionally and globally. It is now estimated that approximately one third of global plant species are at risk of extinction. Scientists say that plant extinction is occurring up to 500 times faster than what would be expected naturally. Over the last 250 years, almost 600 plant species have disappeared.

Plants are very important to our planet; they form the critical base of food chains in nearly all ecosystems. Without plants there would be no oxygen to breathe and no food to eat. In addition, plants help filter water and air, contain many medicinal properties, and provide humans with the ability to make fire and build houses. And, plants like trees and prairie grasses are also very important in the capture of carbon to help alleviate the effects of climate change.

Let's become botanists and learn more and see just how we can help!

But first, let's talk **BIODIVERSITY.**

As you present the following PROBLEM PAGES to the students, take some time to discuss biodiversity. Ask them to use their journals or other paper to write a poem or song about biodiversity, using it to describe biodiversity to friends or family that might not have ever heard of it and tell why it is important.

Activities and Questions

What Do You Know and What More Can You Learn?

Before you tackle the below questions, let's start with a simple and fun activity for everyone, PLANT PARTY! It's easy. As a group, individually, or in teams, go outside (or you can observe from the windows if weather isn't great) and see if you can find 5-10 types of plants in 15 minutes or less. It is ok if you don't know what kind of plant it is, but take observations (in your mind, on paper, etc.) about what you saw: size, color, shape, type of leaves, etc. Also notice where the plants were and were NOT. [*If you'd like to identify the plants or learn more, use a Field Guide for plants or use a website like identify.plantnet.org.]*

You can do this activity more than once, and each time, see if you can find or identify more plants in more places, especially once you know more about different types of plants and how and where they grow.

Now, from your experience with PLANT PARTY and reading and learning about the problems facing plants today, see if you can answer the questions below. Not everyone may answer the same, so share & discuss your answers afterwards.

Name 3 to 5 plants that you can see from your home or school. _____

_____

Name 1 or 2 reasons some plants may not be good for wildlife or people. _____

Are there other things you see that could be harming plants? _____

From what you have seen, heard, and read, do you think plants need our help, or do we need help from plants?_____

Are you, your family, or your school already doing something to help plants in some way?_____

If yes, what? _____

If time allows, find some scratch paper and draw, paint, or write a description of some of the plants you saw during the PLANT PARTY!

Now, get ready to become real "plant people" as we move to the next section and learn more about plants!

Professional Profiles

Who and What IS a Botanist?

WHO you need to know!

In the most basic of terminology, a **botanist** is someone who studies plants. Some might assume you need a Ph.D. to be considered an botanist, however, a Ph.D. is not 'required' to simply study and love plants. With so many types of plants on the planet, from trees and shrubs to wildflowers and grasses, there is so much to explore in the green growing world.

Botanists study plants in their natural habitats or in the laboratory. They also may write research reports and proposals for grants, teach classes, present research to the public, and have administrative duties related to these activities. Some plant people do all these tasks and others may do some of these and many other things related to plants and habitat.

We have many botanists, or "plant people," researching plants right here in Nebraska in many different ways.

Here are profiles of three amazing local **botanists** to inspire your wild plant exploration.

Kay Kottas

Kay Kottas *holds degrees in Horticulture, Plant Biology and Environmental Studies. She is the President and owner of Prairie Legacy Inc., a botanical consulting service and provider of retail plants and seed. She taught Horticulture and native plant identification at the University of Nebraska for several years, and has provided plant inventories of natural areas including several U.S. parks for the National Park Service in Nebraska and South Dakota, for Audubon's Spring Creek Prairie, and for several private individuals. For more than 20 years, Kay has provided expert native plant identification, research, and management assessments on native acres.*

Nathan Duffy

Nathan Duffy *founded Midwest Natives Nursery in February of 2018 and actively runs the day-to-day operations of the greenhouse and company as a whole. Originally from Bellevue, Nebraska, he moved to Lincoln to study Horticulture and Business at the University of Nebraska and graduated with such degrees in May of 2018. Becoming fascinated with pollinators and wildflowers during his time in school, but noticing a lack of availability of native plants at traditional garden centers, he felt compelled to put his talents to good use and began producing native plants to share his love with the community.*

Who and What IS a Botanist

Who you need to know *(continued)*!

Cody Wagner

Cody Wagner *manages the conservation program at Audubon's Iain Nicolson Audubon Center at Rowe Sanctuary including habitat management activities, monitoring, and conservation planning/ partnerships. Cody leads prescribed burns and vegetation surveys to ensure the habitat for wildlife is healthy. He grew up in rural central Nebraska near Chapman. Cody earned a B.S. in Biology and Environmental Studies from Wayne State College in northeast Nebraska. He has previous experience with the Lower Elkhorn Natural Resources District, the U.S. Fish and Wildlife Service, and the Nebraska Game and Parks Commission.*

Can you see YOURSELF as an ***botanist?*** *What more would you like to know about plants? Where would you go to study them? How could your work as a plant expert help your family, community, state, or the world? Draw or put a picture of yourself studying plant life in the box below and write some ideas of what you would be doing 5 or 10 years from now as a* ***botanist!***

YOU! Name: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Materials:

Plant Field Guides

Magnifiers

Journals

Plant T/F Quiz Sheets

Plant Cards

Dichotomous Key

2. Delve into the Details

Ok, Botanists and Plant Pros, it is time to look a little closer at these amazing green living things we call plants. In this section we will find out how much you may already know about plants - YOUR funds of knowledge - and explore several amazing adaptations trees, shrubs, flowers, and grasses have that make them unique.

We have several lab activities planned to explore plants in detail and you can do one or all of them depending on the time you have, but let's start with a check-in of what students may already know with our "What Do You Know About Plants?" True or False activity.

On the following page are 10 - 15 true or false questions about plants. There are many active and fun ways to do this. The simplest is to just have students draw a plant and write answers down next to it. But a more hands-on and visual way to introduce the topic is to have space indoors or outdoors for the students to stand in a group. Then, proceed with the T/F questions and have students answer in one of the following ways:

1) This version of the activity takes more preparation. Each student would make (or the leader could have premade) TWO large plant shapes. One plant shape or picture will have a large word TRUE printed on it, the other will have FALSE printed on it. When the question is asked, the student holds up the corresponding card so all can see. It is okay to be wrong, but ask students to please, give it an educated guess. You can do this activity again at the end of the full Botanist section as a form of assessment.
2) The other version is to use spatial separation. Designate an area of the room or outdoor space with a spot for TRUE and a spot for FALSE and have students stand in between them. When asked the question, they "disperse" like seeds to either the TRUE or FALSE location and visually see how their fellow students answered. Again, it is okay to be wrong, we just want to see how much the students may or may not know about plants and build on that throughout the section.

Once finished with the T/F activity to get to know what you know or don't know, give the students 5 minutes to discuss a few things that surprised them or may have been easy. Then, read the following statement:

If it needs water and sunlight to grow and make its own food, it is probably a PLANT!

Let's look at one or all of these plants along with their amazing adaptations (time-permitting) our plant friends possess as we continue to "Delve into Details!"

2. Delve into the Details *(cont.)*

What Makes a Plant a Plant? True or False

Remember, use plant cards with TRUE and FALSE printed on them or the spatial option to have students move to one space or other to answer TRUE or FALSE. Encourage discussion by asking students to share why they chose "True" or "False." Allow students to change their chosen side based on the discussion. At the end of question and discussion, be sure to reveal the correct answer and, if possible, give an example. Again, it is ok to be wrong. *[If you'd like to use this activity as part of the assessment at the end of the section, make sure to keep scores of answers or ask a student to do so. Then you have data to compare to later.]*

Basic Statements

1. Plants are living things.
2. Plants need sunlight to make their own food.
3. Plants breathe in oxygen and breathe out carbon dioxide, just like animals.
4. All plants have flowers.
5. Plants have roots, stems, and leaves.
6. Plants reproduce by seeds and spores.
7. Plants can survive without water.
8. Some plants have adapted to defend themselves from animals.
9. Plants can't grow without soil.
10. Plants and trees are the same thing.
11. Plants can be carnivorous.
12. Plants can live for hundreds of years.
13. Plants can communicate with each other.
14. Plants can prevent soil erosion.
15. Plants cannot move from one place to another.

Answers: 1)T 2)T 3)F 4)F 5)T 6)T 7)F 8)T 9)F 10)F 11)T 12)T 13)T 14)T 15)T

Explanations

1. Plants are living – they grow, reproduce, and respond to their environment.
2. Plants use a process called photosynthesis to make food using sunlight, water, and carbon dioxide.
3. Plants breathe in carbon dioxide and release oxygen during photosynthesis.
4. While many plants do have flowers, some plants like ferns and mosses do not produce flowers.
5. Roots anchor the plants, stems support it, and leaves help in photosynthesis.
6. Many plants reproduce by producing seeds, while others like ferns reproduce by spores.
7. All plants need water to survive because it helps them transport nutrients and perform photosynthesis.
8. Some plants have adapted things like thorns and poison to prevent animals from eating them.
9. While most plants get nutrients and support from soil, some plants can grow without soil, like air plants and epiphytes.
10. While trees are a type of plant, not all plants are trees. Plants include various types such as flowers, grasses, shrubs, etc.
11. There are some carnivorous plants like pitcher plants and Venus fly traps that get nutrients by trapping and digesting insects.
12. Many tree species can live for hundreds of years.
13. Research suggests that plants can communicate through chemical signals, especially when under attack by pests or in need of nutrients.
14. Roots help to hold soil in place, preventing it from being swept away by wind or water.
15. Plants are rooted in place and cannot move like animals.

Materials:

Plant Field Guides

Magnifiers

Journals

Plant T/F Quiz Sheets

Plant Cards

Dichotomous Key

** Plant photosynthesis is one of the earth's most amazing processes. Learn more here:

⇒ **Kids Animation on Photosynthesis**

www.youtube.com/watch?v=zmYqA9KzenE

2. Delve into the Details *(cont.)*

As we delve further into the amazing world of plants, we will look much closer at a few important adaptations that make plants special. We will look at plant groups and how they are similar and what makes them different.

But, before we do, it is time for a bit of fun with a **PLANT PARTY!** If weather and time permit a search outside, give the students 10 minutes outdoors to search and observe as many plants as they can. Draw or write about them in their journals and/or take photos of them with their phones if allowed. Count how many different kinds the students can find. After the 10 minutes, bring the students back together to discuss and share what was found. Don't worry if you don't know what kind of plants they were—just look, observe, count, and share.

Now it is time to look even closer as we Delve into Details.

Let's begin with the one important distinction. There are 4 main types of terrestrial (land) plants: **TREES, SHRUBS, FORBS, and GRASSES**.

⇒ *All plants make their own food, by using water and sunlight to turn chlorophyll into energy during a process named PHOTOSYNTHESIS*

⇒ *There are 4 major groups of plants: Trees, Shrubs, Forbs, and Grasses.*

But how do we tell these four types apart? What makes a tree different from a shrub and a forb different from a grass? Let's try a fun activity to figure all that out using a **dichotomous key.**

A dichotomous key is a tool used for identifying an unknown item or organism. "Dichotomous" means, "divided into two parts." A dichotomous key always gives two choices, usually Yes or No, in each step. In each step, you must make a decision based on characteristics of the item. For example, *"Does the plant have a woody stem, yes or no. If Yes, go on to question 2. If No, skip to question 5*."

These leading questions will help you identify the plant you are observing as a tree, shrub, forb, or grass. So let's give it a try.

**And don't forget, as with almost everything in science, there may be exceptions!

2. Delve into the Details *(cont.)*

What Kind of Plant is this?? Using a dichotomous key.

There are 4 main types of terrestrial (land) plants: **TREES, SHRUBS, FORBS, and GRASSES**.

But how do we tell these four types apart? Using this dichotomous key activity, students will experience hands-on technique.

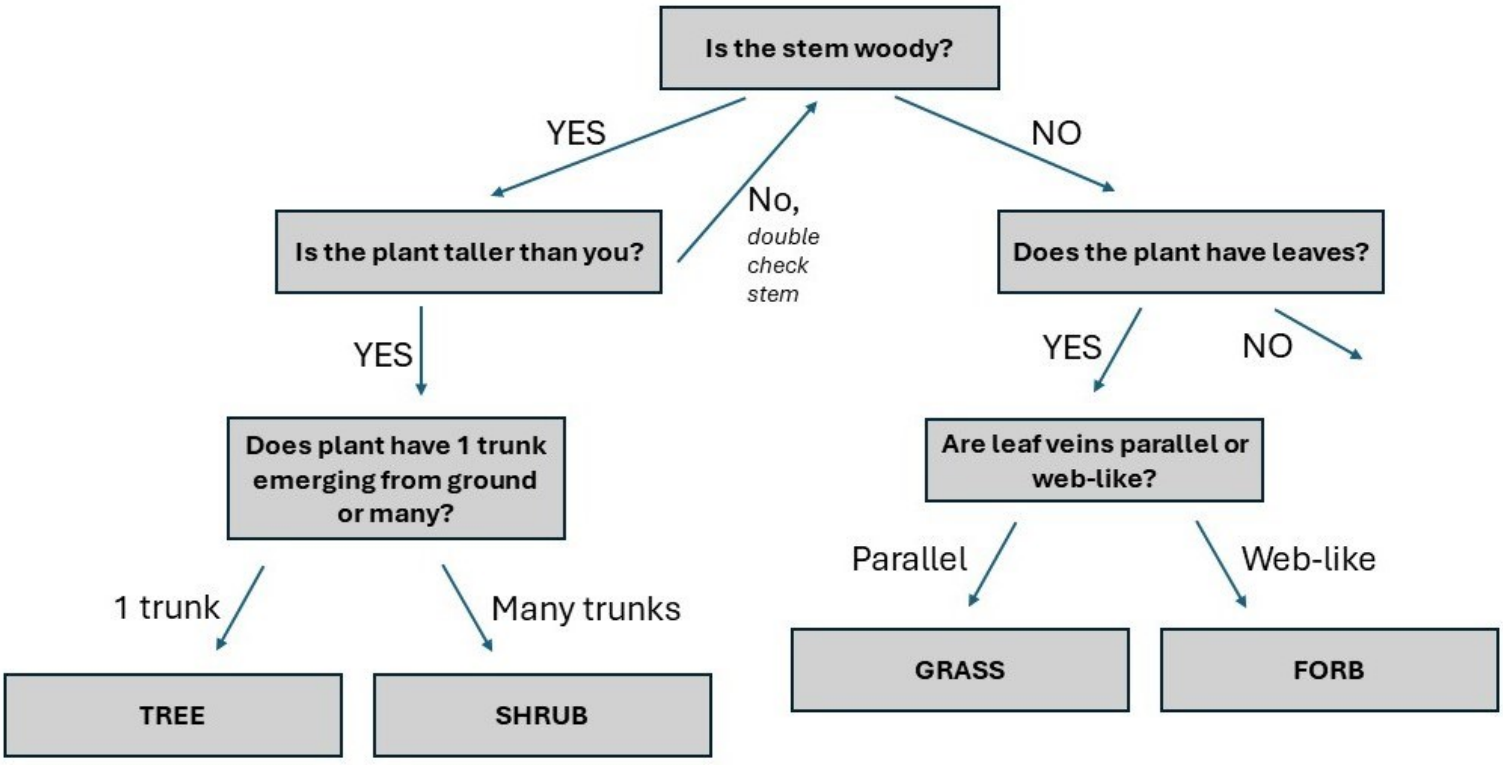
This is an outside-only activity, preferably in a nature area with at least 3 to 4 types of plants. Have a few plants from each of the four plant types pre-chosen and perhaps labeled with a number. If not, take each team of students to a plant you wish them to explore and groups can rotate after about 5-10 minutes at each plant.

Hand each student team a copy of the dichotomous key below and explain how a key works. Start with the first question and, depending on the Y or N answer, move to the corresponding question until they have the answer. Some of the students may know or think they know the answer before, but encourage them to use the key to be sure, as some plants are tricky.

Before we start, we should explain or define a few words and phrases.

1. *FORB is the scientific term for a green flowering plant with a non-woody stem. We usually call these flowers and are plants like sunflowers and goldenrod. But they are not the only plants with flowers, remember.*
2. *Leaves have VEINS that move water around the plant just like our veins move blood around our body. Parallel veins run like railroad tracks, straight down the leaf. Web-like veins spread out like a web of lines with many branches.*

A simple dichotomous key like this can be used to help identify leaf types, differences in flowering plants that looks similar, or telling grasses apart by their seeds. They are an important tool in plant identification.



When finished with one plant, encourage the teams to do the same with 2 or 3 other plants.

Materials

CONSIDER the CHARACTERS Plant Sheets

3. Consider the Characters

An important part of being a botanist is knowing more than general information about all the plants around us, but also specializing and learning about local important plants and their needs.

In this section we will focus on two Nebraska plants. First, Nebraska's state grass, Little Bluestem. We will also look close at a tree that is found across the state, the Eastern Cottonwood. These in-depth studies can be ways to learn more about all plants by focusing close on a local species that may be special, unique, and important.

But before we even consider these characters, it is time for another outdoor activity (weather permitting) or observation period from the window.

Plant Party 2! This is just like the first Plant Party we used to open this section. Gather the students in an outdoor location near the school or local park. Ask the students to search for plants over the next 10 minutes. With what they know now, see if they can keep a tally of how many were trees, how many were shrubs, how many forbs, and how many grasses.

Once students have done their observations, either written or sketched, have them discuss what they observed. Where were plants found? Where were plants not found? Where were the largest plants?

After this discussion and activity, it is time to look much closer at two important Nebraska plants: the Eastern Cottonwood and Little Bluestem.

Please reference the **CHARACTER CONSIDERATION pages** in the appendix for each of these plants. You may want to make copies or show these on a large screen. You can choose one species or several depending on time and student interest, or let them choose which plant. Read/discuss with students or watch a video clip provided.

This next and final step is the lead up to doing outside research and surveys as a botanist would, but connects to the lab research and studies done first.

After students have answered questions on these character plants on the activity sheets, consider asking them what questions do they still have? How could they find the answer to these questions?

Now it is time for everyone to get **READY TO RESEARCH!**

Materials / Tools:

Meter Squares OR Hula-Hoop

Meter Stick

6 ft Measuring Tape or Rope

Magnifiers

Plant Field Guides

Plant Survey Data Sheets

4. Ready to Research!

As a botanist, one of the major tasks is to look at the biodiversity, density, and health of the plant populations supporting all other animal life. What might be some of those techniques a botanist could use to survey plants?

So now it is time for the students to truly become Plant Pros, using tools and techniques Botanists use in the field, and perform some outdoor research in the form of vegetation biodiversity and density surveys!

PLANT BIODIVERSITY and DENSITY SURVEYS!

Biological surveys are field techniques to study populations and answer questions about living organisms, especially plants. There are several techniques to use to survey plant populations depending on the question(s) you want answered. We will be doing three of these techniques and providing information about others. Utilizing magnifiers, data sheets, measuring tapes, and meter squares or circles, students will complete:

- ⇒ **Vegetation Biodiversity Square Sample Survey**
- ⇒ **Vegetation Density and Percent Cover Measurements**

To see what it is really like to be an botanist studying plants, these surveys can help answer:

- ⇒ Is the habitat healthy for a large amount of organisms?

Full instructions for these surveys are with the data sheets following.

You will want to do any or all of these surveys outside in a natural area where you have lots of types of plants, perhaps a park or natural area with wildflowers and grasses.

Another consideration is location. Surveying more than once in different habitat types is also important so students can compare habitat health, types of plants in each habitat, etc.

There are many other types of botany work and surveys, such as specializing on unique plants like cactus, epiphytes (which do not live in soil), or aquatic or marine plants that live in fresh or salt water. You can learn more about Nebraska's very important wetland habitat and the plants & animals that live in them here:

outdoornebraska.gov/learn/nebraska-habitat/wetlands/

Another topic you may find interesting and want to learn more about is Nebraska's other state plant, goldenrod! Learn more here:

hles.unl.edu/goldenrod-0

ENRICHMENT Opportunities:

⇒ Consider a field trip to conducte plant ID or surveying techniques with the group. Compare the local habitat at school/ community with a local park, nature center. Try this with a guide and without—or have students guide.

⇒ Contact a local botanist or plant pro to come and speak to students or give a presentation on their plant specialty/skills

⇒ Contact a local plant nursery or native plant seller to see if students could get the opportunity to observe propagation, planting, etc.

⇒ Consider having students participate in local plant community science projects like iNaturalist, BudBurst, etc.

5. React to Results

Well, we hope that was fun! But now what?

There are several next steps to consider once surveys and research are completed and data has been entered. It is time to react to the results the data are showing us. (If you weren't able to enter data, that is ok. Still have students discuss what they saw and any early trends or results they see.)

Let's start this with an activity that can be done indoors or outdoors (though we prefer outdoors, weather permitting). Gather the students into small groups for a "World Café" session. They will discuss in small groups and then rotate to new groups and provide their observations and answers to the following:

- What is your favorite or most interesting thing you have learned about plants in your time researching?
- What is something that concerns you about plants and ecosystems in Nebraska or the U.S.?
- Is there anything that sticks out from the data or surveys that you noticed?

After time to discuss in smaller groups, bring the full group of students back together and look at some data results. Perhaps ask the students to make a chart or graph of plant biodiversity survey findings and compare to Nebraska or National historic data online. Finally, to use both as a final project (if time allows) and as a form of assessment, ask the students to work together to identify projects they could plan and create to help plants and habitat in their community. Some options are listed below:

⇒ *Students could work individually and create an informational poster about a plant species with information on how to help it and its habitat.*

⇒ *Students could work all together to create habitat at the school or in their community by planting native plants, removing invasive species, etc.*

⇒ *Students decide as a group that there is not enough data yet to provide any answers, so more research is needed.*

ASSESSMENT

Ask students to answer following questions or complete final tasks.

- What is the amazing process for green plants to make their own food?
- Name at least 3 reasons plant biodiversity is declining and provide a possible solution.
- Discuss how surveying plants and collecting this data helps to conserve and keep healthy ecosystems.
- Create their own plant species with unique adaptations to survive 50 to 100 years from now in a changing climate.
- Provide students time and venue for feedback on fellow student projects and posters.

Vegetation Biodiversity, Cover, & Density Survey Instructions & data sheet

Overview

To check a habitat's health, an important survey to complete is a vegetation biodiversity survey. By looking at several small areas within the habitat, you can see if the habitat has lots of types of plants. You can also check on the amount of cover for animals and the density of the plants as well.

Using either a regular sized hula-hoop or an actual scientific and collapsable meter-square, students will look closely at a habitat to be able to average its health overall.

Instructions

First, once you have determined your location for a vegetation survey (and you'll need lots of space), decide if you want to do random plots or pre-designated plots. Pre-designated plots means you place the hoop or square over plants in 3 locations already planned for a survey—and you survey and take photos of these plots throughout the growing season. It may be easier (and take less planning) to use random plots.

1. To use random plots, put students in teams of 2-4, each team with a hoop or square. Then spread out in the habitat and, without looking, drop or toss their square/hoop behind them and then adjust it so they can easily see all the plants growing within the square/hoop.
2. Teams look through the plot very carefully. A magnifier can be used, and make sure to look under taller plants, close to the ground, and even under last year's thatch.
3. Tally up each TYPE (grass, forb, tree, shrub) of plant that can be found that is present. For example, if there are 3 species of grasses, this is 3 tally marks, not one. We are looking for a total amount of types of plants in the plot.
4. If time permits, use a plant field guide online or a book and see if you can identify some of the plants to their species. For example, if you have 3 forbs, one of them may be dandelion, one may be goldenrod, and another unknown. List those in the species list row in the corresponding column.
5. Once the team has agreed they have counted all the plants in the plot and identified those they could, don't move to the next plot yet. You'll need to take 2 more measurements here: density and ground cover.
6. Estimate Ground Cover percentage by looking at the whole plot. Discuss if any open ground is seen at all and if so, what percentage? Think of the plot as a pie. If you can see about 3 slices of pie that are bare or open ground, that is about 25%. Teams can discuss this estimate and record on their data sheet.
7. Finally, teams will need their brightly colored meter stick (like a Robel pole—look this up if not sure what one is) and 6ft measuring tape or rope. Have one student put the meter stick in the center of the plot (without stepping on the plants) and one end of the 6 ft tape on top of the pole. Have another student hold the opposite end of the tape and bend down on one knee. The tape should be held taut and perfectly horizontal to the ground. Have this student put their eye at exactly same level as the tape and look towards the meter stick. The first student runs their index finger slowly down the stick until the second student can no longer see it (when it is blocked by vegetation). This student says STOP. Take the measurement in centimeters and record it on your data sheet. High numbers mean good plant density. Low numbers near bottom of the stick mean very sparse/low plant density and possibly dry conditions.
8. REPEAT all these steps at two other random or pre-designated locations and take all the tallies and measurements.

NOTE on the DATA To use this data to help determine health, consider this: a healthy plant habitat usually has more types of plants growing very close to each other. An unhealthy habitat may only have a few types of plants and lots of bare ground. There are exceptions, of course. What could those be?

Vegetation Biodiversity, Cover, and Density Survey data sheet

NAME:
Date:

PLOT 1

	Grasses	Forbs	Shrubs	Trees	Total
Tally					
Species List					
Density:					
% Cover:					

PLOT 2

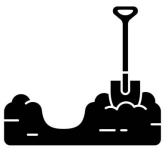
	Grasses	Forbs	Shrubs	Trees	Total
Tally					
Species List					
Density:					
% Cover:					

PLOT 3

	Grasses	Forbs	Shrubs	Trees	Total
Tally					
Species List					
Density:					
% Cover:					

ACTIVITY & LESSON PLANS

Soil Scientist



Wildlife Explorers

SOIL SCIENTIST / DIRT DETECTIVE

SUBJECTS: Science

STEM SKILLS

Investigation, Data Recording and Analysis, Science Tool/ Technique Usage, Career Experience

TIMING

40 - 60 min. each activity,

2-6 hrs full section

KEY WORDS

Soil, Erosion, Decomposition, Topsoil, Biodiversity, Sand, Silt, Clay, Nematode, Compaction, Filtration

NOTE: *Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.*

OVERVIEW

Soil and soil organism degradation is an issue. If there is inadequate food, cover, space, shelter, air, or water for these organisms to thrive, soil health is negatively impacted and soil functions degrade, causing a large number of symptoms including erosion, plant health issues, and water and air quality problems. Students will explore this issue through lab and outdoor research activities.

OBJECTIVES

Students will

- Learn what a Soil Scientist is and the issues they and our soils face
- Learn about soil health, topsoil, and organisms living in the soil
- Explore soil by utilizing tools and techniques used by a Soil Scientist
- Participate in real-time soil surveys and techniques
- Have opportunity for student-led projects to help with issues identified

BACKGROUND

Recent studies show that more than one-third of the corn belt in the Midwest—nearly 30 million acres—has completely lost its carbon-rich topsoil. Furthermore, the study showed that the erosion was likely due to contemporary tillage practices, in which plows are dragged through fields, moving topsoil from higher to lower elevations.

A year later, the study discovered that the Midwest has lost 57.6 billion metric tons of soil since Euro-American cultivation of the region began, approximately 160 years ago. This historical rate of loss, which is mostly due to tillage, is nearly double the rate which the USDA considers sustainable.

Finally, the team recently showed that Midwestern soil is eroding between 10 and 1,000 times faster than it did in the pre-agricultural era, and that the USDA's current upper-limit of sustainable erosion—1 mm per year—is an average of 25 times more than what is actually sustainable.

MATERIALS:

⇒ Soil Backpack

⇒ Soil Color Guides

⇒ Soil Chemical Testing Kit

⇒ Soil Auger and/or Trowel

⇒ Soil Sample Jars

⇒ Water Bottle

⇒ Microscope/Magnifier

⇒ Survey Data Sheets

GETTING READY

- Gather materials and equipment and students in a comfortable outdoor or indoor location. Be near outdoor location to perform surveys.
- Start with basic "What Do You Know About SOIL?" true/false activity.
- Have tools for later soil surveys available.
- PLAN THE SCHEDULE with the 5 Main Sections and Activities in mind.

DOING THE ACTIVITIES

1. What's the Problem?

To start each career section, ask the student group/class/club:

Are there are any issues facing our soil in the U.S. and/or Nebraska today?

Provide some time for discussion to get students just thinking about soil in general and any risks it faces.

Next, using the following Problem Pages about the loss of soil cover, health, and soil organism biodiversity, introduce this issue to the students by having them read the problem pages individually, in groups, or read it aloud to the group and provide the photos in copied handouts or projected on screen from a computer.

After time to consider the problem but without too much more information or description, invite the students to be DIRT DETECTIVES with an activity on top of the second Problem Page. Go outside to an area that the soil can be dug/disturbed and explore what you see in the soil. Following this, have the students answer the short questions on the activity sheet with the Problem Pages. Instruct them this is just to gauge what they saw and know so far, so don't worry about correct answers.

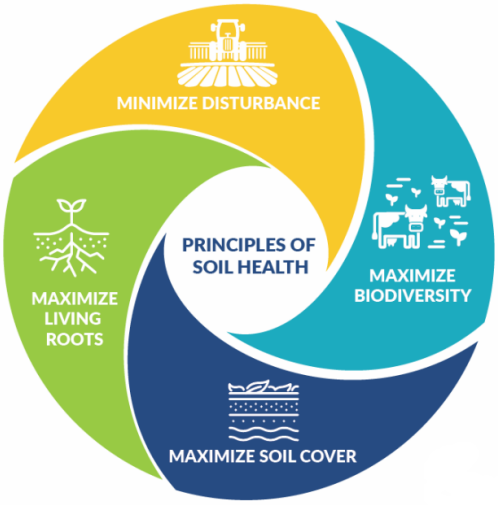
After some time to answer these early soils questions on the activity sheet, share the local Soil Scientist profiles and give the students time to see themselves as a Soil Scientist or "Dirt Detective." This can also be done later at the end of the whole Soils section if you prefer.

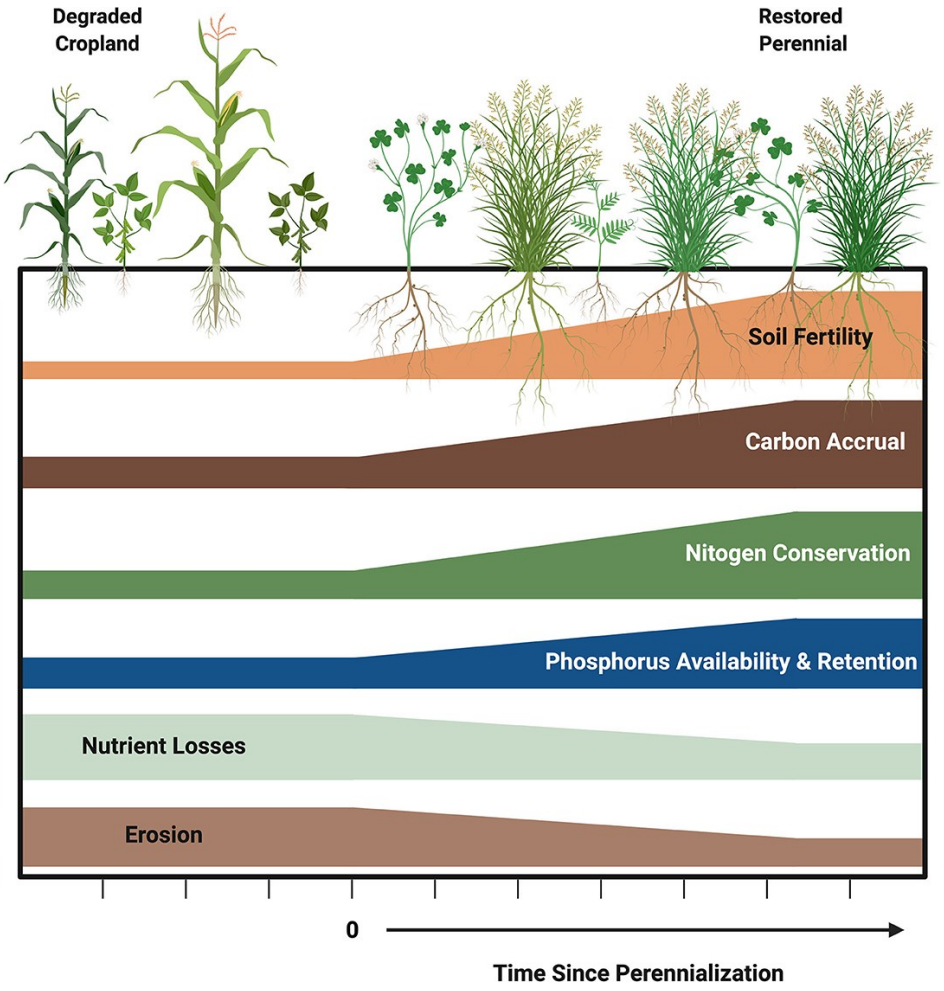
Now that we know the problem and some basics about soil, let's get ready to look closer at the soil, soil health, and organisms living in the soil.

In the section, "Delve into Details," we want to learn as much about soil in general as we can to be on our way to becoming **SOIL SCIENTISTS!**

PROBLEM PAGES

What's the Problem?





What You Need to Know

Recent studies show that more than one-third of the Corn Belt in the Midwest—nearly 30 million acres—has completely lost its carbon-rich topsoil. Furthermore, the study showed that the erosion was likely due to contemporary tillage practices, in which plows are dragged through fields, moving topsoil from higher to lower elevations.

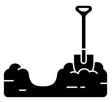
A year later, the study discovered that the Midwest has lost 57.6 billion metric tons of soil since Euro-American cultivation of the region began, approximately 160 years ago. This historical rate of loss, which is mostly due to tillage, is nearly double the rate which the USDA considers sustainable.

Finally, the team recently showed that Midwestern soil is eroding between 10 and 1,000 times faster than it did in the pre-agricultural era, and that the USDA's current upper-limit of sustainable erosion—1 mm per year—is an average of 25 times more than what is actually sustainable.

Also, soil organism habitat degradation is a big issue. When there is inadequate food, cover, space, shelter, air, or water for these organisms to thrive, soil health is negatively impacted and soil functions degrade, causing a large number of symptoms including erosion, plant health issues, and water and air quality problems. The main causes of soil degradation are erosion, organic matter decline, loss of biodiversity, compaction, contamination, and pollution.

PROBLEM PAGES

Activities and Questions



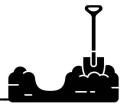
What Do You Know and What More Can You Learn?

Before you tackle the below questions, let's start with a simple and fun activity for everyone, Dirt Detective! It's easy. As a group, individually, or in teams, go outside (weather permitting, or bring some soil into the lab) and see if you can find 3-5 living or dead things in 15 minutes or less. It is ok if you don't know what kind of organism it is, but take observations (in your mind, on paper, etc.) about what you saw: size, color, smell, alive or dead etc. [*If you'd like to learn more about your local soil, use a field guide or look online at websoilsurvey.nrcs.usda.gov.]* You can do this activity more than once, especially in different locations, and see if you find similar or different things.

Now, from your experience being a dirt detective and reading and learning about the problems facing our soils today, see if you can answer the questions below. Not everyone may answer the same—so share & discuss your answers afterwards.

Can you name 3 to 5 ingredients that make soil? _____

_____



Name a problem facing our soil in Nebraska today. _____

Are there other things you see that could be harming the soil? _____

From what you have seen, heard, and read, do you think soil needs our help? _____

Are you, your family, or your school already doing something(s) to help soil in some way?_____

If yes, what? _____

If time allows, find some scratch paper and draw, paint, or write a description of something you saw during your time as a dirt detective.

Now, get ready to become real "dirt detectives" as we move to the next section all about soil!

Professional Profile

Who and What IS an Soil Scientist?

More to know!

In the most basic of terminology, a **Soil Scientist** is someone who studies the dirt and ground. Some might assume you need a Ph.D. to be considered an soil scientist; however, a Ph.D. is not 'required' to simply study soil. And there are many ways to be a soil scientist, from large-scale geography to studying tiny microscopic critters that live in the dirt or helping determine if soil is healthy or not to grow crops in.

Soil Scientists study soil outside or in the laboratory. They also may write research reports and proposals for grants, teach classes, present research to the public, and have administrative duties related to these activities. Some soil scientists do all these tasks and others may do some of these and many other things related to uses of the land.

We have many soil scientists, or "dirt detectives," researching soils right here in Nebraska in many different ways.

Take some time to do some research with students on local/statewide experts on soils. See who they are, where/what they studied, and more about them.

*Can you see YOURSELF as an **soil scientist?** What more would you like to know about the soil? Where would you go to study it? How could your work as a dirt detective help your family, community, state, or the world? Draw or put a picture of yourself studying life below the soil's surface in the box below and write some ideas of what you would be doing 5 or 10 years from now as a **soil scientist!***

YOU! Name: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Materials:

2. Delve into the Details

Ok, Soil Scientists & Dirt Detectives, it is time to look a little closer at our soil and all the live living in it and under it. In this section we will find out how much you may already know about soil - YOUR funds of knowledge - and explore the world of soil composition, decomposition, soil health, and more.

We have several lab activities planned to explore soils in detail and you can do one or all of them depending on the time you have, but let's start with a check-in of what students may already know with our "What Do You Know About Soil?" True or False activity.

On the following page are 10 - 15 true or false questions about soil.
There are many active and fun ways to do this. The simplest is to just have students draw soil and write answers down next to them. But a more hands -on and visual way to introduce the topic is to have space indoors or outdoors for the students to stand in a group. Then, proceed with the T/F questions and have students answer in one of the following ways:

1) This version of the activity takes more preparation. Each student would make (or the leader could have premade) TWO large soil cards/sheets. One soil card or picture will have a large word TRUE printed on it, the other will have FALSE printed on it. When the question is asked, the student holds up the corresponding card so all can see. It is okay to be wrong, but ask students to please, give it an educated guess. You can do this activity again at the end of the full Soils section as a form of assessment.
2) The other version is to use spatial separation. Designate an area of the room or outdoor space with a spot for TRUE and a spot for FALSE and have students stand in between them. When asked the question, they "erode" like soil to either the TRUE or FALSE location and visually see how their fellow students answered. Again, it is okay to be wrong, we just want to see how much the students may or may not know about plants and build on that throughout the section.

Once finished with the T/F activity to get to know what you know or don't know, give the students 5 minutes to discuss a few things that surprised them or may have been easy. Then, read the following statement:

If it is below your feet and you are outside . . . It is the basis of everything, our important SOILS!

Let's look much closer at our topsoil and what lies beneath it as we continue to "Delve into Details!"

2. Delve into the Details *(cont.)*

What Makes up Soil and is it Dirt? True or False

Remember, use soil cards with TRUE and FALSE printed on them or the spatial option to have students move to one space or other to answer TRUE or FALSE. Encourage discussion by asking students to share why they chose "True" or "False." Allow students to change their chosen side based on the discussion. At the end of question and discussion, be sure to reveal the correct answer and, if possible, give an example. Again, it is ok to be wrong. *[If you'd like to use this activity as part of the assessment at the end of the section, make sure to keep scores of answers or ask a student to do so. Then you have data to compare to later.]*

Basic Statements

1. Soil is made up of living things.
2. There are different layers in soil.
3. Soil is necessary for plants to grow.
4. Soil is always the same color.
5. Soil is made up of rocks and minerals.
6. Soil is only found in rural areas.
7. Soil can be eroded by wind and water.
8. Soil is always wet.
9. Soil can't be found in cities.
10. Soil is a non-renewable resource.
11. Soil is only found on land.
12. Desert areas have no soil.
13. Soil formation is a quick process.
14. Soil can clean and filter water.
15. Soil has no effect on the Earth's climate.

Answers:

1)T 2)T 3)T 4)F 5)T 6)F 7)T 8)F 9)F 10)F 11)F 12)F 13)F 14)T 15)F

Explanations:

1. Soil contains living organisms like bacteria, fungi, worms, and insects, which play vital roles in decomposition and nutrient cycling.
2. Soil is made up of distinct layers known as horizons. Each layer has different characteristics and compositions.
3. Soil provides plants with nutrients, support, and water. Without soil, most plants would not be able to grow.
4. Soil can vary in color depending on its composition and the minerals present. It can be brown, black, red, yellow, or even white.
5. Soil is composed of a mixture of weathered rocks, minerals, organic matter, air, and water.
6. Soil can be found in both rural and urban areas. Even in cities, soil exists in parks, gardens, and other green spaces.
7. Soil erosion occurs when wind or water removes the top layer of soil, leading to loss of fertile land and degradation of ecosystems.
8. Soil moisture levels can vary depending on factors like rainfall, temperature, and drainage. Soil may be wet or dry at different times.
9. Soil can be found in cities, often in parks, gardens, and urban green spaces. It's essential for supporting plant life even in urban environments.
10. Soil is a renewable resource, but it forms very slowly over time through processes like weathering and decomposition. Human activities can deplete soil faster than it can be replenished, making it functionally non-renewable in the short term.
11. Soil can be found underwater, especially in shallow areas near coastlines and riverbanks where it supports aquatic plant life.
12. Deserts have soil, but it is often sandy, dry, and low in organic matter. Many plants and animals are specially adapted to live in desert soils.
13. Soil formation is a very slow process and can take hundreds to thousands of years to form just an inch of topsoil.
14. Soil acts as a natural filter, cleaning water as it passes through by trapping pollutants and pathogens.
15. Soil plays a significant role in the Earth's climate system. It stores carbon, which can influence atmospheric carbon dioxide levels and thus affect climate.

Materials:

Character Consideration Pages for Nebraska State Soil: HOLDREGE

3. Consider the Characters

An important part of being a soil scientist is knowing more than general information about all the soil and land around us, but also specializing and learning about local soils and what they provide and need.

In this section we will focus on the Nebraska state soil, Holdrege, and look closer at unique soil organisms called Nematodes. We will also look closer into the soil to see important micro and macroscopic organisms living in the soil and how they are important to its health.

But before we even consider these characters, it is time for another outdoor activity (weather permitting).

Dirt Detective 2! This is just like the first Dirt Detective we used to open this section. Gather the students in an outdoor location near the school or local park. Use an area that allows people to dig into the soil. Provide trowels and/or soil augers and microscopes/magnifiers—and have students observe the soils up close, especially looking for signs of decomposing organic matter and live organisms.

Once students have done their observations, either written or sketched, have them discuss what they observed. What did the soils feel and smell like? Were there living things in it you could see with your eye (macroscopic) or microscopically.

After this discussion and activity, it is time to look much closer at our state soil and important critters that live in it.

Please reference the **CHARACTER CONSIDERATION pages** in the appendix for the special soil and organisms. You may want to make copies or show these on a large screen. Read/discuss with students or watch a video clip provided.

This next and final step is the lead up to doing outside research and surveys as a soil scientist would, but connects to the lab research and studies done already. Comparing more than one location is best if time and transportation allows.

After students have answered questions on this special soil on the activity sheet, consider asking them what questions do they still have? How could they find the answer to these questions?

Now it is time for everyone to get **READY TO RESEARCH!**

MATERIALS:

Trowels

Soil Auger(s)

Soil Sample Jars

Magnifiers

Microscopes

Soil Field Guides

ENRICHMENT Opportunities:

⇒ Consider a field trip to practice soil identification or surveying techniques with the group. Compare habitat to local habitat at school/community with a local park, nature center. Try this with a guide and without—or have students guide.

⇒ Contact a local soils expert to come and speak to students or perhaps provide a soil testing demonstration.

4. Ready to Research!

As a Soil Scientist, one of the major tasks is to look at ways to understand the health of local soils and all the organisms depending on these underground habitats. Soil science is a broad range of studies from topsoil to deep earth to microbes, agricultural concerns, and more.

So now it is time for the students to truly become Soil Scientists, using tools and techniques they use in the field, and perform some outdoor research in the form of soil health and soil organism surveys.

SOIL HEALTH & ORGANISM SURVEYS!

Biological surveys are field techniques to study populations and answer questions about living organisms and habitats. There are several techniques to use to survey our soil health depending on the question(s) you want answered. We will be doing a few of these techniques and providing information about others. Utilizing augers, water, chemical test kits, and more, students will complete the following surveys:

⇒ **Soil Ribboning for moisture and soil texture/type**

⇒ **Soil Sampling and Surveying organisms and organic matter**

⇒ **Soil Health Chemical Tests** *(pH, Nitrogen, Phosphorus)*

To see what it is really like to be a scientist studying soil, completing these surveys help us understand the ecosystem below the surface. This survey technique can tell you many things:

⇒ Is the habitat healthy for supporting above/below ground organisms and habitat?

Full instructions for these surveys are with the survey data sheets following.

Another consideration is location. Surveying more than once in different habitat types is also important so students can compare habitat and soil health, types of organisms in each habitat, etc. Consider sample and survey locations in dry, semi-dry, and wet areas if possible to compare.

For more on checking soils around you or near your home, check out this video on soil particles and ribbon testing from the NC Coop Extension:

https://www.youtube.com/watch?v=lXJb2bJnJ5E

ENRICHMENT Opportunities:

Groups like NRCS, USDA, and local Kiwanis clubs have resources for students to borrow or keep to study more about soil—like samples, tools, and more.

5. React to Results

Well, we hope that was fun! But now what?

There are several next steps to consider once surveys and research are completed and data has been entered. It is time to react to the results the data are showing us. (If you weren't able to enter data, that is ok. Still have students discuss what they saw and any early trends or results they see.)

Let's start this with an activity that can be done indoors or outdoors (though we prefer outdoors, weather permitting). Gather the students into small groups for a "World Café" session. They will discuss in small groups and then rotate to new groups and provide their observations and answers to the following:

- What is your favorite or most interesting thing you have learned about soil in your time researching?
- What is something that concerns you about the soils and organisms in Nebraska soil?
- Is there anything that sticks out from the data or surveys that you noticed?

After giving time to discuss in smaller groups, bring the full group of students back together and look at some data results. Perhaps ask the students to make a chart or graph of soil survey findings and compare to Nebraska or National historic data online. Finally, to use both as a final project (if time allows) and as a form of assessment, ask the students to work together to identify projects they could plan and create to help soil health in their community. Some options are listed below:

⇒ *Students could work individually and create an informational poster about local soils with information on how to help.*

⇒ *Students could work all together to create habitat at the school or in their community by composting, planting cover plants, etc.*

⇒ *Students decide as a group that there are not enough data yet to provide any answers, so more research is needed.*

ASSESSMENT

Ask students to answer following questions or complete final tasks.

- What are the main ingredients that make up soil?
- Name Nebraska's state soil.
- Discuss 2 or 3 different types of soil and how it is important to every living thing on the planet.
- Create their own organism / species with unique adaptations to survive 50 to 100 years from now in the soil in a changing climate.
- Provide students time and venue for feedback on fellow student projects and posters.

Determining soil texture using the ribboning technique

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Agriculture NSW Water Unit

Soil texture refers to how coarse or fine a soil is: that is, how much sand, silt and clay it contains. Texture has a major influence on how much water a soil can hold. Generally, the smaller and finer the soil particles (the more silt and clay), the more water a soil can hold (but this water may not all be available to the crop).

Soil texture can be estimated by hand, using the ribboning technique, but it takes practice to produce a consistent result.

Assessing soil texture

Carry out this ribbon test on a sample from each layer identified in the soil profile.

1. Take a small handful of soil.

2. Add enough water to make a ball. If you can't make a ball, the soil is very sandy.

3. Feel the ball with your fingers to find out if it is gritty (sand), silky (silt) or plastic/sticky (clay).

4. Reroll the ball and with your thumb gently press it out over your forefinger to make a hanging ribbon.

5. If you can make a short ribbon, your soil texture is loamy, a mixture of sand and clay.

6. The longer the ribbon, the more clay is in your soil.

Do this several times for confirmation and compare the average ribbon length with those in Table 1.

Table 1. Soils textures using the ribboning technique

SAND Coherence nil to very slight, cannot be moulded; single grains adhere to fingers; nil to slight turbidity when puddled.
LOAMY SAND Will form a ribbon to 5 mm. Slight coherence; definite turbidity when puddled in palm of hand
CLAYEY SAND Will form a ribbon 5 to 15 mm. Slight coherence, sticky when wet, many sand grains stick to fingers, discolours fingers with clay stain.
SANDY LOAM Will form a ribbon of 15 to 20 mm. Bolus just coherent and very sandy to touch; sand grains visible.
LIGHT SANDY CLAY LOAM Will form a ribbon of 20 to 25 mm. Bolus moderately coherent but sandy to touch; sand grains easily visible.
LOAM Will form a ribbon of about 25 mm. Bolus coherent and spongy; smooth feel and no obvious sandiness; may be somewhat greasy, as organic matter is usually present.
SANDY CLAY LOAM Will form a ribbon 25 to 40 mm. Bolus strongly coherent, sandy to touch; sand grains visible.
CLAY LOAM Will form a ribbon 40 to 50 mm. Bolus strongly coherent and plastic; smooth to manipulate.
SANDY CLAY and LIGHT CLAY Will form a ribbon 50 to 75 mm. Plastic bolus, slight resistance to shearing. sandy clay - can see, feel and hear sand grains. light clay - smooth to touch.
LIGHT MEDIUM CLAY Will form a ribbon 75 to 85 mm. Plastic bolus smooth to touch; moderate resistance to shearing between thumb and forefinger.
MEDIUM CLAY Will form a ribbon 85 to 100 mm. Smooth plastic bolus: handles like plasticine and can be moulded into rods, moderate resistance to ribboning.
HEAVY CLAY Will easily form a ribbon over 100 mm. Smooth plastic bolus; handles like stiff plasticine; can be moulded into rods without fracture; has firm resistance to ribboning shear.

Each soil texture is classified within a ribbon length range (for example, sandy clay loam ribbon length is 25 to 40 mm long). Therefore, once a consistent ribbon length is being produced, you can be reasonably sure that the correct soil texture has been identified.

SOIL SAMPLING

Representative soil sampling is the first step in successful soil fertility management. Accurate interpretation of soil test results largely depends on the care and organization applied to the sampling process.

Representative soil sampling is the first step in successful soil fertility management.

A LaMotte soil sampling tube *with a saw-toothed cutting edge. This model takes a one-inch core sample to a depth of 10 inches.*

SOIL TEXTURE

Through the process of weathering, mineral rocks are broken down over long periods of time into fine particles of sand, silt, and clay. The presence of these particles in varying proportions determines a soil's texture. A predominance of sand gives the soil a gritty feel when rolled between the fingers. A soil with a high silt content has a silky feel much like talcum powder. When moistened, clay is sticky and plastic in texture. A loamy soil is an equal blend of these three fractions. Garden soils of intermediate texture — the sandy loams, loams, and silt loams — are easiest to cultivate.

ORGANIC MATTER

Organic matter is composed of partially decayed and partially synthesized plant and animal residues present in the soil. The decomposition of organic matter releases mineral nutrients, particularly nitrogen, into the soil in available forms for plant use. Organic matter also improves tilth and water holding capacity. The garden hobbyist can improve the organic content of his soil through the application of compost.

After taking soil sample(s) compare to a soil color chart if you have one, and look in it for organic matter. Make a list of all the living things you find (plant roots, worms, etc.) and any decaying plant matter like leaves in the NOTES of data sheet. Take several samples as you will need some for this step and more for running your chemical tests next.

SOIL TEST RECORD

Sampling Area ID #	Date of Sample	Type of Plant Grown	Soil Test Results				Comments or Observations
			Soil (pH) Reaction	Nitrogen	Phosphorus	Potash	

Put notes of organic matter found in soil samples HERE.

Proper handling of chemical test equipment

This test equipment is designed to provide years of dependable service. Following these suggestions will help increase equipment performance:

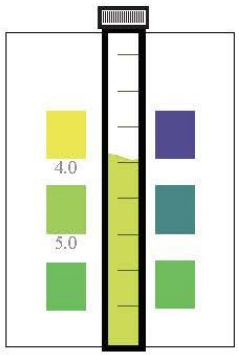
1. Carefully follow all instructions.
2. Do not handle tablets; dispense from cap to test tube.
3. Carefully wash and rinse all apparatus used.
4. Tighten reagent caps immediately after use. Do not interchange caps.
5. Avoid prolonged exposure to direct sunlight.
6. Avoid temperature extremes.
7. Anticipate your requirements for replacement reagents.
8. Keep all reagent containers out of reach of young children.
9. To order individual reagents or test kit components, use the specified code number.

Read the *Garden Guide Manual*

The accompanying *Garden Guide Manual* provides:

1. Instructions on the proper collection and preparation of soil samples.
2. Essential information for interpretation of test results.
3. Lime and fertilizer recommendations.
4. A soil test record form.

Reading the Color Charts



When matching a test color to a color chart, stand with the light source behind the observer and hold the test tube against the white area on the color chart. If the color of a test reaction falls between two standard colors on a color chart, the mid-point between the two standard values is taken as the test result. For example, a pH test color reaction falling between the standard colors for pH 4.0 and pH 5.0 represents a test result of pH 4.5. In the other tests color reactions may either match, fall between, or fall beyond the three standard colors representing "Low," Medium," and "High." Therefore seven different test results are possible: Very Low, Low, Medium Low, Medium, Medium High, High, and Very High.

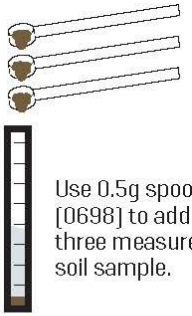
1 lb/acre = 1.12 Kg/hectare

pH Test

1

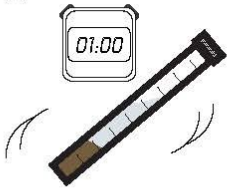
Fill test tube [0755] to line 4 with pH Indicator [5701]. Squeeze bottle gently to control amount dispensed.

2



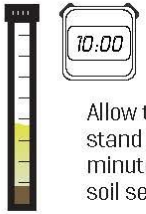
Use 0.5g spoon [0698] to add three measures of soil sample.

3



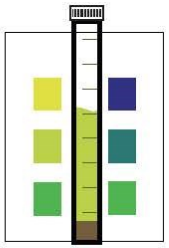
Cap and mix gently for one minute.

4



Allow tube to stand for 10 minutes to let soil settle.

5



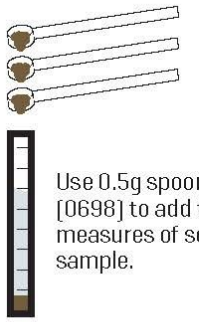
Match color reaction with **pH Color Chart (1353)**. Record result as pH.

Phosphorus Test

1

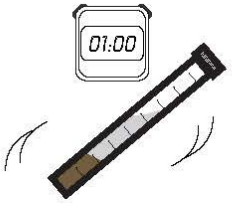
Fill test tube [0755] to line 6 with Phosphorus Extracting Solution [5704].

2



Use 0.5g spoon [0698] to add three measures of soil sample.

3



Cap and mix gently for one minute.

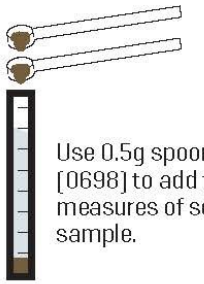
NOTE: Place Dispenser Cap [0692] on *Nitrogen Extracting Solution [5702]. Save this cap for refill reagents.

Nitrogen Test

1

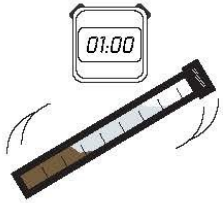
Fill test tube [0755] to line 7 with *Nitrogen Extracting Solution [5702].

2



Use 0.5g spoon [0698] to add two measures of soil sample.

3



Cap and mix gently for one minute.

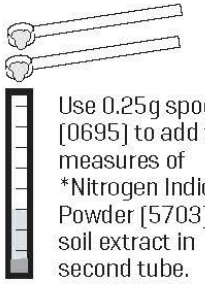
4

Remove cap and allow soil to settle.

5

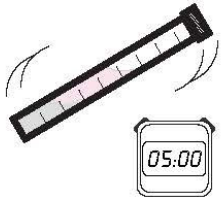
Use a clean pipet [0364] to transfer the clear liquid to a second test tube. To avoid agitation of soil, squeeze bulb of pipet before inserting tip into liquid. Release bulb slowly to draw clear liquid into pipet. Do not pull up any soil. Fill second tube to line 3 with liquid.

6



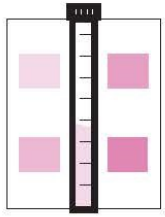
Use 0.25g spoon [0695] to add two measures of *Nitrogen Indicator Powder [5703] to soil extract in second tube.

7



Cap and gently mix. Wait 5 minutes for pink color to develop above the powder.

8



Match test color with **Nitrogen Color Chart [1371]**. Record as Nitrogen.

Low	0-30 lb/acre
Medium	30-60 lb/acre
High	+60 lb/acre

Phosphorus Test, continued

4

Remove cap. Allow to stand, and soil to settle, until liquid above soil is clear.

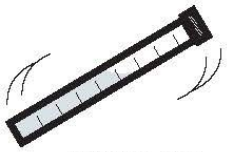
5

Use one pipet [0364] to transfer the clear liquid to a second clean test tube. To avoid agitation of soil, squeeze bulb of pipet before inserting tip into liquid. Release bulb slowly to draw clear liquid into pipet. Do not pull up any soil. Fill second tube to line 3.

6

Add six [6] drops of *Phosphorus Indicator Reagent [5705] to soil extract in second tube.

7

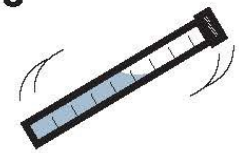


Cap and mix.

8

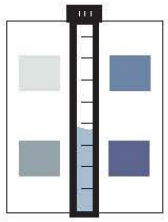
Add one Phosphorus Test Tablet [5706A].

9



Cap and mix until tablet dissolves. A blue color will develop.

10



Match color reaction with **Phosophorus Color Chart [1372]**. Record result as Phosphorus.

Low	0-50 lb/acre
Medium	50-100 lb/acre
High	+100 lb/acre

ACTIVITY & LESSON PLANS

Aquatic Scientist

Wildlife Explorers

AQUATIC SCIENTIST / WATER WARRIOR

SUBJECTS: Science

STEM SKILLS

Investigation, Data Recording and Analysis, Science Tool/ Technique Usage, Career Experience

TIMING

40 - 60 min. each activity,

2-6 hrs full section

KEY WORDS

Aquatic, Wetland, Turbidity, Macroinvertebrate, Flow, Oviposit, Algae, Nymph, Metamorphosis, Eutrophic

NOTE: Not every student will be planning a college or STEM career path. Using language like "**Community Roles**" especially when working with indigenous students and/or historically ignored groups will help keep the focus on not only careers but also on civic and cultural/ community participation and pride.

OVERVIEW

Water quantity is the timing and total yield of water from a watershed, and is measured by total yield and peak flow over a specified period of time. Water quality is the suitability of water for drinking, recreational uses, and as habitat for aquatic organisms and other wildlife. Students will explore Nebraska wetlands like streams, ponds, lakes, playas, etc., and learn to measure the water quality for wildlife and discuss water quantity issues.

OBJECTIVES

Students will

- Learn what an Aquatic Scientist is and the issues they face
- Learn about water and wetlands and organisms in them
- Explore freshwater wetlands with science tools and techniques
- Participate in real-time aquatic surveys
- Opportunities for student-led projects to help with issues identified

BACKGROUND

Over the past 50 years, the nation's water quality and drinking water have improved, but threats to water quality and safety remain. For example, the Environmental Protection Agency and the states have identified almost 70,000 water bodies nationwide that do not meet water quality standards. Water quality and quantity in wetlands for wildlife is also an important issue, as all living organisms need clean and plentiful water to live.

Runoff from rain and irrigation can carry chemicals and topsoil into streams in both urban and rural areas, causing surface water contamination. More than 50 years of crop production has allowed fertilizers and ag chemicals to reach groundwater in parts of the state, causing contamination and making wetlands unsuitable for wildlife and plants that live in the wetland or need it for drinking or bathing.

MATERIALS:

⇒ Binoculars

⇒ 3-5 Bird Beaks

⇒ Various Bird Feathers

⇒ Bird Bone(s)

⇒ Bird ID Field Guide(s)

⇒ Bird Anatomy Chart

⇒ Survey Data Sheets

GETTING READY

- Gather materials and equipment and students in a comfortable outdoor or indoor location. Be near outdoor location to perform surveys.
- Start with "What Do You Know About Wetlands?" true/false activity
- Have tools for later aquatic surveys available
- PLAN THE SCHEDULE with the 5 Main Sections and Activities in mind

DOING THE ACTIVITIES

1. What's the Problem?

To start each career section, ask the student group/class/club:

Are there are any issues facing water and wetlands in the U.S. and/or Nebraska today?

Provide some time for discussion to get students just thinking about water quality, quantity, and ecosystems in general and any risks they face.

Next, using the following Problem Pages about the issues of clean water quality and quantity, introduce this issue to the students by having them read the problem pages individually, in groups, or read it aloud to the group and provide the photos in copied handouts or projected on screen from a computer.

After time to consider the problem but without too much more information or description, invite the students to a Wild Water activity on top of the second Problem Page. Go outside and try and explore any wetlands near on the schoolyard or local park and take some observations. If you don't have a wetland near campus, you can watch a video or, even better, schedule a field trip. Following this, have the students answer the short questions on the activity sheet with the Problem Pages. Instruct them this is just to gauge what they saw and know so far, so don't worry.

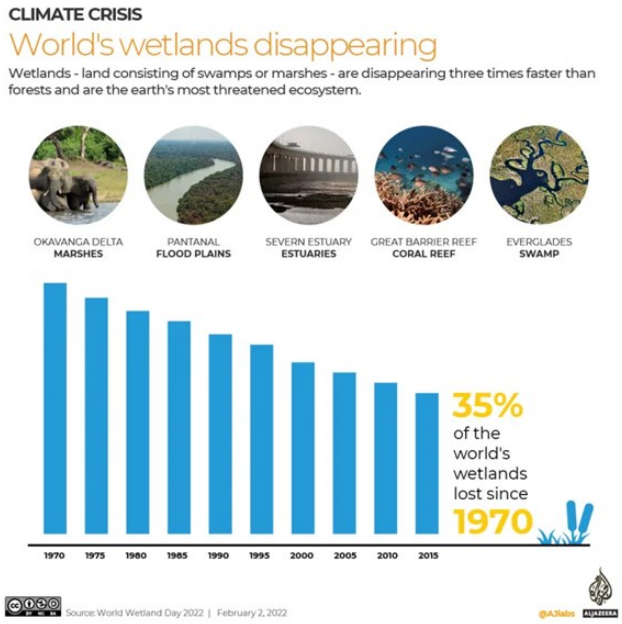
After some time to answer these early wetland questions on the activity sheet, give the students time to see themselves as a Water Warrior. This can also be done later at the end of the whole section if you prefer.

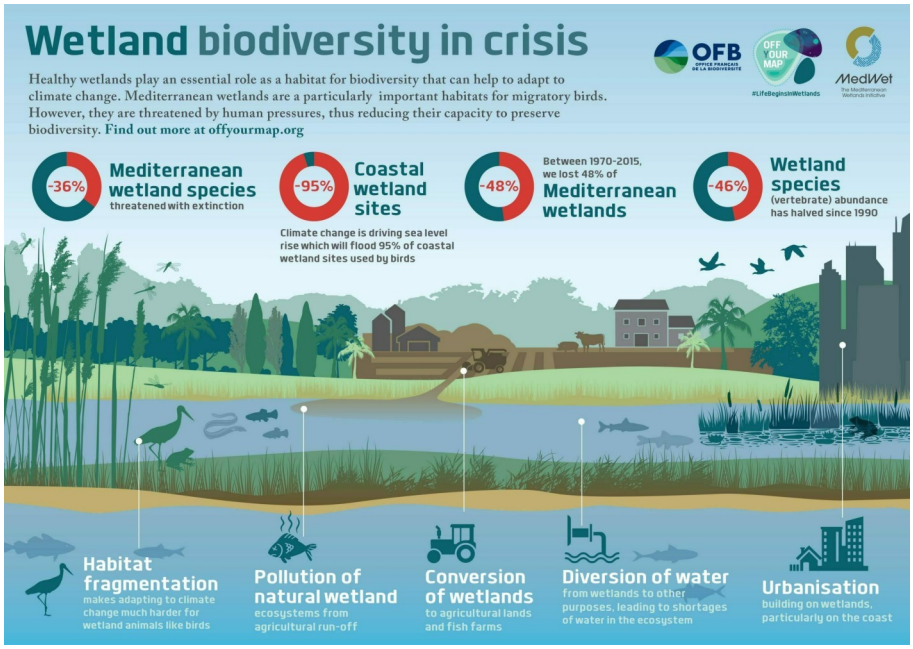
Now that we know the problem and some basics about wetlands, let's get ready to look closer at these amazing ecosystems.

In the section, "Delve into Details," we want to learn as much about water in general as we can to be on our way to becoming **Aquatic Scientists!**

PROBLEM PAGES

What's the Problem?





What You Need to Know

Over the past 50 years, the nation's water quality and drinking water have improved, but threats to water quality and safety remain. For example, the Environmental Protection Agency and the states have identified almost 70,000 water bodies nationwide that do not meet water quality standards. Water quality and quantity in wetlands for wildlife is also an important issue, as all living organisms need clean and plentiful water to live.

Runoff from rain and irrigation can carry chemicals and topsoil into streams in both urban and rural areas, causing surface water contamination. More than 50 years of crop production has allowed fertilizers and ag chemicals to reach groundwater in parts of the state, causing contamination and making wetlands unsuitable for wildlife and plants that live in the wetland or need it for drinking or bathing.

As you can see in the graphics above, we have lost a lot of wetlands across the world. While our sea levels are rising due to a warming climate, seawater is not interchangeable with the importance of freshwater wetlands for drinking and habitat. In addition, our remaining wetlands are decreasing in biodiversity at an alarming rate due to many factors such as habitat fragmentation, pollution, and/or diversion of water flow.

Take some time to read, research, and discuss this problem, the causes, and then use the activity page and questions on the back of this page. When finished, you'll be ready for the next section: Delve into Details about our aquatic ecosystems.

PROBLEM PAGES

Activities and Questions

What Do You Know and What More Can You Learn?

Before you tackle the below questions, let's start with a simple and fun activity for everyone, Wild Water! It's easy. As a group, individually, or in teams, go outside (weather permitting) and see if you can find evidence of water or wetlands near you. Take observations (in your mind, on paper, etc.) about what you saw: size, color, shape, sound, living organisms using the water, etc. Also notice where there is NO water and does the water or wetland look healthy. [*If you'd like more information on water and wetlands in Nebrska: https://outdoornebraska.gov/learn/nebraska-habitat/wetlands]* You can do this activity more than once or in a different location, and compare water sources or wetlands you find.

Now, from your experience with finding Wild Water and reading and learning about the problems facing water quality and supply today, see if you can answer the questions below. Not everyone may answer the same—so share & discuss your answers afterwards.

Can you name other wetlands or sources of water near your home or school? _____

_____

Name 2 or 3 reasons rivers and wetlands might dry up. _____

Are there other things you see that could be harming our water? _____

From what you have seen, heard, and read, do you think wetlands need our help? _____

Are you, your family, or your school already doing something(s) to help wetlands in some way?_____

If yes, what? _____

If time allows, find some scratch paper and draw, paint, or write a description of the water source or wetland you explored! Add any animals or plants you saw near it.

Now, get ready to become real "water warriors" as we move to the next section and learn more!

Who and What IS an Aquatic Scientist?

WHO you need to know!

In the most basic of terminology, an Aquatic Scientist is someone who studies water and what lives in the water. Some might assume you need a Ph.D. to be considered an aquatic scientist; however, a Ph.D. is not 'required' to simply study water. And, there are many ways to study water by specializing. There are many types of aquatic research, from becoming a wetland specialist, a hydrologist, or an aquatic scientist specializing on the micro and macroinvertebrates living in the water and/or wetland.

These scientists study wetlands outside or in the laboratory. They also may write research reports and proposals for grants, teach classes, present research to the public, and have administrative duties related to these activities. Some do all these tasks and others may do some of these and many other things related to wetlands like looking at the effects of climate, amount of water resources, and/or health and quality of the water.

Take some time to do some research with students on local/statewide experts on wetlands, macroinvertebrates, hydrology. See who they are, where/what they studied, and more about them.

*Can you see YOURSELF as an Aquatic Scientist**?** What more would you like to know about wetlands? Where would you go to study them? How could your work as a water warrior help your family, community, state, or the world? Draw or put a picture of yourself studying wetlands in the box below and write some ideas of what you would be doing 5 or 10 years from now as an **Aquatic Scientist!***

YOU! Name: _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Materials:

2. Delve into the Details

Ok Water Warriors & Aquatic Scientists, it is time to look a little closer at our wetlands and all the living organisms in it. In this section we will find out how much you may already know about wetlands - YOUR funds of knowledge - and explore the world of aquatic ecosystems and the importance of both freshwater quantity and quality.

We have several activities planned to explore wetlands in detail and you can do one or all of them depending on the time you have, but let's start with a check-in of what students may already know with our "What Do You Know About Wetlands and Aquatic Macroinvertebrates?" True or False activity.

On the following page are 15 true or false questions about wetlands and wildlife that need them. There are many active and fun ways to do this. The simplest is to just have students draw a wetland and write answers down next to it. But a more hands-on and visual way to introduce the topic is to have space indoors or outdoors for the students to stand in a group. Then, proceed with the T/F questions and have students answer in one of the following ways:

1) This version of the activity takes more preparation. Each student would make (or the leader could have premade) TWO large water cards/sheets. One card or picture will have a large word TRUE printed on it, the other will have FALSE printed on it. When the question is asked, the student holds up the corresponding card so all can see. It is okay to be wrong, but ask students to please, give it an educated guess. You can do this activity again at the end of the full Aquatic section as a form of assessment.
2) The other version is to use spatial separation. Designate an area of the room or outdoor space with a spot for TRUE and a spot for FALSE and have students stand in between them. When asked the question, they "flow" like water to either the TRUE or FALSE location and visually see how their fellow students answered. Again, it is okay to be wrong, we just want to see how much the students may or may not know about wetlands and build on that throughout the section.

Once finished with the T/F activity to get to know what you know or don't know, give the students 5 minutes to discuss a few things that surprised them or may have been easy. Then, read the following statement:

Wetlands are areas of land that are wet at least some time of the year—from playa wetlands that dry up quick, to permanent streams, lakes, and ponds.

Let's look much closer at our Nebraska Wetlands and aquatic ecosystems and continue to "Delve into Details!"

2. Delve into the Details *(cont.)*

What Makes Aquatic Habitats & Organisms Special? True or False

Remember, use water cards with TRUE and FALSE printed on them or the spatial option to have students move to one space or other to answer TRUE or FALSE. Encourage discussion by asking students to share why they chose "True" or "False." Allow students to change their chosen side based on the discussion. At the end of question and discussion, be sure to reveal the correct answer and, if possible, give an example. Again, it is ok to be wrong. *[If you'd like to use this activity as part of the assessment at the end of the section, make sure to keep scores of answers or ask a student to do so. Then you have data to compare to later.]*

Basic Statements

1. Freshwater wetlands are composed of salt water.
2. Benthic organisms inhabit the bottom of aquatic environments and play important roles in nutrient cycling.
3. Aquatic insects spend their entire life cycle in water.
4. Aquatic insects and amphibians are not affected by pollution in the water.
5. Saline wetlands provide habitat for species adapted to high salt concentrations.
6. Phytoplankton are microscopic organisms that form the base of the aquatic food chain.
7. Aquatic insects are an essential food source for fish, birds, amphibians, and other animals.
8. Eutrophication is a natural process that occurs in healthy aquatic ecosystems.
9. Aquatic insects only exist in freshwater environments.
10. Hydrologists focus on the movement, distribution, and quality of water in aquatic environments.
11. Wetlands provide important ecological services, such as flood control and water filtration.
12. Ichthyologists specialize in the study of fish species and their habitats.
13. Vernal pools provide critical breeding habitat for amphibians and other aquatic species.
14. Wetlands are among the most biologically diverse ecosystems on Earth, supporting a wide variety of plant and animal species.
15. Dissolved oxygen levels in water are not important for the survival of aquatic organisms.

Answers:

1)F 2)T 3)F 4)F 5)T 6)T 7)T 8)F 9)F 10)T 11)T 12)T 13)T 14)T 15)F

Explanations:

1. Freshwater wetlands are not connected to the ocean. They can be found along the boundaries of streams, lakes, ponds or even in large shallow holes that fill up with rainwater.
2. Benthic organisms are organisms that live on or in the bottom sediments of aquatic environments, including worms, snails, and insect larvae. They play vital roles in nutrient recycling, sediment stability, and decomposition.
3. Aquatic insects, like mayflies and dragonflies, spend their entire larval in water, butand adult stages while near wetlands, flying out of the water in air or on land.
4. Aquatic insects and amphibians are susceptible to pollution, which can harm their populations and disrupt aquatic ecosystems. The presence of certain aquatic insects and amphibians are in indicator of a healthy ecosystem.
5. Saline wetlands, like salt marshes and saline lakes, have high salt concentrations and support species adapted to these conditions. These wetlands are important habitats for organisms like salt-tolerant plants, brine shrimp, and certain species of birds.
6. Phytoplankton are microscopic photosynthetic organisms, including algae and cyanobacteria, that form the base of the aquatic food chain by converting sunlight into organic matter through photosynthesis.
7. Aquatic insects are an essential food source for fish, birds, amphibians, and other animals, forming a vital part of aquatic food webs.
8. Eutrophication is the process by which excess nutrients, such as nitrogen and phosphorus, enter aquatic ecosystems, leading to increased algae growth, oxygen depletion, and ecosystem degradation. It is often caused by human activities like agriculture and urban runoff, rather than being a natural process.
9. Aquatic insects can inhabit both freshwater and marine environments, with many species found in streams, rivers, lakes, ponds, and even oceans.
10. Hydrologists are scientists who study the movement, distribution, and quality of water in the Earth's hydrosphere, including rivers, lakes, groundwater, and wetlands. They investigate water cycle processes, water resource management, and the impacts of human activities on aquatic systems.
11. Wetlands are transitional ecosystems where water is the primary factor controlling the environment and associated plant and animal life. They provide vital ecological services, including flood control, water filtration, habitat provision, and carbon sequestration.
12. Ichthyologists are scientists specializing in the study of fish species, their behavior, distribution, physiology, and conservation. They often conduct research to better understand fish populations and their interactions with aquatic ecosystems.
13. Vernal pools are essential breeding grounds for amphibians due to their seasonal nature and lack of fish predators. Many amphibian species rely on vernal pools for breeding and larval development.
14. Wetlands are incredibly diverse ecosystems, supporting a wide range of plant and animal species adapted to wet conditions. They are home to numerous species of birds, mammals, reptiles, amphibians, fish, and invertebrates, making them one of the most biologically rich habitats on Earth.
15. Dissolved oxygen levels in water are crucial for the survival of aquatic organisms, as most aquatic organisms require oxygen to respire. Low dissolved oxygen levels, often caused by pollution or nutrient runoff, can lead to fish kills and other ecological problems in aquatic ecosystems.

Materials:

Character Consideration

- Green Darner Dragonfly
- Blanchard's Cricket Frog
- Journal
- Wetland Habitat

3. Consider the Characters

An important part of being an Aquatic Scientist is knowing more than general information about all the wetlands around us, but also specializing and learning about local wetlands and what they provide and what lives in them.

In this section we will focus on Nebraska wetlands and two creatures that depend on healthy wetlands for their whole life cycle, the Common Green Darner Dragonfly and Blanchard's Cricket Frog.

But before we even consider these characters, it is time for another outdoor activity (weather permitting).

Water Wild 2! This is just like the first Water Wild we used to open this section. Gather the students in an outdoor location near the school or local park where you can explore a wetland. If one is not near by, you may need to consider a field trip. Provide aquatic nets, bucketsc and magnifiers because many things that live in the wetland are tiny **macroinvertebrates.**

Once students have done their observations, either written or sketched, have them discuss what they observed. What did you find that lives in or on the water? Was there more or less than expected? Did the wetland seem healthy? Why or why not?

After this discussion and activity, it is time to look much closer at Nebraska Wetlands.

Please reference the **CHARACTER CONSIDERATION pages** in the appendix for each special organism. You may want to make copies or show these on a large screen. Read/discuss with students or watch a video clip provided.

This next and final step is the lead up to doing outside research and surveys as an aquatic scientist would, but connects to the lab research and studies done first before deciding what and how to explore the health of some wetlands around your campus and community. Comparing more than one location is best if time and transportation allows.

After students have answered questions on the wetland organisms on the activity sheet, consider asking them what questions do they still have? How could they find the answer to these questions?

Now it is time for everyone to get **READY TO RESEARCH!**

Materials:

Aquatic Dip Nets

Stream Kick Net

Bucket(s)

Collection Jars

LaMotte Water Testing Kit

Wetland Macroinvertebrate Field Guide(s)

Journals

Data Sheets

Magnifiers

4. Ready to Research!

As an Aquatic Scientist, one of the major tasks is to look at ways to understand the health of local wetlands and all the organisms depending on these important ecosystems. Aquatic science is a broad range of studies from wetland health, hydrology, and water quality, to managing river flow, sampling for water macro and microinvertebrates, and counting fish, turtles, or other organisms that need wetlands.

So now it is time for the students to truly become Aquatic Scientists, using tools and techniques they use in the field, and perform some outdoor research in the form of wetland health surveys!

WETLAND QUALITY MACROINVERTEBRATE SURVEYS!

Biological surveys are field techniques to study populations and answer questions about living organisms and habitats. There are several techniques to use to survey our wetland health depending on the question(s) you want answered. We will be doing a few of these techniques and providing information about others. Utilizing nets, water, chemical test kits, and more, students will complete the following surveys:

⇒ **Water Sampling of Macroinverts for Water Quality**

⇒ **Water Health Chemical Tests** *(pH, Dissolved Oxygen)*

To see what it is really like to be an aquatic scientist studying wetlands, completing these surveys will help us understand the ecosystem below the water's surface. This survey technique can tell you many things:

⇒ Is the wetland healthy for supporting plant and other wildlife in and around the habitat?

Full instructions for these surveys are with the survey data sheets following.

Another consideration is location. Surveying more than once in different habitat types is also important so students can compare habitat and wetland health, types of organisms in each habitat, etc. Consider sample and survey locations as well as different types of wetlands.

For example, if you have access, compare sampling in a creek or stream vs. a pond or lake.

For more on Nebraska's amazing wetlands, check out this website from the Nebraska Game & Parks Commision filled with resources (videos, story maps, and more) about our amazing and diverse wetlands across the state:

https://outdoornebraska.gov/learn/nebraska-habitat/wetlands/

ENRICHMENT Opportunities:

⇒ Consider a field trip to local lakes, streams, ponds to compare habitat. NE Game & Parks also has some amazing parks with staff to help with exploration.

⇒ Contact a local wetland expert from NE Game & Parks Commission or UNL Extension to learn more about wetlands.

⇒ Consider having students participate in a local water or wetland community science project.

5. React to Results

Well, we hope that was fun! But now what?

There are several next steps to consider once surveys and research are completed and data has been entered. It is time to react to the results the data are showing us. (If you weren't able to enter data, that is ok. Still have students discuss what they saw and any early trends or results they see.)

Let's start this with an activity that can be done indoors or outdoors (though we prefer outdoors, weather permitting). Gather the students into small groups for a "World Café" session. They will discuss in small groups and then rotate to new groups and provide their observations and answers to the following:

- What is your favorite or most interesting thing you have learned about wetlands or wetland organisms in your time researching?
- What is something that concerns you about the water and wetlands in Nebraska?
- Is there anything that sticks out from the data or surveys that you noticed?

After providing time to discuss in smaller groups, bring the full group of students back together and look at some data results. Perhaps ask the students to make a chart or graph of water survey findings and compare to Nebraska or national historic data online. Finally, to use both as a final project (if time allows) and as a form of assessment, ask the students to work together to identify projects they could plan and create to help wetlands in their community. Some options are listed below:

⇒ *Students could work individually and create an informational poster about local wetlands and water quality/quantity with information on how to help*

⇒ *Students could work all together to create habitat at the school or in their community by saving water resources, or making a pond or water garden.*

⇒ *Students decide as a group that there is not enough data yet to provide any answers, so more research is needed*

ASSESSMENT

Ask students to answer following questions or complete final tasks.

- What are the main issues facing healthy wetlands today?
- Name at least 3 kinds of wetlands in Nebraska and 3 organisms that live in them.
- Discuss 2 or 3 adaptations water organisms have to survive in wetlands.

- Create their own organism / species with unique adaptations to survive 50 to 100 years from now in a changing climate in our wetlands.
- Provide students time and venue for feedback on fellow student projects and posters.

STUDENT PAGES / DATA SHEETS / RESOURCES

- Water Sampling of aquatic macroinvertebrates to equate to water quality

To facilitate the sampling, you will need to have students at a wetland (lake, pond, stream, playa) that will have macroinvertebrates of some kind to collect and that can be accessed safely. Utilizing an area park, nature center, etc., may be the best option if your site does not have a wetland. Another option is collecting from a location first and bringing the samples IN to the school/lab for students to look at and identify.

Once at the location, have students should line up as close to wetland edge. Encourage them to use their eyes and ears to locate any signs of animal life and make a hypothesis about whether or not the wetland is healthy. Spend a few moments quietly looking and listening. Have students share observations briefly. What other animals do students think they might see if they stayed in this spot overnight? What other organisms might be living IN the wetland under the surface that we cannot currently see?

Dip water from the wetland (before students start to sample and stir it up) and separate it into smaller buckets or into a white larger flat container. The white background make the macroinvertebrates easier to see.

Demonstrate how to use the large dip nets before handing them out. Bumping the nets on plants and the substrate is preferred, but do not scoop large amounts of substrate. Also, ensure students do NOT dump nets into buckets, but instead pick macroinvertebrates out of the nets with their fingers and put them into the containers. This keeps the water clear to view macroinvertebrates.

COLLECTION TIME! Divide students into teams of 2 or 3. Emphasize the importance of safety including not going into water, staying with partners, in sight of facilitator or adult, and taking turns. Remind students of instructions to not add mud to containers and treating all living things gently as these animals are very fragile. Most of the organisms they may collect cannot survive long out of the water so transferring them from the net to the containers quickly is important. Give students a full 10-15 minutes to just collect as many macroinvertebrates as possible with out worrying about identification. Once collection time is finished, ask students to clean/rinse nets and put them down as we will be switching to identification and "scoring."

Using the IOWATER Macroinvertebrate Keys and attached data sheets, have the students identify and tally which macroinvertebrates were collected. Once identified, also ensure to tabulate on the data sheet which group (Pollution Intolerant, Somewhat Tolerant, or Pollution Tolerant) each macroinvertebrate is in. This is an important step to be able to rate the water quality of the wetland.

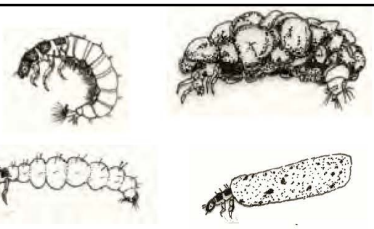
Finally, using the instructions on the data sheet, discover if the wetland you have sampled is High Quality, Middle Quality, or Low Quality for wildlife.

Conclude with a few minutes discussing if the students' earlier hypotheses were correct and what things were interesting about wetland organisms and their adaptations.

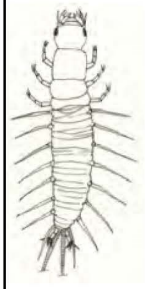
Make sure to leave time to release all creatures back in to the wild of their wetland habitat!

IOWATER BENTHIC MACROINVERTEBRATE KEY

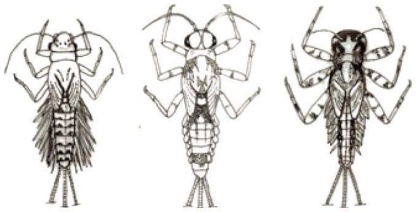
Pollution Intolerant (High Quality Group)



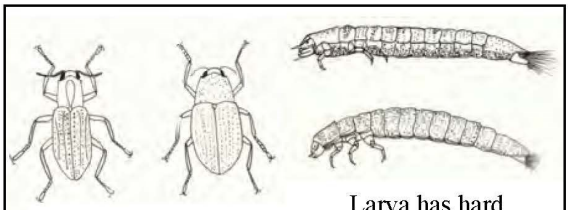
Caddisfly: 6 hooked legs on upper body, 2 hooks on end, may have stick, rock or leaf case, 2-40 mm in length.



Dobsonfly: 6 legs, 8 pairs of feelers and gill tufts on lower half of body, short antennae, 25-90 mm in length.



Mayfly: 6 legs, feathery or oval-shaped gills on lower body, 2 to 3 long tails, 3-30 mm in length.

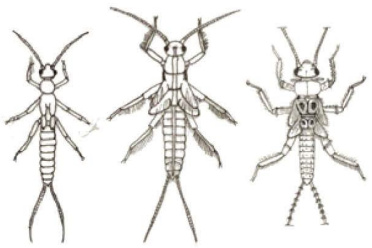


Riffle Beetle: Adult has 6 legs, body covered with tiny hairs, walks slowly underwater, 1-8 mm in length.

Larva has hard plates on each segment, 2-60 mm in length.

Snail (not pouch): When opening is facing you, shell opens on right, operculum (flap over opening) present.

Water Penny Beetle: Flat saucer-shaped body, 6 tiny legs and gills on underside, 4-6 mm.



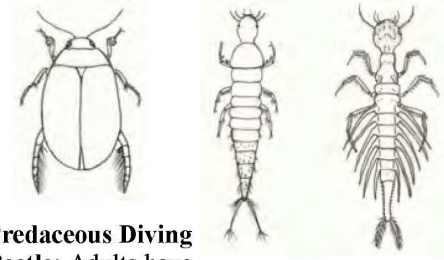
Stonefly: 6 legs with hooked tips, antennae, 2 tails, gill tuffs under legs or no visible gills, 5-60 mm in length.

Somewhat Pollution Tolerant (Middle Quality Group)

Crawling Water Beetle: Larva has one long tail and legs with one hook-like claw, 2-10 mm in length. Adult is often patterned or spotted, 2-6 mm.

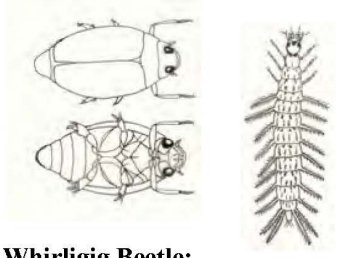
Backswimmer: Forelegs not as spoon-shaped as Water Boatman's, swims upside-down, body is V-shaped, 5-17 mm in length.

Water Boatman: Forelegs spoon-shaped and shorter compared to Backswimmer, 3-11 mm in length.



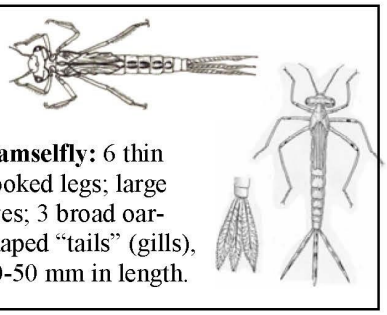
Predaceous Diving Beetle: Adults have an oval streamlined body, longer antennae than Whirligig Beetle, 1-80 mm in length.

Larva has many hairs on body, two feathery tails, large head, 5-70 mm in length.

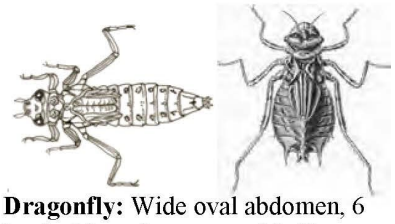


Whirligig Beetle: Flattened oval body, short, clubbed antennae, erratic swimmer, 3-15 mm.

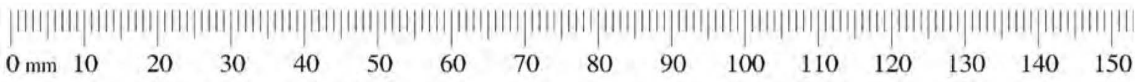
Larva has many hairs on body, short tail or no tail, up to 30 mm in length.



Damselfly: 6 thin hooked legs; large eyes; 3 broad oar-shaped "tails" (gills), 10-50 mm in length.

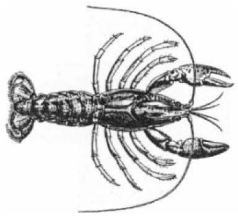


Dragonfly: Wide oval abdomen, 6 hooked legs, large eyes, 10-60 mm in length.



Somewhat Pollution Tolerant (Middle Quality Group) continued

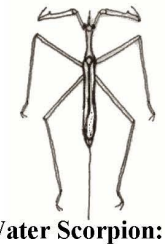
Crane Fly: Milky, green, or light brown color, caterpillar-like segmented body, 4 finger-like lobes at back end, no visible head, 10-100 mm.



Crawdad: 2 large claws, 8 legs, up to 6 inches long.

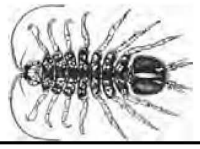
Mussels/Clams: Fleshy body enclosed between 2 clamped shells (bivalve), 2-250 mm.

Scud: White to grey, more than 6 legs, swims sideways, body higher than wide, 5-20 mm



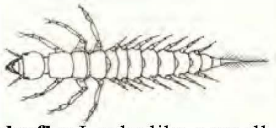
Water Scorpion: Raptor-like forelegs for catching prey, long breathing tube, stick-like long body, 15-45 mm.

Giant Water Bug: Raptor-like forelegs for catching prey, leathery textured, oval body, 15-65 mm in length.



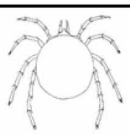
Sowbug: Gray body wider than it is high, more than 6 legs, 5-20 mm.

Water Strider: Slender body, long legs "walk" on water surface, 3-21 mm.



Alderfly: Looks like a small Dobsonfly but has one long tail and no gill tufts, 10-25 mm.

Orbsnail: One shell, coiled and flattened, a.k.a. rams-horn, 3-30 mm

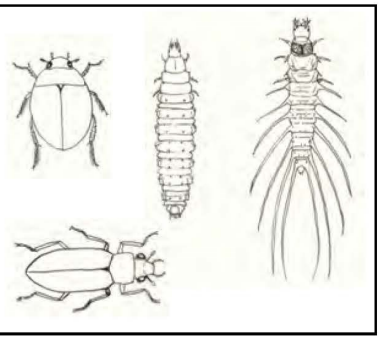


Water Mite: 8 legs, round body, may be brightly colored, 2-3 mm

Limpet: One shell, not coiled, shaped like a flat cone 3-7 mm

Pollution Tolerant (Low Quality Group)

Mosquito: Head has small mouth brushes and short antennae; abdomen has breathing siphon, surfaces for air, 4-12 mm.

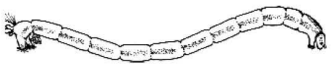


Water Scavenger Beetle: Adult may or may not be streamlined, most have no hairs on legs, short clubbed antennae, 1-40 mm. Larva have short antenna, 8 soft body segments, 4 -60 mm.

Pouch Snail: When opening is facing you, shell opens on the left, no operculum (flap over opening).

Flatworm (Planarian)**:** Flat, soft-bodied worm with arrowhead-shaped head, 1-30 mm in length.

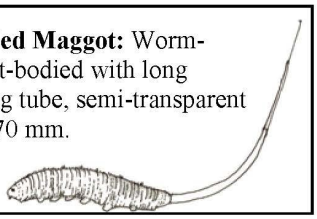
Midge Fly: Small, dark head, 2 tiny legs on each end, 2-20 mm.



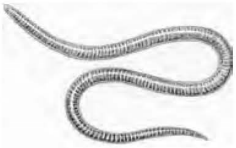
Bloodworm: One type of midge fly, has a red body due to hemoglobin.

Black Fly: One end of body wider, black head and suction pad on other end, 3-12 mm.

Leech: Brown, slimy body, suction pads on body, 5-400 mm.



Rat-tailed Maggot: Worm-like, soft-bodied with long breathing tube, semi-transparent skin, 4-70 mm.



Aquatic Worm: Thin, worm-like, 0.5-700 mm.

Revised: March 2005

Macroinvertebrate Sampling / Water Quality data sheet

NAME:	
Date:	

POLLUTION INTOLERANT (High Quality) Macros

	Caddisfly	Dobsonfly	Mayfly	Riffle Beetle	Stonefly	Others	TOTALS
Tally							
Total							
For ANY found score 3							

SOMEWHAT POLLUTION TOLERANT (Middle Quality) Macros

	Dragonfly/Damselfly Nymph	Diving Beetle	Backswimmer/Water Boatman	Scud	Clams / Orb Snails	Others
Tally						
Total						
For ANY found score 2						

POLLUTION TOLERANT (Low Quality) Macros

	Leech	Mosquito Larva	Aquatic Worms	Pouch Snails	Midge Fly larva	Others
Tally						
Total						
For ANY found score 1						

WATER QUALITY SCORE =	

** Your water quality is HIGH if any score over 10 or if any 1 organism is found from the HIGH or Pollution Intolerant section.

** Your water quality is MEDIUM if any score is below 10 and higher than 5. It is LOW if under 5 total points or only if Pollution Tolerant macros found

pH • MODULE CODE 5890

The pH test is one of the most common analyses in water testing. pH is a measurement of the activity of hydrogen ions in a water sample. The pH scale ranges from 0 to 14. Water samples with a pH below 7.0 are considered acidic, those above 7.0 are basic, with 7.0 considered neutral.

A pH range of 6.5 to 8.2 is optimal for most organisms. Rapidly growing algae and vegetation remove carbon dioxide (CO_2) from the water during photosynthesis. This can result in a significant increase in pH.

Most natural waters have pH values from 5.0 to 8.5. Acidic, freshly fallen rain water may have a pH of 5.5 to 6.0. Alkaline soils and minerals that can raise pH to 8.0 to 8.5. Sea water usually has a pH value close to 8.0.

pH REACTION

pH Wide Range TesTabs® (6459A) contain mixed pH indicators which are sensitive to pH and undergo specific color changes with variation in pH.

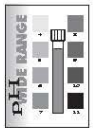
PROCEDURE

1. Fill the test tube (0106) to the 10 mL line.

2. Add one pH Wide Range TesTab (6459A).

3. Cap the tube and mix until the tablet has disintegrated.

4. Compare the color of the sample to the pH Color Chart (5890-CC). Record the result as pH.



pH	SCORE
4	1 (poor)
5	1 (poor)
6	3 (good)
7	4 (excellent)
8	3 (good)
9	1 (poor)
10	1 (poor)
11	1 (poor)

Record the score on the Data Sheet.

For more information on pH, including more extensive tests that you can perform and potential causes of imbalanced pH levels, visit the nitrate page on the Earth Force website at:
www.earthforce.org/GMGREEN

pH	☐ 7	☐ 6, 8		☐ 4, 5, 9, 10, 11

DISSOLVED OXYGEN • MODULE CODE 5889

Aquatic animals need dissolved oxygen to live. Fish, invertebrates, plants, and aerobic bacteria all require oxygen for respiration. Oxygen dissolves readily into water from the atmosphere until the water is saturated. Once dissolved in water, the oxygen diffuses very slowly and distribution depends on the movement of the aerated water. Oxygen is also produced by aquatic plants, algae, and phytoplankton as a by-product of photosynthesis.

The amount of oxygen required varies according to species and stage of life. Dissolved Oxygen levels below 3 ppm are stressful to most aquatic organisms. Dissolved Oxygen levels below 2 or 1 ppm will not support fish. Levels of 5 to 6 ppm are usually required for growth and activity.

Dissolved Oxygen Percent Saturation is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28°C will be 100% saturated with 8 ppm dissolved oxygen. However, water at 8°C can hold up to 12 ppm of oxygen before it is 100% saturated. High levels of bacteria from sewage pollution or large amounts of rotting plants can cause the percent saturation to decrease. This can cause large fluctuations in dissolved oxygen levels throughout the day, which can affect the ability of plants and animals to thrive.

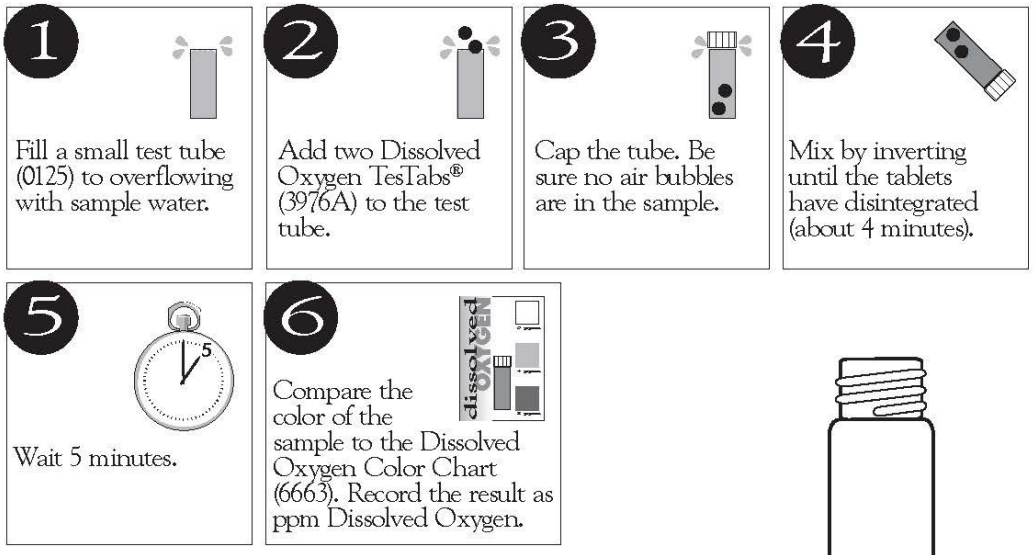
DISSOLVED OXYGEN REACTION

Dissolved Oxygen TesTabs® (3976A) contain sodium citrate and 2, 4-Diaminophenol dihydrochloride. Dissolved Oxygen, in a solution buffered by sodium citrate, oxidizes a proportionate amount of 2, 4-Diaminophenol dihydrochloride to produce a colored solution.

PROCEDURE

For the most accurate results, submerge the test tube (0125) in the river. Carefully remove the test tube from the river, keeping the tube full to the top. Be sure not to mix or shake the sample, as this will add more oxygen.

Record the temperature of the water sample.



actual size
tube 0125

Determine the Percent Saturation from the chart on page 27.

PERCENT SATURATION

TEMP°C	DISSOLVED OXYGEN 0 ppm	4 ppm	8 ppm
2	0	29	58
4	0	31	61
6	0	32	64
8	0	34	68
10	0	35	71
12	0	37	74
14	0	39	78
16	0	41	81
18	0	42	84
20	0	44	88
22	0	46	92
24	0	48	95
26	0	49	99
28	0	51	102
30	0	53	106

Calculations based on solubility of oxygen in water at sea level, from ***Standard Methods for the Examination of Water & Wastewater,*** 18th edition.

Locate the temperature of the water sample on the Percent Saturation chart. Locate the Dissolved Oxygen result of the water sample at the top of the chart. The Percent Saturation of the water sample is where the temperature row and the Dissolved Oxygen column intersect.

FOR EXAMPLE: if the water sample temperature is 16°C and the Dissolved Oxygen result is 4 ppm, then the Percent Saturation is 41.

DISSOLVED OXYGEN (% SATURATION)	SCORE
91-110	4 (excellent)
71-90	3 (good)
51-70	2 (fair)
<50	1 (poor)

Record the score on the Data Sheet.

	4 EXCELLENT	3 GOOD	2 FAIR	1 POOR
BOD ppm DO Original Sample: _____ ppm DO Incubated Sample: _____	☐ 0	☐ 4	☐ 8	

If time allows, the LaMotte Water Monitoring Kit has other tests and instructions if the group would like to investigate the wate quality further.

RESOURCE REFERENCE

The following resources were used for instructions, data collection, and other activities/lesson plans.

- LaMotte Water Monitoring Kit and Instruction Manual
- LaMotte Soil Testing Kit and Instruction Manual
- USDA/NRCS Nebraska Holdrege Soil pages
- IOWATER Benthic Macroinvertebrate Sampling Charts
- NSW Dept. of Industry Soil Texture G

APPENDIX

Character Considerations

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Fill the Bill

Wildlife Explorers

Character Considerations

Nebraska Birds - WESTERN MEADOWLARK

Western Meadowlark. Photo by Evan Barrientos

Western Meadowlark *(Sturnella neglecta)*

Western Meadowlarks (Nebraska's State Bird) are a medium-sized bird, 7.5-9.5 in/19-24 cm, about the size of a robin, with a long slender bill and short tail. They are black and brown on the back and wings, have a yellow throat, breast and belly with a black "V" on the breast. In the winter, meadowlark colors are duller. They are an abundant grassland bird occurring from the Great Plains to the Pacific Coast.

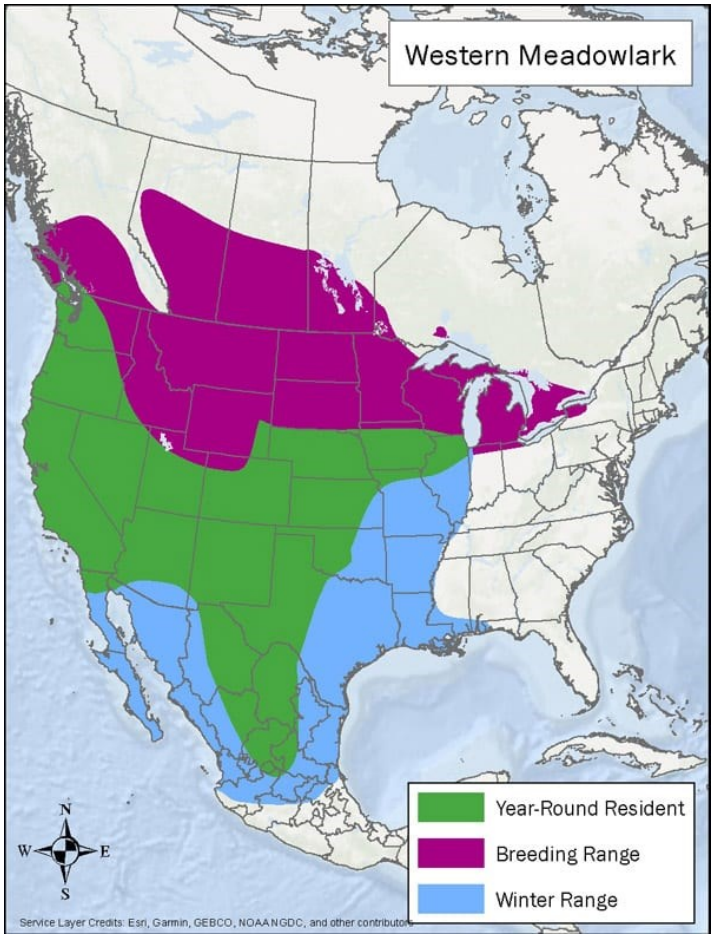
In the spring and summer, males can often be seen singing atop fence posts, shrubs, powerlines and other high points. In winter, Western Meadowlarks are often seen in small, loose flocks foraging on the ground in stubble fields and other farmlands. Birds arrive at their breeding sites in March and April and stay until October or November before fall migration. In the southern part of their range, some will overwinter. Looks almost identical to the Eastern Meadowlark [(which also lives in Nebraska) in colors and pattern], and their ranges do overlap in portions of the Great Plains, this bird is recognized by its very different song and call notes. You can listen to them on Audubon's Bird Guide.

Western Meadowlarks live in prairies, meadows, and open grasslands and avoid wooded edges and areas of heavy shrubs. They prefer lightly grazed pastures and fields. If you see a meadowlark in Nebraska in the winter, it is most likely a Western Meadowlark.

Wildlife Explorers

Character Considerations

Western Meadowlark



Behavior and Status

Meadowlarks forage and nest on the ground. They build cup nests under old grass thatch that will hold five to seven eggs.

Meadowlarks eat mostly insects, especially in the summer and feeding young, but switch to seeds for fall and winter food.

Western Meadowlark habitat is threatened by our changing climate, especially long seasons of drought. Their habitat is also disappearing due to human development and large agricultural fields.

This is a species of concern in Nebraska as well as an Audubon priority bird species.

Meadowlark Interesting Facts

Meadowlarks are actually not larks at all. They are blackbirds in the Icterid group, closely related to grackles and blackbirds. They were thought to be related to the larks in Europe when first seen by early ornithologists like Audubon and Wilson.

A male Western Meadowlark usually has two mates at the same time. The females do all the incubating and brooding, and most of the feeding of the young. The male sings on good habitat but it is the female that chooses.

The oldest recorded Western Meadowlark was only just over 6 years old when it was found in Colorado in 1965. Most meadowlarks and songbirds only live from 3-8 years.

More on Meadowlarks

For more on the Western Meadowlarks, you can find two more photos on the next page, as well as an Activity Sheet of questions about these birds and opportunities and resources for more research.

Wildlife Explorers

Character Considerations

Western Meadowlark

Wildlife Explorers

Character Considerations

Western Meadowlark Activity Sheet

Now that you have explored Nebraska's state bird a bit more, let's see if you can answer the below questions and consider more about this important grassland bird.

Can you list 5 adaptations the Western Meadowlark has or exhibits that help it survive in Nebraska's prairie and grassland habitats? _____

_____

Name 2 or 3 causes of this bird's populations declining? _____

Meadowlarks are not larks. They are in what bird group? _____

Meadowlarks have been known and had different names for thousands of years. The Winnebago/HoChunk peoples call them "Makzi" meaning yellow chest. If you were the first person to see this bird, by what you see and know of its behavior, what would you call it?_____

Can you think of any projects you and your classmates could do to help the Western Meadowlark?

_____

If you were to improve the Western Meadowlark with a new adaptation or behavior, what would it be? Draw the bird and label it with the new adaptation below.

Wildlife Explorers

Character Considerations

Nebraska Birds - NORTHERN CARDINAL

Northern Cardinal pair. Photo by Carole Wiley

Northern Cardinal *(Cardinalis cardinalis)*

One of the most popular birds in North America, the Cardinal is the official state bird of no fewer than seven eastern states. It is also the school mascot of many schools right here in Nebraska and the spark that gets many people into birding and opening a bird field guide. The male's conspicuous bright red is unmistakable and leads to it being called simply "redbird" in many areas. Even the brown females sport a sharp crest and warm red accents. Cardinals don't migrate and they don't molt into a dull plumage, so they're still breathtaking in winter's snowy backyards. In summer, their sweet whistles are one of the first sounds of the morning.

Northern cardinals are permanent residents all across their range, from the southeastern U.S., north to New England and the upper plains and west across Texas. They are a common bird at feeders across their range and prefer woods and suburban areas with lots of dense shrubs for nesting. They are primarily seed eaters but eat an abundance of caterpillars in spring while nesting and feeding their young.

The cardinal's clear whistled song is one of the most famous and a favorite all across its eastern range. And the females sing, too! Mated pairs of Northern Cardinals will duet sing on their territory during spring and summer. To listen to several of the cardinal songs and learn more about them, go to:

audubon.org/bird-guide/bird/northerncardinal

Wildlife Explorers

Character Considerations

Northern Cardinal

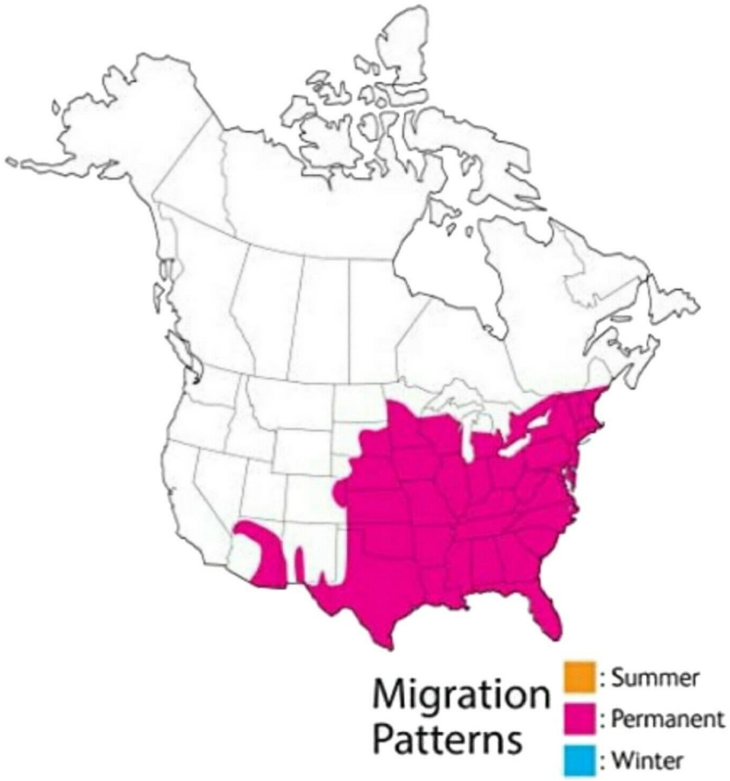
Behavior and Status

Northern Cardinals may be one of only a few species of birds whose population is not steeply declining. In fact, due to their preference for bird feeders and suburban wooded edges, parks, and yards, their numbers may actually be increasing.

When foraging, cardinals tend to search for seeds, insects, and berries on the ground or at feeders. Their large triangular beak is specialized to crack seeds, especially sunflower seeds, a favorite food.

Northern Cardinals build a messy nest of sticks, grass, and sometimes recycled materials like plastic or ribbon. They lay from 3-5 eggs and both parents help feed the nestlings. In good years of plentiful resources, they may have a second clutch of chicks.

While cardinals are not a species of concern in Nebraska or the U.S., climate change may still have a large effect on their habitat and food and water resources.



Cardinal Interesting Facts

The male cardinal fiercely defends its breeding territory from other males. When a male sees its reflection in glass surfaces, it frequently will spend hours fighting the imaginary intruder by pecking the glass or mirror on the side of a car.

The oldest recorded Northern Cardinal was just under 16 yrs old when it was found in Pennsylvania. This is much longer than the usual lifespan of a perching bird like cardinals, robins, and finches, which is usually 3 to 8 years.

Cardinals are one of the most popular mascots for schools and sports teams. They are number 11 overall, and the 2nd most popular bird, second only to eagles.

More on Cardinals

For more on Northern Cardinals, you can find two more photos on the next page, as well as an Activity Sheet of questions about these birds and opportunities and resources for more research.

Wildlife Explorers

Character Considerations

Northern Cardinal

Wildlife Explorers

Character Considerations

Northern Cardinal Activity Sheet

Now that you have explored cardinals a bit more, let's see if you can answer the below questions and consider more about this popular bright red bird.

Can you list 5 adaptations the Northern Cardinal has or exhibits that help it flourish in Nebraska cities and towns? _____

_____

Name 1 or 2 reasons this bird's population may NOT be declining?

_____

Can you name a human tool the cardinal beak is most like? _____

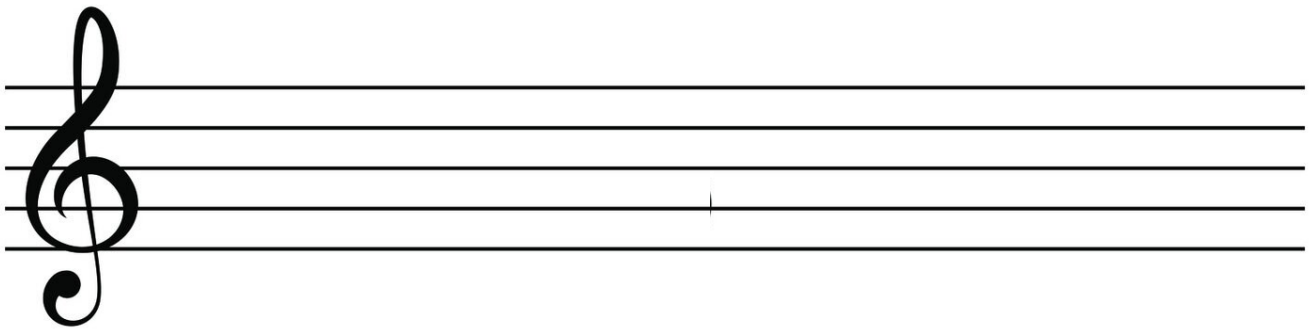
Cardinals are not migratory. How can they survive Nebraska winters?

_____

Can you think of any projects you and your classmates could do to help the Northern Cardinal?

_____

As a group or in teams, can you listen to the cardinal's song and write it out in music notes? Can you give it words to help you remember it?



Wildlife Explorers

Character Considerations

Nebraska Bugs - SALT CREEK TIGER BEETLE

Salt Creek Tiger Beetle *(Cicindela nevadica lincolniana)*

The Salt Creek tiger beetle is a member of the tiger beetle family Cicindelidae. Tiger beetles are metallic colored, ground-dwelling, predaceous insects that chase after their prey like mammalian predators—hence the "tiger" in the name.

The Salt Creek tiger beetle is one of thirty-two species and subspecies of tiger beetles that have been recorded in Nebraska. It is a small-to-medium size beetle approximately one-half inch in length. It can be distinguished from other tiger beetles by its distinctive form and color pattern and habitat long along the salt creeks and flats around Lincoln and Lancaster county. The entire life cycle of the Salt Creek tiger beetle is linked to exposed mud flats of saline wetlands and mud banks of streams that drain these wetland complexes.

This tiger beetle has one of the most restricted ranges of any insect in the United States. This sub-species is endemic to Lancaster County, Nebraska, being found only in the northern third of the county. The Salt Creek tiger beetle occupies an extremely limited habitat type, eastern Nebraska saline wetlands and their associated streams.

Wildlife Explorers

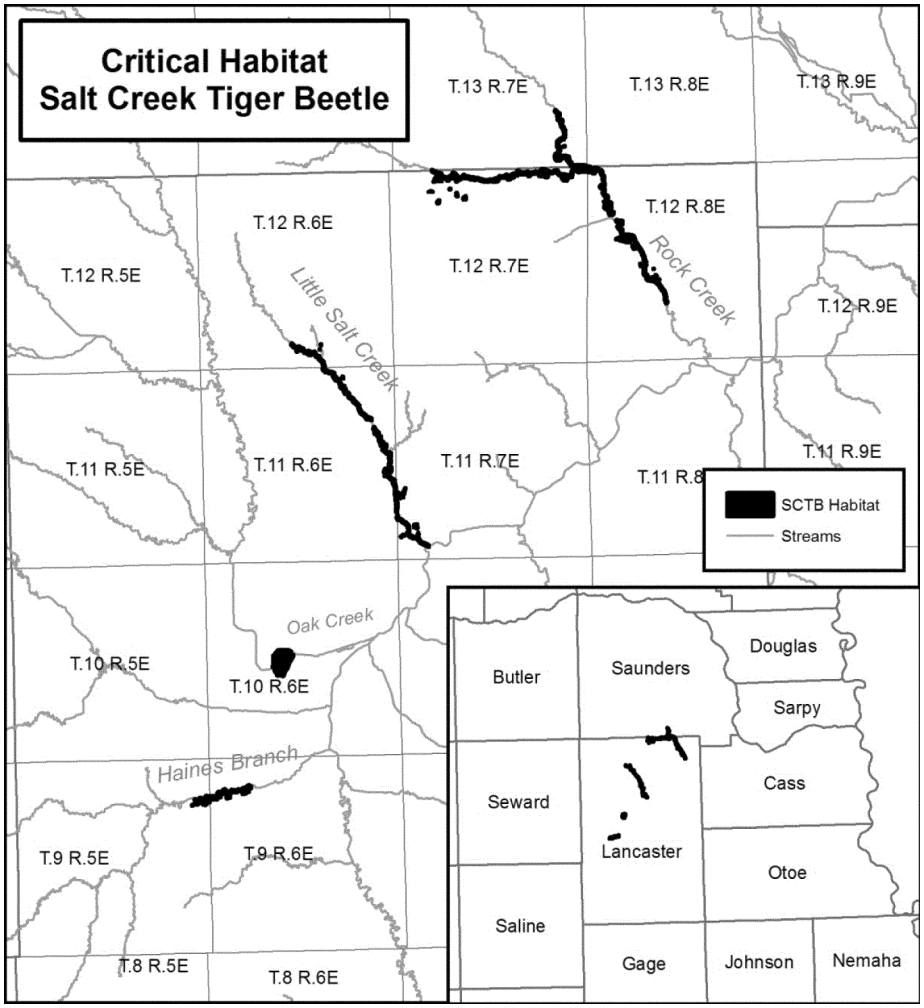
Character Considerations

Salt Creek Tiger Beetle

Status

The Salt Creek tiger beetle has one of the most restricted ranges of any insect in the United States. This sub-species is endemic to Lancaster County, Nebraska, being found only in the northern third of the county. The Salt Creek tiger beetle occupies an extremely limited habitat type, eastern Nebraska saline wetlands and their associated streams.

Due to this and constant pressure from development and insecticide and pesticide use (affecting both the beetle and its prey), the Salt Creek tiger beetle is one of the most endangered insects in Nebraska. It is Federally and State listed as endangered.



Tiger Beetle Interesting Facts

Both the adult and larva are voracious predators, the adult known for its running speed to chase after its prey. They will eat almost any other insect of similar or smaller size.

The larvae of the Salt Creek tiger beetle have 3 special hooks on the underside of the 5th abdominal segment which act as anchors to keep them inside their muddy burrows—no matter how hard a larger prey pulls or tries to get them out.

More on Tiger Beetles

For more on the Salt Creek and other tiger beetles, check out these video links:

Saving Salt Creek Tiger Beetles from Nebraska Public Media: www.youtube.com/watch?v=jEMpcCpUGdo

NE Saline Wetland & Salt Creek Tiger Beetles: www.youtube.com/watch?v=wrLDoScOhko

Tiger Beetles are Incredibly FAST! www.youtube.com/watch?v=xZIrY7VZaNA

Wildlife Explorers

Character Considerations

Salt Creek Tiger Beetle

Wildlife Explorers

Character Considerations

Salt Creek Tiger Beetle Activity Sheet

Now that you have explored this rare and unique Nebraska insect, let's see if you can answer the below questions and consider more about this important bug of the saline wetlands.

Can you list 3-5 adaptations the Salt Creek Tiger Beetle has or exhibits that help it survive in Nebraska's saline wetlands? _____

_____

Name 2 or 3 causes of this bug's declining population _____

Why are tiger beetles named after tigers? _____

How fast would YOU have to run, in proportion to size, to beat a tiger beetle? _____

Adult tiger beetles are known for their running speed and they can fly, but how do their larvae catch food?

_____

Can you think of any projects you and your classmates could do to help the critically endangered Salt Creek Tiger Beetle and/or its habitat? _____

If you were to improve the tiger beetle with a new adaptation or behavior, what would it be? Draw the bug and label its parts with the new adaptations below.

Wildlife Explorers

Character Considerations

Nebraska Bugs - REGAL FRITILLARY

Regal Fritillary *(Argynnis idalia)*

The Regal Fritillary is one of the most striking butterflies to be found on the prairie. As a large "orange and black" butterfly, it may be confused with the Monarch if seen from a distance. However, the hind wings are quite different - dark above and covered with large off-white spots below. Observed closely, the fore wings are distinctive also. The short dark lines running crosswise to the wing veins are not seen on Monarchs.

The caterpillars of Regals, as is true of most fritillaries, eat only violets. In particular, Regals prefer the Birds-foot Violet (Viola pedata) and Prairie Violet (Viola pedatifida). The eggs are laid in late summer. The newly hatched caterpillars overwinter and begin eating the following spring. They are black and yellow with short, branching, spiny hairs. The adults emerge in early summer and may be seen through September. Only one generation appears in a year.

Community scientists, like yourselves, are helping this species in Nebraska by surveying them and Monarch butterflies on prairies all across the stage.

Wildlife Explorers

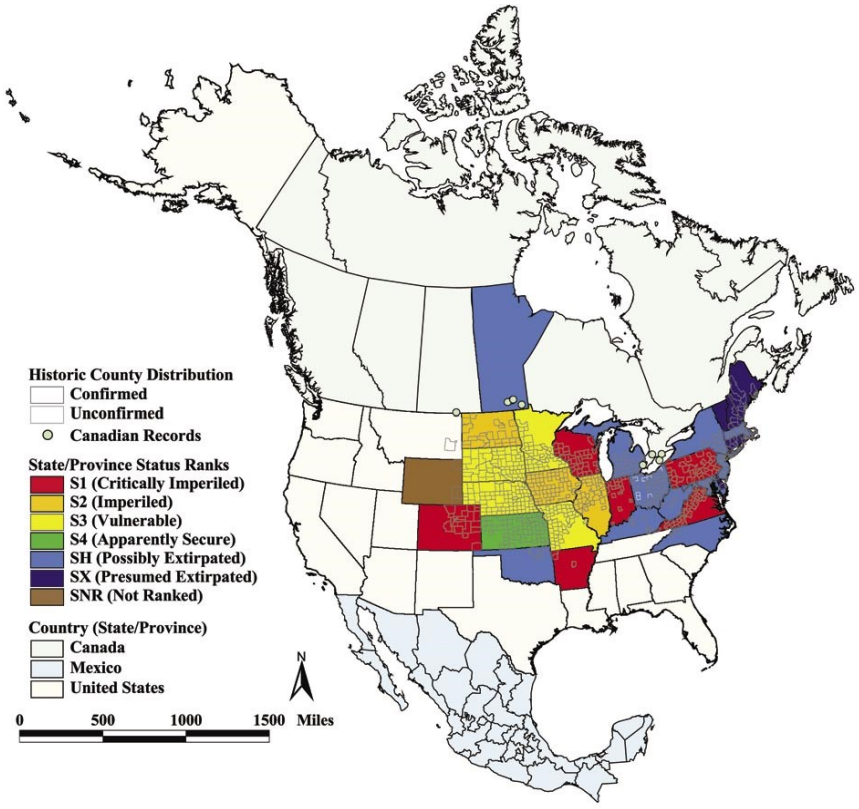
Character Considerations

Regal Fritillary

Status

As a prairie specialist, the Regal Fritillary is threatened across its range due to habitat loss, insecticides/pesticides, and - as their caterpillars are specialist that will only grow by eating prairie violet - it makes the effects of climate and habitat loss even more devastating.

When foraging, the adult butterfly will nectar on many blooms from milkweeds to thistles, but with habitat loss and climate changing the times of many plants blooming, this can be a difficult life stage as well as the larval caterpillar stage. While the population is still listed and vulnerable in Nebraska, it is much better than many other locations due to prairie preservation.



National Heritage Program State/Province Status Ranks and historic county distribution for regal fritillaries in North American (adapted from NatureServe 2005).

Fritillary Interesting Facts

The reproductive biology explains much about why this butterfly is facing extirpation and possibly extinction. First, it is single-brooded, with only one opportunity for reproduction a year. If something destroys eggs, caterpillars, or pupae, there are no more chances that year for further breeding.

Males begin emerging from pupation in early June, and females start to emerge 1–2 weeks later. Males perch on plants and wait for females to fly near. Often, they fly slowly back and forth across prairies in search of emerging females. Most males probably die in July.

Though regal fritillaries mate in early summer, the eggs develop slowly within the female. Regal fritillary mothers do not lay their eggs until late summer or early fall. They lay low through most of the summer, and they require high-quality nectar sources from May through October to sustain them.

More on Fritillaries

For more on Regal Fritillaries, you can find two more photos on the next page, as well as an Activity Sheet of questions about these bugs following. Also, feel free to check out these fritillary videos:

City Park Reintroduces Regal Fritillary: www.youtube.com/watch?v=JQLy0HpH_s8

Scientists and the Regal Fritillary: www.youtube.com/watch?v=URbrL4xpTlw

Wildlife Explorers

Character Considerations

Regal Fritillary

Wildlife Explorers

Character Considerations

Regal Fritillary Activity Sheet

Now that you have explored this unique prairie butterfly a bit more, let's see if you can answer the below questions about it.

Can you list 3-5 adaptations the Regal Fritillary has or exhibits that help it survive on Nebraska prairies?

_____

_____

Name 3 or 3 reasons the population of Regal Fritillaries is declining?

_____

What is unique about this butterfly's life cycle that may be adding to its decline?

_____

What is the term for a plant that an insect's larvae can only eat? _____

Is this a species you will likely see near your school or in a city? _____

Why or Why not? _____

Can you think of any projects you and your classmates could do to help the Regal Fritillary?

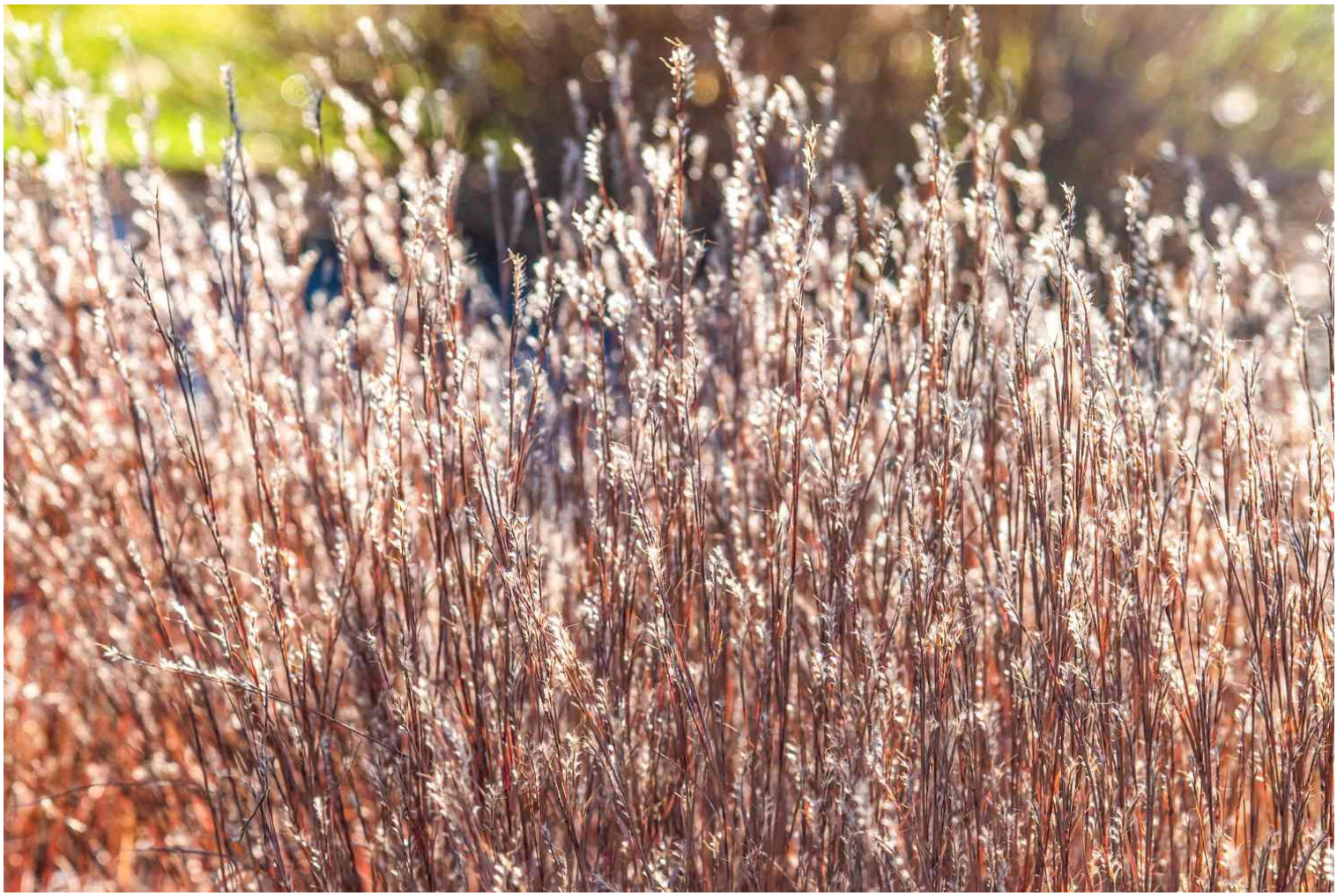
_____

Can you draw the life cycle of the Regal Fritillary and label it in the space below?

Wildlife Explorers

Character Considerations

Nebraska Plants - Little Bluestem



Little Bluestem *(Schizachyrium scoparium)*

Little bluestem was designated Nebraska's official state grass in 1969. This vigorous native prairie grass, grows throughout the Great Plains and beyond and in all four types of Nebraska prairie: shortgrass, mixed grass, tallgrass, and the Sandhills. In central and western Nebraska, it grows in bunches, as many prairie grasses do, and is sometimes called "bunch grass." In some areas, it also is known as "beard grass." The grass is an important native hay and forage grass for bison, deer, elk, and people. In the fall, its fluffy seed tops and "pinky/peachy" color stands out on the prairie.

Little bluestem is a warm-season grass which starts growth in late spring and stops in early fall. Plants grow most actively during the hot days of summer and are quite drought tolerant once established. It's native to a large portion of North America and was one of the main components of the tallgrass prairie.

Wildlife Explorers

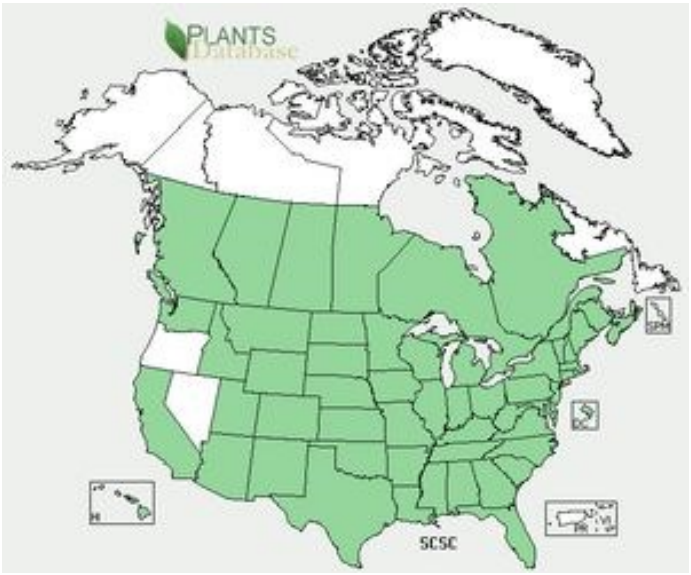
Character Considerations

Little Bluestem

Status

Little Bluestem is widespread across Nebraska and the upper plains, especially in tallgrass and mixed grass native prairies. It has become harder to find as more and more prairies are disappearing for development or agriculture. It is an important grazing grass and the bunches it forms, like many native prairie grasses, provide important habitat for rodents and insects and birds in the summer, and tight warm winter forage for grazers in the winter.

"Little Blue," as it is sometimes called, is very drought tolerant, making it an even more important grass to keep not only on the prairie but in urban and suburban yards and plantings. It can help reduce the need for watering once established as our climate continues to warm.



Little Bluestem Interesting Facts

Little bluestem gets its name from the blue-green color of its new growth in the spring. It also tends to be shorter than its cousin, big bluestem.

In the fall, it turns somewhere between a golden brown and a deep mahogany color or even a "pinky peach." The stems will stay standing most, if not all, of the winter, even if it snows.

Little Bluestem is native to most of the contiguous United States (except California, Nevada, and Oregon) as well as a small area north of the Canada–U.S. border and northern Mexico.

More on Little Bluestem

For more on Little Bluestem, check out this video from Prairie Restoration:

https://www.youtube.com/watch?v=T3DAh2dEaX0

Wildlife Explorers

Character Considerations

Little Bluestem

Wildlife Explorers

Character Considerations

Little Bluestem Activity Sheet

Now that you have explored this special prairie bunch grass, let's see if you can answer the below questions and consider more about this important plant of Nebraska prairies.

Can you list 3-5 adaptations that Little Bluestem has or exhibits that help it thrive on Nebraska prairies?

_____

_____

Name 2 or 3 causes of this plant being hard to find in NE _____

Where does the name "Little Blue" come from? _____

Can you name 2-4 other organisms (birds, insects, mammals) that use Little Bluestem for food, habitat, etc.?

_____

Can you think of any projects you and your classmates could do to help have more Little Bluestem in NE?

_____

If you were to improve Little Bluestem with new adaptations to survive our changing climate, what would they be? Draw the grass and label its parts with the new adaptations below.

Wildlife Explorers

Character Considerations

Nebraska Plants - EASTERN COTTONWOOD

Eastern Cottonwood *(Populus deltoides)*

Eastern cottonwood is the state tree of Nebraska and can grow in great abundance along streams and rivers and other wet areas. Cottonwood grow best on moist, well-drained, fine sandy loams or silt loams. Coarse sands and heavy clay soils are not satisfactory.

Most people can relate nostalgically to large cottonwoods that shaded favorite camping or fishing spots, whispered their rustling leaves in the slightest breeze, and released their cottony seeds like a snow squall on late spring days.

The cottonwood is a fast grower, is resilient to temperature extremes, offers wide-spreading shade, and can have a nice golden-yellow fall color. It is a relatively short-lived tree, seldom surviving for more than 80 years.

Seedlings and young trees are browsed by rabbits, deer, and domestic stock. Beavers use saplings and poles for food and dam construction. It is also vitally important to many important bird and insect species.

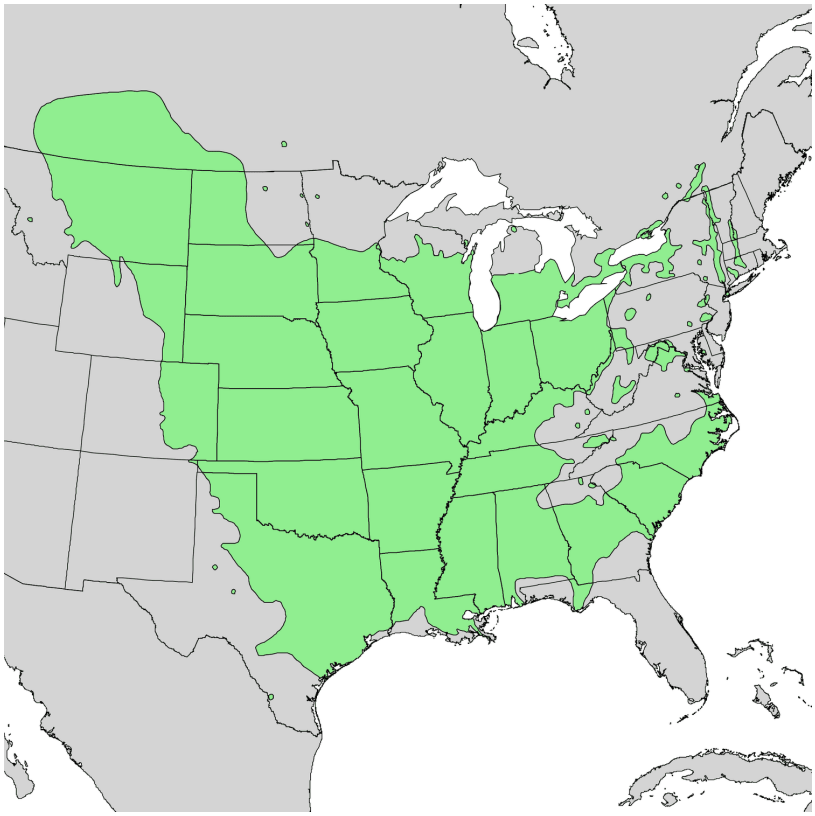
Wildlife Explorers

Character Considerations

Eastern Cottonwood

Status

Eastern Cottonwood is a common tree in Nebraska, especially along creeks, draws, and waterways. It is one of only two original tree species (the other being Burr Oak) that was on the tallgrass prairie before settlement by Europeans. Nebraska is on the western edge of its range. It is declining in the east due to development and forest cutting, and in the west due to agriculture.



Cottonwood Interesting Facts

Native Americans held cottonwood in high regard and it is thought that the leaves, when fashioned into tipis by native children, were the inspiration for the tipi dwellings of the plains tribes. Also, both Native Americans and early settlers used large cottonwoods to see where water was on the horizon when traveling across the plains.

Many people love the sound of the rustling cottonwood leaves in summer and their golden color in the fall, comparing the sound to flowing water.

The Eastern Cottonwood is one of the fastest growing species native to North America, averaging around 5 feet of growth per year – and growing as much as 13 feet in the first year! The leaves of this species are an important food source for the larvae of many species of butterflies and moths.

More on Cottonwoods

For more on the amazing Eastern Cottonwood, check out the following video link:

https://www.youtube.com/watch?v=I3Wrrcc7cnM

Wildlife Explorers

Character Considerations

Eastern Cottonwood

Wildlife Explorers

Character Considerations

Eastern Cottonwood Activity Sheet

Now that you have explored this charismatic tree, let's see if you can answer the below questions about it.

Can you list 3-5 adaptations the Eastern Cottonwood has or exhibits that have helped it thrive in Nebraska?

_____

_____

Name 2 or 3 reasons why we see declines in Eastern Cottonwood populations across the U.S.

_____

Can you describe how this large plant disperses its seeds?

_____

What are some ways this plant helps humans and other animals? _____

_____

Is this a species you will likely see near your school or in a city? _____

Why or Why not? _____

Can you think of any projects you and your classmates could do to help cottonwoods?

_____

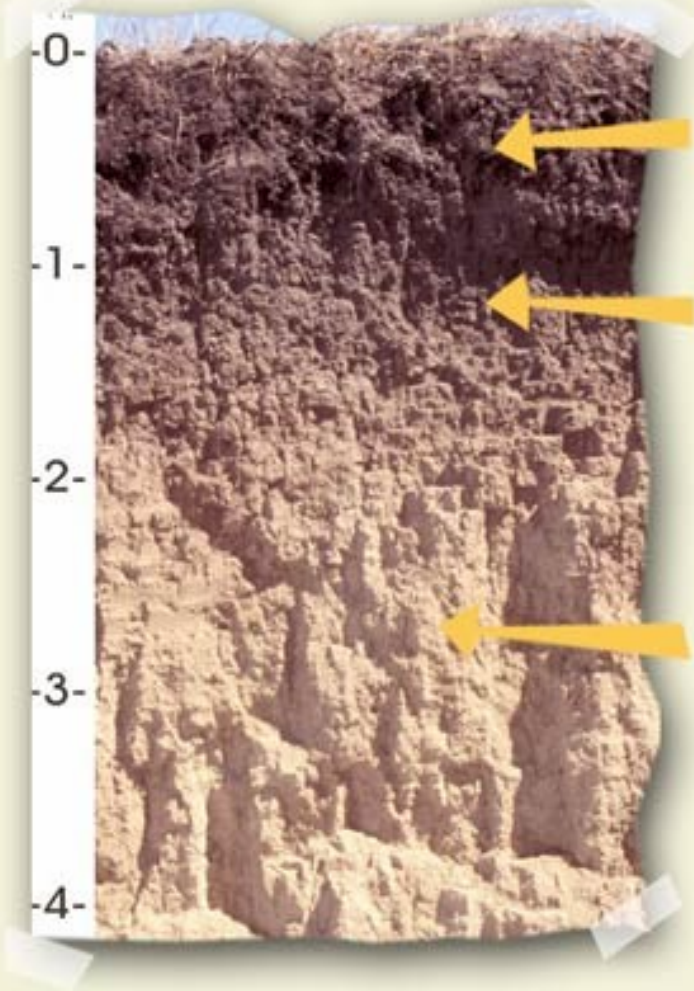
Think of all you have learned about the Eastern Cottonwood. From that knowledge, write a haiku about this amazing tree in the space below.

Character Considerations

Nebraska Soil - HOLDREGE

Official State Soil: Holdrege

What's in it?



HOLDREGE
Grassland Soils

Plowing mixes surface organic matter into the top six inches.

Clays washed down by seeping rainwater accumulate in this layer.

Lime in this layer makes the soil fizz when you add a little acid. Lime-rich silt was one of the soil's "parent" materials.

Wildlife Explorers

Character Considerations

HOLDREGE

Nebraska State Soil

SOIL SCIENCE SOCIETY OF AMERICA

Introduction

Many states have a designated state bird, flower, fish, tree, soil, rock, etc. And, many states also have a state soil - one that has significance or is important to the state. The Holdrege is the official state soil of Nebraska. Let's explore how the Holdrege is important to Nebraska.

History

The Holdrege Soil was first described as separate from surrounding soils in 1917 in Phelps County, NE and named for the nearby community of Holdrege. It was selected by the state legislature in 1979 to represent the soil resources of the state as the Official State Soil. Agriculture and soil are very important aspects of Nebraska's economy.

What is Holdrege Soil?

The Holdrege soils are very deep with small and medium (*clay* and *silt*) sized soil particles that result in excellent water storage but may restrict water movement through the soil. Every soil can be separated into three separate size fractions called *sand*, *silt*, and *clay*, which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil.

The soil particles were originally deposited by wind and stabilized by tall- and mixed-grass prairie. Lands that have been cleared for agriculture have great potential for wind *erosion*. The soil is generally found on flat (less than 4%) slopes and has high natural fertility making it excellent for use in agriculture when conservation practices are observed.

Where to dig a Holdrege

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile* **(Figure 1)**. The different horizontal layers of the soil are actually called *soil horizons*. Holdrege soils occur on about 1.8 million acres in south-central Nebraska. The Holdrege is most often found in the highlighted region of the below map **(Figure 2)**. This does not mean that other types of soil are not found in that portion of the state, just that Holdrege is very common.

Importance

The south-central region of the state, where Holdrege is common, has the greatest concentration of high yielding irrigated corn production in Nebraska **(Figure 4)**. Nebraska ranks third in the U.S. production of corn grain, and Holdrege is one of the many healthy soils that allow this high yield production because of its high natural fertility and high water storage capacity.

Wildlife Explorers

Character Considerations

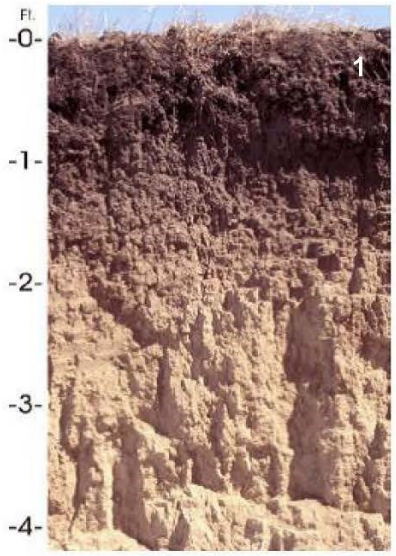
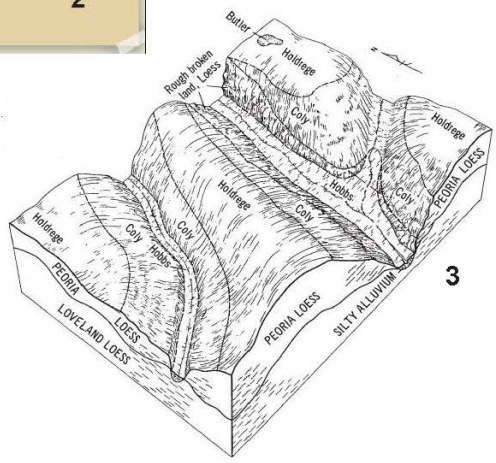


Fig. 1 Holdrege soil profile showing dark top layer due to addition of organic matter from prairie grasses. Source: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=stelprdb1236841

Fig. 2 Holdrege soil series are the most common in the south central part of Nebraska. Source:http://forces.si.edu/soils/interactive/statesoils/index.html

Fig. 3 Holdrege soil is formed on flat upland portion of the landscape which is stable and promotes soil development. Source: NRCS. Soil Survey of Phelps County, Nebraska..



Uses

Soils everywhere are used for agriculture (growing fibers, fuels, and foods for people and animals); support engineering (roads, buildings, tunnels); recreation (ball fields, playgrounds, and camping areas); natural ecosystems (wetlands); and more.

The Holdrege is extensively used for agriculture. Most of this for corn production, but also for other crops including wheat, soybean, sorghum, and alfalfa. Some areas are also used as pasture and rangelands for cattle production.

Some towns are settled on Holdrege soil. How would you feel if your house was built on the State Soil? Special, I think.

Limitations

While soil underlies nearly everything humans do, some soils are not as well suited for one or more of the uses discussed above. This is referred to as a "limitation". Soils with limitations required special management and adaptations in order to be able to carry out the intended use without damaging the soil.

Soil experts, called *Soil Scientists*, have studied the suitability of Holdrege soils for various uses and have determined that there are few limitations to restrict the use of Holdrege soils for construction, recreation, or crop production. The major limitation is that the fine grained particles at the soil surface easily dislodge creating *erosion* hazard and dusty conditions during use.

Holdrege soils have no limitations for support of buildings and homes with and without basements; however, those homes may not be able to use traditional septic systems because the fine textured soil restricts water movement.

The Holdrege soils are generally rated as class II and III for agricultural production. High potential for *erosion* and limited rainfall are the features that keep these flat, fertile soils from attaining the highest rating of class I.

Management

The primary limitation is also the main management concern for use of the Holdrege and other soils in Nebraska. It is critical to minimize *erosion* and preserve soil resources for a sustainable future. The keys to reducing *erosion* are to keep the soil surface covered and to reduce disturbance of the soil surface **(Figure 5)**. Keeping the soil surface covered can be accomplished by leaving more residue in the field after harvest or using mulches in gardens and construction sites. Soil disturbance can be reduced by reducing tillage in crop fields and only disturbing areas necessary during construction.

No-till is a practice for crop production where the field is not plowed between crops. This means the soil is not disturbed. It also leaves residue on the soil surface rather than bury it under ground. No-till has also been proven to allow more water to be stored in the *soil profile*. Since Nebraska is a state with limited natural rain and increasing groundwater use restrictions for *irrigation*, increasing the water storage of the soil profile is beneficial to crop production.

The region where Holdrege commonly experiences a good deal of wind *erosion* **(Figure 6)**. In addition to increasing ground cover and reducing disturbance, management practices that reduce wind access to soil are also beneficial for reducing *erosion*. One example of such a practice would be to plant tree wind breaks at field borders. Trees lift winds and protect the soil surface for a distance 10 times the height of the wind break. Reduced winds will also reduce evaporation and water losses from the soil (leaving more water for plant growth).

Fig. 4. Irrigation is a major source of water for growing corn on the Holdrege soil.Photo credit: Wale Adewunmi

Irrigation water management is an important concern in central Nebraska. Soil scientists recommend using low pressure sprinklers or other systems designed to increase water use efficiency and decrease water *erosion* caused by *irrigation* water.

Holdrege Soil Formation

Before there was soil, there were rocks, and in between, ClORPT. Without ClORPT, there will be no soil. So, what is ClORPT? It is the five major factors that are responsible for forming a soil like the Holdrege. These are **Cl**imate, **O**rganisms, **R**elief, **P**arent material, and **T**ime. The ClORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Holdrege soil (and all other soils) are determined by the influence of ClORPT. Weathering takes place when environmental processes such as rainfall, and freezing and thawing cycles act on rocks causing them to dissolve or break into pieces. After weathering, ClORPT acts on rock pieces, deposited sediments, and vegetative materials to form soils.

Climate – Temperature and precipitation influence the rate at which parent materials weather, and dead plants and animals decompose. They affect the chemical, physical and biological relationships in the soil. Holdrege soils formed in areas with relatively low annual rainfall, resulting in less horizon development than wetter regions, and therefore are considered young soils. There has been enough precipitation for *clays* and *carbonates* to move in the soil creating some horizon development.

Organisms – This refers to plants and animal life. In the soil, plant roots spread out, animals burrow in, and bacteria break down plant and animal tissue. These activities and others speed up the breakdown of large soil particles into smaller ones. Plants and animals also influence the formation and differentiation of *soil horizons*. Plants determine the kinds and amounts of *organic matter* that are added to a soil under normal conditions. Animals breakdown complex compounds into small ones and in so doing add *organic matter* to soil. Holdrege soils formed under prairie grasses, the extensive roots of which led to being high in *organic matter* (which increases its fertility) and excellent for crop production. Darker soil colors indicate greater *organic matter* content **(Figure 1)**.

Relief –Landform position or relief describes the shape of the land (hills and valleys). The steepness of a location and the direction it faces make a difference in how much sunlight the soil gets and how much water it stores. Deeper soils form at the bottom of the hill rather than at the top because gravity and water move soil particles downhill. Holdrege soils formed on relatively flat *upland* landscapes **(Fig.3).** Soils on flat *upland* surfaces are more stable and therefore have more development than those found on slopes, which experience *erosion*, or lowlands, which experience *deposition*.

Fig. 5. Maintaining ground cover by leaving crop residue on the soil is one of the conservation practices to reduce soil loss by wind erosion. Photo credit: Wale Adewunmi

Fig. 6. Holdrege soil is prone to wind erosion of fine soil particles of silt size. Conservation management practices must be used to prevent this type of soil loss.

Parent material (C horizon) – Just like people inherit characteristics from their parents, every soil inherited some traits from the material from which it formed. Some soils form into bedrock but many have parent materials that were transported and deposited by glaciers, wind, water, or gravity. The Holdrege soil formed in *loess* (pronounced luss), which is fine grained (typically *silt* sized) material that has been deposited by blowing wind. Calcium *carbonates* present in these *loess* deposits can still be seen in the deeper, undeveloped part of the *soil profile* known as the C horizon.

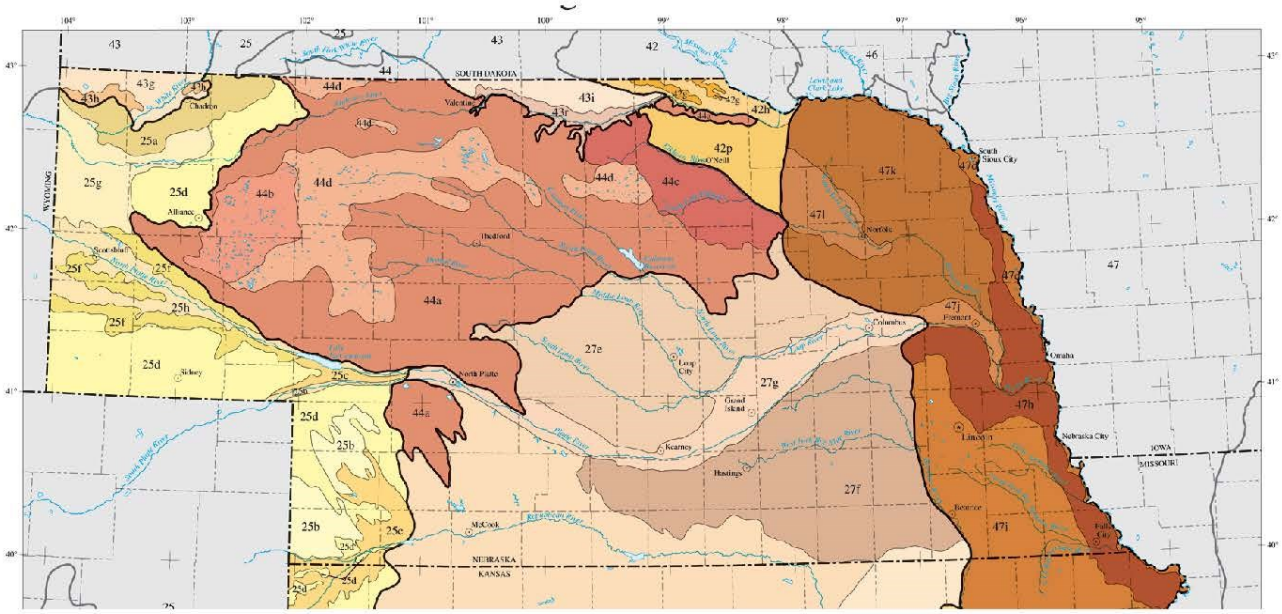
Time – All the factors act together over a very long time to produce soils. As a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined *horizons* than younger soils. Less time is needed for a soil profile to develop in a humid and warm area with dense vegetative cover than in a cold or dry area with sparse plant cover. More time is required for the formation of a well-defined *soil profile* in soils with fine textured material than in soils with coarse-textured soil material.

Ecoregions, Soils, and Land Use in Nebraska

Nebraska is a large state with great soil diversity. It also has much more topography than it generally recieves credit for. The windy nature of the state has created topography from loess hill deposits and sand dunes. However, of the six recognized *ecoregions* of the state, five are considered plains and are made up of soil that is dominantly silty in nature **(Fig.7)**. The portion of the loess hills that are in Nebraska fall into the Western Corn Belt Plains *ecoregion*.

The three main plains areas (Western High Plains, Central Great Plains, Western Corn Belt Plains) can trace their separation to climate. The drier, western area was dominated by short grass prairie; the soils of this region are the least developed and have the shallowest *horizons*. The wetter, eastern plains (part of the Corn Belt) were dominated by tall grass prairie and have the deepest, most developed soils of the state. The central region was stabilized by mixed-grass prairie. These *ecoregions* are all suitable for and dominantly used for agriculture with higher water use crops (corn and soybeans) grown in the eastern portion of the state and lower water use crops (sunflower and dry beans) grown in the western portion of the state.

The sixth *ecoregion*, the Nebraska Sand Hills, is where Nebraska finds its greatest ecosystem diversity. The sand hills are both the largest sand dune complex in the Western Hemisphere and the largest wetland system in the United States with a number of seasonal and alkaline lakes also present to house great wildlife diversity. The Sand Hills are a fragile ecosystem that is laregely unsuitable for crop production or urban infrastucture but has proven very successful as rangeland for cattle production and habitat for wildlife and game.



25 Western High Plains
- 25a Pine Ridge Escarpment
- 25b Rolling Sand Plains
- 25c Moderate Relief Rangeland
- 25d Flat to Rolling Cropland
- 25e Rolling Cropland and Range
- 25f Scotts Bluff and Wildcat Hills
- 25g Sandy and Silty Tablelands
- 25h North and South Platte Valley and Terraces

26 Southwestern Tablelands
- 26a Cimarron Breaks
- 26b Flat Tablelands and Valleys

27 Central Great Plains
- 27a Smoky Hills
- 27b Rolling Plains and Breaks
- 27c Great Bend Sand Prairie
- 27d Wellington-McPherson Lowland
- 27e Central Nebraska Loess Plains
- 27f Rainwater Basin Plains
- 27g Platte River Valley

28 Flint Hills
- 28 Flint Hills

29 Central Oklahoma/Texas Plains
- 29a Cross Timbers

39 Ozark Highlands
- 39a Springfield Plateau

40 Central Irregular Plains
- 40b Osage Cuestas
- 40c Wooded Osage Plains
- 40d Cherokee Plains

42 Northwestern Glaciated Plains
- 42g Ponca Plains
- 42h Southern River Breaks
- 42p Holt Tablelands

43 Northwestern Great Plains
- 43g Semiarid Pierre Shale Plains
- 43h White River Badlands
- 43i Keya Paha Tablelands
- 43r Niobrara River Breaks

44 Nebraska Sand Hills
- 44a Sand Hills
- 44b Alkaline Lakes Area
- 44c Wet Meadow and Marsh Plain
- 44d Lakes Area

47 Western Corn Belt Plains
- 47d Missouri Alluvial Plain
- 47h Nebraska/Kansas Loess Hills
- 47i Loess and Glacial Drift Hills
- 47j Lower Platte Alluvial Plain
- 47k Northeastern Nebraska Loess Hills
- 47l Transitional Sandy Plain

- Level III ecoregion
- Level IV ecoregion
- County boundary
- State boundary

Fig. 7. Soil ecoregions in Nebraska.

Holdrege Soil Activity Sheet

Now that you have explored this rare and unique Nebraska soil, let's see if you can answer the below questions and become a "Dirt Detective."

List an importance of the Holdrege soil to Nebraska _____

_____

Name 2 or 3 ingredients needed to form Holdrege soil. _____

What are the layers in soil called? _____

What dead organic matter is present in the Holdrege soil's dark top layer? _____

Do some research on your local area. What types of soil are common where you live?

_____

Wildlife Explorers

Character Considerations

Aquatic—DRAGONFLIES (Green Darner)

Common Green Darner Dragonfly *(Anax junius)*

The green darner or common green darner, named after its resemblance to a darning needle, is a species of dragonfly in the family Aeshnidae. One of the most common and abundant species throughout North America and as far south as Panama.

The common green darner dragonfly is about three inches long and has a bright green thorax. Males and females can be distinguished by the color of their abdomens — males' abdomens are an intense blue while females' abdomens are reddish brown. Green darner naiads (or immatures) live in ponds and streams and have cylindrical bodies with long legs.

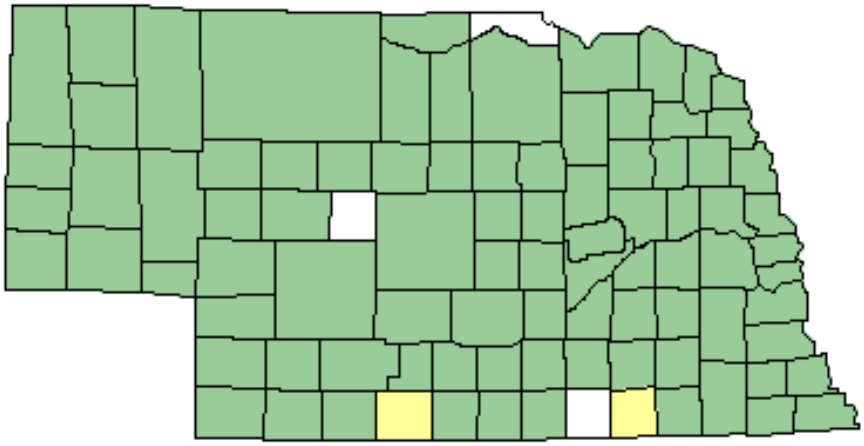
Green Darners are true aquatic and wetland creatures, living their early stage of life IN the water and then feeding above wetlands as adults. Like other dragonflies, the green darner is a skilled aerial predator. They eat many types of flying insects, such as flies, gnats, moths, butterflies, mayflies, damselflies, mosquitoes, and even other smaller dragonflies. The aquatic naiads eat other small aquatic insects and can even eat small fish and tadpoles.

Wildlife Explorers

Character Considerations

Common Green Darner

Due to the Common Green Darner's highly migratory nature, they can also be seen in a wide variety of non-wetland habitats. Green Darners inhabit a variety of well-vegetated lakes, ponds, marshes, and vernal pools, some temporary or even brackish, as well as small streams. They are common across most of Nebraska and are an important piece in keeping mosquito populations low.



Green Darner Interesting Facts

According to a study published by the Royal Society last fall, common green darners, which are found from Cuba to Canada, make a long, complex journey that takes three generations and spans a distance of more than1,500 miles

Like all dragonflies, the common green darner undergoes simple or **incomplete metamorphosis** with three stages: egg, nymph (sometimes called larva or naiad), and adult. The female green darner **oviposits** her eggs while in tandem with her mate and is the only darner in North America to do so.

"Darner" is a folk name for this type of dragonfly for its likeness to a darning needle.

This dragonfly's compound eyes have 30,000+ simple eyes (ommatidia), can see almost 360° around, and can see UV light.

Dragonflies are ancient—some of the earliest winged insects living around at the time of the dinosaurs.

More on Green Darners & other dragonflies

For more on the Common Green Darner, check out these video links:

Species Highlight: Green Darner from Burlington County Parks:

https://www.youtube.com/watch?v=yYDYcdSyVqg

Green Darner migration: https://www.youtube.com/watch?v=A9zmywD4NWM

Wildlife Explorers

Character Considerations

Wildlife Explorers

Character Considerations

Dragonfly Activity Sheet

Now that you have explored this common Nebraska insect, let's see if you can answer the below questions and consider more about this important bug of the wetlands.

Can you list 3-5 adaptations the Common Green Darner has that help it survive in Nebraska's wetlands?

_____

_____

Name 2 or 3 causes of this bug's declining population _____

How do Green Darners help with mosquito issues? _____

What is it called when an adult dragonfly lays eggs in the water? _____

Dragonflies go through change several times during their life cycle. What is this type of change process called?_____

Can you think of any projects you and your classmates could do to help Common Green Darners and their habitat? _____

If you were to improve the green darner with a new adaptation or behavior, what would it be? Draw the bug and label its parts with the new adaptations below.

Wildlife Explorers

Character Considerations

Aquatic - Blanchard's Cricket Frog

Blanchard's Cricket Frog *(Acris blanchardi)*

The Blanchard's cricket frog is one of Nebraska's smaller frogs with fully webbed hind feet, a warty appearance on its back, and colors that range from reddish-brown to cream or olive green. A dark triangle shape will occur between the eyes on the head.

This frog is common along edges of both temporary and permanent bodies of water. They prefer areas with abundant vegetation where they can hide from predators. During the fall months, the cricket frog is commonly found in areas a fair distance from water.

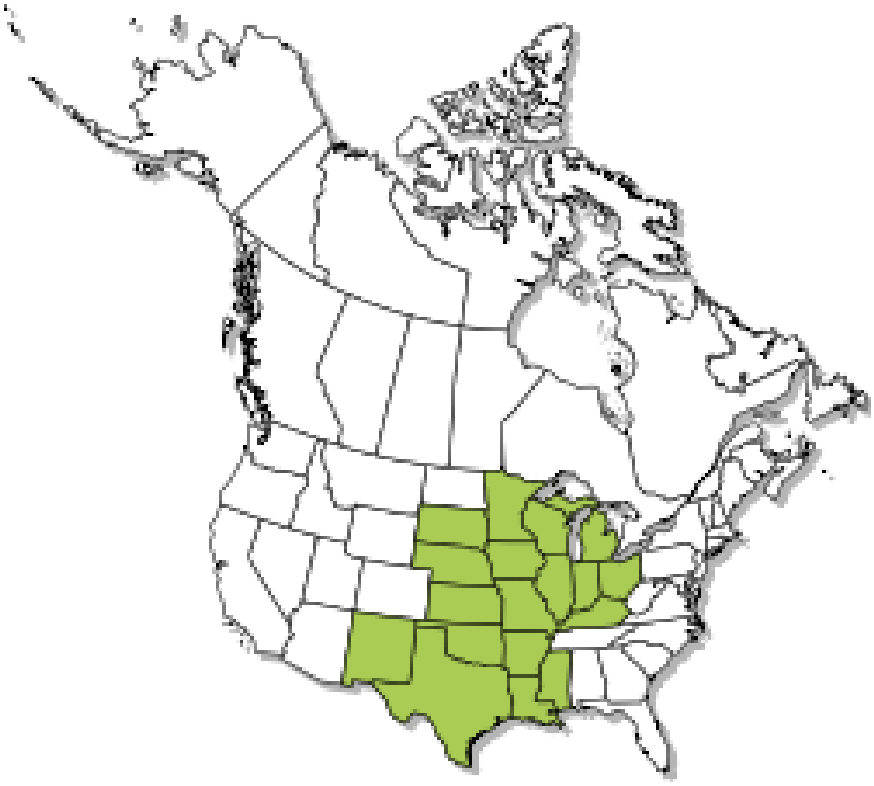
Wildlife Explorers

Character Considerations

Blanchard's Cricket Frog

Status

Blanchard's Cricket Frogs are declining and endangered in some states. They are found in the eastern two-thirds of Nebraska in freshwater wetlands.



Cricket Frog Interesting Facts

The Blanchard's cricket frog is a member of the tree frog family but is predominantly a ground-dweller.

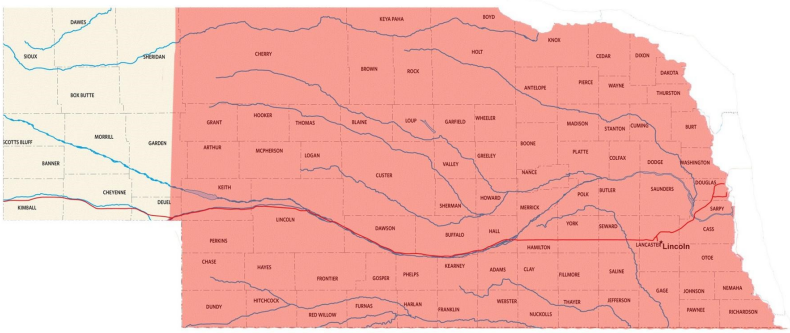
This frog will make a noise similar to two small marbles or pebbles clicking together: "rik-rik-rik-rik-rik-rik-rik-rik"

These tiny frogs are diurnal.

Active season: March – November

Breeding season: late March – late July

They lay eggs in wetlands,
100 eggs per female.



More on Cricket Frogs

For more on Blanchard's Cricket Frogs, you can find more photos on the next page, as well as an Activity Sheet of questions about them following. Also, feel free to check out these videos:

Cricket Frog calling: https://www.youtube.com/watch?v=VLk4b-jRt20

Cricket Frog bio with Ohio DNR: https://www.youtube.com/watch?v=70Rc7ZoI-JU

Wildlife Explorers

Character Considerations

Blanchard's Cricket Frog

Wildlife Explorers

Character Considerations

Blanchard's Cricket Frog Activity Sheet

Now that you have explored this unique Nebraska amphibian a bit more, let's see if you can answer the below questions about it.

Can you list 3-5 adaptations the Cricket Frog has or exhibits that help it survive in Nebraska wetlands?

_____

_____

Name 2 or 3 reasons the population of cricket frogs is declining.

_____

Describe the life cycle of the Blanchard Cricket Frog or draw it below.

_____

Frogs can breathe more than one way—can you name both? _____

Is this a species you will likely see near your school or in a city? _____

Why or why not? _____

Can you think of any projects you and your classmates could do to help cricket frogs and their habitat?

_____

Fill the Bill

Grade Levels: 3- 8

Overview: Students participate in eight activity stations that demonstrate how different types of beaks help birds eat specific types of food.

Subject Areas: Science, Art, Math

Duration: Prep: 15 minutes Activity: 30 minutes

Learning Objectives: Students will describe different types of beaks and explain how each is adapted to feed on different foods.

Materials:

- chopsticks
- clothespins
- slotted spoons and/or strainers
- small fishnets
- tweezers
- tongs
- small log or piece of wood
- rice
- 2 large bowls
- fake worms (pipe cleaners)
- dry oatmeal
- container for oatmeal
- cotton balls
- tall, thin cup
- sunflower seeds
- styrofoam chunks
- small rocks

Background Info:

It would be impossible for a hummingbird to gobble up a mouse. And it would be just as impossible for a hawk to slurp up some nectar from a flower. Each type of bird has a special beak and tongue adapted to eating a certain type of food. In this demonstration your group can find out which beaks are best for tearing, scooping, cracking, and picking by going to different stations you've set up and trying to find out which "tools" go with which types of "food."

Talk about different bird beaks to get the kids thinking about how beaks help birds survive. Here are some examples of birds and beaks you can talk about:

Hummingbirds have long hollow beaks that they use to probe flowers for nectar. The beak protects the tongue which slurps up the nectar.
Curlew, godwits, kiwis and snipes have very long beaks that they use to probe for worms, crustaceans, and other small creatures in mud and water.
Cardinals, sparrows, grosbeaks, and other finch like birds have very short, conical beaks. The beaks are very strong and can break even tough seeds.
Spoonbills and pelicans have long, flattened or pouch-like beaks that they use to scoop up fish and other aquatic creatures.
Flamingos and some ducks have bills that act like strainers to filter tiny plants and animals from the water. (Only certain kinds of ducks are filter feeders.)
Nighthawks, whip-poor-wills, swifts, and swallows have large, gaping mouths that act like nets to trap insects. These birds catch insects on the wing.
Warblers have small, sharp, pointed beaks for eating insects from leaves, twigs & logs. Toucans have very long, thick beaks for reaching out and plucking fruit from trees.

Preparation:

You'll need to set up seven different stations, each with a special type of "food" that fits one of the seven different types of beaks we've described. And at each station you will need three different tools—one that fits the food and two that don't fit as well. Also, have a sign at each station that tells what type of food is represented, and/or a picture of the bird. For example, have a sign that says "nectar" (and/or a picture of a hummingbird) at Station #1, one that says "worms in the mud" (and/or a picture of a curlew or snipe) at Station #2, and so on. Here's a list of food and tools for each station (the * indicates the tool that best fits the food).

Station #1: Water in a tall, thin cup to represent nectar in a flower. (hummingbirds). Tools include **straw with pipe cleaner***, envelope or small fishnet, and large scoop or slotted spoon.

Station #2: Large container filled with dry oatmeal and fake worms (pipe cleaners) on the bottom to represent worms buried in the mud. (curlews, godwits, kiwis, & snipes) Tools include **chopsticks***, nutcracker or pliers, and strainer.

Station #3: Seeds with hard coverings. (sparrows, cardinals, grosbeaks, & other finch like birds) Tools include **clothespin or nutcracker***, tongs, and chopsticks.

Station #4: Styrofoam chunks floating in a bowl filled with water to represent fish and other aquatic animals. (spoonbills & pelicans) Tools include **strainers or slotted spoon***, eyedropper or straw, and chopsticks.

Station #5: Small pebbles or rocks in a bowl filled with water to represent tiny aquatic plants and animals. (flamingos & some ducks) Tools include **tongs***, forceps or tweezers, and tongs.

Station #6: Cotton balls tossed in the air (which must be caught while in the air) to represent flying insects. (nighthawks & whip-poor-wills) Tools include **small fishnet***, forceps or tweezers, and chopsticks.

Station #7: Rice spread on a log to represent caterpillars and other insects. (warblers) Tools include **tweezers***, envelope or small fishnet, and nutcracker or pliers.

Procedure:

1. Divide the class into seven teams and start each team at a different station.
2. Explain that there will be three different tools at each station, each of which represents a different type of bird beak function. Each group must decide which tool would most efficiently get the food at each station by trying out each tool.
3. After 3-5 minutes, each team switches stations.

Assessment:

► Discuss beak adaptations in general. Explain that many birds, after millions and millions of generations, have evolved very specialized beaks (beaks that can eat only one certain type of food). Ask the group how specialized beaks can help some birds stay alive. (A bird with a specialized beak can often eat a type of food that no other bird can eat.) Then ask how a specialized beak might hurt a bird.
(If the bird's habitat changes and its food is no longer available, the bird might die because it can't eat anything else.) Explain that some birds, such as crows, have very versatile beaks which allow them to eat fruits, nuts, berries, dead animals, and even fish and small rodents.

Extension:

Discuss the different foods (such as seed, suet, etc in your bird feeders) found in your outdoor classroom's bird habitat, the types of birds that eat those foods, and the types of beaks those birds have.